Logistic facilities and territory: Spatial dynamics and policy issues

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Abstract
This article argues that logistics not only is a fundamental component of firms' strategy and a globalization vehicle but is becoming also a challenge for regional development. The paper explores the relationship between logistics and the spatial framework in terms of its forms and its determinants. A systemic analysis of the interactions between logistics system, production system and land use system is driven. The geographic dimensions of the logistics system are so explored. We analyse the spatial dynamics of various logistical sites by emphasizing the importance of the logistics infrastructures planning with respect to territorial challenges. We propose directions to public decision making.

Keywords:
Spatial Dynamic, Logistic Platforms, Systemic Analysis

Titre
Implantations logistiques et territoire : Dynamiques spatiales et enjeux de politiques publiques

Résumé
La logistique est non seulement un élément fondamental de la stratégie des entreprises et un véhicule de la mondialisation, mais devient également un défi pour le développement régional. Le papier se propose d'explorer la relation entre logistique et territoire, ses formes et de ses déterminants à partir d'une analyse systémique des interactions entre système logistique, système de production et territoire. Les dimensions géographiques du système logistique sont ainsi explorées. Les dynamiques spatiales des sites logistiques aux différentes échelles géographiques sont analysées. Le papier met en exergue l'importance de la planification des infrastructures logistiques au regard de ses enjeux territoriaux.

Mots-clés :
Dynamiques spatiales, plates-formes logistiques, analyse systémique

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1 Introduction

Logistics is not only a fundamental component of firms' strategies (Heskett, 1977; Cooper et al., 1997) and a vehicle for globalization (Hesse and Rodrigue, 2006; Hesse, 2007), it is also becoming an issue for regional development and planning (Savy, 2006, 2012; Masson and Petiot, 2012).

In a production system where synchronization and reactivity are keywords, logistics plays a critical role in the spatial organization of markets. Globally, the international fragmentation of production processes has a significant impact on the flows and associated design logistics (Hesse and Rodrigue, 2006). The dual phenomenon of vertical disintegration and concentration of activities led to a geographical concentration of logistics units (Hesse, 2002; Hesse and Rodrigue, 2004; Cidell, 2010). Furthermore, the polarization of logistics facilities doubles as a spatial spreading on the peripheries of urban metropolises (Dablanc and Ross, 2012). The performance of logistics authorizes and even today accompanies the transformation of the productive system and its spatial setting. Then, the growing prominence of environmental concerns makes it increasingly important to take account of the interactions between the organization of logistical chains and that of territory. Researchers and public authorities have therefore started to consider the issue of spatial planning for logistics.

The aim of this article is to discuss the relationship between logistics and its spatial setting, in terms of its forms, the associated issues and its determinants. Little research has explored the link between logistics and land use, even though logistics is a complete system of spatial and temporal interdependencies and the spatial impacts of logistical chains are not negligible, especially in terms of sustainable development. *What interactions are there between logistics and territories? What are the spatial dimensions of logistics? What model explains the location of logistical infrastructure? What are the territorial issues for logistics facilities? Is the logistics territorial planning necessary?* The contribution of the article is to analyse the relationship between logistics and its spatial setting by conducting a systemic analysis of the interactions between logistics system, production system and

land use system. It emphasizes the importance of planning logistics facilities with regard to territorial challenges and proposes some directions to public decision making.

Following a precise definition of the concepts of logistics, supply chain and logistical systems, the first part of the paper sets out the framework we use to shed light interaction between the logistics system and areas. Part two investigates the basis for the interactions between logistics and territory, namely the interdependencies between the logistical system and the production system and the links between production system and territory. Part three begins by describing the different spatial dimensions of the logistical system and provides some theoretical perspectives on the location of logistical infrastructure and the spatial dynamics of logistical chains. We then examine the process of territorial planning of logistics and its shortcomings. These analyses focus on the French case. Last, the paper considers what the future holds for the relationship between logistics and its spatial setting and the disruptions that may occur in the medium term.

2 Logistics and territory: definitions and analysis framework

The function of logistics and its role in the value chain have undergone some major changes (Porter, 1985). It is essential to define precisely the concepts of logistics, supply chain and logistical system (2.1) before proposing a framework for analysing the interactions between logistics and territory (2.2).

2.1. Definitions

Initially, logistics was seen as mainly consisting of the operational management of physical flows, but it is now perceived as a strategic function that is concerned with the scheduling and management of physical and information flows in the extended firm, in particular under the impetus of Supply Chain Management (SCM). Logistics is a process of moving and handling goods and materials, from the beginning to the end of production to satisfy customers and improve business competitiveness. It takes in the control of product flows and the coordination of resources and opportunities and

achieves a given level of service at the lowest possible cost (Heskett, 1977). Logistics makes use of in-house or outsourced resources along a chain that stretches from input to output and which takes in all the physical operations (transport, warehousing, storage, cross-docking, freight handling, P-manufacturing, co-packing, distribution, *etc.*). The aim is to achieve customer satisfaction under the best possible conditions for the firm (the time-cost-quality triangle). Logistics also relies on the use of increasingly sophisticated information and communication systems (information system software packages, EDI[1], RFID[2], *etc.*).

The logistical chain is defined as a set of three or more entities linking a supplier to a client which carries upstream and downstream flows of products, services, information and finance between a supplier and a client (Mentzer et al., 2001). These entities purchase, produce and in some cases store, transport and sell goods or services. The logistical chain is based on physical infrastructure such as logistical sites. Its performance depends on the organization of the logistical network. Logistical chains can be classified according to the characteristics of their participants. If the sites are located in different countries, we use the term global logistical chain. If the participants all belong to the same legal entity (even if the firm has a number of sites) we use the term internal logistical chain. Last, an external logistical chain is one in which an inter-organizational rather than an intra-organizational approach is applied, which involves both the firm's suppliers and its clients, and in some cases even end consumers.

