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ABSTRACT This manuscript aims to disentangle the conceptual ambiguity around the notion of logistics centre. It proposes an overarching framework that categorizes different types of infrastructure and identifies their distinctive components. The lack of a sound conceptualization of logistics centres originates from the variety in temporal and spatial approaches. In transportation chains, path-breaking trends in market needs, technological innovations and institutional changes, as well as the place specificity of logistics centres embedded in various national contexts inevitably led to a substantial theoretical ambiguity. This study consolidates prior fragmented works and identifies suitable criteria for classifying logistics centres. The functional criterion is proposed as a cornerstone for building a sound conceptualization of these infrastructures. By capturing the distinctive characteristics of each type of logistics centre, the paper proposes an original and comprehensive taxonomy, which emphasizes commonalities and specificities of various infrastructures. The paper provides a contribution to literature by sketching out a trustworthy conceptualization of logistics centres. In addition, the outcomes bring insightful implications for researchers, policy makers and practitioners.

Keywords: logistics centres; conceptualization; taxonomy; literature review; path dependence; embeddedness.

Introduction

The tremendous growth of world trade and the spatial dispersion of production and consumption areas, coupled with the ongoing globalization process, resulted in profound reconfigurations of transport supply chains (Notteboom and Rodrigue, 2005). The massification of cargo volumes on trade lanes, the rise of long-distance maritime and air freight transport, the atomization of inland flows and the reconfiguration of continental distribution systems stimulated the surge of a wide array of logistics centres for supporting modal operations and offering value-added services.

Although the notion of "logistics centre" was introduced in the 1970s, scholars started to address this phenomenon in more detail relatively late (early-2000s) (Bolten, 1997; UNESCAP, 2002). Seminal contributions emphasized the nature and the functional characteristics of several types of facilities, e.g. dry ports, inland terminals, distriparks, etc. At this early stage, academics did not achieve yet an univocal definition and conceptualization of these infrastructures (Grundey and Rimienė, 2007).

The lack of a sound conceptualization originates from a variety of temporal and spatial perspectives (Meidute, 2005; Notteboom and Rodrigue, 2009; Rodrigue and Notteboom, 2009; Higgins et al., 2012). Path-breaking trends in market needs, technological innovations and institutional changes, as well as the place specificity of logistics centres embedded in various national contexts inevitably contribute to a substantial theoretical ambiguity (Rodrigue et al., 2010). The observed literature gap holds practical relevance as logistics centres heavily affect the competitiveness of multinationals and commodity supply chains (Niérat, 1996; Palsaitis and Bazaras, 2004).

The objective of this research is to disentangle the conceptual ambiguity around the notion of logistics centre by proposing an overarching framework that categorizes different types of infrastructures and identifies their distinctive components. We investigate the main reasons behind the conceptual ambiguity surrounding the concept of logistics centre. Using insights from evolutionary economics and institutional economics, we identify temporal and spatial dimensions as key determinants of the observed conceptual ambiguity.

In this study, the consolidation of prior fragmented academic works enables to identify suitable criteria for classifying logistics centres. The functional criterion is proposed as a cornerstone for building a sound conceptualization of logistics centres. By capturing the distinctive characteristics

of each type of logistics centre, the paper proposes an original and comprehensive taxonomy, which emphasizes both commonalities and specificities of logistics centres.

We believe such an academic exercise is relevant to the academic and business communities and in view of policy formulation. The presentation of a clear-cut taxonomy on logistics centres based on a wide range of dimensions adds to extant literature and overcomes existing ambiguity in the use of terminologies. In addition, the paper defines a multi-stage research avenue for advancing knowledge in the field. Theoretical arguments enriched by empirical examples suggest further research streams. The research outcomes can also assist decision makers at policy level to use an advanced normative framework which explicitly takes into account the impact of logistics changes. We will demonstrate that this policy-relevant framework recognizes some level of regionalism in the use of the appropriate terminological spectrum. Finally, the presented taxonomy can help practitioners to select relevant peers and competitors in view of benchmarking exercises and to identify some drivers and dimensions of competitiveness for each type of logistics centre.

The paper is structured as follows. Section 2 investigates the reasons behind conceptual ambiguity in a spatial-temporal view. In Section 3, classification criteria for categorizing logistics centres and capturing their specificities are reviewed and critically discussed. Section 4 settles an overarching conceptual framework identifying distinctive components of each type of infrastructures. In Section 5, further research avenues are drawn before concluding.

Reasons behind existing conceptual ambiguity: temporal trends and spatial embeddedness

The concept of "logistics centre" was introduced in the 1970s. However, the debate on its nature and functions within the supply chain only started in the last decade (UNESCAP, 2002; Higgins et al., 2012).

Academics achieved a certain degree of consensus on nodal transport infrastructures such as inland terminals, distriparks, dry ports, transloading facilities and European Distribution Centres (Hesse and Rodrigue, 2004; Parola et al., 2006; Roso et al., 2009; Rodrigue and Notteboom, 2009; Rodrigue et al., 2010; Padilha and Ng, 2012). So far a univocal definition and conceptualization about logistics centres is still lacking (Grundey and Rimienè, 2007). Extant literature recognizes the fuzziness and ambiguity on the conceptual boundaries of logistics centres (Tsamboulas and Dimitropoulos, 1999; Meidute, 2005).

Evolutionary economics and institutional economics can provide theoretical underpinnings (Martin and Sunley 2006; Martin, 2010) that shed light on . how temporal- and spatial-related variables shape this conceptual ambiguity (Figure 1). Logistics centres are embedded in a proximate geographic space, i.e. the spatial dimension. Its institutional and social context evolves along with historical trajectories and contingencies, i.e. the temporal dimension (Gertler, 2001; Notteboom et al., 2013).

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From an evolutionary economics perspective, the dimensions affecting the interpretation and conceptualization of different types of logistics centres are related to the main path-breaking trends occurring in transport chains such as logistics needs, technological changes in transportation and a more proactive role of the public sector (Notteboom and Winkelmans, 2001; Notteboom and Rodrigue, 2005; UNESCAP and KMI, 2005; Hesse and Rodrigue, 2006). Thus, changes in firm routines and public policy, innovation and application of new technologies can affect the role and functions of logistics centres. However, the routines of firms and organisations are historically rooted and reproduced over time, leading to path dependence and lock-in effects.

From an institutional economics approach, we argue that historical and linguistic issues, orographic and socio-demographic characteristics, as well as the institutional and political context affect the notion of logistics centres (Meidute, 2005; Rodrigue and Notteboom, 2010; Higgins et al., 2012). Territorially-based institutions and regulatory systems can result in a local embeddedness of logistics centres. The decisions made in the past shape expectations of actors for the future (North, 1990). This locks institutional change into certain development paths. However, institutions can change rather abruptly through revolutions and by ‘external shocks’ or through incremental adaptation and deliberate design (Boschma and Frenken, 2006).

Path Dependence and Path Disruption: the Temporal Evolution of the Concept

The concept of logistics centre changes over time, in line with the evolution of three major path-breaking trends (Figure 2).

First, the evolution of logistics needs can profoundly alter the nature and functions of these infrastructures (Bowersox, 1969; Holtgen, 1996; Rodrigue and Notteboom, 2010). The growing outsourcing of non-core activities to third-party logistics providers (Johnson and Wood, 1996; Rushton, 2010) gave room to logistics centres to experiment with new organizational forms and a wider scope of activities (Wiegmans et al., 1999; Ballis and Golias, 2002; Waters, 2003; Rodrigue et al., 2010).

