

Logistics Sprawl

Subjects: Business

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The concentration of warehouses in peripheral regions of metropolitan areas in a time period is called logistics sprawl (LS).

Keywords: logistics sprawl ; warehouses ; spatial pattern

1. Introduction

Logistics sprawl (LS) describes the phenomenon of logistics facilities' concentration in peripheral regions of metropolitan areas over time ^[1], also defined as a land use phenomenon ^[2], which can be caused by the increase in population density ^[3], the land price in central areas, and the larger space availability in peripheral areas ^[4]. Identifying the LS phenomenon leads to understanding aggregated tendencies in urban freight transport and the anticipation of its impacts at a regional level ^[5]. Logistics sprawl has received attention from academia in recent years ^[6].

LS negatively affects travel time and delivery reliability due to the increase in traveled distance. On the other hand, travel time increase and speed decrease caused by congestion in central areas' access ways contribute to fuel consumption increase and pollutant emissions ^[1], as well as transportation cost increases ^[2].

LS could support public policies related to urban freight transportation. This concept was proposed by reference ^[1] in 2010, with an analysis for Paris. Since then, the number of papers related to this topic increase year by year, but research is still scarce, as we will show in the literature review. We observed analyses for Europe, North America, Asia, and Latin America. Although the research method is recurrent in the literature, the data collection is specific for each study. Additionally, many studies seek to obtain the LS indicator (LSI) without exploring the variables that contribute to this phenomenon.

2. Logistics Sprawl

The literature related to LS was identified through a systematic literature review. By using the keyword "logistics sprawl" in Google Scholar, we have identified a set of papers related to this topic. As we said, this phenomenon was analyzed in European, Asian, Oceanian, North American, and Latin-American metropolitan areas (MAs), as summarized in [Table 1](#). [Table 1](#) also presents the data source, the research method, the time period of analysis, and the LSI (in kilometers). In general, the analyses of logistics sprawl computed the LSI ^{[6][7]}. A negative or close to zero LSI is desirable, which indicates that the phenomenon did not occur or occurred moderately over the time analyzed. The biggest LSI is observed in Southern California (+12 km) ^[8], while the smallest value is observed in Amsterdam (-2 km) ^[9].

LS has impacts on urban freight geography and commuting of logistics employment, contributing to increasing the distances traveled by trucks and to environmental impacts ^[10]. By knowing this phenomenon, it is possible to propose freight land-use strategies to reintegrate the logistics facilities in inner areas coordinated with logistics real state ^[10].

Concerning the data, most studies used public data. It is important to mention that obtaining data is the greatest challenge for many studies involving urban freight transport since a large amount of accurate data is necessary ^[7]. Despite many studies having used public data, the source influences the data collection ^[7]. Many times, it is necessary to use secondary data. As an example, the yellow pages were used by reference ^[1] to identify warehouses in Paris. Nowadays, Internet search engines can be a substitute for yellow pages. Heitz et al. ^[11] present a procedure to identify warehouses and logistics terminals comparing data from a public data set and satellite images and proposing a typology to classify these logistics facilities.

Regarding the research method, the studies used centographic analysis to identify the LS indicator. Additionally, some analyses used econometric techniques to estimate the factors that explain the concentration of warehouses in the study area, as explored by references ^{[3][9]}.

Table 1. Summary of literature on logistics sprawl (LS).

Metropolitan Area (Country)	Data Source	Research Method	Time Period	LS Indicator (LSI) (km)
Atlanta (USA) ^[12]	Public data	Centrographic analysis	1998–2008	+6.8
Belo Horizonte (Brazil) ^[13]	Commercial board	Centrographic analysis	1995–2015	+1.2
Calgary (Canada) ^[14]	Private data	Centrographic analysis	2012–2012	+3.5
Chicago (USA) ^[5]	Public data	Centrographic analysis	1998–2013	+8.8
Flevoland (Netherlands) ^[9]	Public data	Centrographic analysis	2007–2013	+3.3
Gothenburg (Sweden) ^[14]	Public data	Centrographic analysis	2000–2014	+ 4.2
Halifax (Canada) ^[15]	Private data	Centrographic analysis	2012–2012	+1.1
Los Angeles (USA) ^[16]	Public data	Centrographic analysis	1998–2009	+9.8
Montreal (Canada) ^[15]	Private data	Centrographic analysis	2012–2012	+0.3
Noord Holland (Netherlands) ^[9]	Public data	Centrographic analysis	2007–2013	–2.0
Palmas (Brazil) ^[17]	Public data	Centrographic analysis	2002–2016	+0.2
Paris (France) ^[1]	Yellow pages	Centrographic analysis	1974–2008	+10
Paris (France) ^[9]	Public data	Centrographic analysis	2004–2012	+4.1
Phoenix (USA) ^[5]	Public data	Centrographic analysis	1998–2015	+2.7
São Paulo (Brazil) ^[18]	Public data	Centrographic analysis	2000–2017	+1.6
Seattle (USA) ^[16]	Public data	Centrographic analysis	1998–2009	–1.3
Shanghai (China) ^[7]	Private data	Centrographic analysis	2005–2018	+3.44
Southern California (USA) ^[8]	Public data	Centrographic analysis	1998–2014	+12
Toronto (Canada) ^[19]	Private data	Centrographic analysis	2002–2012	+1.3
Tokyo (Japan) ^[20]	OD survey	Average shipment distance	1980–2003	+6,4
Vancouver (Canada) ^[15]	Private data	Centrographic analysis	2012–2012	+4.1
Utrecht (Netherlands) ^[9]	Public data	Centrographic analysis	2007–2013	+0.5
Winnipeg (Canada) ^[15]	Private data	Centrographic analysis	2012–2012	0.0
Wuhan (China) ^[3]	Public data	Geospatial	1993–2014	+8.2
Yangtze River Delta (China) ^[7]	Private data	Centrographic analysis	2005–2018	+2.04