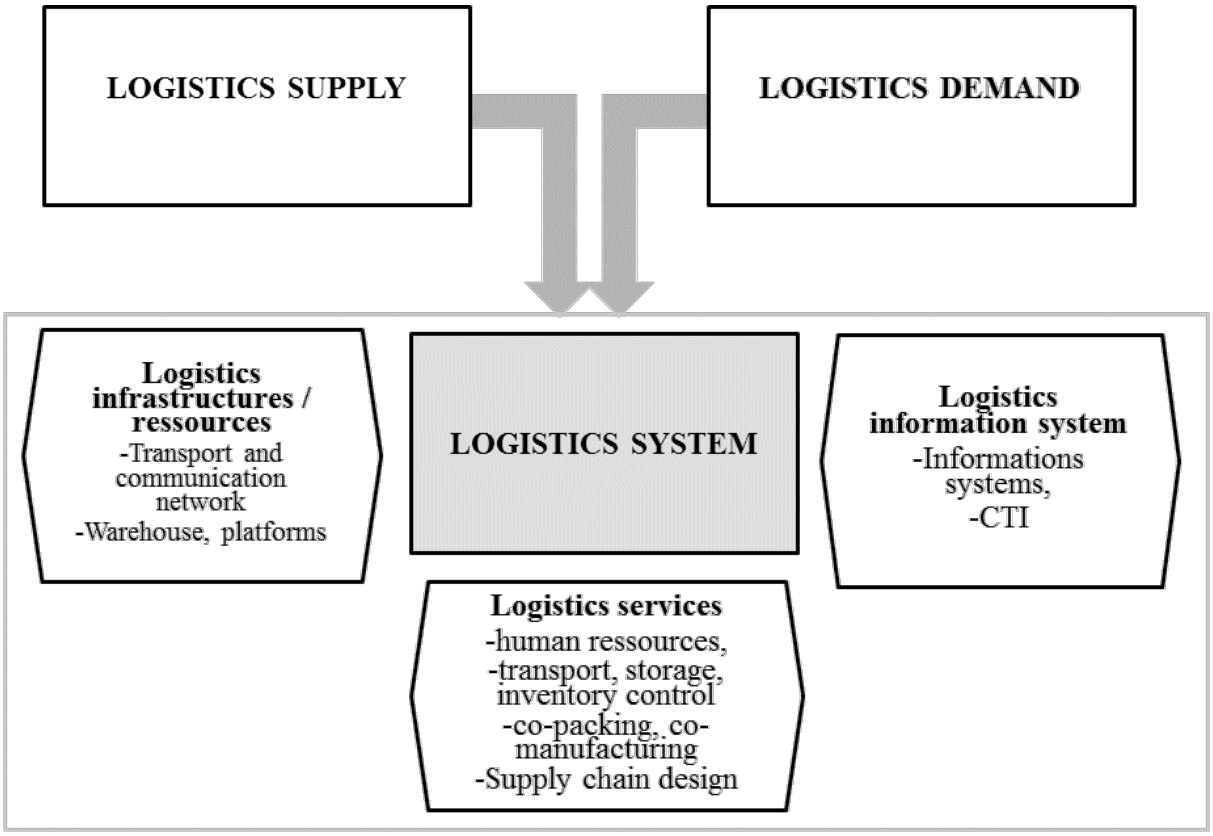
The concept of SCM, which appeared in the 1990s, reflects the desire on the part of firms in the industrial, distribution and logistical services sectors which operate within the same value chain to respond to customer demand by developing, producing and selling products under terms which are satisfactory as regards cost, quality of service and responsiveness (Mentzer, 2004; Christopher, 2005; Bowersox et al., 2009). SCM employs an integrating and systemic vision, considering logistics primarily from the strategic (as opposed to an instrumental) angle. The structure is

[1] EDI: Electronic Data Interchange
[2] RFID: Radio Frequency IDentification

decompartmentalized, linking the supplier upstream to the clients downstream. SCM is thus concerned with optimizing the logistical chain as a whole rather than on a segment by segment basis. The goal is to integrate all the logistical processes by synchronizing all the information flows and coordinating all the actors involved in or affected by the processes in question. These new trends in logistics management highlight the role of the pivot-firm and sometimes the distance between places of decisions and places of logistics operations.

Last, in order to investigate the relationship between logistics and its spatial setting, we need to define the logistics system (see Figure 1), which is made up of logistics supply and demand. Logistics supply depends on logistics and transport infrastructure (logistics hubs, transhipment terminals, motorways, railways, *etc*.) and the actors in the logistics sector (the logistics departments of industrial and commercial firms, logistical services providers, *etc*.). Logistics demand depends on the flows and stock levels that are required by the system of production. The logistics system achieves a match between supply and demand, from upstream to downstream in the value chain. It is a complex, multidimensional system (Hesse and Rodrigue, 2004), made up of different sub-systems: the logistics infrastructures and resources system which comprises warehouses, logistics platforms, transport and communication network; logistics information system which include modelling and management of informative flows, tracking and tracing and logistics services system which organize the movement of materials and products from inputs through production to consumers, as well as associated reverse flows (BTRE, 2001).

Figure 1. Logistics system



The logistics system must also include the geographical dimension because it brings supply, which depends on spatially distributed technical systems, into contact with demand which exists at different geographical levels (ranging from local to global). Indeed, logistics operations take place in specialised building and zones, in the nodes of logistics networks (transfer logistics platform, cross-docking platform, storage platform, *etc.*). The quality of the territorial organization of the logistics system conditions its performance.

2.2. Interactions between logistics and territory: analytical framework

Logistics is intrinsically linked to territory and there is a strong interaction between logistics and territory. If a profuse literature exists on the analysis of the relationship between transport infrastructure and territory, yet, with a few exceptions, logistics appears to be neglected in contemporary research (Hesse and Rodrigue, 2004). However, inscribed in globalization, the logistics

heavily involves the organization of the territory. Scientific publications in logistics are numerous but mainly derived from the disciplines of management science and operations research, and focused more on issues related to the processes and logistics methods. Researches concerned with logistics in the spatial point of view are thus few and relatively recent. Early researches focus on the problem of freight movement in the city and of urban logistics in a context of traffic congestion and willingness to develop sustainable transport policies (see for example Thompson and Taniguchi, 2001; Muňuzuri et al., 2005, 2012; Dablanc, 2007; O'Connor, 2010; Gonzalez-Feliu and Morana, 2010; Neubert and Moutaoukil, 2013). Hesse and Rodrigue (2004, 2006), Hesse (2007), Bowen (2008), McKinnon (2009), Cidell (2010), Wagner (2010), Dablanc and Rakotonarivo (2010) and Dablanc and Andriankaja (2011) are interested in the modification of the geography of logistics activities, highlighting the dual phenomenon of geographical concentration of these activities on a select few points in national or continental areas and deconcentration on the peripheral areas, as well as the extent of land requirements for these activities. Savy (2006), Hesse and Rodrigue (2004, 2006), Wackermann (2005), Mérenne-Schoumaker (2007), Jakubicek and Woudsma (2011), Masson and Petiot (2011, 2012), Raimbault et al. (2013) and Strale (2013a, 2013b) analyse the springs of spatial dynamics of logistics. Hesse (2006) and Cidell (2011) underline that the territories are still relevant despite the supposedly placeless world structured by the global logistics network. Specifically, Dablanc and Ross (2012), Masson (2013), Masson and Petiot (2013) and Raimbault et al. (2013) examined the strategies of public and private actors in the production process of industrial space and questioned the territorial governance of these activities. Nozick and Turnquist (2001), Bhatnagar and Sohal (2005) and Melo et al. (2009) provide analyses of operational research location logistics companies. Furthermore, several studies focus on distribution Centers, their spatial role and location (Sheu, 2003; Oum and Park, 2004). Finally, Sheffi (2012) and Van den Heuvel et al. (2013a; 2013b) interested in understanding the spatial concentration of logistics activities and question the government on the effects of co-location of these activities.

