

Comparative Analysis of Ports Practices and Activities in the Tri-City and China

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ABSTRACT: The following article presents a comparative analysis of the operation of Polish ports in the Tri-City as well as the characteristics of the most prosperous Chinese ports. The comparison of such unreasonably different size ports aims at directing Polish ports to development opportunities in order to achieve transshipment and development growth. The change in how cargo management in an area remote from the port affects the work of the city and the port itself may suggest changes in the management of the current situation.

1 INTRODUCTION

The following article presents a comparative analysis of the operation of Polish ports in the Tri-City in comparison to ports located in China. Five ports will be compared to each other: namely: Ports in Gdańsk and Gdynia with ports in Shenzhen, Hong Kong and Tianjin. The traffic generators that lead to the port areas have also been taken into account. Solutions used at Chinese ports may provide new opportunities to improve the operation of out-of-port traffic in the Tri-City. Port-related development is at the same time a development for the entire city. The introduced infrastructural and urban changes can improve the flow of vehicles on the roads while developing other modes of transport

2 THREE-CITY PORTS

2.1 *Port of Gdansk*

The largest seaport in Poland is located in the southwestern part of the Gulf of Gdansk. The Port of

Gdansk plays a large role in the national economy, about 43% of cargo traffic in seaports takes place in Gdańsk. The surface of the port is 1091.6 ha, of which 412.6 ha are water, the total length of the port infrastructure is 23.9 km. Access to the western part of the port from the A1 motorway leads through the S6 expressway, further along the national road 91 so-called. St. Adalbert. The eastern part of the port can be reached by the S7 expressway and then by the national road 89. Between the two sides of the port there is a tunnel under the Martwa Wisła. The port has an extensive network of railway infrastructure [8]. The location of the Port of Gdansk is shown in Figure 1. The port is divided into two areas:

- internal port (along the Martwa Wisła and the port channel), maximum draft 10.2 m, transshipment capacity 13.6 million t;
- external port (directly in the water areas of the Gulf of Gdańsk), maximum draft 15.0 m, transshipment capacity 85.5 million t [8].



Figure 1. Location of Port Gdansk
Source: <https://www.google.com/maps>



Figure 3. Location of Port Gdynia
Source: <https://www.google.com/maps>

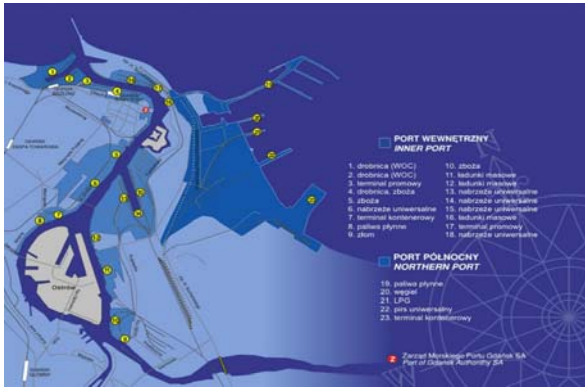


Figure 2. Map of Gdansk Port Source: <https://www.naszbaltyk.com/wszystkie-kategorie/porty-w-polsce/348-port-gdansk.html>

The port has 38 terminals and wharves, the largest of which is the DCT container terminal. In Figure 2, the locations of these terminals and wharves are indicated. Different types of cargo are transhipped at individual terminals, they can be divided into: general cargo, containers, ro-ro loads, passengers, coal, liquid fuels and other bulk cargoes. In addition, the Gdańsk Shipyard area is nearby. Thanks to the draft of up to 15 m, the port is able to serve as the only large floating vessels in Poland, which makes it unrivaled in the country. The DCT terminal is able to accept vessels containing more than 20,000 TEU [8].

To the south of the DCT container terminal was the Pomeranian Logistics Center (PCL). Currently, it is the largest logistics center in Poland. Warehouses allow you to efficiently receive loads from a nearby terminal, store them and send you deeper into the country. PCL has close connections with: the S7 expressway, then with the motorway, railway infrastructure, and Gdansk airport.

