# Development of dry ports in Europe

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**Abstract:** Many German dry ports have already been successfully established and positioned in the past; however, several questions may arise. Can they keep pace with latest standards? Can they maintain their strong capabilities or are there locations in Europe, of whose achievements German dry ports can still 'learn'? What impulses come in turn from the German dry ports? The aim of this study was to illustrate the international logistics landscape and furthermore to give recommendations for the successful development of macro logistics concepts in Europe. The European ranking of 2015 is based in terms of its methodology on the scientific assessments of the authors. Therefore, it is evident that the results for example with use of a different weighting of the 40 evaluation criteria can certainly lead to different ranking results. In comparison to the first European Ranking 2010, there is no change among the TOP 3 in the ranking 2015.

**Keywords:** logistics services; dry port; macro logistics concept; hinterland; intermodal terminal; Europe.

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## 1 Introduction

Current trends in maritime logistics often consider the presence of inland freight terminals where consolidation of goods, custom services, information processing activities, short-term storage and value-added manufacturing services for the containerised goods take place before shipment toward the next destinations (Crainic

et al., 2015). An increase in sea freight flows generates an almost proportional increase in inland freight flows, and what takes place inland will influence the ability of intermodal transport systems to further accommodate the growth of international trade. This could be facilitated by dry ports, which have been developed to support seaport operations as well as the overall operations of intermodal transport systems (Hanaoka and Regmi, 2011; Rodrigue and Notteboom, 2012; Bask et al., 2014). The development of intermodal transport requires transport links, nodes, and services. The development of dry ports, an important component of intermodal transport, could play a major role in promoting intermodal transport (Hanaoka and Regmi, 2011). With the increase of containerised traffic, container terminals have started to develop in new locations in the hinterland of seaports (Korovyakovsky and Panova, 2011). Development of dry ports reduces customs costs, improves rail-sea intermodal capacity, and minimises transportation time (Ng and Cetin, 2012; Wang et al., 2016).

Now the port's potential hinterland can be defined as the area that can be reached at a cheaper cost or shorter time than from another port. As a result, hinterlands overlap. Therefore ports and carriage providers compete to service locations in these overlapping segments. With the advent of inland terminals, inland ports and dry ports, hinterlands are now extended even further inland, adding to the complexity of the analysis of port economics and logistics activities (Lee et al., 2008; Roso et al., 2009; Wilmsmeier et al., 2011). The management and expansion of the port hinterland is at the core of ensuring the competitiveness of modern ports (Shi and Li, 2016).

At the same time, port enterprises are paying more and more attention to the construction of dry ports (Li and Jiang, 2014). In addition to reduce the port's spatial and environmental pressure and to lessen the congestion of highway transport, the main purpose of a dry port is to extend the port hinterland by improving the facilities of the inland distribution centre, which closely integrate the maritime and inland freight depots (Shi and Li, 2016).

However, despite the emerging popularity of the dry port concept, very little research has been done on the assessment of development of dry ports in European countries. The goal of this paper is to support the transfer of positive effects on national and European level that are generated by dry ports on local and regional levels. The response to the first European ranking (2010), initiated by the Deutsche GVZ-Gesellschaft mbH (DGG), already showed the enormous interest of many dry port actors to get insights and information concerning market positioning and strategies of individual dry ports in Europe. Regarding the assessment of development of the dry ports in Germany and Europe, DGG conducts regularly extensive data collections. The collected data allows a profound overview of the status quo of the investigated dry ports (national or international) and allows the creation of a ranking to identify for example best practices.

## 2 Review of literature

### *2.1 Locational characteristics of dry ports as a driving force for the development of local and regional economies*

One of the imperative issues of dry port development in developing economies is location planning. While the minimisation of set up costs and total logistics costs are key factors in dry port location analysis, there are also other more qualitative location factors driven

by multiple stakeholders involved like operators, users and the community (Notteboom and Rodrigue, 2009; Nguyen and Notteboom, 2016). As a rule, the dry ports are located along the developed transport corridors (Panova and Hilmola, 2015). Dry port location planning requires a thorough decision making process as it is too costly to relocate the facility in the short term. Many models used for facility location attach a substantial role to transport costs in view of finding the optimal location (Nguyen and Notteboom, 2016). Usually located at strategic places near gateway seaports, industrial areas or along major transportation axes, dry port plays significant roles in optimising all activities to ensure cargoes can be delivered from one end to another in an efficient manner (Juhel, 1999). Furthermore, as proposed by (Azcárate, 2007), in the design of a methodology for location of an unwanted plant, a series of steps are carried out:

1 Exclusion phase: define a set of exclusion criteria.

2 Definition phase: the definition of a set of factors that allow us to measure the adequacy of the different places that have passed the previous restriction criteria.

