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Container terminals and port city interface – a study of Gdynia and Gdańsk ports

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Abstract

The development of international trade, supply chains and transport increases the turnover of container terminals. Changes in the port environment and the functions of terminals have created a demand for logistics solutions and value-added services. On the other hand, these changes have also influenced the port - city interface.

The purpose of this paper is to present the activity of container terminals and examine how the growing turnover of container units has affected the port cities. The interaction between the latter and port terminals has been discussed. The research is based on the terminals located in Polish port cities of Gdynia and Gdańsk, which play a leading role in the development of the economy in the region.

The research has shown that maritime networks have an ever-growing influence on ports and port – city relationships. On the one hand, the growth of maritime logistic services has a positive influence on the labor market and transport infrastructure, which is also used by the inhabitants. On the other hand, the increase in container cargo volume has a negative impact on urban areas through a number of negative externalities (congestion, noise, pollutant emissions, etc.). This creates a conflict in which the city has to bear the external effects of the port operations. In this context, solutions incorporating the sustainable development of both port and urban areas are essential.

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Keywords: port–city; container terminals; interface

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1. Introduction

Ports and cities have expanded in a close relationship – many large metropolises in the world have developed in coastal areas. Sea ports initiated the growth of many cities which became links between maritime and land transport. The strong interrelationship of port and urban development can also be observed over the last few decades (Merk, 2013).

There have been significant changes over the last 30 years to the interdependence of ports and cities. The relationships between them have been influenced by many factors such as changes in the world transport system, development of container shipping, development of global supply chains and the increasing demand for logistics services. Hall and Jacobs state that seaports have become strategic operational nodes in global trade routes and shipping networks (Hall & Jacobs, 2012).

The functions of seaports – traditionally considered as transport nodes with services involving only transport, loading, discharging and storage – have altered. The ports have become logistic centers with specialized activities and services. Container terminals are primarily capable to perform the functions of logistic platforms.

The purpose of this paper is to present the activity of container terminals and to examine how the growing turnover of container units has affected the port cities. The interaction between the latter and port terminals will be discussed. The research is based on the terminals located in Polish port cities of Gdynia and Gdańsk, which play a leading role in the development of the economy in the region.

2. Port – city interdependence, literature review

Port development has been analyzed by numerous researchers and there are multiple studies on the relationship between a port and a city. Ducruet states that maritime networks have had a significant influence on port and city interface for last three decades. He mentions the container revolution and new spatial distribution of industrial activities as the major factors in the port – city relationship (Ducruet, 2007).

Merk emphasizes that the link between port and city growth has become weaker due to changes in the environment (Merk, 2013). Hall and Jacobs imply that most of the world's important ports are still urban (Hall and Jacobs, 2012). The mutual interdependence is vital to the growth of both ports and cities. However, the authors state that the relationship has been disrupted due to containerization, one of the main factors influencing the process of disconnection between ports and cities. In economic terms, Jacobs et al. stresses that ports have become less important in the urban labor market due to the increased automation and operational rationalization and that cities have become less dependent on terminals for local economic growth (Jacobs et al. 2010). The status of main European container ports is presented in Table 1.

Table 1. Selected European port cities with container traffic in 2013

Port	Type	Containers in TEUs (million)	Population (million)
Rotterdam	urban/transshipment	10.93	2.6
Hamburg	urban/transshipment	9.3	1.73
Antwerp	urban/transshipment	8.2	0.5
Bremerhaven/Bremen	transshipment	5.8	0.5
Le Havre	non-urban/transshipment	2.29	0.17
Algeciras	non-urban/transshipment	4.3	0.3
Felixstowe	non-urban	3.4	0.03
Barcelona	urban	1.69	1.6
Gothenburg	urban	0.86	0.49
St. Petersburg	urban	2.5	4.99
Gdansk	urban	1.18	0.46

Source: own elaboration based on Eurostat data

Port cities are classified according to various criteria such as land area, population or traffic volumes. Ducruet proposes a classification matrix of port – city relationships based on the criteria of city size (area) and port traffic (see Figure 1).