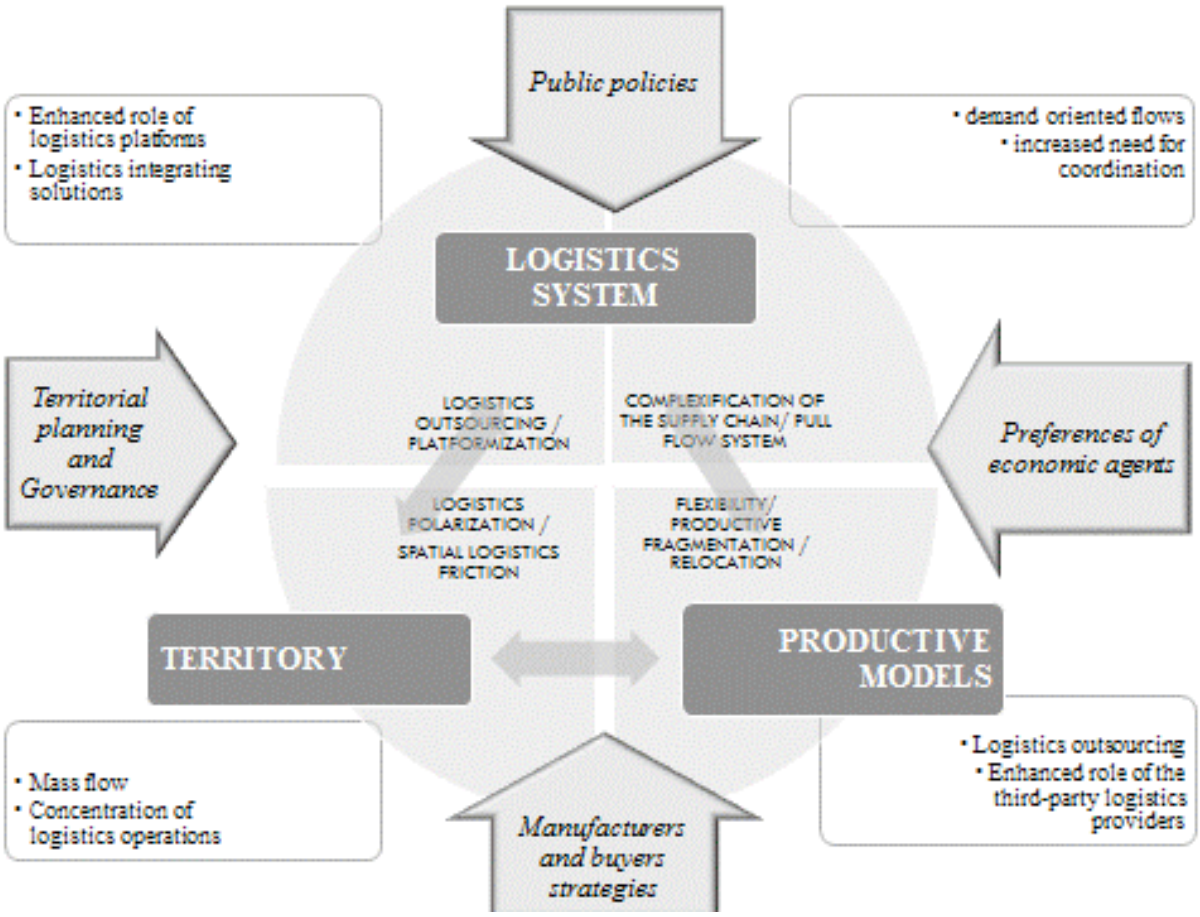
This late interest in spatial issues of logistics is explained by the relatively recent development of logistics as the pivot of the productive organization, by the lack of consolidated statistics on the geography of logistics units, and certainly by the fact that the logics of those logistics facilities are essentially private. Since the early 2000s, the evident interest on the spatial registration of logistics is explained by the increasing complexity of supply chains in the context of globalization reinforced, the growing outsourcing of logistics activities and especially the explosion of facilities logistics sites. Moreover, competition for land and the injunction to sustainable development have highlighted the significance of the territorial dimension of logistics.

In order to identify the relationship between logistics and its spatial setting, it must be borne in mind that logistics provides the operational link between production and consumption. The organization of logistics therefore depends on the organization of the system of production it serves. Then, to analyse the interactions between logistics and territory we mobilize a systems-based framework (Von Bertalanffy, 1969; Walliser, 1977; Morin, 1990; Lapierre, 1992; Lugan, 1993). The strength of the approach rests in the holistic analysis of structure, relationships, and emergent dynamics of problematic situations. The links between logistics and the territory may therefore be observed by conducting a three dimensional systemic analysis of the interactions between the logistics system, the productive model and the territory (see Figure 2). The aim of the systems analysis is to identify the elements that make up the system, to characterize the interactions between them, to define the boundaries of the system and analyse the interactions between the subsystems.

The links between logistics and territory may therefore be observed by conducting a systems analysis of the interactions between the logistics system, the production system and the territory (see Figure 2) as the interactions between logistics and territory depend on the interactions between territory and the production system.

The aim of the systems analysis is to identify the elements that make up the system, to characterize the interactions between them, to define the boundaries of the system and analyse the interactions between the subsystems. A distinction must be made between two types of interactions: internal links, which are shown in Figure 2 by links between each subsystem, and external links which relate to the impact of variables that are exogenous to the system, for example public policies, changes in the preferences of economic agents or in firm's strategies and territorial planning and governance, on the nature of the interactions between the subsystems and how these interactions change. Systems analysis also provides an opportunity to identify tensions and disruptions within the logistics system, by examining how it interacts with the production system and the territory. These disruptions may, in particular, result from growing environmental concerns and be brought about by the influence of the exogenous variables.

Figure 2. Interactions between logistics and territory



The aim of this article is first to discuss the interactions between logistics system, territory and productive models from the proposed conceptualization of Figure 2. Second, logistics is likely to consume an increasing amount of energy and land and contributes to a wide range of problem as negative externalities (air and noise emissions, congestion, land use conflicts, *etc.*). It emphasizes the need for policy and planning to support a sustainable development.