3 Selecting assessment phase.

The results (Awad-Núñez et al., 2014) give greater importance to the aspects considered in the classical theories of industrial location. However, setting the most appropriate location to place a dry port is a geographical multidisciplinary problem with significant economic, social and environmental implications. Conventional notions of port choice have focused on geographical location as one of the main determinants of a port's attractiveness. The choice of a port is not merely a function of proximate convenience but derives considerable implications as well from the overall transit costs of cargo trafficking. For example, the distance between the port and the port user's premises has a major impact on inland transportation costs (Tiwari et al., 2003). In their surveys, (Willingdale, 1984, Murphy et al., 1991) found that the location factor had a relatively low ranking, yet they cited other studies, which have demonstrated that this is in fact a primary factor. One explanation they have given was that significant improvements in domestic transportation system appeared to have lessened the importance of close geographical proximity between ports and their customers in port choice decisions. Onut et al. (2011) reported that the main performance criteria of the port include geographic location and physical characteristics. Tovar and Rodríguez (2015) results show that use of a combination of cost frontier and cluster methods to define robust port typology and SOMs, jointly or in isolation, offers useful information to the decision-makers.

The Economic and Social Commission for Asia and the Pacific (ESCAP) has recognised the importance of dry port locations and suggests that the following criteria be considered when deciding upon a location:

a inland capitals, provincial/state capitals

b existing and potential industrial and agriculture centres

c major intersections of railways, highways, and inland waterways

d intersections along trunk railways lines, major highways, inland waterways, and at airports (Hanaoka and Regmi, 2011).

Chang et al. (2015) suggest a cost-minimisation linear programming solution is proposed, with the aid of a genetic algorithm, to choose the optimal location as well as capacity level among the candidate inland cities.

However, while a number of research works investigating the locational characteristics and spatial dynamics of dry ports in Western, advanced economies exist (Rutten, 1998; Hesse, 2004; Hesse and Rodrigue, 2004; Roso, 2005; Rahimi et al., 2008; Notteboom and Rodrigue, 2009; Roso et al., 2009).

As far as investing in port assets is concerned, there are two ways, almost in contrast with one another, of regarding the port: The port may be considered a public service that is generally useful to the economy, justifying the tax system being utilised for the purpose of funding the investments required. The port may be considered a business system that operates within a highly competitive market and requires investment projects to be selected with efficiency. The line drawn between these two functions changes depending on the country, environment, business, social and political culture, and period and political trends (Musso et al., 2006).

The role of port as a driving force of the development of local and regional economies, both in developing (Omiunu, 1989), and developed countries (Witherick, 1981) is widely accepted by many scholars (Hilling, 2005; Ducruet, 2009). A large number of studies has shown that port activities (transportation, handling, storage, treatment and distribution) make ports of crucial importance for the development of regions where they are located (Deng et al., 2013) providing comparative advantages to them in terms of trade. However, several researches and studies which are carried out over time, place under contestation the local and regional benefits of ports (Gripaios and Gripaios, 1995) and their transport infrastructure, mainly for harbors sited away from economic regions (Malchow and Kanafani, 2004). Notteboom and Rodrigue (2005) in their research note the increasing regionalisation of ports and the gradual transfer of distribution centres towards the interior of the hinterland.

More particularly, the port function contributes to increased business activity, which is specialised in the shipping and transport services, while enhancing the business activity associated indirectly with this (banks, insurance companies, tourist agencies) (de Langen, 2004) and giving the opportunity to relevant stakeholders to invest (Dooms et al., 2015). Thus, dry ports in accordance with the above are catalysts of economic growth and employment creation (Jung, 2011) favouring the globalisation process.

## *2.2 Development of dry port concept*

The dry port concept is based on moving of intermodal terminals further to hinterland from the port areas. It helps to avoid traffic bottlenecks, to connect cargo handling from the port with other types of cargo at one common transport centre and it can help develop the hinterland areas (Jaržemskis and Vasiliauskas, 2007). Dry ports in the original discussion were generally developed from the landside towards the sea, a requirement emerging from being landlocked or otherwise suffering from poor maritime access (Wilmsmeier et al., 2011). It was noted in the literature review that early dry port definitions referred to landlocked (or poorly-connected) countries using the terminal as a maritime access point. Since then, the term has been used in various ways, but without clear definition (Monios, 2011).

In many places around the world bimodal and trimodal terminal facilities in the hinterland have become an intrinsic part of the transport system, particularly in regions having a high reliance on trade (Rodrigue and Notteboom, 2012). These nodes in the hinterland networks of seaports have been referred to as dry ports, inland terminals, inland ports, inland hubs, inland logistics centres, inland dry ports, inland clearance depots, inland container depots, intermodal freight centres and inland freight terminals (Cardebring and Warnecke, 1995; Wiegmans et al., 1999; Roso, 2005; Jaržemskis and Vasiliauskas, 2007; Notteboom and Rodrigue, 2009; Roso et al., 2009). Thus, there seems to be no consensus on the terminology used.