Relying on the intuitive metrics dependent on port traffic and city size, the author classifies them from coastal port towns to world port cities (Ducruet, 2007). World port cities are large cities with large ports, like New York, Hong Kong and Singapore. In those metropolises, urban and port functions are comparable with respect to size. In some coastal metropolises the port function is smaller than urban one, e.g. Stockholm, Helsinki, and Copenhagen in the Baltic Sea region. In the case of so-called major port cities such as Rotterdam or Le Havre, the port size is relatively larger than the city size (Merk, 2013). Container terminals that exist in ports have affected the host cities with regard to the spatial development, transport infrastructure, employment and negative externalities.

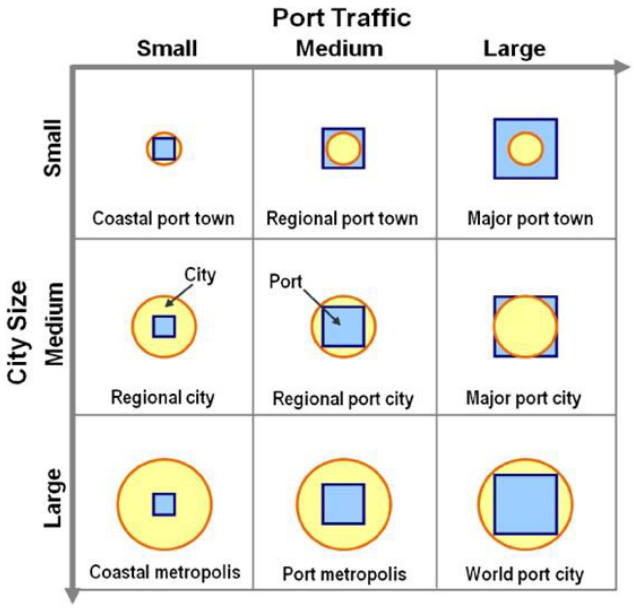

Fig. 1. Classification of port cities
Source : Ducruet and Lee (2006), Merk (2013)

Port and cities affect each other in manifold ways. Merk states that ports have various effects on cities and towns. Some impacts are positive, but some can be considered negative (Merk 2013). Positive effects are primarily related to economic benefits. Ports, particularly container terminals, play a crucial role in global supply chains and influence the costs of transport and time of delivery. Port efficiency is one of the main determinants of international transport costs (Wilmsmeier et al. 2006). Value added created by ports and port-related industries is another economic benefit. For example, the value added of the port cluster in Rotterdam in 2007 amounted to 10% of the regional GDP, while the port cluster of Le Havre/Rouen contributed approximately 21% of the regional GDP (Merk 2013). It is estimated that containerized cargo generates value added between 40 and 149 USD per metric ton.

It should be underlined that port cities benefit to a large extent from the economic impacts of the ports. Most of the direct port-related value added is still created in port cities. Port cities also benefit from the effects of clustering industries in the port area and the possible economies of scale and knowledge transfer related to it (Merk, 2013).

The negative impact on cities is a product of a number of factors. The first determinant concerns the environment and includes ports' influence on air emissions, water quality, soil, waste, biodiversity, and noise. It should be emphasized there are conflicts in the social goals related to clean environment and the life quality of the inhabitants of port cities (Merk, 2013). The port activities and the container terminal generate external costs related to pollution,

congestion and noise. The location of terminals for containers and other units often contributes to the urban congestion caused by the traffic to and from the port area. Road transportation has a large share in the container transport between the port and the hinterland, substantially contributing to road traffic in the urban area and often causing congestion.

Land use of port activities is also considered an important negative impact. Port territories occupy a relatively large share of the metropolitan land surface in port cities such as Antwerp, Rotterdam, Hamburg and many other ports with container terminals.

Research on port cities integration is often based on direct and indirect effects. Ferrari implies that in general four different types of impact are distinguished: direct, indirect, induced and catalytic. Direct impacts are jobs and income generated by the construction and operation of the port. Indirect impacts are the employment and impact created by the suppliers of goods and services. The induced impact is connected with the employment and income generated by spending the incomes earned by those employed as a result of the direct and indirect effects. Catalytic impact is generated by the port as an accelerator of productivity growth and attractor of new enterprises (Ferrari et al. 2010).