Logistics experienced four major development stages. Traditionally logistics has been interpreted as "physical distribution" before the introduction of the "material handling" approach (Bowersox, 1969). Logistics centres were mainly warehouses and other basic transport-related infrastructures (Master and Pohlen, 1994). When the paradigm shifted towards integrated logistics a rethinking of the functions of logistics centres took place (Meidute and Vasiliauskas, 2005) with a growing attention to supply-demand synchronization as well as operational and information technology integration (Higgins et al., 2012).The introduction of supply chain management (SCM) principles and innovative managerial practices to support firm's competitive advantage provoked a dramatic shift in the design of logistics centres (Cooper et al., 1997; Teo et al., 2001; Meidute, 2005). New generations of advanced logistics centres emerged, e.g. freight villages, distriparks, logistics platforms, etc. (Grundey and Rimienè, 2007; Higgins et al., 2012). *< insert figure 2 about here >*

Evolutionary trends triggered logistics centres to enlarge their functions and the spectrum of services, ranging from labelling, (re)packaging and bar coding to tracking and tracing, quality control, total logistics management and even forms of postponed manufacturing.

Second, technological changes in transportation shaped technical and managerial dimensions of logistics centres (Ballis and Golias, 2002; Rodrigue et al., 2010). Since the 1960s, containerization strongly contributed to the enlargement of port hinterlands and the reshaping of continental distribution systems (van Klink and van den Berg, 1998). New hinterland concepts emerged in view of linking seaports to delocalizing storage facilities in inland areas via high-density intermodal corridors (Notteboom and Rodrigue, 2005). Since the 2000s, academics and practitioners started to debate on dry ports and extended gates as extensions of deepsea terminal operations (McCalla, 1999; Slack, 1999; Roso, 2007; Roso et al., 2009; Veenstra et al., 2012; Ng

and Cetin, 2012). Technological advances also affected air freight logistics. . Since the 1980s, the growing role of Japan, Taiwan and South Korea in the electronics industry and the emergence of technology-driven express integrators led to the emergence of large air freight platforms. Advanced warehouse management systems, barcoding and (semi)automated forklift technology facilitated the development of distribution systems focused on a large-scale main distribution centre. The last major path-breaking trend, which modelled the logistics centre concept worldwide, is the changing role of the public sector in supporting national economies and international trade or attracting FDIs (Hesse, 2004; Meidute, 2006). In the 1970s, pioneering public initiatives in Mexico, Ireland and Singapore aimed to stimulate foreign trade by creating ad hoc economic trades zones (ETZs) and free trade zones (FTZs). In the mid-1980s, a lot of countries undertook new public development policies enabling the rise of manufacturing and logistics areas devoted to specific commodity chains (Gouvernal et al., 2011), such as export processing zones (EPZs). Local governments started to directly fund these logistics and transport nodes, given their support to the competitiveness of international seaport and airport hubs (Nam and Song, 2011). The ultimate frontier of political intervention was the implementation of special economic zones (SEZs) (Makabenta, 2002). SEZs became the home for a new generation of logistics centres focused on supply-demand synchronization and value-added services for cargo, people and multinationals.

The above path-breaking trends have urged the introduction of new concepts of logistics centres (such as extended gates, freight villages and SEZ). However, also older terminology on logistics centres (such as inland clearance depot - ICD) continues to be used. This can lead to a possible misuse of specific notions related to logistics centres thereby adding to a growing ambiguity in the use of terminology.

Spatial Embeddedness: the Spatial Dimensions Affecting the Specificities of Logistics Centres

The temporal evolution is only one dimension affecting the notion of logistics centres.

The lack of a common and well-established conceptual framework for categorizing the major types of infrastructures also originates from a number of spatial dimensions (Bontekoning et al., 2004; Notteboom et al., 2013). The case studies and examples of dry port development in different parts of the world as discussed in Bergqvist et al. (2013) show that even the same term

might be implemented in different ways. Economic, social, institutional and environmental differences among regions lead to diverse approaches to and uses of the notion of dry port.

We identify three main groups of spatial dimensions, i.e. historical and linguistic issues; orographic and socio-demographic characteristics; institutional and political backgrounds (Figure 3).

Historical and linguistic issues include both the semantic value and the theoretical underpinnings related to logistics centre, which are influenced by the conceptual perspectives characterizing each country (Meidute, 2005). Each country or linguistic area uses different terms to refer to similar types of logistics centres. *Freight village*" in UK, "*plateforme multimodale*" in France, "*guterverkehrszentrum*" in Germany, "*Zona Actividades Logisticas"* (ZAL) in Spain, as well as "*interporto*" in Italy, are rather heterogeneous terms used in diverse national contexts for indicating a quite similar concept (Notteboom and Rodrigue, 2009; Higgins, 2012; Iannone, 2012). Countries that have strong linguistic, economic, historical or cultural links typically show some convergence in the use of concepts of logistics centres. Heterogeneous country groups are likely to see a growing divergence and ambiguity in the meaning attached to concepts which linguistically are quite similar or the same.

The diverse interpretation of similar terms and concepts originates from the different cultural heritage (Notteboom and Rodrigue, 2009; Rodrigue et al., 2010). For example, in the USA and in Japan, as well as in several European countries, logistics centres are studied not only as transport nodes but also as "business generators" capable of supporting local economies (Van den Berg et al., 1996; Meidute, 2005; Higgins et al., 2012).

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In addition, orographic and socio-demographic characteristics deeply affect the conceptualization of logistics centres (Hesse, 2013). In particular, local specificities in terms of territorial extension, territorial morphology and urbanization degree influence the concrete development of the logistics centres embedded in a determined national context.

For example, in developed systems like in North America and Europe, port operators and port authorities are highly involved in integrating seaports with their hinterland. In contrast, most

logistics centres in developing economies are land-driven as they have been established to serve the export-based industrial zones.

The morphology of territory (e.g. inland waterways, the presence of mountains) plays a role as well. The presence of inland waterway networks, for instance, stimulated the development of barge-oriented logistics centres in countries such as Belgium, the Netherlands, Germany, USA and China (van der Horst and De Langen, 2008; Konings, 2009). As these facilities are located along canals or rivers, they are not referred to as 'dry ports', a term which is more associated with rail-based hinterland solutions.

In addition, the degree of urbanization and the spatial dispersion of the consumption and production units influence the configuration of the transport and logistics systems of each geographic area (Notteboom and Rodrigue, 2004). The presence of wide and densely populated metropolitan conurbations favored the growth of large logistics centres, e.g. European Distribution Centres (van den Heuvel et al., 2013) and air freight hub terminals connected to large passenger airports.

Finally, the heterogeneity in the notion of logistics centre originates from a third group of space-related variables, i.e. the institutional and political context at a national or supra-national level. The normative framework, which regulates local logistics infrastructure and shapes the overall national transport system, sets several aspects such as public and private parties involved, allocation of responsibilities, operating rules, public interests protection, etc. (Roso, 2008). Second, governmental policies aiming to facilitate international trade or attract inward FDI may affect the nature and the core function of national logistics infrastructures (Gouvernal et al., 2011; Nam and Song, 2011). For example, the EU has launched a number of programs for planning and developing logistics centres capable of supporting TEN-T networks (European Commission, 1997; 2000; Europlatforms, 2004).

The establishment of special zones feeds import, export, or re-export activities and he agglomeration of logistics sites (Wang and Olivier, 2006). Governmental policies influence the conceptualization of territorially rooted logistics centres (UNESCAP, 2002).