A recent academic definition of dry ports contends that for a fully developed dry port concept the seaport or shipping companies control the rail operations (Roso et al., 2009). Furthermore, the authors contend that dry ports are used much more consciously than inland terminals (Roso et al., 2009). Dry port, just as its name implies, is a concept we can contrast with water port. This term originated from Western countries in the twentieth century. The Council of Europe defined dry port as: a landlocked station which is connected to the seaport directly and geographically (Zhu, 2009). A dry port is a logistics node which improves cost-efficiency, environmental performance and the quality of hinterland network connections (Woxenius and Bergqvist, 2009; Cullinane and Wilmsmeier, 2011). This definition has been redefined as an extended container terminal gate (Törnquist and Gustafsson, 2004). Therefore this definition actually contradicts the original definition of a dry port, as it is driven from the seaward side. More recently, the term ‘dry port’ has been used in the industry as a marketing tool, perhaps to imply that an inland facility has reached a particular level of sophistication in terms of services offered, such as customs or the presence of third party logistics (3PL) firms within the site and/or an adjoining dry port or similar (see also GVZ in Germany, ZAL in Spain, interporti in Italy) (Wilmsmeier et al., 2011). But in Germany, dry port is usually referred to as inland cargo village. Dry ports, as nodes in transport networks, have been developed, among other reasons, to support seaport operations and the sustainable development of international intermodal transport chains, or links (Hanaoka and Regmi, 2011; Roso, 2013). Dry ports could make goods handling more efficient, and shifting freight volumes from road to rail (between port and dry port) could result in a lower environmental impact. In line with this, (Roso, 2013) claim that the construction of dry ports near strategic urban locations can help reduce the number of freight trips.

## 3 Methodology

The following elaboration outlines the results of the ranking in 2015. As part of the data collection in 2015 the DGG identified dry ports in 32 European countries. The ranking of the dry ports in 2015, as an outcome of the collected data, illustrates which dry ports in Europe could gain a very good performance due to a particularly successful development. As a basis of the creation of the current questionnaire, the questionnaire of the first European ranking 2010 conducted by the DGG, was used.

### *3.1 Benchmarking partners and criteria*

Firstly, base of the study were considerations which logistics locations might be involved in the study. The main issue was here to verify the ‘transferability’ and so the use in the

European context of the definition of the 'Bund-Länder-Grundsätze' of dry ports which was largely shaped by the DGG. A dry port is a building area where traffic commercial, logistics service providers, complementary service facilities and logistical industrial and commercial enterprises settle down as independent companies. A dry port is linked to several, but at least two transportation modes. A spatial split into functionally structured subareas is permitted. Due to the different forms of approaches in the various European countries, a direct transfer of the German definition is not possible. In order to achieve a high number of potential dry ports and to realise the widest possible analysis of national development levels, a broad interpretation was firstly selected, for that reason, also the 'dry port approach' was taken into consideration: based on (Roso, 2006).

A dry port is an inland intermodal terminal directly connected by road or rail to a seaport and operating as a centre for the trans shipment of sea cargo to inland destinations. In addition to their role in cargo trans shipment, dry ports may also include facilities for storage and consolidation of goods, maintenance for road or rail cargo carriers and customs clearance services (Beresford and Dubey, 1990; Jaržemskis and Vasiliauskas, 2007). The location of these facilities at a dry port relieves competition for storage and customs space at the seaport itself.

After the recording of nearly 300 locations in Europe the delivery of the questionnaire started in early 2015. The exact list was used later on as a basis for the assessments of locations and for the final creation of the ranking. The response rate was over 40% and almost all TOP dry port locations could be included in the final ranking.

Benchmarking is a process like this: first, select a representative enterprise in a certain industry, and then compare the research subject with the selected enterprise in several aspects (such as manufacturing, customer, distribution, management). Generally speaking, the main criterion for benchmarking is as follows: firstly, benchmarks should be enterprises with the best performance in the industry; secondly, benchmarks should be selected among competitors in the same industry and enterprises with similar functions and management (Li and Jiang, 2014).

The evaluation criteria are based on the criteria of the first European ranking 2010 (Koch et al., 2010). However, the evaluation criteria were extended from 29 to 40 (Table 1) and are no longer divided in 4, but 16 clusters (Figure 1).

**Table 1** Evaluation criteria

| *Criterion number* | *Criterion* |
|---|---|
| 1 | Size of total area |
| 2 | Exploitation in % in relation to total area |
| 3 | Current status of marketed area size in ha |
| 4 | Opportunities expansion of space in ha |
| 5 | Storage capacity in square meter |
| 6 | Current number of companies |
| 7 | Number of companies at final stage |
| 8 | Current number of employees |
| 9 | Final expansion of number of employees |
| 10 | Employees per ha exploited area |
| 11 | Time period between planning phase and first business settlement |
| 12 | Year of complete development and marketing |