Port industries require local employment, but its level is relatively marginal in comparison to the wider regional economy in which ports operate. Even in the largest ports the employment rarely exceeds a few thousand jobs. Several trends, including containerization, automation and economies of scale, have made port operation and cargo handling increasingly capital- and land-intensive and decreasingly labor-intensive. Over the last decades, many ports have shed labor in order to become more productive and competitive (Merk, 2013).

3. Port city models

One of the first and well-known models related to the influence of the changes in shipping on the spatial development of port and cities is the Anyport Model developed by Bird. The model shows how ports located near the city centers have evolved into specialized terminals spatially distant from the cities and old port locations (Rodrigue et al., 2006). Bird's model presents five stages of port facilities development.

The first step (setting) is presented as the initial setting of a port based on geographical determinants. Port were located adjacent to city/town centers. The main port activities were warehousing, loading, discharging and wholesaling. The second stage (expansion) in port development was determined by the Industrial Revolution. This stage comprised two steps. Port facilities expanded, e.g. quays and the port superstructure were adjusted to handle growing cargo volumes and larger ships. Furthermore, development of railway connections improved access to a wider hinterland. Port activities also included industrial activities (Rodrigue et al., 2006). Most of the new functions were located downstream. The third stage (specialization), with two steps, changed the spatial structure of sea ports. Specialized terminals dedicated to different cargoes were constructed, e.g. to handle freight such as containers. The increase in ship size required greater water depth of harbors. The activities moved further away from the cities and closer to the outskirts. The old settings were often repurposed in the process of gentrification as waterfront parks, commercial and housing districts (Rodrigue et al., 2006).

The Anyport Model was extended by Notteboom and Rodrigue (Notteboom & Rodrigue, 2005). The authors proposed the next phase in the development of port cities – regionalization – and argued that the Bird model does not explain the growth of seaport terminals serving as transshipment nodes in the hub-and-spoke model and that it also does not account for the inland connections. Since the '90s, the large growth in containerized flows has created the need for effective land transportation. In the regionalization phase intermodal transport corridors and inland terminals are incorporated into a port system (Rodrigue & Notteboom 2011; Notteboom & Rodrigue, 2009). Port development at the regionalization stage is mainly caused by two factors. The first one concerns the globalization process influencing the shipping sector (Rodrigue & Notteboom 2010). The ports have become primary nodes in the global supply chains. In this context, hinterland accessibility is regarded as one of the most important factors for the competitiveness of container ports (Van der Horst & De Langen, 2008). The next factor in port regionalization concerns the constraints and negative externalities impacting the urban areas (Rodrigue & Notteboom 2010).

Another example of modelling port - city connections is the port – city interface model. Hayuth, one of the first authors who described the model, points out that many ports and cities developed on the basis of mutual benefits. Ports were located in urban areas, but expanding cities and port facilities caused the latter to move downstream where space for bigger terminals was available (Hayuth 1982).

A similar study was conducted by Hoyle who argues that coastal cities and ports do not need to be geographically connected. In the last decades, port activities have become separated from city functions. Geographically and economically, ports and host cities have been growing apart (Hoyle, 1989). Hoyle states that the evolution of maritime industry, changes in port functions, decline in employment related to port operations have influenced the close relations of ports and cities.

The model created by Hall and Jacobs is based on Bird's Anyport Model and port city models based on Central Place Theory. The model is based on four relations between port and city development (Hall & Jacobs, 2012):

- Port has a positive impact on the city – more port activity leads to more urban activity
- City has a positive impact on the port – growing cities attract cargo for their ports
- Port has a negative impact on the city – port activity externalities displace other urban activities
- City has a negative impact on the port – urban growth displaces port activity

The first relationship assumes that the increase of port activity creates demand for employment, increases tax revenue and economic activity. The positive effect concerns not only the local enterprises connected with handling of cargo or passenger services but also entrepreneurs, e.g. producers, who settle in port areas. The second positive interdependence is based on the assumption that rise of urban activity, e.g. growth of transport infrastructure or industrial activity, will have an effect on growing cargo flows (Hall & Jacobs, 2012).