Institutional change can be locked-in into certain development paths as past trajectories influence the future development potential. The lock-in effect at the level of logistics centres can emerge in several national contexts. Hong Kong, Singapore, Freeport (Bahamas) and Macao adopted legislative and organizational solutions focused on "free port" status strongly connected to seaport, inland port and or airport activity The United Arab Emirates (Jebel Ali), Panama

(Colon) and USA (Miami) experimented with commercial free zones. In countries such as Taiwan, Malaysia and the Dominican Republic, public intervention has been channeled towards industrial free zones and export processing zones (Rondinellli, 1987). Logistics facilities located in proximity to these areas specialized themselves in the execution of soft/light postponed manufacturing strategies (Notteboom and Rodrigue, 2004; Leal and Pérez, 2009).

Classification Criteria: Critical Dimensions for Competitiveness

The temporal and spatial evolution of the logistics centre concept requires an overarching conceptual model to understand similarities and differences across various infrastructural typologies.

Widely recognized classification criteria and taxonomies are still lacking when it comes to dimensions such as the physical location, the infrastructural endowment, as well as the range and scope of logistics services provided (Steenken et al., 2004; Baker and Canessa, 2009; Grundey and Rimienè, 2007; Higgins et al., 2012).

The conceptual model builds upon extant literature and proposes a novel framework for integrating a number of complementary, non-overlapping, classification criteria. A pivotal role is attributed to the *functional criterion*, which enables to discriminate logistics centres based on their primary function in transport and commodity chains (UNESCAP, 2009). This cornerstone criterion captures the intrinsic nature of each type of infrastructure, i.e. its attitude and competence in matching demand expectations and its specific role within the whole logistics network.

Based on the functional criterion, we consider three main categories. The first group consists of logistics nodes whose primary function is cargo warehousing and storage (i). These logistics centres are devoted to ensure the storage of manufacturing goods and commodities. It is possible to further discriminate between facilities devoted to short-term storage (such as cross-dock facilities) and infrastructures where goods and commodities mostly dwell for a longer period.

The second group includes logistics centres characterized by a prominent transit function (ii). These facilities aim to reduce transit time and optimize the speed at which goods and commodities move through the logistic chain from production to consumption. These logistics centres can be classified in the light of the dominant transport mode used, or of the monomodal/intermodal nature of the logistics services provided (Leitner and Harrison, 2001; Flämig and Hesse, 2011). In this

category, the modal split and the parcel size distribution function heavily condition operations and affect the bundling of commodity flows and network organization, e.g. point-to-point bundling, hub and spoke network, line network, trunk line with collection and distribution (Melkote and Daskin, 2001; Jeong et al., 2007; Higgins et al., 2012).

Finally, the third group consists of logistics centres focused on value added services (iii). Their prominent objective is the maximization of goods value in the transport chain, also supplying additional services for vehicles, firms and people. The range and scope of logistics services help to discriminate between this group of infrastructures (Lai et al., 2004; Du and Bergqvist, 2010).

Although the functional criterion has its value, other analytical dimensions should be included for capturing the variety of forms and specificities of logistics centres. Additional criteria of our comprehensive taxonomy include (Europlatforms, 2004; Grundey and Rimienè, 2007; Du and Bergqvist, 2010; Higgins et al., 2012): infrastructural size, geographical market scope, position in transport and commodity chains, strategy, organization and technology, and governance settings (Figure 4).

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The size of a logistics centre is a key dimension affecting some other variables related to an infrastructure (Wiegmans et al., 1999). It can refer to the physical extension of available areas and superstructures (hectares), to the cargo throughput (tons, TEU or air freight containers), and to the positive economic externalities (e.g., revenues, personnel, number of customers, etc.). This profile is highly correlated with the number and type of facilities (e.g., warehouses, storage spaces, rail yards, etc.) located inside the logistics centre and, therefore, influences the complexity of operations management (Tsamboulas and Dimitropoulos, 1999).

The criterion of the geographical market coverage has essentially a dual nature (Niérat, 1996). First, it considers the hinterland-based, foreland-based or the mixed geographical focus of the facility (Wiegmans et al., 1999; Rodrigue and Notteboom, 2010b). This criterion also emphasizes the role played by the (Euclidean versus travel) distance, as well as the scope and the heterogeneity of the geographic markets. Along these lines, extant literature commonly labels logistics centres as international, regional, national or local (Grundey e Rimienė, 2007).

The position in transport and commodity chains impacts on the direction of cargo flows (inbound versus outbound) and the types of commodities (e.g., raw materials, components, finished products, etc.) transiting through the logistics node. These factors affect the management of operations and the organization of processes (Meepetchdee and Shah, 2007).

The strategic criterion can be articulated in a number of dimensions such as the scope of the business portfolio, and the range of services provided Facilities focused on specific commodity chains are different from those engaged in various businesses (Rodrigue and Notteboom, 2009). There are centres providing a broad spectrum of services (e.g., material handling, cross-docking, VAS, etc.) and those limiting themselves to specific operations such as transloading of intermodal transport units (Jennings and Holcomb, 1996; Li et al., 2004; Rodrigue and Notteboom, 2012).

The technological and organizational criterion takes into account the infrastructural endowment of the logistics centre in terms of warehouses, intermodal facilities and equipment and ICT systems. Containers, swap bodies, air freight containers, semi-trailers, and piggyback traffic bring different organizational and operational challenges (Stevenson and Hojati, 2007; Wiese et al., 2011).

Finally, governance settings have been argued to significantly affect the model, strategies and performance of logistics centres (Monios, 2014 and Monios, 2015). Governance allows to discriminate infrastructures in line with their single- or common-user nature (Jarzemskis e Vasiliauskas, 2007) or ownership (i.e. land, basic infrastructure and superstructure). Major differences can be observed when it comes to the actors responsible for designing, financing, building, and operating the logistics centre (Europlatforms, 2004; Du and Bergqvist, 2010).

These additional criteria contribute to the specification of the overarching conceptual model, capturing distinctive components of diverse logistics centres.

Disentangling Ambiguity: the conceptual model

In this section, we provide an original and comprehensive taxonomy of logistics centres based on the classification criteria identified in the previous section. The primary function of logistics infrastructures is taken as a key variable for clustering facilities in three groups. The resulting

multi-layered approach of classification criteria provides a structured overview of the types of logistics centres. Complementary dimensions of categorization include infrastructural size, geographical market scope, position in transport and commodity chains, business and strategy, organization and technology, and governance settings. These additional dimensions also enable to scrutinize logistics centres within each group of peers, outlining specificities and critical factors for competitiveness. The discussion presented below is aimed at advancing the conceptualization of logistics centres along spatial and temporal dimensions and taking into account the close interaction between path dependence and forces of spatial embeddedness.

Logistics Centres Focused on Storage, Deposit and Warehousing

The first group includes logistics centres focused on storage, deposit and warehousing. It concerns basic facilities characterized by low/medium levels of infrastructural/managerial complexity (e.g. warehouses, empty container yards and inland container depots), and more sophisticated infrastructures, such as main distribution centres / European Distribution Centres (EDC) (Table 1).

In particular, warehouses are facilities for cargo storage holding a buffer function for optimizing inventory management among suppliers, producers and customers (Higgins et al., 2012). Therefore, their primary role is supply-demand synchronization across time and space within complex commodity chains (Meepetchdee and Shah, 2007; Kappauf et al., 2012).

< insert table 1 about here >

A number of specific declinations of warehouses and depots exist. In particular, previous contributions (e.g., Choong et al., 2002) make reference to (empty) container yards as those facilities which are dedicated to the storage, cleaning and maintenance of empty containers. As these infrastructures facilitate port operations by increasing stevedoring services and reducing turnaround time in handling activities, they are expected to be located near maritime gateways (Steenken et al., 2004; Wang et al., 2012).