**Table 1** Evaluation criteria (continued)

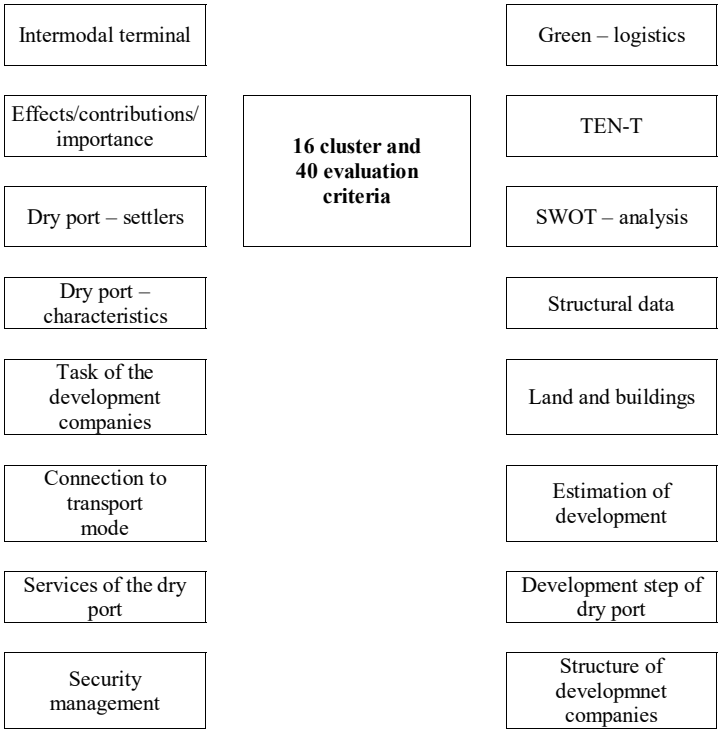
| *Criterion number* | *Criterion* |
|---|---|
| 13 | Decentralised/centralised dry port |
| 14 | Greenfield/Brownfield |
| 15 | Modality |
| 16 | Number of the service facilities |
| 17 | Market share of the total regional offered property |
| 18 | Vacancy rate in % |
| 19 | Personal estimation of level of development (own dry port) |
| 20 | Number of employees of dry port development companies |
| 21 | Range of tasks from management companies – amount |
| 22 | Intensity of task (all estimations added and divided by the amount) |
| 23 | Transport mode: all assessments added and divided by the amount mode of transport |
| 24 | Positioning in TEN-T (amount) |
| 25 | Terminal capacity in loading units |
| 26 | Terminal utilisation in loading units |
| 27 | Terminal utilisation in % |
| 28 | Terminal service offers – amount |
| 29 | Green logistics: amount of the measures implemented |
| 30 | All assessments of the implemented measures added and divided by the amount measures |
| 31 | Security management: amount established measures |
| 32 | Risks for the site (all assessments added by the amount) |
| 33 | Strengths – amount |
| 34 | Weaknesses – amount |
| 35 | Opportunities – amount |
| 36 | Threats – amount |
| 37 | Modal traffic shift |
| 38 | Urban logistics |
| 39 | Green logistics |
| 40 | Importance for the region |

In order to guarantee the comparability of the European dry ports within the benchmarking process single samples were distinguished by processes. Processes in this context are to be understood as occupations that are preceded similar at various dry ports. As an example, the marketing strategy of the respective dry port can be mentioned. A second procedure is to make the processes comparable and more detailed based on the index. Basically absolute numbers are differentiated from ratio numbers.

First of all, a weighting of the benchmark criteria was created to evaluate the final ranking 2015. The basis of this weighting is the relevance of the respective criteria. The range of points is measured by 1 (low importance) to 6 (very high importance). Due to this grading, it is guaranteed that important criteria such as the current number of

employees receive the appropriate attention in this ranking. In order to analyse the individual dry port location, the evaluation criteria were valued on a four-step scale from 0 to 3. A valuation of 0 indicates the lack of this feature in the dry port. A criterion valuated with 3 means a high importance for the dry port. Each criteria valuation represents different circumstances, resulting in differentiated definitions. In this context, exemplary characteristics are as folIows: 0 = not present, no relevance; 1 = low, below average, at start of development; 2 = average; 3 = high/large, above average, advanced; 4 = (highest value in criterion number 17 'real estate').

**Figure 1** Benchmarking clusters with evaluation criteria




As a reward for special advanced locations, so called 'Best in class', special points were awarded. To determine the score (performance) of a criterion, the valuation was multiplied by the weighting (Table 2).

**Table 2** Criteria weighting (example cluster dry port settlements)

| *Critetion number* | *Criterion* | *Weighting* | *Max. value* |
|---|---|---|---|
| 6 | Current number of companies | 3 | 3 |
| 7 | Final expansion number of companies | 3 | 3 |
| 8 | Current number of employees | 6 | 3 |
| 9 | Final expansion of the number of employees | 4 | 3 |
| 10 | Employees per ha exploited area | 3 | 3 |
| | | Max performance points | |

For the final ranking Table 2 of locations and the respective answers were joined with the weighted evaluation criteria. The individual value per criterion of each dry port was summed up at the end, so that each location earned a total score between 0 (minimum) and 380 (maximum).

## 4 Results

In the following chapter the results of the data collection (2015), which covers 90 dry ports, are presented and analysed. As explained in Section 2.3 they are divided into 16 clusters with each associated criteria. Parts (10 clusters) of the 16 clusters will be described in detail.

### *4.1 Cluster 1*

To evaluate a dry port, key figures concerning the total area, storage capacity or notably, area expansion options are of particular importance. Also data concerning the development or marketing status (in ha) are of high interest for logistics properties. Implementation of a close dry port in a seaport's immediate hinterland increases seaport's terminal capacity and with it comes the potential to increase productivity since bigger container ships will be able to call at the seaport (Kovacs et al., 2008).

The average total area of the 90 dry ports in the ranking 2015 is ca. 180 ha of particular note is the size of Zaragoza PLAZA (Spain) with a total area of about 1,300 hectares, which is seven times as large as average. Among the German locations the GVZ Bremen (503 ha) and the GVZ Leipzig (640 ha) are significantly higher than the average European area size.