The negative influence of growing port activity is the third possible relationship. In this case externalities such as pollution and congestion as well as imported commodities may lead to relocation of urban activity and displacement of local activity. The last relationship illustrates the case when the growths of urban environment and industry relocate port activities from traditional urban core location (Hall & Jacobs, 2012).

4. Characteristics of containers terminals in the Tri-City

There are four container terminals located on the Gulf of Gdańsk – two in the port of Gdańsk and two in the port of Gdynia.

Baltic Container Terminal (BCT) is the oldest Polish terminal specialized in container handling and has been in operation since 1979. It is one of the largest in the Baltic Sea region in terms of handling capacity. It is located in the western part of the port of Gdynia, at the Helskie Quay. The second one, Gdynia Container Terminal (GCT), owned by Hutchison Port Holdings (HPH), started its operation in 2005 at the Bulgarskie Quay, just opposite the BCT.

BCT and GCT terminals connect Gdynia with the port hubs of Western Europe such as Hamburg, Bremerhaven and Rotterdam as well as a few Baltic ports, e.g. St. Petersburg, Klajpeda, Kotka. They serve primarily feeder connections and short sea links, hence majority of containers are transported directly to/from the hinterland. Both terminals are well connected with the hinterland by rail and road transport. Both terminals are connected with the Tri-City ring road and the A1 motorway via Kwiatkowskiego Street. The terminals are situated in the central part of the City of Gdynia, so road cargo traffic shares the city infrastructure with the city inhabitants.

At the moment, the largest terminal in the region is located in Gdańsk's Outer Port. Deepwater Container Terminal (DCT) received its first vessel on the 1st June 2007. Since January 2010, DCT Gdańsk started to serve the first direct ocean connection with the Far East operated by Maersk Line within AE- 10 service. This direct link with Asia established DCT as a key Baltic Sea hub. In August 2015, the second ocean link with Asia was launched by Alliance G-6. DCT is also connected by feeder services with Finnish ports and St. Petersburg. The port is located downstream and has a good road connection via Sucharskiego Street with the southern ring road and the A1 motorway, thereby allowing to avoid the inner city roads.

The last one is Gdańsk Container Terminal (GTK), situated inside the old estuary of the Vistula river in the Inner Port. It has been operating at the Port of Gdańsk since 1998. The terminal offers feeder services to Rotterdam, Hamburg and Bremerhaven. The connection with the hinterland is hindered by the need to pass through the center of the city.

Table 2. The container turnover in ports of Gdynia and Gdańsk (2008-2009)

Terminal	2008	2009	2010	2011	2012	2013	2014
BCT	440 591	226 764	281 142	361 856	408 722	394 478	475 275
GCT	167 502	149 273	199 101	246 382	263 586	333 657	370 558
DCT	106 469	162 253	451 730	634 871	896 962	1 150 887	1 188 380
GTK	77 889	74 809	62 309	43 057	31 729	26 392	22 952

Source: own elaboration based on data (Namiary.. 2015)

Deepwater Container Terminal has shown a considerable growth in container handling. Operating as a hub, iy handles a considerable number of units in transshipment. In 2010, containers transshipped to Russia and Finland accounted for 44% of the total container transport volume, and in 2012 the number dropped to 37%. Due to unavailability of later data it is not possible to accurately report the current share of transshipment; however, the declining trend is highly probable to continue due to a decline in the Russian market. The importance of GTK terminal is marginal, considering the location and competitiveness of other terminals.

Terminals operating in Gdynia are strongly influenced by their location. Due to being situated in the heart of the city, they suffer from a lack of territory, which inhibits their further growth.

