An updated perspective on the concept of logistics hubs

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Abstract
The concept of logistics hubs is still far from reaching an agreement in literature. By evaluating different concepts and hierarchies of logistics facilities, we bring an updated perspective on the definition of logistics hubs. We also propose a classification based on the hub positioning, distribution network, and goods handled.

Keywords: logistics hub, concept, review

INTRODUCTION

A transport infrastructure is an essential requirement for the movements of products, whether commodities or consumer goods. It comprises not only roads, railroads, or waterways, but also a variety of logistics facilities that support industrial and commercial operations, promoting the flow of goods and information across local, regional, national and international borders. These facilities allow increasing the logistics service level, particularly through the reduction of lead-times and transport costs. Among the available facilities, logistics hubs have gained prominence in the recent years in academia, business, and government.

Although the concept of logistics hubs has been around for some time, it is still far for reaching an agreement in literature. While several studies point out classification criteria or present hierarchy proposals for logistics facilities, in an attempt to differentiate among them, there seems not to be a consensus on a general framework for ranking facilities. In addition, a wide range of terms is associated with this type of facility, which seems to vary according to the region where the hub is located, the services offered, and its integration with the available infrastructure. Due to this, the main features and function of such hubs as part of transport networks are also not yet properly defined.

This paper reviews the literature in order to propose a suitable and comprehensive concept for logistics hubs, distinguishing it from other facilities. It also presents a typology and discusses the vocation of different types of hubs, taking into consideration their role as supply chain players and the types of products handled.

LOGISTICS FACILITIES HIERARCHY IN THE LITERATURE

The classification of logistics facilities is the first step in determining the concept of logistics hub. This aids in identifying basic features, goals, and operational boundaries of each type of facility, differentiating them against other existing structures. Regarding this aspect, Savy (2005) formerly distinguish the different forms of logistics facilities agglomeration. The author presents a structured hierarchy of four levels. In the first level we find single establishments such as depots, warehouses, and sorting centers. The second level comprises specialized facilities in a logistics zone, also called platform if it is a formal organization. Logistics hubs encompass several zones or platforms in a given area and are situated in the third level. Lastly the author defines the logistics area, which corresponds to a large scale agglomeration in a metropolitan/regional scope.

Grundey and Rimienė (2007) review the literature and identify the terms most commonly used to define logistics centers. A three-level hierarchy is proposed, based on the facility performance and activities performed. Thereby, in the first level we find less sophisticated structures, such as warehouses and distribution centers, which increase in complexity as we go higher in the hierarchy; third level structures comprise so-called logistics nodes. The authors also indicate the possible conceptual interconnections among facilities at the same level and at different levels. They point out, however, that the use of the hierarchy is highly dependent on the surveyed authors and on the definitions they adopted, since each one of them ends up devising a particular description and characterization for each facility.

On the other hand, Notteboom and Rodrigue (2009) classify freight terminals regarding the added value of services offered, the size, and the scope of facilities. The suggested classification structure is divided into four levels, where one can identify the possible transport connections between terminals at different levels. According to the authors, the assortment of logistics facilities is related precisely to the possibilities of connections between sites, which directly affect the geographical coverage of each facility and the range of transport systems.

Based on the ideas of Grundey and Rimiené (2007) and Notteboom and Rodrigue (2009), among others, Higgins *et al.* (2012) propose a more complex classification, identifying eight types of logistics facilities which were categorized into three hierarchical levels. For this, the authors took into account information on facility size, functionality, scope of activities, and terminology used. However, Higgins *et al.* (2012) point out that the categories are not exclusive, and that a facility can be classified in one or another category depending on the characteristics presented. The authors hold true the considerations of to Grundey and Rimienė (2007) regarding the need of care when using particular terminologies, since they tend to change over time and over regions as freight transport and logistics services evolve.

There is a consensus among the abovementioned authors that, much more than the size of the facility itself, it is the complexity of logistics activities and the number of logistics services providers (LSP) what distinguishes among levels of a hierarchy. According to the authors, while at lower levels more generic service providers are found, intermediate levels usually comprise logistics operators. In turn, fourth-party-logistics tend to function in higher level structures. Hence, the higher the position in the hierarchy, the more features/services are offered and the more should the services contribute to obtaining scale and scope economies (Grundey and Rimienė, 2007; Higgins et al., 2012; Notteboom and Rodrigue, 2009).