Under the criterion '*exploitation in relation to total area*' the ratio of developed area/total area was observed. The average developed area in the European dry port is about 140 ha. Consequently, the developed area is close to 80% on average. Nevertheless, at some dry port the total area size is already completely developed, such as the GVZ Nuremberg, where the proportion of developed area is equal to the total area size (337 ha).

The marketing status was calculated in % proportional to the developed area. It is notable that in many cases a marketing status of about 100 % is already reached. Even in 10 German dry ports a value higher than 90% was determined. It is apparent that with an average marketing status of 80%, the ratio from marketed area to developed area is generally high.

The ranking 2015 showed that many European dry ports have area expansion opportunities. On average the expansion area is about 60 ha. It should be noted that it is particularly difficult for dry port in conurbations to have sufficient space for expansion. In this regard for example dry port in Germany like GVZ Berlin and GVZ Nuremberg have nearly no potential for area expansion.

The average storage capacity of European dry port is approximately 260.000 square meters. Within this criterion, Plaza Zaragoza needs to be mentioned as 'Best in class' with a storage capacity of 4,270,000 square meters. The GVZ Bremen is in the second place with a capacity of 1,300,000 square meters, which is five times higher than the European average. Another remarkable feature is the storage capacity of Interporto Torino with a capacity of 900,000 square meters.

### *4.2 Cluster 2*

The current number of companies and the predicted number at final stage are important indicators for the development of European dry port. In addition to that, DGG included the current number of employees and the considered number of employees at final stage, to estimate the number of employees per hectare marketed settlement area. These numbers are becoming very helpful for the assessment of the resulting tax revenue and multiplier effects for the respective dry port region.

In 2015, the average number of companies in the European dry port was about 60. The number of companies at final stage is estimated at an average of about 95. Appreciable in Germany is GVZ Nuremberg with 260 established companies. 'Best in class' is with a current number of companies about 300 and 400 at final stage, Zaragoza Plaza in Spain.

The average number of employees in the European dry port is about 2.000. Within the TOP 5 of this criterion (6.500 – 13.000 employees) are two German dry ports. Quadrante Europa (Italy) as 'Best in class' has 13.000 employees.

The final stage of number of employees in Europe is on average 3.800. The ranking 2015 showed that there are ca. 30 employees per one hectare developed area. This is an absolute average value that contains next to the variance between the 90 dry ports also the range in logistics usages. For example, in modern logistics facilities several hundred workers per hectare are employed, whereas in intermodal terminals the value is below 10 employees per hectare.

### *4.3 Cluster 3*

To create a characteristic of single dry port in Europe, criteria such as the distinction between a 'central and decentralised dry port', the differentiation between 'greenfield and brownfield development' or as well the criterion 'modality' where included in the questionnaire developed by the DGG.

Central dry ports have a significantly higher overall performance within the ranking 2015 than decentralised dry ports. Reasons are among others the agglomeration economy and higher synergy effects. Approximately 20% of the included locations indicated a decentralised site structure. Overall, a clear trend towards a central dry port structure can be recognised in recent years.

The determination of the original area of the dry ports has shown that a minor part of dry ports (16%) perform a "brownfield-development". The identification of the dry port-origin area has shown that only a small part of dry port is based on a 'brownfield-development', although it is considered more positive with a point of view of urban development and land use aspects. Over 40% of companies have performed a shared 'greenfield/brownfield' or pure 'greenfield development'.

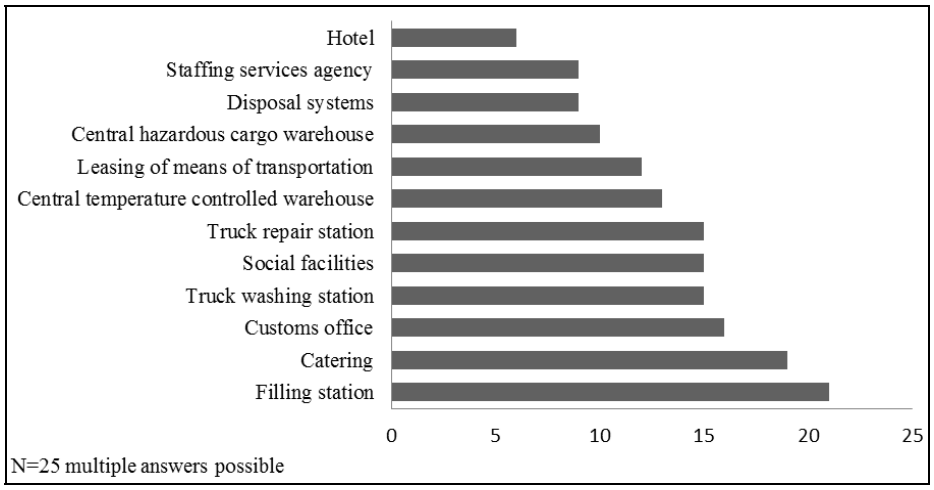
When asked about the number of existing modes of transport, the report shows a significantly higher number of 'bi-modal' dry ports (64%) as expected. Locations with three or more modes of transport represent 36% within the dry ports that made a statement on this criterion.