2.2 Port of Gdynia

The port in Gdynia is the third largest seaport in Poland. It covers 755.4 ha of land, including 492.6 ha of land. Gdynia Port is characterized by good conditions taking into account the location and the fact that the water in the port, even in winter, does not freeze [17]. Figure 3 shows the location of the Port of Gdynia. Due to the location of the port from the city center, its further development is difficult. The northern part of the port is used by the navy area. The only direction of development leads to the construction of port facilities on the water. There is no distribution center near the port.

In the port of 10 terminals (mainly handling container handling, but also transhipment of bulk goods (eg grain, coal), ro-ro and general cargo, additionally there is a ferry terminal and the Gdynia Shipyard area in the port area. Permissible draft in the port is 13.5 m deep [9] The road can be reached by Janka Wiśniewskiego St., which continues to Eugeniusz Kwiatkowski, then you can get to the A1 motorway using the Tricity beltway, and the railway network is also connected to the terminals, relieves the traffic of heavy goods vehicles Figure 4 shows the location of Gdynia Port terminals.



Figure 4. Map of Gdynia Port
Source: <https://www.port.gdynia.pl/pl/port/mapa-portu>

2.3 Analysis of off-port traffic generators in the area of Port of Gdansk and Port of Gdynia

The main traffic generator in the vicinity of the Port of Gdansk is the traffic of heavy goods vehicles to the port or port. A large part of the cargo must be transported deep into the country and the other way through this area. A large number of enterprises operating in the port area contribute to the increase in the number of vehicles on the road. Cars are another traffic generator. This mainly applies to employees who have to get to the workplace, but also residents who live near the port. To the south of the port is the city center which affects the traffic capacity in this part of the Port of Gdansk and prevents further expansion. The additional traffic of passenger cars, especially on the western part of the port, is caused by migration in order to visit the Westerplatte peninsula. This place is located in the furthest part north of the

port, as a result people moving in this direction have to cross the greater part of the port. An important investment connecting the eastern and western part of the port was the construction of a tunnel under the Martwa Wisła, which was put into use in 2016. The route consists of two tunnels with a total length of 1.4 km. This allowed moving heavy vehicles straight into the western part of the port. The continuous increase in the amount of cargo handled in the port means that the tunnel capacity reaches the limit [8]. The Sucharski route, located from the eastern part of the port, allows to relieve the road traffic occurring closer to the city center to a large extent. The truck traffic is managed by this section, thanks to which vehicles have access to the expressway and the A1 motorway, which are accessible (without traffic lights and congestion). The port in Gdańsk invests not only in road infrastructure, but also develops railway infrastructure in order to use this mode of transport on a larger scale. Six sidings operate actively in the port area. Thanks to the last investment, 30 km of new tracks, 5 viaducts and bridges as well as 42 new turnouts were built. As a result of railway expansion, the number of transports transported by road has decreased [8]. An additional solution that relieves the traffic directly related to the transport area is the use of transport, which connects the Naftoport terminal with the "Przyjaźń" pipeline. The advantage of this technology is an independent line infrastructure. The transport of cargo can take place irrespective of the intensity of the roads and atmospheric conditions [2]. Traffic to ports in Gdynia is generated mainly in the form of freight transported from and to the port. The location of the Port of Gdynia at the Naval Academy, the Captain's Office and the Museum of Immigration also in some way increases the traffic present on the roads. In addition, truck journeys in the city lead to the formation of congestion in the intersections of the road with the railway. Passenger terminals introduce an additional type of traffic outside the port related to the supply of a given ship before the cruise as well as the passengers themselves heading towards the port for the upcoming voyage. In 2014, works on the construction, reconstruction and modernization of roads and railway infrastructure were completed, allowing the connection of the Port of Gdynia with the national railway network. This allowed in some way to reduce the number of trucks entering and leaving the port [9]. The Gdynia port compared to the port in Gdańsk has a worse location considering the availability of the A1 motorway. Gdynia is located further north which is connected with the need to overcome the entire Tri-City area. Trucks must share beltways with other road users.