3 Interactions between LogistiCS AND PRODUCTION SYSTEMs

The logistics system is both an active participant in the production system and a vehicle that facilitates its operation (3.1). Furthermore, the production system has impacts on the organization of space. Firms' strategies are responsible for their location, thereby shaping the territory. The territory in its turn helps to structure the production system (3.2).

3.1. Interactions between the production system and the logistics system

The spatial extension of the production system generates flows of products and information which require the implementation of logistical models (*3.1.1*). Moreover, logistics and the way it is organized influence the development of production systems (*3.1.2*).

3.1.1. The logistical impacts of modifications in the production system

Logistics reveals the motivation behind industrial and commercial strategies. The logistical system is defined by the organization of the production system because the function of logistics is to coordinate supply and demand. Logistics includes both coordination upstream (procurement, production inputs), and downstream (distribution, customer relations). Coordination is necessary both in time (storage, just-in-time, seasonality issues, *etc.*) and space (distribution, transport flows). The organization of logistics reflects production constraints (the nature of demand, models of production, and types of resources used, positioning in the sector and types of product) which result from trade and interaction between the actors.

The logistics system is therefore driven by changes in the organization of the production system. The latter has undergone major modifications since the 1970s, changing from the Fordist model to a system of "flexible" production, whose most extreme form is the "just-in-time" model (Hollingsworth and Boyer, 1997; Boyer, 1998; Boyer and Freyssenet, 2002). The main features of the *post-Fordist model* are the result of strategies of vertical disintegration on the part of firms (refocusing the firm's activities on its core activities and the strategic dimension). Vertical disintegration leads to specialization, concentration within the industry (creation of large groups, reduction in the number of production sites, increase in the volume output by each production unit), outsourcing, and an increased tendency to internationalize and delocalize processing units. This model is a response to changing markets in which demand is no longer stable but fluctuating. The production system is thus driven more by demand than supply (pulled flow). Planning horizons and delivery deadlines are shortened. The reorganization of the production system also expresses the transition from a stock-based economy (mass production, relatively low levels of diversification, slow turnover rates) to a flow-based economy (personalization of products, renewal of ranges). The goal of reducing inventories has taken the place of maximizing production capacities. Other fundamental goals are achieving flexibility and responsiveness. The restructuring of production systems means that cycles of supply, production and distribution are functionally integrated and driven by demand. As a result of this reorganization logistics has acquired a strategic regulating role between production and the market that takes in the whole production process. The management of information flows becomes essential in order to improve synchronization. Applying the SCM approach becomes vital.

The reshaping of the production system affects both flows and the organization of logistics provision. The concentration of the industry leads to increasingly consolidated flows. The globalization of the locations of supply and the international segmentation of the production process lengthen the distance between areas of production and consumption, increasing transport distances and leading to the creation of new interface sites (warehouses and logistical hubs). The concentration of distribution has also led to a reduction in the number of delivery points and the

consolidation of flows. Then, logistics hub or Distribution Centers (DC) are becoming larger and plays an increasing role in the flows organization.

While the concentration of actors favours the consolidation of flows, other factors are tending to break them up, in particular in the case of end legs. These factors include faster product turnaround, the desire to reduce stocks, the need for the instant availability of goods, the erratic and unpredictable nature of demand, the growing number of items and the reduction in product life cycle durations. Also, the vertical disintegration of the production system has encouraged the outsourcing of logistical services and the emergence of a logistical services provider sector.

Last, since the 1990s, the rate of globalization has increased, with not only an increase in international trade, but, above all, an increase in the international fragmentation of productive process that aims to reap the combined benefits of specialization and economies of scale. This concept was referred to as Global Production Network (GPN, see Henderson et al., 2002; Coe et al., 2008), Global Value Chain (GVCs, see Gereffi et al., 2005; Sturgeon et al., 2008; Elms and Low, 2013), Global Commodity Chain (GCCs, see Wallerstein, 1988; Gereffi and Korzeniewicz, 1994). International production, trade and investments are increasingly organized in a scheme where the different stages of the production process are located across different countries. Globalisation motivates companies to restructure their operations internationally through outsourcing and offshoring of activities. Firms try to optimise their production processes by locating the various stages across different sites according to the most optimal location factors across countries. The past decades have witnessed a strong trend towards the international dispersion of value chain activities such as design, production, marketing, distribution, *etc.* Then, globalization is looked at by decomposing it into two phenomena: fractionalization concerning the unbundling of supply chains into finer stages of production and dispersion concerning the geographic unbundling of stages.

The links in the value chain are increasing in number and being distributed all over the world according to the relative advantages of each area, thereby creating an ever increasing number of

transport flows. In logistical terms, the impacts of this are to substitute the movement of information for stocks, to substitute transport capacities for stocks and reduce the size of the batches that are pre-manufactured and transported (Dornier et al., 1998).

Then, these changes in global production increase the complexity of the supply chain, reinforcing the idea that logistics strategies and practices become key elements for companies. The degree of logistical complexity increases as organizations start to adopt a geographically dispersed model of production and distribution in order to meet to expectations of their customers adequately (Da Silva et al., 2014).

The creation and use of logistics operations centers (or Distribution Centers (DC) or logistics platforms) become an alternative to the current level of dynamism and competitiveness. Logistics operations centers can generate benefits such as the shared use of logistics infrastructures, the possibility of increasing productivity, the reduced customer order cycle, the generation of innovation in services and the added value at the final product (Da Silva et al., 2014). The use of a system of logistics operations that is capable of integrating the activities and also the actors involved in the supply chain becomes a strategic concern for companies (Notteboom and Rodrigue, 2005).

Hesse and Rodrigue (2004) propose the concept of *logistics friction* which permits to capture the relationship between the evolution of the productive and logistics systems. These authors emphasize that this relationship goes through the complexity of the supply chains brought by changes in productive organizations. *"The more complex the supply chain, the higher the friction since it involves both organizational and geographical complexity"* (Hesse and Rodrigue, 2004: 180).

3.1.2. Logistics at the heart of changes in the production system

Logistics is playing an increasing role in restructuring production systems because it has the potential to improve their efficiency (Rodrigue, 2006). Flexible order and supply behaviour is actually made possible by the performance of the logistics system, as well as its physical, organisational and informative dimensions. The flexible productive model combined with the international

fragmentation of productive process requires a high level of coordination and implies increasing flows transport. The geographic dispersion, which concerns the spatial unbundling of stages, has been made also possible by a considerable reduction in transaction costs, mainly through lower logistical costs. Logistical functions still account for a considerable proportion of total production costs even though it is difficult to measure. Logistical costs account for between 10% and 14% of global GDP (Rodrigues et al., 2005). The reduction in logistical costs has been brought about both by technological progress (the specialization of vehicles and improvements in the components of the information system) and organizational changes. The specialization of transport equipment has increased both productivity and capacity allowing greater consolidation and a reduction in costs. Another source of productivity gains and reliability of transport chains is containerization, which permits to reduce the breaking loads and facilitates door-to-door transport chains. Major developments in the Information Technologies (IT) tools used in information systems have facilitated the optimization of the management of flows and logistical integration and played an important role in improving logistical performance. The organizational improvements relate both to the design of transport networks with the general adoption of the "hub-and-spokes" system and logistical integration. Furthermore, the development of logistics outsourcing and the third-party logistics providers It supports the operational realization of the changes of the productive models.