A synthesis of the available hierarchies in literature is presented in Figure 1. The proposed hierarchy helps in understanding the function, scale, and scope of facilities, moving forward in developing a comprehensive classification for logistics facilities. Our goal here is to identify and classify logistics facilities, distinguishing especially the logistics hubs, based not only on abovementioned criteria, but also on their role as part of transport networks. We also try to use more generic terms, avoiding specific definitions by particular authors – leaving, thus, the traditional facilities terminology aside.

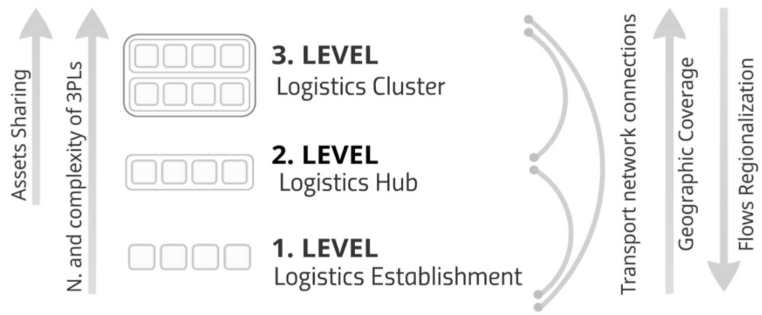

Figure 1 – Synthesis of the logistics facilities hierarchies available in literature

First level facilities are called here logistics establishments, especially because they tend to act in a standalone manner. For second level facilities the term logistics hub seemed more appropriate. Hubs serve as a platform for cooperation among LSPs and other supply chain players, for providing more complex services, and for coordination of related logistics flows. Finally, third-level structures are defined as clusters, given their capacity of broad agglomeration of various facilities and diversity of services. The next session will explore in more depth the differences among these facilities, with the aim of devising a concept for logistics hubs.

STRUCTURING A CONCEPT FOR LOGISTICS HUBS

A wide range of criteria may be related to the characterization of logistics facilities. Although we do not make a discreet delimitation of all features in each level of the proposed hierarchy, there are some key factors that can be used to distinguish between two or more types of facilities. While some of these criteria can be analyzed in isolation, most of them are not enough to, alone, differentiate each one of the categories. A combination of criteria seems more suitable for the task of classifying logistics facilities.

Distinguishing among hierarchical levels

Issues related to the availability of logistics activities and number of LSPs, their form of organization and their capability of sharing assets, when evaluated together, clearly denote the heterogeneity among facilities. These actually seem to be the key-points that account for leveling up in a hierarchical structure. In addition, there is a tendency of facilities to organize themselves together in a specific area as they level up in a hierarchy. Having common goals, LSPs operating in such facilities also tend to increase assets sharing among themselves, seeking to improve service performance and add value to logistics flows (Sheffi, 2012).

In general, one can say that the first level includes standalone facilities such as warehouses, distribution centers, and container yards, which can operate in two different ways: i) as private structures, owned by an industry or LSP, serving only one client; or ii) as a public structure, managed by an LSP but serving many clients. Second level facilities consist of are more complex facilities, with a well-defined structure, which comprises several LSPs, including logistics operators. They serve various clients through asset sharing, in an organized manner. Facilities such as freight villages, interporti, logistics centers, and Guterverkehrszentrum, among others, may be characterized as logistics hubs. Third level facilities, in the other hand, have much broader structures, such logistics areas (Savy and Liu, 2009) or clusters (Sheffi, 2012), where fourth-party logistics operate. Clusters are geographically more disperse and are not necessarily in a well-defined area (Sheffi, 2012).

A second set of aspects that allow us to characterize logistics facilities is related to transport geography. Regarding geographical coverage, the higher the level of the facility in the hierarchy, the greater is its ability to embrace markets. While logistics cluster allow access to international transport corridors, logistics hubs cover areas that are not so spread out. Logistics establishments, in turn, usually function in more local or regional areas. These characteristics reveal the possibilities of transport connections between facilities, which allow reaching both distant and local markets. This enables and further increases the regionalization of flows through the use of different network topologies and of freight consolidation/deconsolidation operations.

We can also observe a difference in the transport modes adopted for the network connections between supply chain players. Logistics establishments, because of the type of market they serve, tend to use road transport. Logistics hubs, in turn, can be unimodal or multimodal. Clusters usually resort on multimodal networks, especially those that include rail or maritime transport. This also implies that the volume of freight handled and type of cargo unitization tend to increase as one ascends in the hierarchy, substantiating the use of larger scale transport modes.