### *4.4 Cluster 4*

Nguyen and Notteboom (2016) claim that the demand for dry port services in the location is one of the most important concerns to investors. Its rating/score can be obtained from demand forecasts related to the dry port project. The investment and operating cost is another imperative criterion. In terms of cost factors, the model considers land cost, energy cost, labour cost and the cost to relocate the railway station for rail network accessibility. Another factor is the room for expansion at the site, here measured by the maximum area allocated to the project. The next criterion is the investment and operational climate, which is indicated by the banking environment, government support and existing competition in the area. They reflect the ease of doing business, economic governance and administrative management and reform of local government, or in other words, the interaction between investors/operators with government and local players. Available indices such as the provincial competitiveness index (PCI) can be used for rating this criterion. The last criterion of inter-project explains that some investments are made despite of their negative net project value if they generate positive inter-project effects for other projects (De Schepper et al., 2015).

Based on cluster 5 ‘services of the dry ports’ the number of existing activities and service facilities of the European dry ports was considered in more detail. Types of service facilities offered or planned by the dry ports are for example filling stations, truck repair station, social facilities (as sanitation) or catering (e.g., restaurants or canteens). Impressive is the number of existing service facilities of the Italian Interporto di Nola, which has all requested services and thus for example also a temperature-controlled warehouse, waste disposal facilities and a staffing service agency.

**Figure 2** Service facilities within the dry ports in Europe (selection)

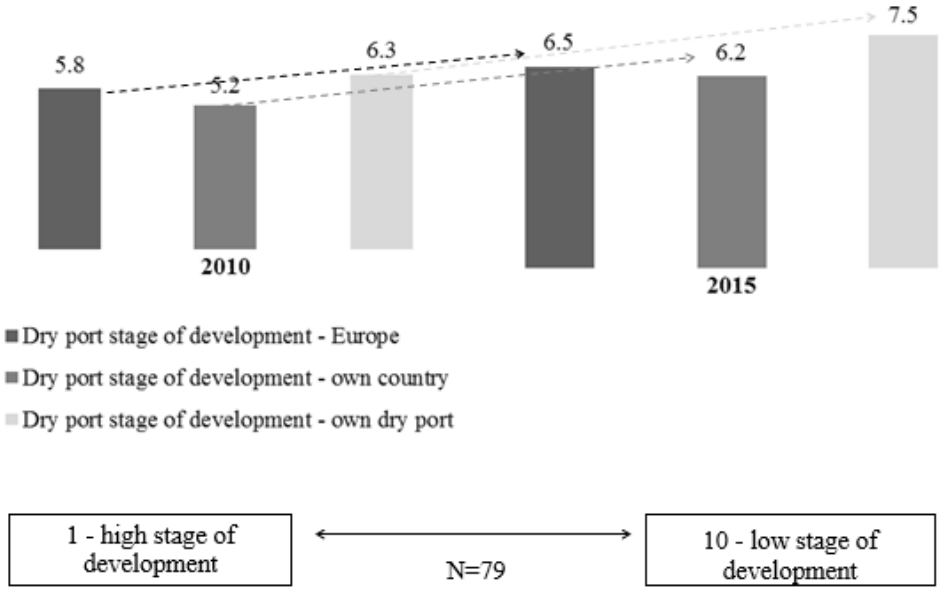



Looking at the range of services in the sum of European dry ports (Figure 2) it becomes clear that most of them contain catering offers, filling stations as well as a customs office. Truck repair stations and social services are also frequent. Need for expansion was identified in the field of truck wash and rental of transport equipment.

### *4.5 Cluster 5*

The development companies have estimated the level of development of the respective dry port in the respective country as well as in Europe. Figure 3 shows a comparison of the average assessment of level of development in Europe between the years 2010 and 2015. A clearly positive trend, especially in the estimation of level of development of the own dry port (+1.2) can be recognised.

**Figure 3** Stage of development compared 2010/2015




### *4.6 Cluster 6*

During the further procedure, the offered activities by the development companies were considered in detail and its relevance was identified.

The range of activities by dry port development companies can be highly diversified and includes among others: support the planning process of the area, support the implementation process of the operating phase, acquisition of new tenants, location marketing (participation in trade fairs etc.), organisation of capacity balancing (e.g., joint use of energy, telecommunications, material etc.), further education and training offers (e.g., by seminars), logistics and consulting activities, cooperation in research projects, development and rental of logistics facilities.

In the consideration of the range of tasks the Italian Interporto Padova SpA is worth while mentioning this development company man ages beside the above-mentioned activities also City Porto, one of the major European City Logistics Services.

The relevance of the applied management activities and thus the activity intensity was examined by an own assessment by the dry port responsible person. In order to compare the intensity of tasks of the German dry port development companies with the European

standards, a comparison with the Spanish and Italian dry port-development companies was made (Table 3).

**Table 3** Intensity of tasks

| | *Average Italy* | *Average Spain* | *Average Germany* |
|---|---|---|---|
| Supporting the planning process of the area | 9.6 | 9 | 9.4 |
| Acquisition of new tenants | 9.2 | 8.7 | 8.6 |
| Location marketing (participation in trade fairs, etc.) | 9.7 | 9.3 | 8.1 |
| Support of the implementation process/operating phase | 9.2 | 8.6 | 6.5 |
| Organisation of capacity compensation (for example, sharing of energy, telecommunications, material etc.) | 7.9 | 6.7 | 5.2 |
| Logistics-consulting activities | 7 | 6.3 | 4.9 |
| Cooperation in research projects | 8.1 | 3.2 | 4.9 |
| Development and rental of logistics facilities | 7.6 | 6.8 | 4.7 |
| Organisation of (further) training (for example through seminars) | 8.4 | 7.8 | 3.5 |
| Total average | *8.5* | *7.4* | *6.2* |

Note: 1 – low task intensity; 10 – high task intensity.