Ultimately, the logistics system plays an essential role in the development of the production system and globalization, thus in the regional and transport systems.

3.2. Interactions between the production system and territory

The location of activities depends on the overall strategies of manufacturers and distributors which are nowadays becoming increasingly integrated at a global level. The locations of activities structure territories (*3.2.1*). Territories in their turn help to shape the production system (*3.2.2*).

3.2.1. The impacts of the production system on land use

As we underline above, the restructuring of productive model leads to changes in geographical organisation. Two phenomena can be observed: the fractionalisation of production process coupled with spatial dispersion at the international level and the geographic concentration of activities and metropolization tendencies. The internationalization of trade has led to an increase in the size of market areas. This phenomenon is accompanied by a change in strategies for optimizing the location of industrial sites, in particular on the basis of production costs. This leads to relocation. The transformation of the production system is also causing the polarization of activities and metropolization. The largest conurbations seem to attract the major share of activities and superior functions, leaving other areas with production with lower added value. Moreover, the shift to a demand-pulled mode of production imposes specific locational choices. These are dictated by the desire to apply delayed differentiation. The strong need for market responsiveness results in geographical proximity or ultra-short logistical circuits.

Last, globalization does not mean that space has been eradicated but that spatial relationships have been modified. The interaction between the global and local levels has spawned the concept of *glocalization* (Veltz, 2007).

3.2.2. The spatial dynamics of the production system

The analysis of spatial dynamics examines the basis for corporate locational decisions. Locational decisions have been studied for centuries (Von Thünen, 1842; Weber, 1929; Christaller, 1933). It is not the scope of this paper to discuss the theoretical debate about the relationship economics activities and have with space. Nevertheless, it should be borne in mind that the first economic studies of the location of activities, following on from the work of Weber (1929), considered locational decisions from the standpoint of the cost-distance-space triangle (Ponsard, 1988). The accessibility of resources, inputs and markets is thus a decisive factor for the location of economic activities. The striking improvements in transportation technologies (specialized transport vehicles and terminals, capacity increases, *etc.*) and information and communication technologies have

lowered transaction costs and one might have anticipated a more even spatial distribution of activities. However, what we observe is the opposite - a global process by which economic activities are becoming more concentrated.

Since the work of Perroux (1950) on the forces of agglomeration and dispersion of polarization and diffusion (growth-pole theory), there has been a lot of attention for the phenomena of spatial concentration, The New Economic Geography (NEG) (Fujita and Krugman, 2004) provides valuable insights into this process in the case of imperfect competition and explains spatial concentration of activities by agglomeration economies. A firm's locational choice is the outcome of a trade-off between the centripetal forces that depend on the interactions between increasing output and externalities and that encourage agglomeration, and centrifugal forces linked to transport costs which encourage activities to become spatially dispersed (Krugman, 1991a; 1991b; Puga and Venables, 1996; Fujita et al., 1999). The Krugman model (1991b) shows that when transport costs are low, activities exhibit a dynamic of agglomeration which enables them to take advantage of external economies of scale.

Another perspective emerging from the Italian literature on industrial districts (Becattini, 1986; 1992) underlines the role of social relationships in industrial district (the *industrial atmosphere* of Marshall (1890)) to explain agglomeration of economic activities and their growth. This approach endogenizes space. Space becomes "territory" and generates singular modes of operation and provides specific resources (Becattini, 1992) which explain the agglomeration of activities and their competitiveness. Last, the "Proximity Dynamics" group (Torre and Gilly, 1999; Torre and Rallet, 2005) considers concept of proximity and proposes to give it content. The proximity has two dimensions namely geographical proximity and organisational proximity. The latter highlights the role of non-pecuniary externalities and the choice of locations for activities, as well as the importance of coordination between the actors in the area.

4 THE LOGISTICs SYSTEM AND territory: SPATIAL dimensionS OF LOGISTICS, THEORETICAL perspectiveS AND land use IMPACTS

The relationship between logistics and its spatial context takes many forms. Territories are shaped by the logistical system as much as they shape it. After describing the different spatial dimensions of the logistical system (4.1), we shall examine the spatial dynamics of logistics from a theoretical perspective (4.2). Last, we will consider the territorial issues of logistics and the need of land use planning and governance for logistics facilities (4.3).