While many hierarchies are based on the functionality and ability of facilities to add value, service providing in primary levels can also be highly sophisticated and specialized, i.e. either because LSPs act in specific market niches, carry out product finishing operations or perform postponement activities. Following the same line of reasoning, the diversity of products handled in each facility is also a weak predictor of classification. On the other hand, the use of information and communication technologies (ICT), although it can also be extensively applied in logistics establishments, is a determining factor for the existence of hubs and clusters. Therefore, increased coordination among LSPs through the use of ICT is a feature that becomes especially noticeable from the second hierarchical level upwards.

Main features of a logistics hub

The proposed hierarchy and the characteristics for logistics hubs found in literature guide de construction of a concept for second-level structures. This concept is based on a tripod of components, which are interrelated: i) assets' sharing among LSPs; ii) a collaborative framework of operation; and iii) provision of valued-added logistics services.

Sharing assets for performing logistics and transport services is the most discussed topic in literature; according to Higgins *et al.* (2012) and Eryuruk *et al.* (2013), it is a basic feature of logistics hubs. Other authors such as Meidutė (2005, 2007), Jaržemskis (2007), Afandizadeh and Moayedfar (2008), Li (2011), Eryuruk *et al.* (2013), Jurásková and Macurová (2013) e Tambi *et al.* (2013) also highlight the importance of assets' sharing for obtaining economies of scale. Actually, the assets shared go beyond those needed to carry out traditional logistics activities, but also include services provided by shipping agents, brokers, shippers, and packing companies (Rodrigue and Notteboom, 2009), as well as those related to support activities, e.g. foodservice, hospitality, and banking. Kabashkin (2007) and Li (2011) also emphasize the importance of sharing information through the use of ICTs, which are indispensable for the existence of a cooperative system that enables the efficient use of available assets.

If assets' sharing exists, then naturally more than two LSPs operate together in a collaborative framework. While authors such as Eryuruk *et al.* (2011), Krzyzaniak *et al.* (2012), and Tambi *et al.* (2013) generally suggest that in a logistics hub there must be a grouping of independent companies, others point out that these companies should be LSPs (Cassone and Gattuso, 2010; Fernandes and Rodrigues, 2009; Meidutė, 2005). These LSPs can also take shape as logistics operators, who increase the synergy of collaboration by providing more complex and complementary logistics services (Afandizadeh and Moayedfar, 2008; Jaržemskis, 2007; Jurásková and Macurová, 2013; Meidutė, 2007). Such collaborative framework drives horizontal "coopetion", allowing LSPs to benefit from synergy and value adding while still competing against each other.

For this reason, Jaržemskis (2007) asserts that a logistics hub must include LSPs that provide different and complementary services, which are integrated through sharing information, infrastructure, facilities, and/or equipment. Although this might imply a sort of coordinated management, discussion on this topic is generally aimed at defining the type of management that should exist (whether private, public or in the form of public-private partnerships), as showed in the work of Eryuruk *et al.* (2011), and not yet at how to implement it.

Value-added services in logistics and transportation may seem quite obvious as a criterion for defining logistics hubs. Although increasing the value of goods through logistics should be inherent of using any kind of logistics facility, some benefits are accentuated by the use of hubs when compared to standalone establishments. Krzyzaniak, Hajdul and Fechner (2012) suggest that logistics hubs are key network nodes in which transport modes and logistics solutions fully show their potential and advantages. Even if they cause a rupture in the flow of goods, hubs enable the development of more efficient transport networks, adding value as an element of coordination and articulation of larger distribution systems (Rodrigue and Notteboom 2009).

Indeed, the added value obtained in logistics hubs is related to both geographical and functional aspects of such facilities. According to Rodrigue (2004) the increased efficiency in transport is due to the establishment of strategic interfaces between networks of different dimensions, whether they are local, regional, and/or global. These interfaces are implemented through transport connections and corridors, which consequently increase geographic coverage and enhance flow regionalization. On the other hand, the polarization of logistics services in hubs leads to greater economies of scale and scope (Cambra-Fierro and Ruiz-Benitez 2009). The authors point out that a logistics hub should act to reduce transport lead-time, improve customer service, and gain competitive advantages.