Inland container depots differ from container yards due to their localization, closer to production-consumption areas rather than ports, and their size, as they tend to assume bigger dimensions in the pursuit of the economies of scale needed along high capacity corridors.

Therefore, the position in transport and commodity chains and the infrastructural dimension are valuable classification criteria to discriminate between these types of infrastructures.

Compared to traditional warehouses, distribution centres combine cargo storage with material handling functions (Bowersox et al., 1969; Holtgen, 1996; Wang and Olivier, 2006). The strategic criterion enables to better understand the specificities of these logistics centres, as they commonly provide also value-added services such as cross-docking, order picking, returns processing, kitting, labelling and bar coding, as well as cargo-related information flows. Distribution centres hold a pivotal role within distribution systems (e.g. urban freight distribution) and boost the competitiveness of the involved commodity chains (Kia et al., 2003). When it comes to the geographical market coverage criterion, academics and practitioners often make a distinction between international, regional, national and local facilities (Lu, 2004). For example, in a European context, one can make a distinction between European Distribution Centres (EDC), National or Regional Distribution Centres (NDC/RDC) and Local Distribution Centres (LDC). Sometimes these centres are combined to form a complex tiered distribution system such as an EDC connected to a number of RDCs.

Logistics Centres Focused on Cargo Transloading and Rapid Transit

Logistics centres devoted to cargo transloading and rapid transit can be typified in line with the monomodal vs. intermodal essence of their services (Table 2).

Within this group of facilities, inland (freight) terminals and intra-modal gateways have the lowest degree of infrastructural and managerial complexity. These infrastructures are multi-user facilities, where national and international traffic flows are received and dispatched in a fast way (UNECE, 1998). These infrastructures do not require the presence of an intermodal terminal, due to the monomodal or multimodal nature of their handling operations. These logistics centres play a critical role in stuffing and stripping intermodal units for long-haul transport services. By doing so, they enable to pursue economies of scale and to make transport chains more efficient (Macharis and Bontekoning, 2004). For example, cargo cities, i.e. logistics facilities that support air supply chains by handling unit load devices (ULDs), are physically located within airport complexes characterized by considerable cargo flows (Van den Berg et al., 1996; Tsamboulas, 2008). These infrastructures tend to focus on specific commodity chains, e.g. perishable goods, value-added products or time-sensitive goods. Therefore, both the position in transport and commodity chains

and the strategic criterion are relevant dimensions to be considered for disentangling ambiguity related to this type of logistics centres.

< insert table 2 about here >

Next to this, intermodal terminals are facilities focused on transshipment and storage of intermodal loading units (Roso et al., 2009). These single-plant facilities facilitate hub and spoke or interlining operations for regional and continental trade by offering intermodal logistics services.

Intermodal freight centres are agglomerations of co-localized facilities devoted to intermodal exchange, where several logistics service providers offer complementary and auxiliary services (Cardebring and Warnecke, 1995). Dimensional and strategic criteria permit to distinguish these logistics centres from mere intermodal terminals. In addition, also organization and technology, as well as governance settings bring insights on this type of infrastructures, as they are characterized by a high level of organizational complexity compared to the previously portrayed facilities. Ownership structure, coordination mechanisms among various logistics chain actors and other governance variables tend to be more developed in intermodal freight centres.

Within logistics centres focused on cargo transloading and rapid transit, dry ports are conceived and defined as intermodal logistics infrastructures functionally interconnected with a port, acting as a remote yard area for shippers and logistics service providers (Woxenius et al., 2004). Besides the services traditionally offered by intermodal terminals, dry ports supply a wider spectrum of auxiliary services, e.g. storage, consolidation, depot, track and trace, maintenance of containers, and customs clearance (Roso, 2008; Roso et al., 2009). A dry port modifies the interactions and interdependencies between a port and its hinterland (Notteboom, 2002; Notteboom and Rodrigue, 2007). Dry ports can help to overcome port congestion and the high opportunity cost of land use in seaports (Heaver et al., 2000; 2001). In addition, they enable to reduce environmental pollution, providing a stimulus to reach a more sustainable modal split (van Klink and van den Berg, 1998; Notteboom and Winkelmans, 2001).

Extant literature largely debated on the role and functions of dry ports in international supply chains and in the port-hinterland relations, identifying three main typologies of dry ports: distant, mid-range and close dry ports (Roso et al., 2009). The distance between the dry port and its primary

maritime facility deeply affects its fundamental functions (Woxenius et al., 2004; Roso, 2008; Roso et al., 2009).

More recently, academics further developed the notion of dry port, theorizing the extended gateway concept (Pettit and Beresford, 2009). This organizational and production model emphasizes the concerns which may emerge in relation to traffic flow coordination and integration within multimodal hinterland networks. In this perspective, both governance settings (definition of duties and legal responsibilities in the network, resources committed by various player in the supply chain, coordination mechanisms, etc.) and information management shape the efficiency and effectiveness of logistics centres (Veenstra et al., 2012). In the extended gateway framework, port actors (e.g., terminal operators, port authority, etc.) are expected to assume an orchestrating role in the logistics chain, due to their relations with various integrated logistics nodes and hinterland markets. The criteria related to governance settings as well as technology and organization, therefore, have a prominent role in discriminating this type of infrastructures from other logistics centres focused on cargo transloading and rapid transit.

Logistics centres focused on value added services (VAS) and soft/light manufacturing

The third group, i.e. logistics centres focused on value-added services (VAS) can be further split into two categories: i) freight villages and facilities with similar business models (Table 3a); ii) various types of special zones, i.e. large areas characterized by favorable institutional/normative settings, stimulating co-location of logistics infrastructures and functional agglomeration of manufacturers and logistics service providers (Table 3b).

< *insert table 3a about here* >

< *insert table 3b about here* >

As concerns the first category, a freight village constitutes an ideal archetype. It can be defined as "*the hub of a specific area where all the activities relating to transport, logistics and goods distribution – both for national and international transit – are carried out, on a commercial basis, by various operators*" (Europlatforms, 2004). Several logistics firms operate in the same logistics centre, by providing a wide range of complementary services for goods, vehicles, firms and people. These operators may acquire, or simply rent, spaces, logistics areas or facilities within the centre. The attractiveness of the logistics centre for logistics service providers and other customers depend on the presence of public facilities/equipment managed on a common user base (Meidute, 2006). Notably, this type of logistics centre is managed by a neutral legal body, preferably under public-private-partnership arrangements (Europlatforms, 2004). Governance settings and strategy (i.e., scope of business portfolio, and spectrum of services offered) are key classification criteria in the definition of this type of infrastructure.

Another logistics centre focused on value-added services is the distripark, i.e. a large-scale advanced logistics complex, endowed with appropriate facilities for distribution operations, connected with maritime or air freight terminals and multimodal transport facilities

(UNESCAP, 2002; Grundey e Rimienè, 2007). Distriparks commonly use the latest information and communication technologies for supporting cargo-related data flows (e.g. Port Community Systems or PCS). The technological and organizational criterion, therefore, helps to achieve a deeper understanding of this type of infrastructure. Commonly, this type of infrastructure is directly connected to container terminals, air freight terminals or multimodal transport facilities for transshipment. As a result, also the position in transport and commodity chains may be used as a complementary classification criterion.