4.1. The spatial dimensions of the logistics system

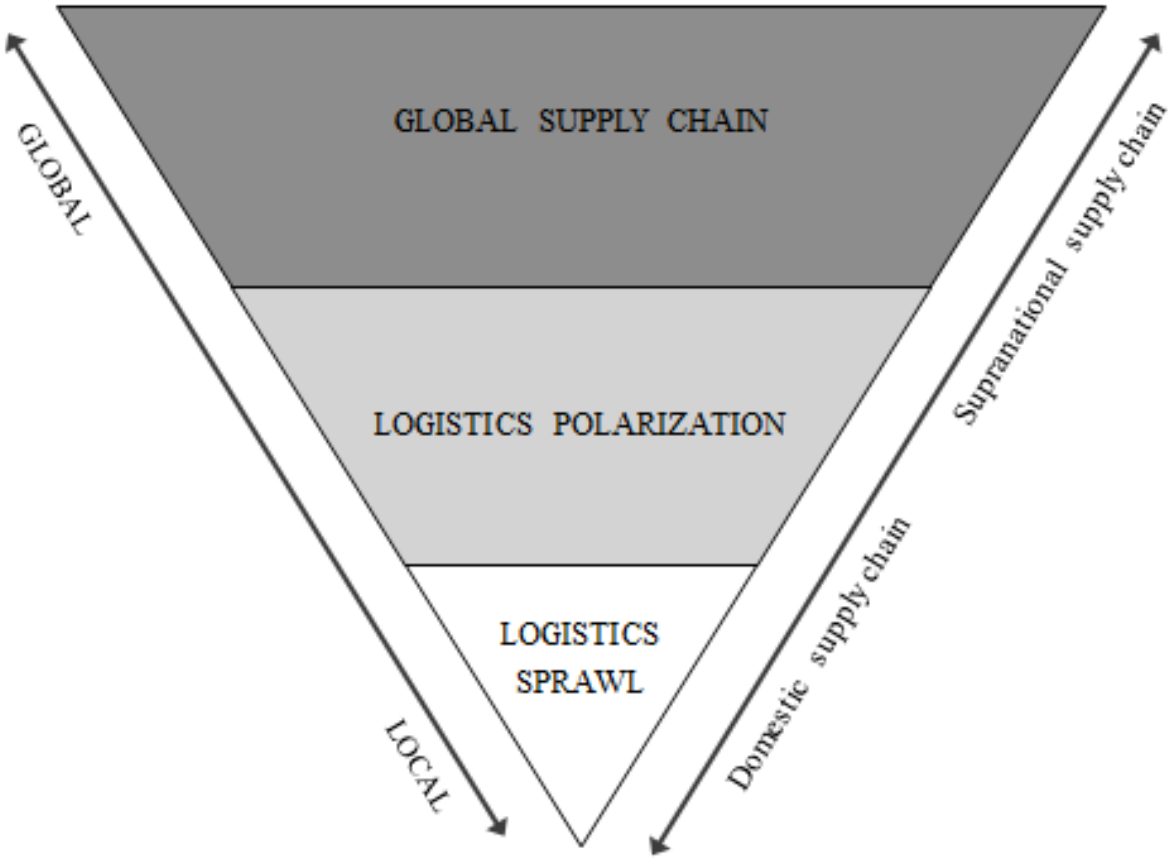
The spatial impacts of logistics take place at several geographical levels. Logistical chains generate flows and breaks in the transport chain. The way they are organized and their efficiency depend on logistical infrastructures, which are the spatial manifestation of static logistical activities. At the global level, we can observe that logistical chains are expanding internationally. The supply chain also plays an organizational role which involves not only several countries but an entire continent, or even the whole planet. In this context, logistics outsourcing and logistics service providers play a crucial role, boosting geographical expansion by supporting and assisting the internationalization strategies implemented by producers and distributors. The geographical integration of logistics raises the issue of simultaneously managing the interfaces between global and local geographical levels in an efficient manner. The emergence of spatially fragmented commodity chains, which produce high complexity in the management of physical flows, is carried by logistics platforms as spatial interfaces. The problem facing organizations is that they must simultaneously manage flows in several different countries, either in a given continent or in different parts of the world, while at the same time managing small-scale distribution to the end client. The challenge is to create an interface between these two geographical dimensions of supply chain organization. In this context, the terms “exogenous logistics” and “endogenous logistics” are applied. Endogenous logistics is based on the production activities that take place within an area. It is concerned with consumption within the

same area and involves linking up local logistical sites (factories, stores, hubs and warehouses). Spatially, endogenous logistics is concerned with choosing the location of sites and the extent to which they should be grouped together or dispersed. Endogenous logistics may become a means of bringing about development in an area. It is local in nature and based on production structures that exert an influence at local geographical scales. Exogenous logistics is concerned with the needs of logistical organizations that are based outside the area in question and exert an influence at national, continental or intercontinental levels. It is above all the outcome of larger scale geostrategic positioning and only affects certain well-located areas. Exogenous logistics is extensive in nature and associated with internationalized organizations of production.

The interfaces between different geographical levels are managed physically by logistics infrastructures or logistics hubs which perform the function of nodes in logistical networks. As Bowen (2008) has pointed out, SCM is reinventing the role of logistics hubs. The role of freight distribution centers becomes increasingly significant (Hesse and Rodrigue, 2004; Cidell, 2010, 2011).

Thus, logistics sites can be taken as an expression of the interaction between local and global flows. The relationship between logistics and its spatial context therefore involves a number of different nested scales (Figure 3). It depends on a physical network of logistical and transport infrastructures and is based on the geographical integration of logistical chains. The practical impact is a tendency for logistical infrastructures to become polarized. The global scale is structured by the megaports and the major freight corridors. The continental and national scale is also affected by the polarization of logistical facilities. At the more local scale, this consolidation process is accompanied by spatial sprawl and raises the issue of urban logistics.

Figure 3. The relationship between logistics and its spatial context: geographical levels and trends



The logistical infrastructure regulates flows in time and in space. It provides the location for breaks in the transport chain such as transhipment, modal transfer, consolidation-deconsolidation, warehousing or storage, *etc*. These hubs belong to networks and may consist of ports, airports or terrestrial hubs. At the global level, logistical facilities are becoming larger and larger and are increasingly located at strategic geographical connections. The geographical changes in industrial strategies are changing the distribution of freight. The changes in flows management and network orientation in the port and maritime industry have redefined the functional role of ports in value chains and have generated new patterns of freight distribution and new approaches to port hierarchy (Notteboom and Rodrigue, 2005; Notteboom, 2010). The port hierarchy is tending to contract to the advantage of megaports which act as interfaces between the main sea leg and the post-routing legs. Like hubs in the case of air transport, they act as break-bulk or transhipment ports

and their attractiveness is such that they are gradually drawing in the major part of global traffic, thereby minimizing transport costs. Their varied and multiple facilities help to provide rapid services (Wackermann, 2005). The concentration of port services, combined with the growth of feedering, makes it possible to manage the interface between the local and the global scales. In correlation with this, large-scale freight flows are directed towards gateway ports and hubs that are located at motorway nodes to provide access to the principal market areas.

At the continental or national level, the relationship between logistics and its spatial setting is also responsible for logistical concentration. In Europe in particular, port concentration is accompanied by the formation of multi-port gateway regions (Notteboom, 2010). Inland logistical infrastructure is concentrated at a limited number of points, essentially in Benelux and North-Eastern France. In France, in 2010, more than 40% of surfaces of warehouse are concentrated in only four regions (Ile-de-France with Paris, with Lyon Rhône-Alpes, Nord-Pas-de-Calais to Lille and Bordeaux Aquitaine with) (Masson and Petiot, 2012, 2013, 2014) which were home to 24% of the nation's population (Figure 4).

Figure 4. Distribution of square meters of warehouses in the French regions in 2010

Last, the concentration of logistical activities in urban centres is accompanied by a tendency for warehouses to spread into the outskirts of major centres. In the case of France, the warehouses of urban areas with populations of over 500,000 are mostly located in the suburbs (Dablanc and Rakotonarivo, 2010; Petiot and Masson, 2011). Cidell (2010) has confirmed the tendency for logistical hubs to move into the suburbs in North-American cities.