2.4 Prospects for development

Due to the growing demand for transport in the outer port and its planned expansion, the Port of Gdańsk must focus on the expansion of road and rail infrastructure in this part of the port. In order to ensure good capacity in rail traffic, PKP PLK plans to modernize, among others: North Port stations, Kaszubski Canal, Gdańsk Zaspas Towarowa station with access to the western side of the port [8]. The Maritime Office is planning to extend the accessibility of the inland road to Martwa Wisła. This investment will allow the combination of sea and inland

waterway transport. Some of the cargo, especially the mass one, will be able to be directed towards the Vistula without interfering with traffic. The ratio of such transport to the total transshipment capacity of the port is likely to be small, as the inland transport infrastructure in Poland is currently underdeveloped [8]. An important element of the improvement of the port's operation is further expansion of PCL. The warehouse complex is planned on an area of 100 ha, its location allows access to the DCT terminal in a short time, and on the other hand to the express road [8]. In addition, the Port of Gdańsk plans to implement scales for heavy goods vehicles on the area of port roads. This investment will increase road safety. The road pavement's service life will also increase, overloaded vehicles will not negatively interfere with the road surface at such a fast pace. Thanks to this, the time between the renovation of road infrastructure will be extended, which will improve the traffic of vehicles [7].

Currently TRISTAR system operates in the Tri-City, it is an intelligent traffic control system. The system has two motion control algorithms Epics for local control and Balance for area control. The additional task of the system is road monitoring and immediate response in case of congestion (signaling and calling appropriate services to the place of the event) by operators. The project is constantly developing in order to provide the best possible road capacity. The Port of Gdynia plans many investments related to the development of port infrastructure for ro-ro vessels with access to railways and roads. The solution to reduce the traffic in the vicinity of Gdyni Port is the project of construction of the Red Road leading north-west of the port and the extension of the Tri-City beltway to Chylonia. This will ease the traffic from the Kwiatkowski Estuary, where passenger traffic is now connected with the truck [9]. Fig. 5 shows the planned expansion of the route leading to the Port of Gdynia.



Figure 5. Plan to build the Red Road and extend the bypass
Source: <https://www.trojmiasto.pl/wiadomosci/Droga-Czerwona-obojetna-dla-Gdyni-n124677.html>

3 PORTS IN CHINA

3.1 Tianjin

The port of Tianjin is currently the largest port of northern China. It is located between the cities of Tianjin and Beijing [21]. Tianjin is a connection with

180 countries, offering 500 sea routes. In 2013, over 13 million TEU of containerized cargo were handled. Daily, the port leaves an average of 200 vessels [24]. It is divided into North Port, South Port, East Port and the South Zone of Harbor Economic Area. North Port and East Port are mainly focused on accepting containerized cargoes. In addition, North Port allows you to accept general cargo. South Port deals with bulk cargo, while the South Zone of the Harbor Economic Area, for example, with heavy loads or food [21]. Figure 6 shows the location of the Tianjin port.

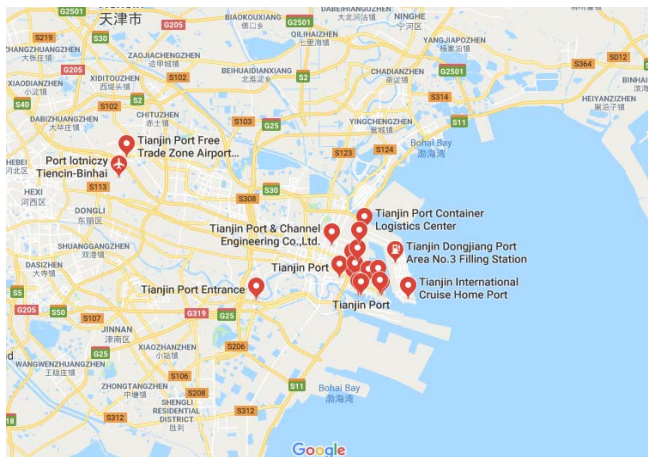


Figure 6. Location of the Port of Tianjin
Source: <https://www.google.com/maps/>

3.2 Shenzhen

The port of Shenzhen is located in Guangdong Province, located in the Pearl River Delta region (PRD), directly bordering Hong Kong. Its location is an ideal point for transporting goods between Hong Kong and mainland China. Shenzhen is a relatively young city, because it was created less than half a century ago. Between 1980-2006, the city of Shenzhen has grown by 27% each year. The city, which not long ago was a fishing village, has now become a high-level city in terms of infrastructure, high-tech technology and a dynamically developing container port. Shenzhen goes through a total of 230 international routes [11]. The Port of Shenzhen is divided into 9 separate parts offering routes on a local and international scale. In 2013, the port appeared on the podium (in 3rd place) in terms of capacity [14]. Figure 7 shows the location of the port in Shenzhen.