TYPOLOGY OF LOGISTICS HUBS

The structure of a logistics hub is dependent of the market served and products handled (Grundey and Rimienė, 2007; Meidutė, 2005; Rodrigue, 2004), which restrict the use of transport modes and logistics services. Indeed, many products may require specialized services and handling, as is the case of e.g. electronics, commodities, chemicals or food. An example of product/market oriented facility is found in the case studies of Eryuruk *et al.* (2011; 2013), where the authors describe the planning and implementation of a logistics hub aimed at the textile industry in Turkey.

On the other hand, a logistics hub structure is also associated to the cargo type and packaging. There are service-specific processes and equipment according to the type of goods, whether they are dry, refrigerated, hazardous or perishable, as well as the type packaging, such as bulk, containers, full load or less-than-truck load. The served market, e.g. international or domestic, may also require specific services, such as customs clearance. Port hubs are good examples where one can find some particular conditions: they handle containers, in which a great variety of products of same nature may be stored, for which maritime transport is required, and where customs services may be found (Dadvar *et al.*, 2011; Rodrigue, 2008).

A great variety of products may be suited for logistics hubs. According to Šulgan (2006) these can be related to the auto, electronics, chemical, and textile industries, as well as consumer goods and supermarket chains. Besides these, Krzyzaniak *et al.* (2012) mention that products from the agribusiness and mining industry, machinery, equipment, furniture, and recyclable materials may also flow through logistics hubs. As a matter of fact, Afandizadeh and Moayedfar (2008) point out that logistics hubs can handle any type of product, whether bulk cargo or manufactured goods, as long as they can take advantage of the available services and infrastructure. This is the case of the Spanish hub PLAZA, where one can find from clothes to seafood goods (Sheffi, 2012): although at a first glance they may seem quite different, both products take advantage of the hub structure by sharing the same transport mode and being destined to the retail market.

Setting up a logistics hub and defining its value-adding potential are directly related to specific attributes of the supply chain(s) it services (Rodrigue and Notteboom, 2009), volume of goods handled, and flows that go through such facility (Konings, 1996). According to Rodrigue and Notteboom (2009), each supply chain may involve several different markets, which result in different ways of using the hub and of performing hinterland operations. With this in mind, it seems reasonable to distinguish logistics hubs according to their type. The analysis of literature and observation of existing hubs shows that the classification could be related to the point of the supply chain where the hub is positioned, the characteristics of products´ flows and the served market. The proposed typology, in which the different logistics hubs may be interrelated, is showed in Figure 2. It consists of four elements: industrial hub, port hub, distribution hub, and reverse hub.

Industrial hubs are facilities dedicated to the articulation of products flows between different levels of manufacturing, including agribusiness and mining commodities; i.e. before the goods leave for distribution to end customers. Such hubs may offer multimodal transport, depending on the available infrastructure. In many cases, industrial plants can be found next to the hub, or even integrated to its own structure (Sheffi, 2012). Cargo flowing through the hub can be unitized as full-load or less-than-truckload, according to the type of product and vocation of the facility. An example of industrial hub that serves the textile industry can be found in the work of Eryuruk *et al.* (2011; 2013).

Operating usually as part of logistics clusters, such as ports or border points, port hubs handle bulk cargo or containers. This type of hub is generally related to international trade, although it can also handle cargo from domestic trade to be transported by coastal shipping or railways, for example. While providing customs services, it takes shape as a dry port. Due to its characteristics, it often comprises multimodal transport. Authors such as Fernandes and Rodrigues (2009), Rodrigue and Notteboom (2009) and Dadvar *et al.* (2011) address this type of logistics hub.