Logistics platforms, on the contrary, are VAS-oriented infrastructures, which differ from the other logistics centres belonging to the third group, as they are often dedicated to specific commodity supply chains in a national or international perspective. These logistics centres may strongly contribute to the internationalization (exporting) strategies of domestic manufacturers. Due to their commodity specialization (Leal and Pérez, 2009), the strategic criterion and position in commodity chains are key to identify and describe these forms of logistics centres.

The second category of logistics centres focused on VAS and soft manufacturing is made up of different special zones. These areas share the common intent of the central or regional government to facilitate international trade and to attract foreign investment (UNESCAP and KMI, 2005).

These special areas attract the co-location of many industrial sites and several logistics zones aiming to support inter-plant transport flows and international trade including import, export and re-export flows. In each type of special zones, diverse logistics centres are commonly located. The main common features of special zones are (UNESCAP and KMI, 2005): i) a superior endowment of infrastructure supporting entrepreneurship; ii) a flexible and favorable regulation of business activities; iii) the availability of offshore areas; iv) a number of public incentives for attracting foreign direct investments (FDI).

In line with their primary activity, these areas can be further split up in logistics special zones (focused on export and re-export activities); special zones for distribution (focused on import) and industrial special zones (focused on manufacturing). Internationally, the most widespread special zones are free trade zones (FTZ), export processing zones (EPZ), industrial zones (IZ) and free economic zones (FEZ).

FTZ are a special area where goods can be freely introduced as import duties and taxes are exempted (Nam and Song, 2011). In these areas a broad range of functionally interconnected logistics infrastructures is settled for providing value-added services to cargo flows and in view of strengthening the competitiveness of commodity chains. EPZs are spatially bonded areas in which free trade is permitted (Johansson and Nilsson, 1997). Logistics centres located in these zones, therefore, are established for supporting export activities of domestic industrial clusters. These special zones are broadly settled in developing countries where firms can exploit low labor costs and appealing regulatory regimes.

Industrial zones are special areas for industrial manufacturing activities, stimulating the co-location of domestic firms and foreign investors. These firms are attracted by tax facilitation/exemption and prompt customs clearance (Lim, 2011; Trappey *et al.*, 2013). In these areas, logistics centres are capable of providing both value-added services and light manufacturing support.

Free economic zones are broad parts of a territory of a state including residential areas, schools, enterprises, infrastructures and facilities, devoted to ensure a good business environment by offering public incentives. In these regions, most types of economic and production activities are encouraged (Grubel, 1982).

Strategy, governance settings and the position within transport and commodity chains are relevant criteria for discriminating among logistics centres focused on VAS and soft manufacturing.

Conclusions

We presented a conceptual model in order to address the existing ambiguity and the lack of a sound conceptualization on logistics centres. Using insights from evolutionary economics and institutional economics, we argued that the aforementioned ambiguity is a result of a series of temporal and spatial dimensions that make the concept of logistics centre time and place dependent and subject to forces of path dependence and spatial embeddedness. The paper recognizes that the role and the functions of logistics centres evolve thereby guided by trends in logistics needs, technological standards in transport chains, and export/FDI public policies. In this vein, logistics centres are

continuously challenged to reinvent themselves to fit new market requirements or to exploit time-window opportunities. Path-dependent trajectories are also subject to local forces that are an expression of the embeddedness (place-dependence) of logistics centres rooted in a specific nation or region. Historical and linguistic issues, orographic and socio-demographic characteristics, as well as the institutional and political context are the most significant dimensions affecting the characteristics of logistics centres at a regional or local level.

The conceptual model brings insightful implications for researchers, policy makers and practitioners and provides academic foundations for advancing the theory on logistics centres. The model adds to extant literature as it blends a number of complementary classification criteria in order to present a comprehensive taxonomy. This conceptualization allows to overcome existing ambiguity in the use of terms related to logistics centres, as it identifies similarities and differences across different types of these infrastructures. The taxonomy captures the fundamental dimensions of logistics centres, i.e. their primary function, size, market geographic coverage, position in transport and commodity chains, strategy, organization and technology, and governance settings. It also suggests how each dimension contributes to the positioning and competitiveness of each type of logistics centre.

The findings provide valuable insights for policy makers. By providing evolutionary and institutional perspectives on the conceptualization of logistics centres in, the paper can help policy makers to upgrade/update the normative framework in line with the evolution of logistics needs and technological changes. At a country level, a dated legislation may frustrate the development of well-performing infrastructures and blemish a country's competitiveness within international transport and supply chains. International benchmarking may provide guidance to policy makers in defining institutional and normative frameworks. Still, the spatial embeddedness of the notions related to logistics centres suggest that local and national specificities should be carefully evaluated when shaping decision-making in this sector. As the different categories of logistics centres carry out different primary functions, each central government is recommended to provide incentives for those infrastructures, which factually contribute to international competitiveness of domestic industries and commodity chains.

For practitioners, our taxonomy can help private managers to identify relevant peers and competitors. The conceptual framework enables to group together facilities with similar characteristics and discriminate between those with diverse functions. In addition, for each type of

infrastructure, the paper points to some drivers of competitiveness which can help managers to concentrate their analytical efforts on the relevant infrastructures' dimensions.

The presented detailed conceptual model and the theoretical arguments leave some room for further refinement and sophistication. The notion of embeddedness applied to logistics centres appears as a novel and promising theoretical framework. There is room for further theory building, particularly at the level of a systematic and multi-level analysis of embeddedness on different territorial scales. Future studies are encouraged to investigate more in-depth some neglected analytical dimensions, such as strategic issues (e.g. the scope of business portfolio and the range of supplied services), organization and technology (e.g. physical and immaterial infrastructures) and governance settings (e.g. ownership structure, responsibilities-based reward allocation and management system, etc.).

Additional research can be focused on the empirical validation of the conceptual model. In this vein, a survey can be conducted among managers of logistics centres in order to identify additional variables capable of affecting the competitiveness and positioning of these infrastructures. Furthermore, we encourage comparative case study analyses in view of testing and refining the presented taxonomy of logistics centres and its ability to capture the impact of spatial and temporal dimensions.

Another avenue for future research lies in the empirical application of our conceptual model using insights from evolutionary and institutional economics. Such studies could focus on forces towards path dependence/lock-in and path disruption in the development of logistics centres, as well as the extent of the territorial embeddedness of the associated development path. Also, the transition/upgrading of the functions of existing logistics centres could be assessed from an institutional perspective using concepts of institutional plasticity (characterized by processes of layering and conversion, see e.g. Notteboom et al. 2013) and windows of opportunity/critical junctures (see e.g. Jacobs and Notteboom, 2011). Such approaches could shed more light on the drivers of and obstacles for the evolutionary path of logistics centres and the impact of specific events or situations on their development path.