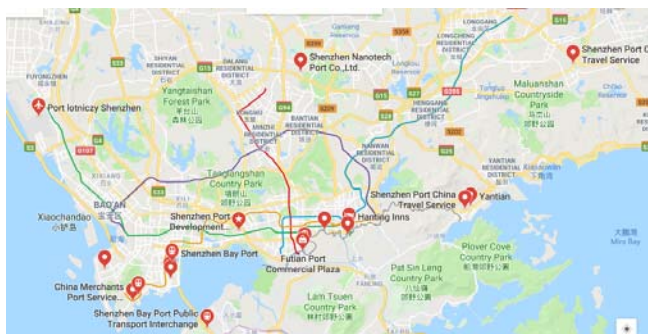


Figure 7. Location of the port in Shenzhen
Source: <https://www.google.com/maps/>

3.3 Hong Kong

In the port of Hong Kong, traffic is very frequent, it is one of the most effective ports in the world. In 2018, he served about 19.6 million TEU. The port offers approximately 310 calls a week combining Hong Kong with 450 destinations around the world. Hong Kong became a free port at the time of its transfer in 1842 to the British government. The result of this action was the opening to the international market already in the nineteenth century. Over the years, the port has developed on a global scale becoming the main port of international trade as early as 1900. At the beginning of the container age in 1960, the expansion of the port with container terminals began. Currently, the port in Hong Kong is mainly referred to as a container port, because $\frac{2}{3}$ cargo transported to the port is containerized [19]. It has 9 container terminals operated by 5 different private companies [15]. Figure 8 shows the location of the Hong Kong port.

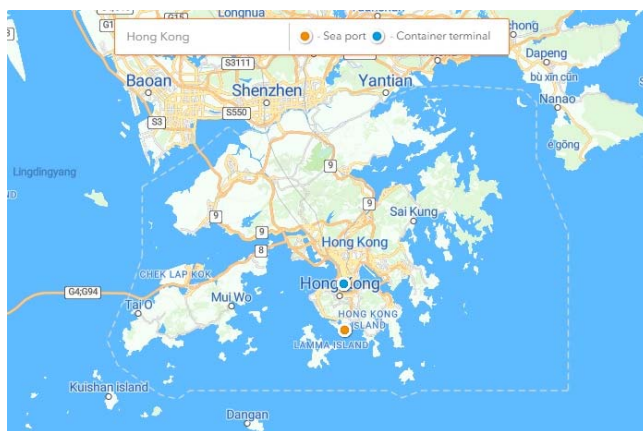


Figure 8. Location of the port of Hong Kong
Source: <https://www.searates.com/maritime/china.html>

3.4 Analysis of off-port traffic generators in the area of Chinese Ports

Many ports have found a solution to bridge off-port traffic by building so-called "dry ports". Such a dry port is a part of the port away from the coastal areas. It is connected to the port, however, using, for example, the railway network. Movement is therefore moved to other places to simultaneously reduce the congestion occurring on the road infrastructure at the port. The distance between dry ports and coastal ports is a fairly dependent issue. We distinguish dry ports of far, medium and short range. Loads destined from distant parts of the country can easily be transported directly from and to the sea port [18]. Road transport has been relieved in some way by rail transport. Loads are transported to dry ports, then they are reloaded on the railways and directly transported to coastal ports. This allows to compensate for the time lost in standing at port gates or road congestion [22]. The formation of dry ports in China has been quite popular in recent years. The first dry port was built in 2002 in Beijing-Tianjin. Most of these ports carry goods using rail transport, however, equally dry ports are supported using inland transport [23].

The port in Tianjin strongly exploits the opportunities associated with dry ports. Currently,

they have as many as 23 of them, of which 15 are operated quite successively [21]. Some of these ports are located up to 400 km from Tianjin and are connected to the port by rail and road infrastructure [12]. Fig. 9. shows the location of the dry ports of the Tianjin port. The Port of Shenzhen is connected by a system of railways and highways allowing for efficient transport of goods to the central regions of the country. The result of this connection was a thriving multimodal transport. Pingyan and Pingnam lines connect directly to the port. Both lines join the Beijing-Guangzhou and Beijing-Kowloon lines by Guangzhou-Shenzhen in the later stage, expanding the area of transport to further areas of the PRD [16].