4.2. Some insights into the spatial dynamics of the logistics system

The spatial organization of the territory and the actions of public and private sector actors within it, determine the location of logistical sites and how well the logistical system performs. Logistics reveals the spatial division of activities (Savy, 2006). The siting of logistical activities follows logic of its own, between that of industries and that of services (Mérenne-Schoumaker, 2007). It is driven by a number of determinants (*4.2.1*). In addition, the spatial dynamics of logistical chains can be analysed in terms of the dynamics of proximity (*4.2.2*).

4.2.1. Analysis of locational choices for logistical infrastructure

There is geography for logistics. The location of logistics facilities and activities follows a specific pattern. There are a number of determinants that drive the location of logistical sites and they differ according to the geographical level and the sector of logistics. However, there are some universal factors, which we will describe below.

The effect of centripetal "market area" forces seems paramount in the case of locational decisions for logistical hubs in order to achieve proximity to shippers (particularly distributors), in particular in the case of logistical hubs whose flows are pulled from downstream. Apart from this impact of the market, grouping together near their markets provides other benefits for logistical activities by generating local (Marshall) externalities. These are pecuniary in nature, for example access to a pool of skilled labour which reduces training and recruitment costs and attracts new qualified staff, or the creation of a dense and diversified network of suppliers (transport undertakings in the case of logistical activities). There are also some non-pecuniary externalities, for example of a technological or informational nature, linked to the importance of proximity for the transmission of knowledge and know-how. The concentration of logistical infrastructures also generates demand externalities because the grouping together of logistical service providers means that clients can make economies of scale when prospecting for logistical services. In addition, the concentration of logistical activities generates inter-industry externalities that make it possible to implement consolidation and pooling

strategies. Last, the proximity of complementary services facilitates cooperation between firms and assists the development of more complex transport and logistics services which meet the needs of more demanding shippers. This concentration makes it easier to justify direct connection to the primary network of heavy infrastructure (motorways, railways, seaports and waterways) which is very important for the users of the logistical zones.

In contrast, the outward movement of logistical facilities (Cidell, 2010; Dablanc and Andriankaja, 2011; Dablanc and Ross, 2012) is due to centrifugal forces that, under the impetus of urban planning regulations, push logistical hubs away from urban centres in order to minimize negative externalities. Density creates land and housing pressure and pushes salaries upwards. Competition also becomes more intense (Masson and Petiot, 2014). Furthermore, logistical polarization tends to increase road congestion which slows flows. In a general it way it is responsible for conflicts over the use of the urban area. Last, warehouses, which require more and more space, are on the look out for considerable areas of land. The strategy of moving away from the dense centres of urban areas aims to optimize logistical chains. The more the organization of supply chains is based on the outsourcing and pooling of activities, the more vital it becomes to locate logistical sites in peripheral areas (Petiot and Masson, 2011).

Generally speaking, the location of logistical infrastructures is caused by strong pressure on supply chains as a result of both goal of cost reduction and improve customer responsiveness On the one hand the goal of inventory cost reduction provides motivation for centralization of inventories. On the other hand, the goal of customer responsiveness provides motivation for proximity to the final consumer. Thus, there is a basic conflict between these objectives, and locating distribution centers is a critical decision in finding an effective balance between them (Nozick and Turnquist, 2001).

4.2.2. The spatial configuration of the logistical system: analysis based on the "Proximity Dynamics" group

As supply chains require the coordination of a number of actors, it is natural when wishing to shed light on the spatial strategies they employ to adopt the proximities approach (Bellet et al., 1993; Torre and Gilly, 1999; Pecqueur and Zimmermann, 2004; Torre and Rallet, 2005). The works of the "Proximity Dynamics" group are concerned with the role of proximity in the spatial coordination of agents. This analysis supplements the analysis of the choice of the location of logistical activities we have presented above, but pays more attention to the logistical chain. In this context, the need for coordination and proximity helps us understand the spatial distribution of agents and how it changes. Proximity is a central concept in logistics, providing the basis for SCM because, as the goal of SCM is to optimize the interactions between the actors in the logistical chain, it sets out to organize local space.

An analysis of the relationship between logistics and its spatial setting highlights a contradiction between the global geographical extension of supply chains and the need for very good responsiveness to markets, hence the need for marked proximity. This reveals the co-existence of two apparently contradictory trends: the significant geographical remoteness of major suppliers and the need for a high degree of responsiveness as a result of the increased application of just-in-time practices. Proximity takes different forms and employs different approaches along the supply chain, from geographical proximity to organizational proximity. The quality of the interactions between actors within the supply chain depends more on organizational proximity than geographical proximity. Organizational proximity can be described formally by the network that structures the interactions: network architecture, density of interactions, the management of flows and the nature of links. In SCM, organizational proximity is founded on the sharing of information systems which makes it possible to synchronize flows in real time.

It also depends, at a more operational level, on the implementation of *"network proximity"* (Frigant, 1996). The reason for this is that the operation of the supply chain involves physical flows which must be precisely synchronized. The actors in the supply chain need network proximity which is based on transport and communication infrastructures, and, above all, their networking. The concept of network proximity highlights the role of accessibility and therefore the ability to serve one's markets with adequate speed, delivery times and reliability. It depends on the radialization of transport systems (Bonnafous, 1990) which is accompanied by the creation of logistical infrastructure such as hubs. Network proximity overcomes the issues of distance and movement in space which are specific to transport, and highlights the issue of time and the acceleration of flows, which are specific to logistics (Hesse and Rodrigue, 2004).

Last, spatial constraints are not completely absent from the operation of logistical chains and geographical reasoning still plays a very important role in firms' strategic decisions (Lasserre, 2004). It would seem that whether actors are located upstream or downstream in the supply chain and whether flows are pushed or pulled determines the extent to which they are inclined to locate near one another. The trend towards logistical polarization near major urban centres expresses a strong need for geographical proximity which increases as one becomes closer to the downstream end of the chain and in the case of pulled flows Sometimes spatial proximity provides the only way of coping when high levels of tension are applied to flows by reducing the purchase cost of components by lowering storage and transport costs.

4.3. Territorial issues of logistics, land-use planning and governance for logistics facilities

Logistics plays a role in the organization of the economic space. The presence of logistical infrastructure, such as logistical hubs, is a locational factor for firms. Logistical supply can therefore be considered as a factor of attractiveness for the firms that use the services (Masson and Petiot, 2012). Logistical sites encourage the location of industrial and commercial activities as a result of the externalities of urbanization. Logistics thus increases competitiveness and growth, as the

performance of economic fabrics and firms, in particular in terms of the functions that are linked to the trading economy, depends on the efficiency of local logistical systems and the strategies of the actors that put them in place. Logistical infrastructure, acting as physical nodes for logistical flows, improves the quality of the connections with global markets, speeds up and improves the responsiveness of flow management, and optimizes the competitiveness of logistics. In addition, the territorial dynamics of logistics infrastructures raises major questions relating to spatial planning and sustainable development (4.3.1). However, the spatial regulation of the implementation of logistics activities is still in its infancy and lack of efficiency in terms of sustainable development (4.3.2)

4.3.1. The issues related to the development of the production of logistics space

First, the logistics concentration shows a strong spatial differentiation of territories with, on one hand, regions with a very high density of logistics services and, on the other hand, areas characterized by low supply density. This inequality of densities of the logistics supply is accompanied by a strong differentiation of logistics vocations of territories. Logistics platforms "pivots" are located on high density logistics territories.