Metropolitan Area (Country)	Data Source	Research Method	Time Period	LS Indicator (LSI) (km)
Zuid Holland (Netherlands) ^[19]	Public data	Centrographic analysis	2003–2013	–1
Zurich (Switzerland) ^[21]	Public data	Distance analysis	1995–2012	+7.7

Measuring the Logistics Sprawl

The first LS analysis was carried out in Paris ^[11]. By analyzing data between 1978 and 2008, the warehouses moved +10 km from the urban core, generating 6.45 million tons of CO₂ each year ^[11]. Heitz and Dablac found a similar LSI (+0.5 km/year) analyzing data from 2000–2012 in Paris ^[21]. In addition, there are different spatial patterns considering the typologies of logistics facilities in Paris (as parcel terminals, groupage transport terminals, and groupage transport hubs) ^[22].

The difference in LS between monocentric (Paris) and polycentric metropolitan areas (Noord Holland, Zuid Holland, Flevoland, and Utrecht—all in the Netherlands) was analyzed by reference ^[9]. The logistics suburbanization was measured by the population density and number of warehouses and the differences between these metropolitan areas are explained by urban structure, the planning policies, and the freight hub for distribution across Europe ^[9].

In an analysis of the LS pattern in Gothenburg (Sweden), Heitz et al. identified the concentration of logistics facilities in the center of this metropolitan area ^[14]. Between 2000 and 2014, the number of warehouses increased by 56.8% and the mean distance of the center of gravity moved from +9.1 km to +13.3 km (+4.2 km). The proximity of the consumer market, the land price, the employees' accessibility, and the accessibility of transport infrastructure are the potential factors that explain the locations of logistics facilities ^[14].

Todesco et al. explored the sprawling of logistics activities in the Zurich region (Switzerland), where the mean distance to the city center of Zurich increased for storage (+9.5 km), courier services firms (+7.7 km), and transportation firms (+0.7 km) between 1995 and 2012 ^[2]. Warehouse sprawling using employment data from the 1995–2012 period in Brussels (Belgium) was analyzed in reference ^[23]. The evolution of logistics facilities in Katowice (Poland) and the phenomenon defined as “anti-logistics sprawl” was considered in reference ^[24]. The analyses made for Brussels and Katowice did not measure the LSI.

By using data from a freight survey, Sakai et al. analyzed the spatial distribution of logistics facilities in Tokyo (Japan) ^[20]. The authors calculated the spread between the shipment origins and destination using average shipment distances (Euclidean distance between the facility and the origins or destinations) ^[20]. Results indicated spatial mismatch increase as facilities move away from the urban center. The average distance from the center moved from 26.2 km (pre-1981) to 32.6 (1991–2003) ^[20].

The location of the warehouse, the spatial distribution, and other factors driving the spatial distribution of warehouses were explored by reference ^[3], through a case study in Wuhan (China). Between 1993 and 2014, the LSI was +8.2 km (9.2 km in 1993 to 17.1 km in 2014) and the warehouses are more decentralized and concentrated ^[3]. The population density, land rent, and warehouse land use are the major factors contributing to the spatial distribution of warehouses in Wuhan ^[3]. The impacts of LS on agricultural freight were analyzed in Beijing (China) in reference ^[25] through traffic simulation. The authors evaluated the reallocation of all large wholesale centers from the fifth ring road of Beijing to outside the fifth ring road ^[25]. In Shanghai and the Yangtze River Delta (China), He et al. identified a movement of logistics enterprises to the southeast of the region, with the mean distance of the center of gravity moving from 27.57 km in 2005 to 31.59 km in 2015 in Shanghai and, from 153.99 km in 2005 to 165.63 in 2015 in the Yangtze River Delta ^[7]. The number of logistics enterprises increased 72.14% and 92.83% in 10 years in Shanghai and the Yangtze River Delta, respectively ^[7]. The public policy, land price, and technological progress could have contributed to the sprawling of the warehouses ^[7].