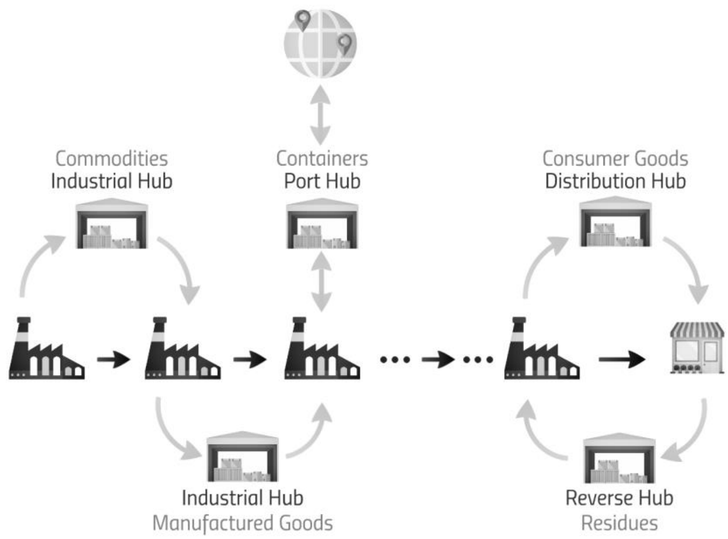

Figure 2 – Typology and vocation of logistics hubs

Distribution hubs, in turn, handle the movement of goods to meet end-customers of supply chains, either through wholesalers or retailers. Therefore, it adopts as transport mode the road network. In this category we also include urban hubs, which concentrate logistics activities outside large cities or metropolitan areas in an attempt to improve traffic and distribution as a break-bull structure (Afandizadeh and Moayedfar, 2008). This can be done, for example, through consolidation/deconsolidation of cargo or transfer between large trucks and smaller vehicles. Distribution hubs are among the most cited in literature and can be found in the work of Jaržemskis (2007), Rodrigue (2008), Li (2011) and Tambi *et al.* (2013).

Finally, reverse hubs follow the current trend of changing from the traditional paradigm of producing and consuming goods to that of a circular economy. In this latest economic model, beyond the traditional flow of goods, we find a reverse flow of materials after their consumption, which could be destined to maintenance, reuse, redistribution, remanufacturing or recycling, setting up closed loop supply chains (Ellen McArthur Foundation, 2013). Yet, while direct distribution channels are already well defined, reverse paths are still scattered, making it difficult to implement this newer idea. Reverse hubs can be used as elements for organizing and articulating reverse flows, aiding in the set-up of pools of materials. In this sense, reverse hubs can also be integrated to other types of hubs, e.g. distribution or industrial hubs, taking advantage of economies of scope and of the use of transport connections and corridors. Although we have not identified papers that deal with the application of circular economy concepts to logistics hubs, Krzyzaniak *et al.* (2012) point out that recyclable materials can indeed be handled in logistics hubs.

FINAL THOUGHTS

The growing interest in logistics hubs foments the reflection of its concept and properties. Based on the classification and hierarchy of logistics facilities, it is possible to eliminate ambiguities in the definition of hubs. For this, one must take into account a variety of criteria which allow distinguishing not only among different types of facilities, but also among hubs.

Indeed, the analysis of the existing facilities and structures shows that the heart of this issue is related in greater deal to the profile of the facilities than to the specific definitions adopted by each author. Hubs have, in essence, a conceptual tripod: collaborative framework, assets sharing, and value-added services, which can be expanded and absorbed by the existing facility terminology despite of their original nomenclature. Although greater economies of scale and scope are the main targets of a hub, each one of them is unique according to the proposed typology. The design of a hub can take into account the amount of LSPs operating, the transport infrastructure, the nature of goods handled, and markets served, among others.

The differentiation between logistics hubs and other facilities, and also among hubs, may be explained in an uncomplicated manner by means of analogies between shops and facilities, shopping malls and logistics hubs, and shopping areas and clusters.

Logistics establishments, such as warehouses, behave as regular shops spread around cities. We may even find large department stores, which resemble shopping malls. Indeed, this type of shop can have greater market coverage, or be highly specialized, e.g. those targeted to the construction market, but they are still individual units and usually do not show signs of collaboration with other stores in the area.

Secondly, there is also a correlation between logistics hubs and shopping malls. The configuration and operation of these facilities are similar, especially in the case of distribution hubs due to the disaggregated form of products unitization. In a shopping mall, we find individual shops, but with a common goal: offering consumer goods and other services related to the shopping experience to its customers. Different shops inside a mall may be compared to the different LSPs operating in a hub. A mall is installed in a delimited area, where stores share infrastructure and administrative services and may benefit from consolidated transport through the use of urban hubs. Shopping malls also perform, from time to time, collaborative actions that benefit the entire group while still competing, such as seasonal sales and advertising. Moreover, in the same way as distinct logistics hubs, different malls may be targeted to different markets, either local or disperse, can be focused on customers with different purchasing power, or even driven to a particular type of product, like furniture and home decor.

Finally, greater shopping areas may encompass different malls, department stores, and smaller shops, while serving geographically disperse markets. The area is not so well defined, and is usually installed outside great metropolitan areas. Nonetheless, the facilities still benefit from the agglomeration in different ways. In this sense, they resemble logistics clusters.

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Bibliography

Afandizadeh, S., R. Moayedfar. 2008. The feasibility study on creation of freight village in Hormozgan Province. *Transport* **23**(2): 167–171.