The combination of Hong Kong and the Republic of China is an important issue considering the amount of cargo being carried. Close road connections between HK and nearby cities was a convenient way to PRD. Circular transport was used until the nineties of the previous century. The development of the Chinese economy on a large scale increased the amount of transported goods, which at the same time resulted in an increased number of cars on the roads. However, it should be noted that HK connections to the central-eastern and western parts of China are hampered by insufficient road connections. As a result, lorries heading in that direction must cross the round road (through the eastern part), increasing the duration of the journey by at least one hour. Despite the poor connection to the aforementioned part of China by land, the location in the Pearl River Delta allows you to overcome this route by sea. An alternative to trucks have become barges, which can hold from 100-150 TEU containers. This solution brings many benefits, namely reducing the amount of fuel consumed, energy and saving costs. In addition, it is a more environmentally friendly form [13].



Figure 9. Location of Tianjin dry ports along with railway lines operating for this port
Source: https://en.wikipedia.org/wiki/Port_of_Tianjin_operations_and_logistics

4 GOOD PRACTICES THAT MAY APPLY IN THE THREE-CITY PORTS

The main changes that can be used by the Tri-City ports are the construction of dry ports throughout the country. As you can see, the dry port system is the best way to level traffic around the port. Carriage of goods should be carried out mainly by the railway system and water system. Whenever possible, cargo should be transhipped on shoulders and on Vistula to dry harbors in the south of the country. The development of inland waterway transport would be the most environmentally friendly alternative transport of cargo. Dry ports away from river areas should be transhipped on the railways. The number of areas in the vicinity of the ports does not allow too extensive possibilities of reconstruction of port areas, therefore dry ports would be the best option. The introduction of dry ports would not have to be limited only within the country. The opening of a dry port at Poland's neighbors without access to the sea would allow the development of international transport. These countries would get indirect access to the sea in some way. Loads from a given country would be transported to a given dry port, transhipped to the railroad and from there directly go to Gdynia or Port of Gdansk. The best solution would be to carry loads by rail to 100 km from the destination. The number of lorries on roads would diminish dramatically, reducing congestion while unequivocally increasing road capacity. When the destination from the port is small, road transport is the only option. In this case, the construction of further tunnels under the Martwa Wisła would be the most effective.

In Fig. 10. The cargo turnover of the selected ports was compared in 2016.

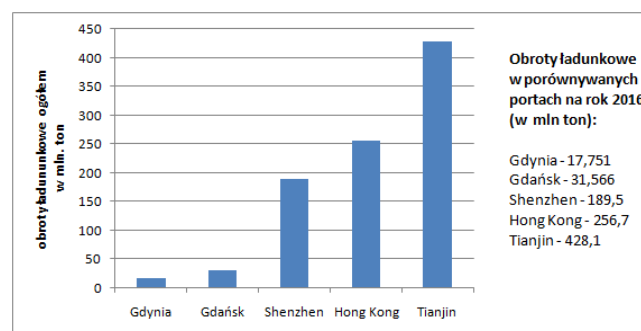


Figure 10. Cargo Turnover per port in the 2016 year
Source: Own development on the basis of GUS, 2018

5 CONCLUSIONS

Due to the constantly growing volume of cargo passing through the ports in Gdansk and Gdynia, one should constantly invest in the development of port and port infrastructure. It is essential that the flow of cargo works efficiently and does not cause downtime. In the case of insufficient capacity, the transport costs will increase and transport losses will occur. In the Tri-City ports over the last few years, investments have been implemented to improve traffic in their vicinity. In the meantime, when current port needs

are planned, you must think about future plans at the same time.

It should be taken into account that the expansion, construction or other infrastructural and modernization changes will be associated with some kind of communication difficulties during the given investment. Therefore, it is worth doing them in order, for example, the development of inland waterway transport would lead to a reduction in the amount of goods going to trucks. Some of these loads can be transported by rail at the same time. When the amount of trucks is removed, you can start working on the roads. The issue of good planning can allow for maximum compensation of damages related to road works. A holistic view on transport and the city as well as its traffic generators can facilitate decision making by the superior service as well as local and international companies associated with maritime transport.

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