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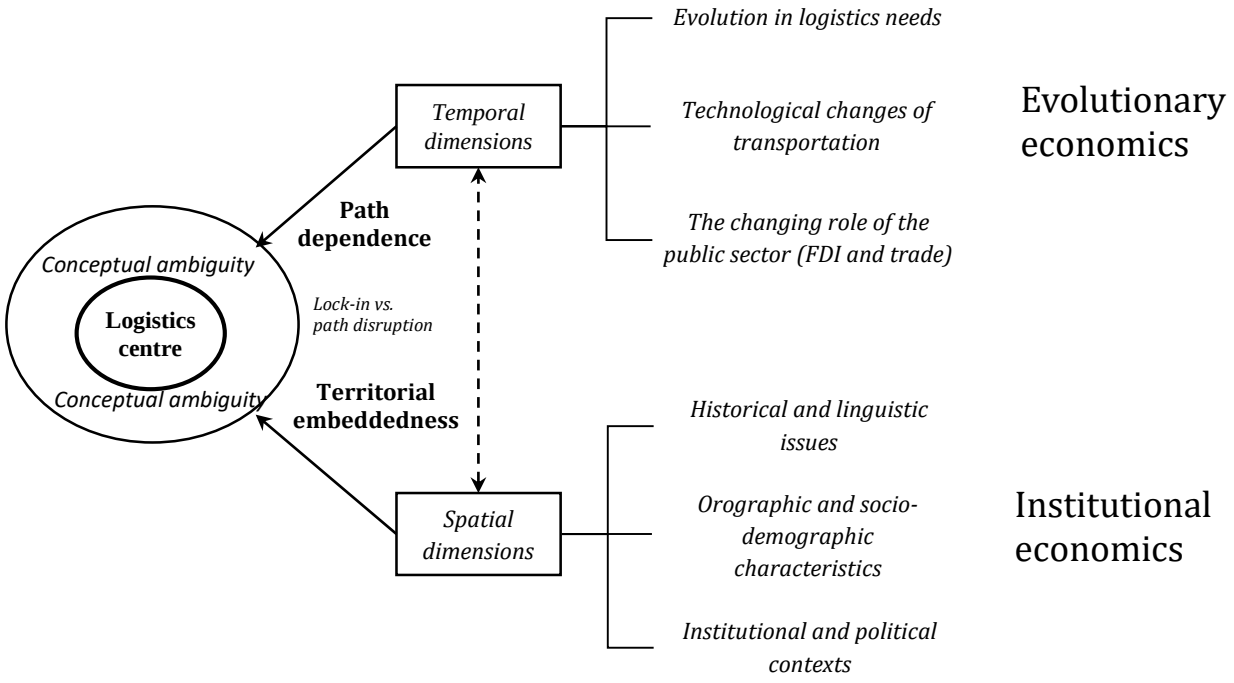
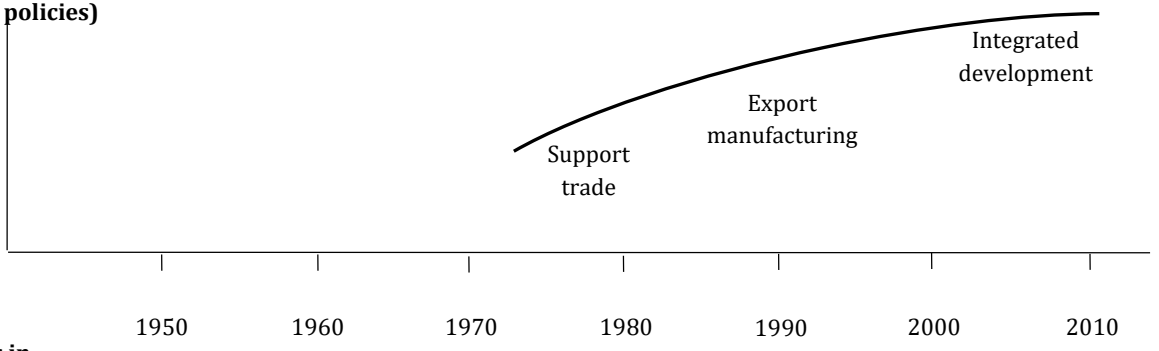
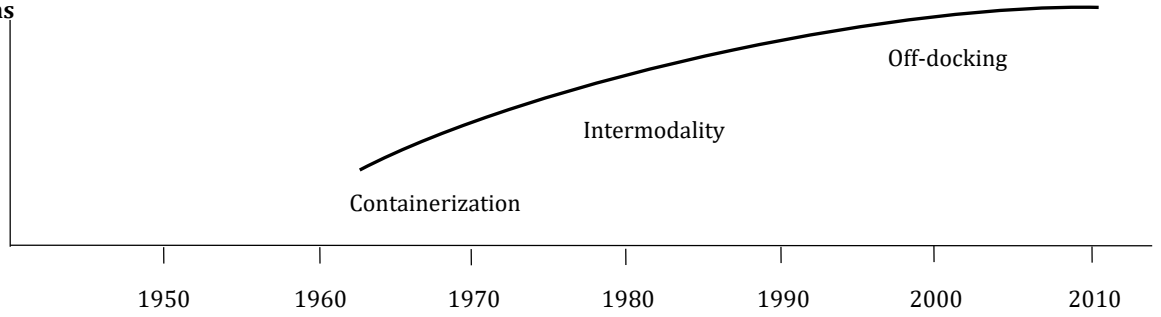


Figure 1. Logistics centre: reasons behind conceptual ambiguity

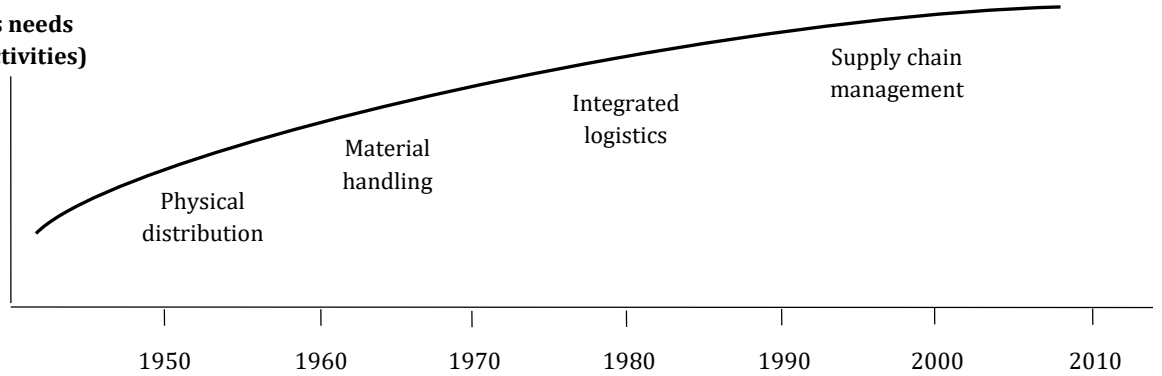
The changing role of the public sector (incentives and policies)



Technological changes in transportation chains



Evolution of logistics needs (wider spectrum of activities)