In North America, we identified studies for Atlanta, Seattle, Southern California, and Toronto. In Piedmont Atlanta Megaregion (PAM), the number of warehouses increased 203.8% between 1998 and 2008 (from 132 to 401), while the LSI increased +6.8 km in the same period ^[12]. Dablac et al. compared the spatial patterns of warehouses in Los Angeles and Seattle: while the warehouses sprawled (+9.8 km) in Los Angeles, the average distance decreased (–1.3 km) in Seattle between 1998 and 2009 ^[16]. A similar result was found in reference ^[8] analyzing data between 1998 and 2014. Also, the authors found a spatial correlation between warehouses and the industries, and the number of warehouses is explained by population density ^[8].

In the Greater Toronto Area (GTA), the number of warehouses increased 38.2% between 2002 and 2012, and the average distance of center moved from 16.7 km to 17.9 km (+1.3 km) north of the region ^[19]. The low LSI could be related to the lack of land for expansion in GTA ^[19]. Another five Canadian metropolitan areas were analyzed in reference ^[15], which did not identify a trend in the spatial pattern of warehouses.

In Chicago, the average distance from the mean center for warehousing increased +8.8 km between 1998 and 2013, with the number of warehouses having increased 115% in this period (from 217 to 446) ^[5]. In Phoenix, between 1998 and 2015, the number of warehouses rose 346% (from 41 to 183), while the LSI increased 15% (from 17.86 km to 20.60 km) ^[5]. By analyzing data from 64 US metropolitan areas and using the relative distance between two activities, Kang identified that the trend of increasing the distance from the warehouse to business establishments stopped since 2008, as a consequence of the economic recession in the US ^[26].

In Latin America, LS studies were developed for three Brazilian metropolitan areas: Belo Horizonte, Palmas, and São Paulo. In Belo Horizonte, most of the warehouses are located in high-income areas, closer to roads and railroads ^[13]. Using data from a commercial board, the number of warehouses increased by 322% (95 to 401) between 1995 and 2015, and the LSI was 1.2 km ^[13]. In Palmas, the logistics land-use planning concentrated the warehouses closer to the city center (+6.06 km in 2002), and its location did not move in 2016 (+5.83 km in 2016). In São Paulo, the number of warehouses increased from 209 to 417 between 2000 and 2017, while the LSI was +1.6 km ^[18]. In Brazil, LS may be related to government investments in terms of the development of the northern region of Belo Horizonte and the public policies adopted by Belo Horizonte's neighboring cities ^[13]. In Palmas, the LS has the same movement as the urban sprawl ^[17]. Furthermore, there may be a possible influence of taxes, such as service tax on the location of warehouses in São Paulo ^[18].

By using the concept of reallocation of logistics facilities, the location of the wood market in New Delhi (India) was analyzed in reference ^[27], where the size of the wood market measured the LSI. The fruit and vegetable wholesale market reallocation from a central suburb to a suburban area in Melbourne (Australia) was analyzed in reference ^[28]. From a telephone questionnaire with retailers, the delivery schemes were identified, and the market relocation increased the distance traveled by wholesalers by 31% ^[28]. In addition, considering a new freight village in Palmas airport, the average distance from the city center could increase by 86%, with negative impacts on urban freight transport ^[17].

Understanding the spatial distribution of warehouses is fundamental for effective metropolitan logistics planning ^{[12][22]}. A possible influence of the local policies regarding land use in LS was observed in Atlanta ^[12], reinforcing the concept presented in reference ^[2] that LS is a land-use phenomenon. In other metropolitan areas, the LS indicator did not present a significant value, probably due to the lack of land for warehouse expansion ^[19]. Land use also seems to have influenced the location of warehouses in Southern California since they are close to road infrastructure and intermodal facilities ^[8].

The lack of logistics policies associated with the lack of logistics land use could have contributed to the logistics sprawl in many metropolitan areas, favoring the increase of land price in the core of these metropolitan areas ^[29]. In this way, logistics land use coordinated with infrastructure accessibility, employee accessibility, and population density are elements that could lead to a spatial pattern of less decentralized warehouses that do not contribute to logistics sprawl. For this, it is important to know the LSI for the development of public policies.

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