As expected, it becomes visible that a strong focus in all three countries is to support the planning process of the area, the acquisition of new tenants and the location marketing. Especially the Italian dry port development companies (often owners of the dry port area and logistics facilities) put a great emphasis on supporting the implementation process and the operating phase. Moreover, it is remarkable that in Italy training offers receive a value above average.

### *4.7 Cluster 7*

Inter-modality manifested by combined transport is of fundamental importance for dry ports. A trans-shipment facility is a defining characteristic for dry ports and a condition for an intermodal traffic network or rather for the realisation of combined transport (Koch et al., 2010).

To analyse the terminal capacity, the capacity of loading units (i.e., TEU converted into unit load) was indicated. This includes, for example, container, swap bodies and semitrailer. Imposing is the capacity volume of Interporto 'Quadrante Europa Verona' in Italy with 1,400,000 loading units. Average in Europe is a terminal capacity of 150.000 loading units.

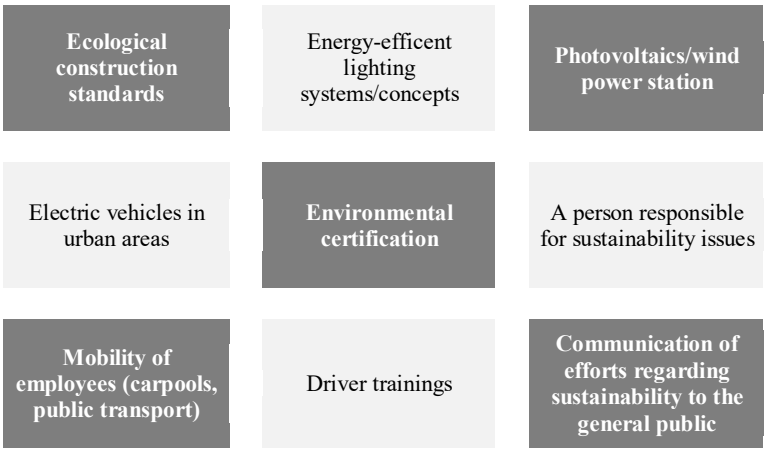
The terminal utilisation measured by the absolute number of loading units, is on average 75.000 loading units in the European dry ports. Taking also into consideration the utilisation of the sites, Quadrante Europa (Italy) with 700.000 loading units leads in Europe.

The terminal utilisation percentage was calculated in relation to the capacity and an average of little more than 50% was identified. However, six dry port sites, such as the GVZ Leipzig (Germany) or CLIP Logistics (Poland) have reached a utilisation level of approximately 100%.

## *4.8 Cluster 8*

'Green logistics' provides opportunities for companies and the environment. For this reason, the European ranking 2015 includes strategies and processes from dry ports, which contribute to resource efficiently and eco-friendly logistics.

**Figure 4** Measures for 'green logistics'




It should be mentioned that Merk (2012) with his research estimated that around 50% of the global shipping emissions are derived from the 25 largest ports in the world. Thus, in a large extent the negative port-city impacts depend on port size. A related report of the IMO (Smith et al., 2014) states that the international shipping is responsible for the production of 3.1% of global CO2 emissions. More specifically, the study by Miola et al. (2009) using data measurements estimated the externalities caused by the port operation in Venice city, while the study of Ng and Song (2010) were based on published data of the Port of Rotterdam to assess its overall environmental impact in the region.

Based on some examples the measures that have already been implemented by the dry ports were determined. Outstanding in the field of 'green logistics' is for example GVZ Nuremberg, which implemented all the measurements shown in Figure 4. – except the use of wind power station.

On the question, how many companies within the dry ports have implemented the above mentioned measures the answer was on average of 4.6 on scale of 0 (no companies) to 10 (all companies with high intensity). This shows that there is still need for action in the field of 'green logistics', even though some significant progress has been already achieved.

## *4.9 Cluster 9*

The security management of the European dry ports was detected for the first time in more detail within the European ranking 2015. Here, the measures to increase the security level of dry ports as well as the biggest risks for dry port are considered in more detail.

Measures that increase the security level of dry ports are for example: Physical security systems for the entire dry port area (e.g., fencing). Security system in form of entrance and exit gates. Security officer. Emergency plans (e.g., in case of flood).Almost half of the surveyed sites have established all the above mentioned measures. This can be observed particularly in the Southern European dry port, whereas German GVZ usually has no central gate.

An estimation of significant risks, as for example extreme weather events, accidents or terrorism was given during the further procedure. The majority of dry ports estimate these risks remarkably low. The estimation of the most significant risks for dry ports was given on a scale of 1 (Iow risk) to 10 (high risk). The average was about 3. It is obvious that the estimation of risks varies greatly and that the risk of accidents or extreme weather events is considerably higher estimated in Germany than Italy and Spain. The probability of terrorism within the dry ports is measured in general relatively low.