The temporal evolution of the concept

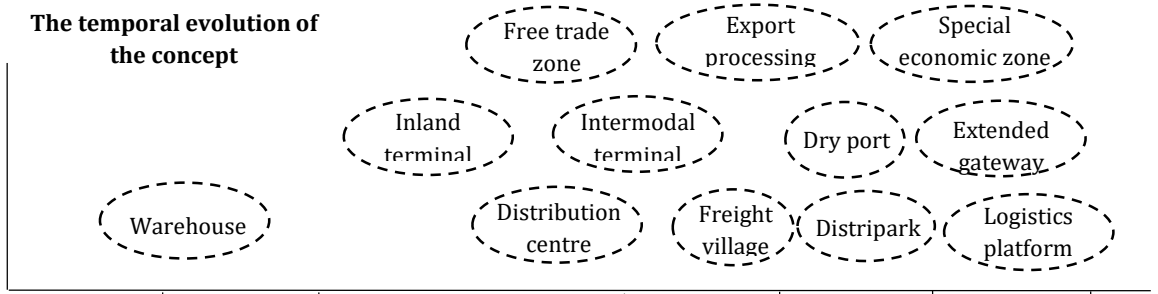


Figure 2. Temporal dimensions and logistics centre's specificities

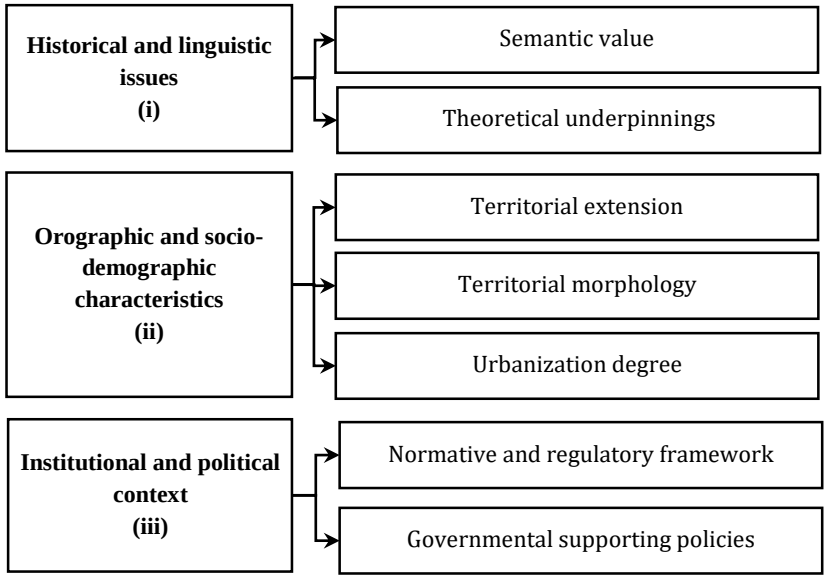


Figure 3. Spatial dimensions affecting the specificities of logistics centres: national embeddedness

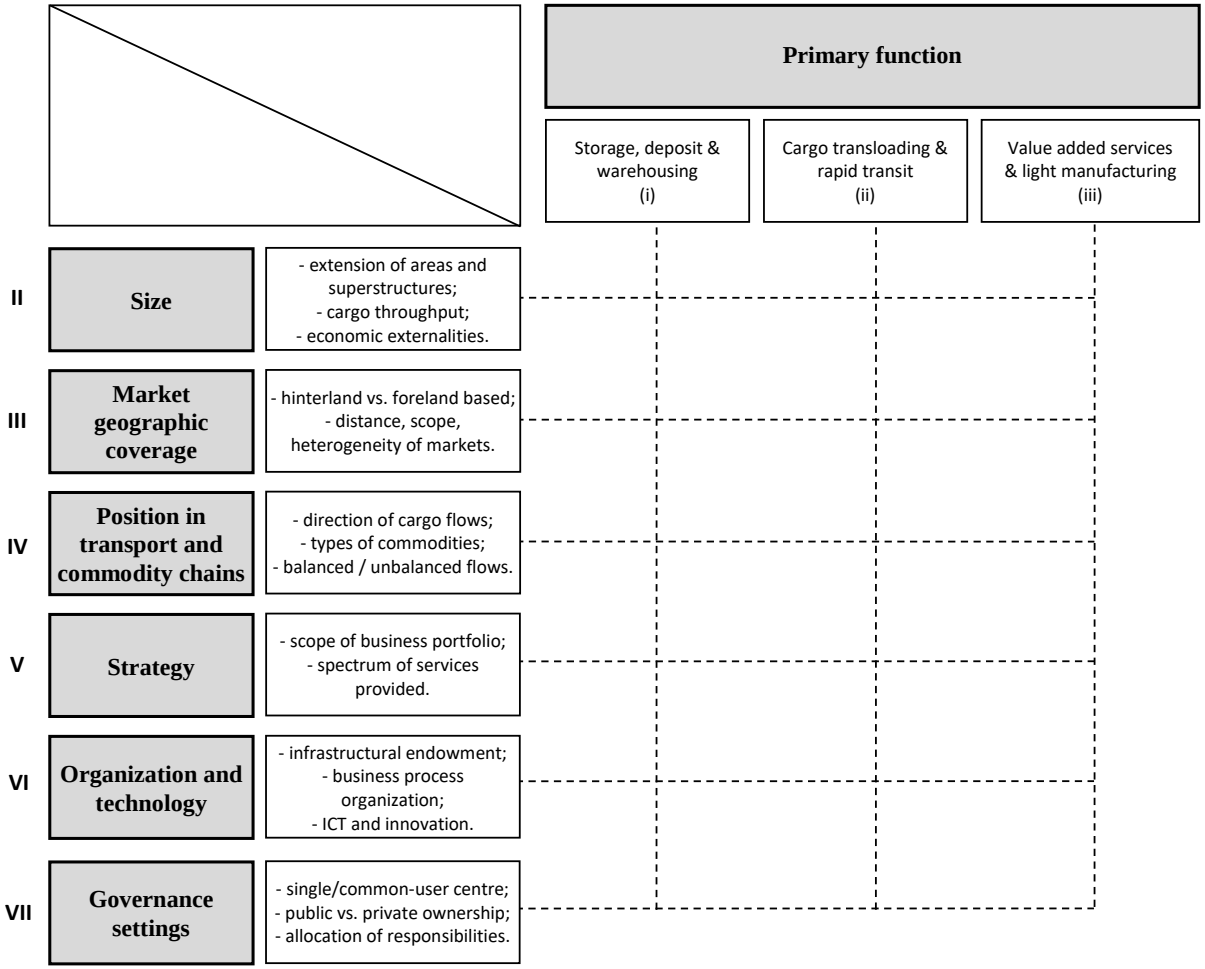


Figure 4. Towards a taxonomy of logistics centres: complementary classification criteria

Table 1. Logistics centres focused on storage and warehousing

Typology	*Definition*	*Specificities*	*Complementary classification criteria*	*References*
Warehouse (centralized, peripheral, etc.)	"*structural unit with all resources and organizational provisions necessary for the execution of processes connected to inventory and warehouse management, including the organizational units involved with goods receipt and shipping*" (Pfohl, 2004; p. 124).	– Cargo storage; – Buffering function; – Low technical complexity of the infrastructure; – Moderate organizational and managerial complexity.	– Position in transport & commodity chain; – Organization & technology.	Johnson and Wood (1996); Bowersox *et al.* (2002); Lu (2004).
(Empty) container yard	"*is a facility dedicated to performing the basic functions of storage, cleaning and repair of empty containers. Like a warehouse, this facility acts as a buffer in the transport chain by ensuring a smooth supply of containers, to facilitate the movement of goods. These facilities can be located near a mainport terminal or other logistics centres as a way to improve service and handling turnaround times*" (Higgins *et al.*, 2012).	– Storage, cleaning, maintenance & repair of empty containers; – Localization inside or nearby port areas; – Low organizational and managerial complexity.	– Position in transport & commodity chain.	Steenken *et al.* (2004); Wang *et al.*, (2012).
Inland container depot	"*is a common user facility with public authority status, equipped with fixed installations and offering services for handling and temporary storage of import/export stuffed and empty containers*" (Jarzemskis and Vasiliauskas, 2007).	– Container storage; – Remote localization with respect to port areas; – Barge and/or railway connection; – High minimum optimal scale.	– Size; – Market coverage; – Position in transport & commodity chain.	Jula *et al.* (2006); Higgins *et al.* (2012).
Distribution centre	"*physical facility used to complete the process of product live adjustment in the exchange channel. Primary emphasis is placed upon product flow in contrast to storage.*" (Bowersox., 1969). "*a place where consignments from different origins are grouped or split, it is above all a transport organization centre, located at nodal points in the system, i.e. at the meeting points of flows of goods in regional, inter-regional or international trade"* (Reynaud and Gouvernal, 1987).	– Storage and fast handling of cargo; – Supply of basic and sophisticated logistics services; – Emphasis on distribution; – Growing managerial and technical complexity of the infrastructure.	– Size; – Market geographic coverage; – Strategy; – Governance settings.	Lu and Yang (2006); Grundey and Rimienė (2007).