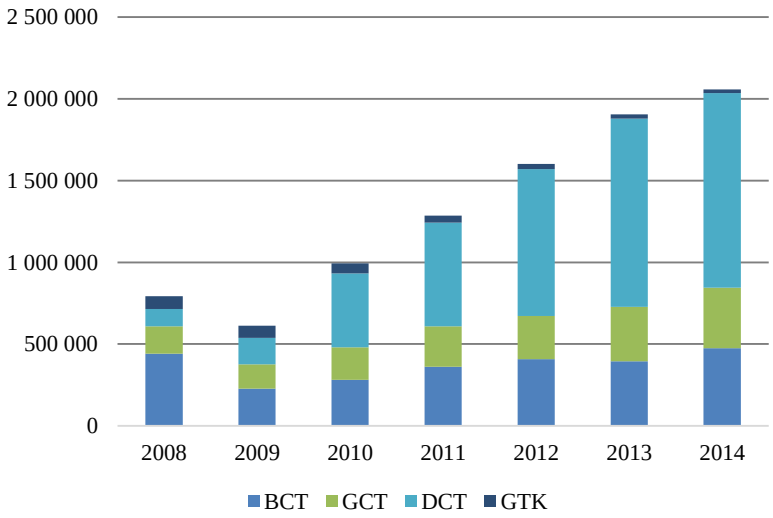

Fig. 2. Container terminals turnover in 2008-2014 (TEU)
Source: based on data from (Namiary…, 2015)

5. Interface between container terminals – the cities of Gdynia and Gdańsk

The starting point of the analysis was an assessment of the level of development of the region (Pomeranian Voivodeship) against the socio-economic development of Poland. In most cases, the region exhibits the average national results. Examples include the size of the population (5.9% of the country), participation in GDP (5.5%), or foreign trade generation (6.4%) (Matczak, 2011).

The latter indicates the strong position of the Tri-City ports, particularly in the handling of containerized cargo, where their share in the Baltic market reached 13.1% in 2010 and 20.1% in 2014 (Baltic Container, 2014).

The structure of activities related to maritime industries influencing the port and its socio-economic environment is as follows:

- Ports – loading, discharging, warehousing, handling of cargo, port authority activity
- Direct environment – activity of firms serving the maritime transport e.g. forwarding, maritime agencies, customs agencies, ships brokerage, maritime education
- Indirect environment – manufacturing and repairing of ships, industry serving the maritime transport, maritime tourism, inland transport

In all of the above layers, the first issue to be discussed is the labor market associated with seaports and their environment.

According to the accessible data, employment exclusively in ports amounted to 4482 persons in 2010, while in 2014 it decreased to 3872 workers (Maritime, 2015). The number of employees in Polish ports has been steadily declining, to a large extent due to the automation of processes and unification of handling technology as well as workforce optimization at port terminals. The tendency is primarily visible at container terminals. For example, the number of employees at BCT dropped to about 300 and at GCT to less than 250 persons. On the other hand, the development of logistic activities in the terminals and cities, arising from the container turnover, creates the need for both manpower and specialist workforce in direct and indirect port environments, e.g. forwarding, agencies, haulage and rail transport, education. Container terminals may be therefore recognized as a creator of labor market for companies cooperating with sea ports or supporting them. The structure of maritime sector employment is presented in Figure 3.

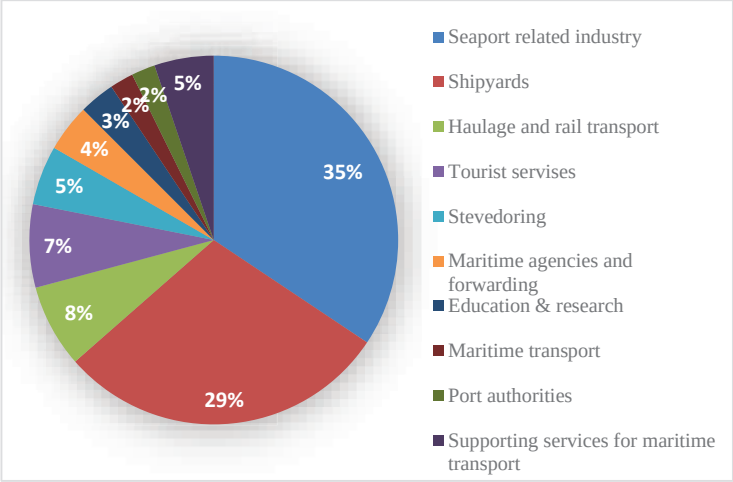

Fig. 3. Structure of the maritime sector employment in 2013-14
Source: own elaboration based on (Maritime Economy…, 2015)