Secondly the spatial configuration of logistics facilities strongly determines the flow and nature of the associated transport traffic. The logistics facilities are a spatial marker of transport flows. Their locations determine modal shifts and intermodality. This raises the problem of the environmental impacts of traffic, particularly carbon emissions.

Thirdly, and more generally, logistics platforms induce environmental impacts: noise due to freight and handling; emissions of pollutants and CO2, problem of wastewater treatment, high use of spaces, *etc*.

Fourth, the implementation of logistics platforms raises the issue of territorial disputes between residential planning and logistical planning (conflict urbanization) as well as the acceptability of logistics activities. In addition, the logistics facilities present a risk of precariousness so far as their territorial anchorage depends on logistics strategies of the companies (Hesse, 2008). Furthermore,

the spatial looseness of logistics activities as a result of competition for size and difficulty of preserving land in densely populated areas causes the problem of logistics sprawl and strengthens suburbanization.

Fifth, metropolization and development of e-commerce induce growing needs of goods distribution in the heart of cities. The organization of urban logistics has become an essential component of the competitiveness of urban areas.

Finally, the geographical configuration of logistical systems determines logistical performance. This depends on the time-cost-quality triangle. In particular, it requires the cost of logistics to be optimized, in other words, the rationalization of transport costs (in particular by consolidating flows and pooling resources, using the most efficient modes of transport for the distances and types of products to be carried). In addition, the costs of warehousing and storage must be limited (by minimizing storage space and volumes, by sharing warehousing facilities between a number of suppliers and/or clients). As far as time is concerned, logistical performance depends on the control of transport times but also and above all, at an earlier stage, the management of flows by means of new information and communication technologies. To be efficient, logistical hubs must be connected to transport nodes and have access to technological infrastructure.

Thus, all levels of government are involved in the logistics spatial planning. The central government is concerned with the attractiveness of its territory, but also has the mission to reduce emissions of greenhouse gases by encouraging modal shift. Beyond the transport infrastructures, it is the configuration of circuit and logistics networks that determines the traffic generation. The central government also guarantees the reduction of territorial inequalities. At the other end of the territorial level, municipalities are directly involved in the implementation of logistics platforms because of their power of urban planning.

4.3.2. The terms of territorial governance logistics

It is clear that there is no real framework or instance institutionalized at the initiative of the authorities to conduct a joint reflection on the geography of logistics. Dablanc and Ross (2012) denounce uncoordinated logistics planning. Nevertheless, it is necessary that the logistics are integrated into a planning process and territorial development. The planning of logistics, by which we mean the siting of logistical facilities, brings into play a large number of actors some of which do not belong to the supply chain*:* not only shippers and logistical service providers but also local authorities, actors of logistics real estate (property developers, investors) and, lastly, planners. The planners are often public bodies with links with local government. They aim to bring about regional and economic development and their involvement precedes the locational process taking the form of planning and making land available.

Local authorities can orient the implementation of logistics platforms. They are involved both in planning land use as in the level of regulatory planning. The municipalities issue building permits and the intermunicipalities are responsible for developing and managing business parks.

The analysis of territorial governance practices of logistics in France (Masson, 2013; Masson and Petiot, 2013; Raimbault et al., 2013) shows highly differentiated approaches according to the areas and the relevant geographic scales. Some local governments have understood the importance to control the locations of logistics and accompanied the development of logistics parks. However, the logistics facilities are carried very often at the whim of land and economic opportunities. Local governments want to anchor the logistics activities in limited places, which would represent a first transformation into a logistical planning (Raimbault et al., 2013).

Hesse (2004) highlights the emergence of a new real estate market that is specifically dedicated to warehousing and distribution land uses. It is due to both the quantitative increase in logistics services and their qualitative transformation. He emphasizes the growing power of large real estate firms that

have won a space allocation power for logistics facilities vis-à-vis the warehouse users and local authorities and other urban planning authorities.

The analysis of logistics governance practices (Masson, 2013) highlights that the conditions for the emergence of a territorial logistics governance are related to implementation of relational innovations, like spatial logistics cluster, among local actors for initiating social structures of animation logistics. Several elements are essential: the mix of actors (public and private); the ability of stakeholders to coordinate their actions to cooperate; the definition of common objectives and the knowledge of logistical problems.

5 Conclusion and prospects

The interest of the systemic analysis set out in this article provides a clearer picture of the determinants of the relationship between logistics and its spatial setting and the forms this relationship takes. Systemic analysis shows that the location of logistics platforms depends on factors falling within global transformations of the world economy in relation to the change in productive models. We have studied these relationships by analysing the interactions between the production system and the area around it. They are the outcome of the implementation of industrial and commercial strategies in a context of globalization. Furthermore, logistics has major local impacts. It has certain spatial preferences and implements a specific geography. The flows it generates are always situated within a given space. Their need for transport and logistical infrastructure means they consume public space. The relationship between logistics and its spatial setting directly raises the issue of sustainable development. This is why the spatial planning of logistics activities is essential, but complex.

In the future, a number of factors can influence the location logics of logistics activities, especially under the pressure of the injunction of sustainable development. Sustainable logistics generates risks of medium-term disruptions in the system of interactions between the logistical system, the

production system and the area in question. These disruptions are related to public policies, the state of technology and changes in the preferences of economic agents. First, public policies support the aims of sustainable development and, depending on the nature of the policy (carbon tax, *etc*.), may impose certain logistical choices on companies and challenge the way logistical chains are organized, particularly in the case of long logistical circuits. Public policies may also implement a governance framework for regional logistics (regional logistical plans for example) that minimize the environmental impact of the spatial organization of logistical infrastructure. Second, the state of technology exerts a major influence over the way systems are inter-related. The current spatial configuration of logistics was partly determined by advances in transport technology, but above all by advances in information and communication systems. Finally, the current system may be disrupted by changes in consumer preferences. For example, the concerns of sustainable development entail a change in consumption behaviours as priorities shift in favour of socio-environmental considerations leading to a preference for proximity This may raise fundamental doubts about decisions regarding firms' production systems, in particular their decision to delocalize, and cause them to modify their logistical organization.

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