Source: Authors' compilation

Table 2. Logistics centres focused on cargo transloading and rapid transit

Typology	*Definition*	*Specificities*	*Complementary classification criteria*	*References*
Inland (freight) terminal	"*consolidation terminals where lorries operate over long distances and pick-up and delivery routes respectively are coordinated*" (Roso *et al.*, 2009). "*is any facility, other than a seaport or an airport, operated on a common-user-basis, at which cargo in international trade is received or dispatched*" (UNECE, 1998).	– Rapid receiving and dispatching of cargo; – Stuffing and stripping of intermodal units for long-haul transport services; – Monomodal or multimodal approach.	– Strategy (*limited spectrum of services provided*); – Governance settings.	Slack (1990).
Intermodal terminal	"a place equipped for the *transhipment* and storage of intermodal loading units" (Roso *et al.*, 2009).	– Focalization on intermodal operations; – Single-plant facility.	– Size (*limited*).	Macharis and Verbeke (1999); Arnold *et al.* (2004).
Intermodal freight centre	"*a concentration of economically independent companies working in freight transport and supplementing services on a designated area where a change of transport in ILUs (intermodal loading units) between traffic modes can take place*" (Cardebring and Warnecke, 1995).	– Agglomeration of co-localized facilities devoted to intermodal exchange; – Supply of value-added services.	– Size; – Strategy; – Organization & technology; – Governance settings.	Iannone (2005; 2012).
Dry port	*"is an inland intermodal terminal that has direct rail connection to a seaport, where customers can leave and/or collect their goods in intermodal loading units, as if directly to the seaport. As well as transhipment, which a conventional inland intermodal terminal provides, services such as storage, consolidation, depot, track and trace, maintenance of containers, and customs clearance are available at dry ports"* (Roso, 2008).	– Intermodal facility connected to the port by rail; – Logistics centre affecting the port-hinterland dialogue; – Diverse typologies (distant, mid-range and close).	– Market geographic coverage; – Position in transport & commodity chains; – Strategy.	Woxenius *et al.* (2004); Roso (2007); Roso *et al.* (2009).
Extended gateway	*"is an inland intermodal terminal directly connected to seaport terminal(s) with high capacity transport mean(s), where customers can leave or pick up their standardised units as if directly with a seaport, and where the seaport terminal can choose to control the flow of containers to and from the inland terminal"* (Veenstra *et al.*, 2012).	– Role of coordination and control of cargo flows within the transport network; – Legally responsible for intermodal operations and the treatment of information.	– Organization & technology; – Governance settings.	Pettit and Beresford (2009); Rodrigue and Notteboom (2010a).

Source: Authors' compilation

Table 3a. Logistics centres focused on value-added services (VAS) and soft/light manufacturing

Typology	*Definition*	*Specificities*	*Complementary classification criteria*	*References*
Freight village	*"…the hub of a specific area where all the activities relating to transport, logistics and goods distribution – both for national and international transit – are carried out, on a commercial basis, by various operators. The operators may be either owners or tenants of the buildings or facilities … built there. In order to comply with free market rules, a Logistics Centre must be accessible to all companies involved in the activities set out above.* *In order to encourage intermodal transport for goods handling, a Logistics Centre should preferably be served by a variety of transport methods (roads, rail, sea, inland waterways, air). It is vital that a Logistics Centre be managed as a single and neutral legal body (preferably by a Public-Private-Partnership) if synergy and commercial cooperation are to be ensured.*" (Europlatforms, 2004).	– Relevance of value-added services; – Accessible by logistics operators under free market conditions; – Availability of various facilities and equipment (intermodal terminal is a primary requisite); – The logistics centre is managed by a "third-party" player (under Public-Private Partnership arrangements).	– Strategy; – Organization & technology; – Governance settings.	Tsamboulas and Kapros (2003); Grundey and Rimienè (2007).
Distripark	"*…is a large-scale, advanced, value-added logistics complex with comprehensive facilities for distribution operations at a single location, which is connected directly to container terminals and multimodal transport facilities for transit shipment, employing the latest information and telecommunication technology. Container ports are generally a preferred choice to set up Distripark, since they are already closely located to various inland transport facilities and highly skilled workforce."* (Grundey and Rimienè, 2007).	– Logistics complex for the supply of VAS nearby port areas; – Relevance of ICT infrastructures for supporting cargo-related information and data flows.	– Size; – Position in transport & commodity chain; – Organization & technology.	UNESCAP (2002); Pettit and Beresford (2009); Sheffi (2013).
Logistics platform	*"…can be defined as a specialised area with the infrastructure and services required for co-modal transportation and added value services, where different agents coordinate their activities to benefit the competitiveness of the products making use of the infrastructure"* (Leal and Pérez, 2009).	– Infrastructures for the provision of VAS in regard to specific commodity chains; – Focalization on specific commodity supply chains.	– Position in transport & commodity chain; – Strategy; – Governance settings.	Iannone (2005); Cambra-Fierro and Ruiz-Benitez (2009).

Source: Authors' compilation

Table 3b. Logistics centres focused on value-added services (VAS) and soft/light manufacturing

Typology	*Definition*	*Specificities*	*Complementary classification criteria*	*References*
Free Trade zone (FTZ)	"*parts of the territory of a state where any goods introduced are generally regarded, in so far as import duties and taxed are exempted*" (Nam and Song, 2011).	– Zones outside national customs borders; – Ad-hoc regulation for facilitating international trade.	– Market geographic coverage; – Position in transport & commodity chain.	Reynaud and Gouvernal (1987); Cai (2004).
Export Processing Zone (EPZ)	"*are geographically or juridically bounded areas in which free trade, including duty-free import of intermediate goods, is permitted provided that all goods produced within the zone are exported. The objective is to lure export-oriented enterprises to the EPZs. In addition to free trade status, various incentives such as tax rebates are commonly offered*" (Johansson and Nilsson, 1997).	– Similar to FTZ; – Orientation to manufacturing operations for exporting cargo products.	– Position in transport & commodity chain; – Strategy.	Papadopoulos and Malhotra (2007).
Industrial Zone	*"offer trade incentives to encourage manufacturers to expand the capacity of their existing industry infrastructure to better supply the global market"* (Trappey *et al.*, 2013).	– Special areas for industrial manufacturing activities; – Co-localization of domestic firms and foreign investors; – Tax facilitation and/or exemption; – Customs clearance.	– Strategy.	Lim (2011).
Free Economic Zone (FEZ) and **Special Economic Zone (SEZ)**	"*trade policy reforms have been applied to selected areas called Special Economic Zones (SEZs) and thus, allowing the government to provide foreign investors with a free trade environment without having to dismantle the system of protection in the economy as a whole. Firms authorized to operate within these zones are exempted from the customs duties and other controls normally imposed on imports into and exports from the principal customs territory . ... Moreover, these firms are permitted the duty free importation not only of raw materials and intermediate goods used in production but also of capital equipment requirements*." (Makabenta, 2002).	– Large areas for building/favoring a stimulating business environment; – Existence of diverse forms of incentive (labor regime, tax facilitation for FDIs, simplification of customs procedures, etc.); – Development of various economic activities; – Customs clearance.	– Size; – Organization & technology; – Governance settings.	Grubel (1982); Wang and Olivier (2006).

Source: Authors' compilation