The high increase in the number of companies cooperating with the ports has been observed in the recent years, primarily in the sector of small and medium companies e.g. forwarding agencies, intermodal operators, haulers and customs agencies. (Figure 4)

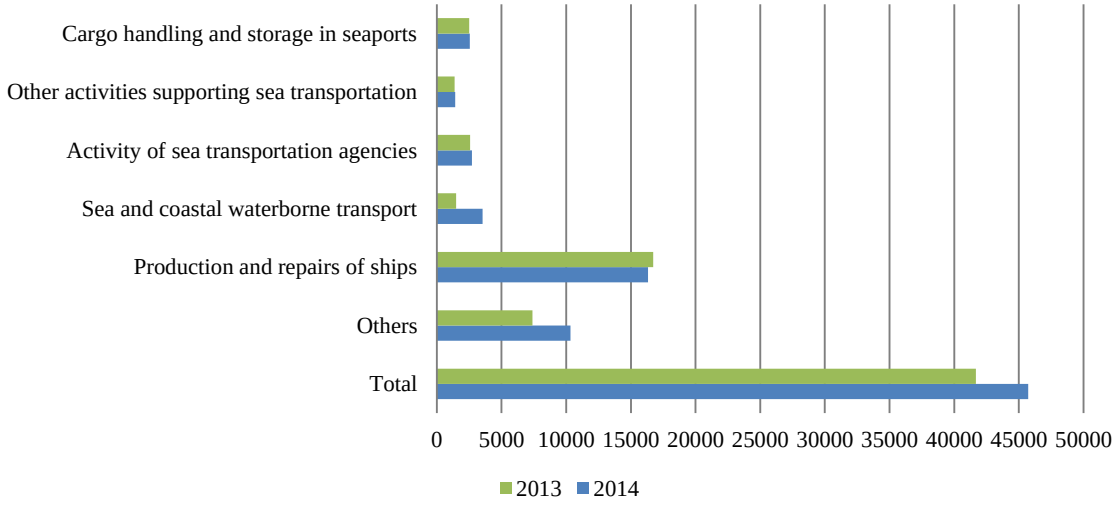

Fig. 4. The number of employees in maritime sector in Pomorskie Voivodeship in 2013-2014
Source: own elaboration based on (Maritime Economy…, 2015)

The next issue related to the port – city relationship is the added value creation. In 2010, sea ports generated PLN 489.9 million in gross value added and PLN 399.2 million in GDP. It means that their share in generating value in the region accounted respectively for 0.76% and 0.54% (Matczak, 2011). However, taking into account the ports in a broader sense and their economic environment, this share increases to 15.66% and 14.92%, making the ports an important factor of economic development of the region. (Fig. 5)