### *4.10 Cluster 10*

Finally, an assessment of effects, contributions and importance of the respective dry port was given. Based on a scale of 0 (no or very low) to 10 (very high), an evaluation about the criteria 'modal traffic shift', 'urban logistics', 'green logistics' and 'importance of the dry port for the region' was given.

Modal contributions of the modal shift from road to rail or inland waterway were rated with 8.0 on average. The modal shift is consequently one of the major 'brand cores' of the European dry ports idea.

The reduction of traffic in the urban area was estimated with 7.3 on average on a scale from 0 (very low) to 10 (very high). Occasionally the increasing activities of sites fall within the field of 'urban logistics'.

The importance of 'green logistics' was assessed lower than the 'urban logistics'. On average the European dry ports value topics like energy efficiency with a 6.4 on a scale from 0 to 10. Nevertheless, this value is rather remarkable. Although in this case not only concrete measures, but also the spatial position of the dry ports plays a role.

## 5 Conclusions

The results of the empirical investigation demonstrated that the relative ranking of ports changes when measurements are taken into account simultaneously, both positive and negative effects of their operation, in relation to their respective position when considering only the one side of effects (Agallos, 2016). The benefits of port operation spread to a greater extent in the hinterland, indicating the significant importance of the location of a port in determining the port performance.

Several studies examine the general impact of the operation of ports (general impact assessment of port operations). In the methodological framework of these researches it is feasible to incorporate two important methods: the cost-benefit analysis (CBA) and the multi-criteria decision making analysis (MCDMA). These methods are used to evaluate ports regarding expansion projects, upgrades and construction of new port projects, taking into account both economic and environmental criteria (Agallos, 2016). The MDMA is based on an extended number of criteria that are used for the benchmarking of alternatives. In this category the studies written by Notteboom (2011) and Libardo and

Parolin (2012) must be highlighted incorporating economic, social and environmental criteria in order to show off the most profitable port or project. However, the indicators that are used by each study to lead to the final result are significantly different.

**Table 4** Total ranking of European dry ports

| *TOP* | *Number* | *Description* |
|---|---|---|
| Top 20 | 1 | I – Interporto Quadrante Europa (Verona) |
| | 2 | D – GVZ Bremen |
| | 3 | D – GVZ Nürnberg |
| | 4 | D – GVZ Berlin Großbeeren |
| | 5 | E – Plaza Logistica Zaragoza |
| | 6 | I – Inrterporto Nola Campano |
| | 7 | I – Interporto Padova |
| | 8 | I – Interporto Bologna |
| | 9 | D – GVZ Leipzig |
| | 10 | I – Interporto Parma |
| | 11 | ES – ZAL Barcelona |
| | 12 | I – lnterporto di Torino |
| | 13 | H – BILK Logistics Centre (Budapest) |
| | 14 | I – Interporto Novara |
| | 15 | PL – CLIP Logistics (Swarzedz) |
| | 16 | F – Delta 3 Dourges (Lille) |
| | 17 | D – GVZ Berlin West Wustermark |
| | 18 | A – Cargo Center Graz |
| | 19 | D – GVZ Südwestsachsen |
| | 20 | UK – DIRFT Daventry |

In comparison to the first European ranking 2010, there is no change among the top 3 in the Ranking 2015 (Table 4). The top dry ports in Europe are: Interporto Verona, GVZ Bremen and GVZ Nuremberg. Interporto Verona, as one of the central dry port in Europe, took the lead due to a very good performance and so it is the first place in the ranking 2015.

There are some new placements within the TOP 20: GVZ Berlin Wustermark and GVZ Südwestsachsen. Six German dry ports gained a placement within the top 20. GVZ Leipzig (position 9) and GVZ Berlin (position 4) integrated themselves within the upper part of the ranking next to the already mentioned German dry port. Especially the GVZ Berlin Süd Grossbeeren improved in comparison to the first European ranking by some important positions. One reason is the high marketing dynamics. This is among other things due to the numerous logistics settlements in the context of the booming e-commerce (B2C) and the supply of consumer goods in the capital region. The German GVZ and the Italian Interporti are the leading dry ports in Europe and set the international performance standards. This is due to the high professional dry port development companies. The good position of the German dry ports is caused by the high impact on employment and the various area options. In addition, Spain is also one of the

pioneers of the successful establishment of the dry port idea. A newcomer in the top 20 is CLIP Logistics (Poland) which demonstrates that the establishment of the dry port idea also made headway in Eastern Europe. This is confirmed by the positioning within the top 20 of BILK logistics centre (Budapest). Regarding intermodal terminals substantial research has been done on how to find the optimal location for inland intermodal terminals (Arnold et al., 2004).

How could be the ranking continued in the future? For example, the development of a worldwide 'rough'-ranking, based on only some criteria, could be projected. This global ranking could have as a result a notable visibility in the logistics community and in the corresponding media. It may be also interesting for port users and for business and institutions related to port industry.

The ranking of the dry ports is very important at policymaking level, as in this way good practices identified. Furthermore, the position of each dry port at the international level can be explained and understood as well. Consequently, it is necessary to construct indicators which use those data that will deliver the degree of sustainability of each dry port, while simultaneously will make the comparison between international ports feasible (Agallos, 2016).

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