Cambra-Fierro, J., R. Ruiz-Benitez. 2009. Advantages of intermodal logistics platforms: Insights from a Spanish platform. *Supply Chain Management* **14**(6): 418–421.

Cassone, G. C., D. Gattuso. 2010. Models of intermodal node representation. *European Transp. - Transporti Europei* (46): 72–85.

Dadvar, E., S. R. S. Ganji, M. Tanzifi. 2011. Feasibility of establishment of "Dry Ports" in the developing countries-the case of Iran. *Journal of Transportation Security* **4**(1): 19–33.
Ellen McArthur Foundation. 2013. Circular Economy - Interactive system diagram. Available at: http://www.ellenmacarthurfoundation.org/circular-economy/circular-economy/interactive-system-diagram [Accessed October 21, 2014].
Eryuruk, S. H., F. Kalaoglu, M. Baskak. 2011. Logistics centre design for the Turkish clothing industry. *Fibres & Textiles in Eastern Europe* **88**(5): 17–22.
Eryuruk, S. H., F. Kalaoglu, M. Baskak. 2013. Comparision of Logistics and Clothing Sectors for a Logistics Center Site Selection Using AHP. *Fibres & Textiles in Eastern Europe* **98**(2): 13–18.
Fernandes, C., G. Rodrigues. 2009. Dubai's potential as an integrated logistics hub. *Journal of Applied Business Research* **25**(3): 77–92.
Grundey, D., K. Rimienė. 2007. Logistics centre concept through evolution and definition. *Engineering Economics* **54**(4): 87–95.
Higgins, C., M. Ferguson, P. Kanaroglou. 2012. Varieties of logistics centers. *Transportation Research Record: Journal of the Transportation Research Board* (2288): 9–18.
Jaržemskis, A. 2007. Research on public logistics centre as tool for cooperation. *Transport* **22**(1): 50–54.
JuráskMová, K., P. Macurová. 2013. The study of logistic parks in the Czech republic. *Journal of Applied Economic Sciences* **8**(3): 299–310.
Kabashkin, I. 2007. Logistics centres development in Latvia. *Transport* **22**(4): 241–246.
Konings, J. W. 1996. Integrated centres for the transshipment, storage, collection and distribution of goods: A survey of the possibilities for a high-quality intermodal transport concept. *Transport Policy* **3**(1-2): 3–11.
Krzyzaniak, S., M. Hajdul, I. Fechner. 2012. The Concept of a logistics centre model as a nodal point of a transport and logistics network. *Archives of Transport* **24**(2): 165–186.
Li, X. 2011. The analysis on the factors of developing zhengzhou city into a regional center of international logistics. *Communications in Computer and Information Science* **210 CCIS**(PART 3): 586–591.
Meidutė, I. 2005. Comparative analysis of the definitions of logistics centres. *Transport* **20**(3): 106–110.
Meidutė, I. 2007. Economical evaluation of logistics centres establishment. *Transport* **22**(2): 111–117.
Notteboom, T., J. P. Rodrigue. 2009. Inland terminals within North America and European supply chains. *Transport and Communications Bulletin for Asia and the Pacific No. 78: Development of Dry Ports*. New York, Economic and Social Commission for Asia and the Pacific, United Nations, 120.
Rodrigue, J. P. 2004. Freight, gateways and mega-urban regions: the logistical integration of the Bostwash corridor. *Tijdschrift voor Economische en Sociale Geografie (Journal of Economic & Social Geography)* **95**(2): 147–161.
Rodrigue, J. P. 2008. The Thruport concept and transmodal rail freight distribution in North America. *Journal of Transport Geography* **16**(4): 233–246.
Rodrigue, J. P., T. Notteboom. 2009. The terminalization of supply chains: Reassessing the role of terminals in port/hinterland logistical relationships. *Maritime Policy and Management* **36**(2): 165–183.
Savy, M., X. Liu. 2009. Freight Villages and Urban Planning: a Sino-French Approach. *THNS Forum*. Shanghai, 1–12.
Sheffi, Y. 2012. *Logistics Clusters*. Cambridge, MA, MIT Press.
Šulgan, M. 2006. Logistics park development in Slovak Republic. *Transport* **21**(3): 197–200.
Tambi, A. M. A., M. N. Mohid, I. A. Shukor, M. S. M. Arip. 2013. Planning for a logistics village. *World Applied Sciences Journal* **25**(3): 421–427.