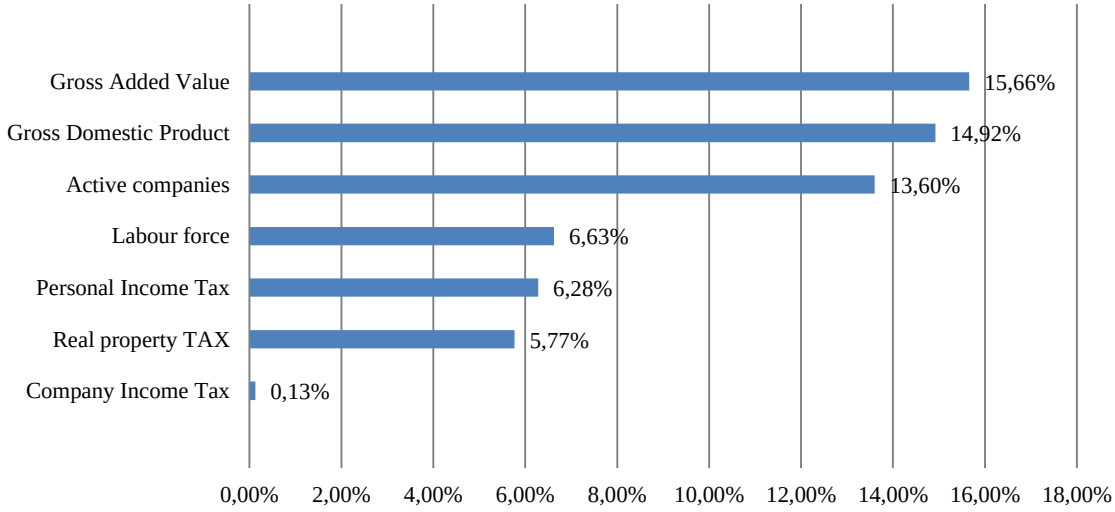

Fig. 5. The place of the maritime industry in Gdańsk and Gdynia development process
Source : own elaboration based on (Matczak, 2011)

Considering the ports' impact on the regional development, the influence of port activities on natural environment must not be overlooked. According to the accessible data and taking into account the modal split of connections with

the hinterland, the ports of the region generate external costs of a total of EUR 70.1 million per year, where the ports of Gdańsk and Gdynia accounted for, respectively, EUR 23.5 million and 46.7 million in 2010 (Matczak, 2011). Since the hinterland connections mostly rely on road transport, the external costs are very high. It has been counted that in 2014 on average nearly 600 trucks in export and 460 in import passed the gate of BCT daily. In GCT the numbers, according to the terminal's data, were about 20% lower. Haulage of units has become a large problem for the municipalities and port authorities. It exacerbates urban congestion and air pollution as well as contributes to traffic accidents, especially on the Kwiatkowskiego Street and the ring road.

Since a complete elimination of external costs is impossible, the terminal operators and port authorities should make efforts to minimize the negative impact on the environment, while maintaining an appropriate level of efficiency and quality of service. During the last 3–4 years a visible growth of intermodal transport has been observed and the share of rail connections with the ports has been increasing. For example, in Gdynia it is now estimated at 34–35%, hence the external costs generated by the port of Gdynia are estimated to decrease.

Port-related external costs are also generated by ships' emissions resulting from fuel consumption during in-port operation. However, the recent and forthcoming environmental regulations on shipping aimed at reduction of the sulfur and nitrogen oxides content in ships' exhausts are quite likely to minimize this external cost of sea port activity.

Generally, the recent research has proven that the environmental performance of Polish ports has improved significantly (Klopott, 2013). The air and water quality is monitored systematically, as are bottom sediment contamination and noise emission. The latter, however, still constitutes an unsolved problem in Gdynia, as the permissible values of noise emission are exceeded due to loading/unloading operations in container terminals. The port has invested in the modernization of terminal equipment and new noise-absorbing tracks for gantry cranes have been fitted, but the problem still exists.

6. Conclusions

The ports of Gdańsk and Gdynia can be classified, according to Ducret's proposal, as regional port cities. Both the size of the cities and container traffic fulfil the assumptions of this model. The container terminals located in both ports have developed dynamically (except GTK, whose role is marginal) and thus the importance of these ports has risen, especially within the Baltic region. Notwithstanding the opinion on the weakening relationships between ports and cities, we can still observe that Polish container terminals and ports contribute significantly to the regional development.

Despite of the decrease in employment at all the terminals, the demand for employees in industries cooperating with and supporting the terminals is growing. Moreover, port and maritime industries generate a significant amount of added value.

The port (terminal) and city relationship depends on the type of terminal and the share of units in transshipment. DCT has the weakest influence on the city, as the share of transshipment is very high. Terminals located in Gdynia, where the port is closely linked with the urban area both geographically and socio-economically, reveal the strongest influence on the port city, both positive and negative.

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