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The physical distribution of goods in a megalopolis: Strategies for policies on the location of logistics facilities within the Central Region of Mexico

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Abstract

This paper presents the main steps taken in order to propose strategies for policies for locating logistics facilities; these policies are oriented towards improving the physical distribution of goods within the central region of Mexico. It includes a description of geographic information of logistics centres, logistics parks and other logistics facilities, the identification of territorial clusters with logistical activities, case studies on the main distribution centres, the identification of logistical nodes, a set of proposed projects for the development of new logistics centres, and the bases for public policies which can promote logistics centre projects.

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1. Introduction

The location of logistics facilities has been studied a great deal. Taniguchi et al. (1999) presented a model (which considers traffic conditions) for determining the optimal size and location of public logistics terminals; this model was applied to a real road network. Leitham et al. (2000) applied stated preference experiments for the analysis of the influence of road transport and other factors on industrial location choice. The importance of road links to location choices varied considerably between the groups of firms (classified as local relocations, foreign inward investors and branch plants sourced from national bases). Recently, Lu and Bostel (2007) presented a two-level location problem with three types of facilities to be located in a specific reverse logistics system (where “forward” and “reverse” flows were simultaneously considered), and proposed a 0–1 mixed integer programming model and a heuristic.

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We have studied a location problem where limited information is available and most of the information obtained (by means of field work, surveys and interviews) is not quantitative. Hence, it was not possible to determine the exact size of the logistics facility, merely its type and general size; nor it was possible to select the exact site to locate it, only a possible area (whose viability will depend on many factors).

The main background of this research is:

- a general review and classification of logistics centres, based on Mexican and international experience, particularly with the European situation in mind (Antún et al., 2008a),
- a previous study confined to the MZMC and the first ring of urban expansion (Lozano et al., 2008a; 2008b), and
- the analysis of new trends on the physical metropolitan distribution of goods (Antún et al., 2008c).

This paper is based on the main results of the study “Strategies for a competitive logistical territorial management of the Central Region of Mexico”, which was carried out by the Transport and Territorial Systems Group (Laboratorio de Transporte y Sistemas Territoriales) of the Engineering Institute of the Universidad Nacional Autónoma de México, upon request from the Ministry of Economy of the Federal Mexican Government and the Committee for the Central Region Development (FIDCENTRO) (Antún et al., 2008b).

This paper presents the main steps undertaken in order to propose strategies for policies associated with the location of logistical facilities within the central region of Mexico; such policies are oriented to improve the physical distribution of goods.

The general results of this research are the generation of an inventory and a diagnosis concerning the infrastructure related to transport and logistics within the Central Region of Mexico, as well as the analysis of the logistical implications of the supply chains, linked to economic activities, in order to formulate strategies for policies on the location of logistical facilities. These strategies, which could improve the competitive logistics territorial management of the Central Region of Mexico, include:

- the choice of high-priority nodes where logistics facility projects for the development of Logistics Centres (LC) can be located,
- the determination of adequate sites for locating Reserved Areas for Logistics Activities (RALA), in order to facilitate the physical distribution of goods to a market of over 30 million inhabitants inside multiple cities forming the megalopolis, and
- the determination of basic models for LC projects.

The paper is divided as follows:

i. a description of geographic information of logistics centres, logistics parks and other facilities dedicated to logistics activities which are currently in operation;
ii. the identification of territorial clusters with logistical activities;
iii. case studies on the main distribution centres within the Metropolitan Zone of Mexico City (MZMC), recently developed by leading companies;
iv. the identification of logistical nodes within the Central Region of Mexico;
v. a set of proposed projects for the development of new logistics centres within the Central Region of Mexico, and
vi. the basis for public policy for promoting logistics centre projects.

2. Geographic Information of Logistics Centres, Logistics Parks and Other Facilities Dedicated to Logistics Activities, which are Currently in Operation

Based on information from the Mexican Industrial Parks Promotion System (SIMPPI, in Spanish) and the Mexican Association of Industrial Parks (AMPIP, in Spanish), the major industrial parks and logistics parks within the Central Region of Mexico were identified. Each facility was geo-referenced in a Geographic Information System (GIS), and its attributes were included in a database. The total number of identified Industrial and Logistics Parks (I&LP) was 62, which are located as shown in Table 1.
A territorial analysis of the obtained information reveals that the majority of the industrial and logistics parks are located in a few areas or corridors (see Figure 1).

**Table 1 Industrial and logistics parks inside each state of the Central Region**

<table>
<thead>
<tr>
<th>STATE</th>
<th>INDUSTRIAL PARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico State</td>
<td>22</td>
</tr>
<tr>
<td>Puebla</td>
<td>16</td>
</tr>
<tr>
<td>Hidalgo</td>
<td>11</td>
</tr>
<tr>
<td>Tlaxcala</td>
<td>9</td>
</tr>
<tr>
<td>Morelos</td>
<td>3</td>
</tr>
<tr>
<td>Federal District</td>
<td>1</td>
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</tbody>
</table>

In Mexico State, three corridors were identified:

- The México-Querétaro highway corridor, where the Tultitlán-Cuautitlán-Tepotzotlán, and Tlalnepantla-Huehuetoca areas are located;
- The Toluca-Lerma corridor, to the south of Toluca City; and
- The Toluca-Ixtlahuaca-Atlacomulco-Jilotepec corridor.

In Hidalgo State, three corridors were identified:

- The México-Pachuca highway corridor;
- The Pachuca-Sahagún corridor; and
- The segment of the Mexico-Queretaro highway corridor within Hidalgo, mainly in the Tepeji del Río and Tula-
Atitalaquia areas.

In Puebla State, industrial parks are concentrated between the San Martín Texmelucan and Puebla-Amozoc areas. In Morelos State, the main industrial parks are located on the Alpuyeca-Cuernavaca and Cuautla corridors. Tlaxcala State has a quite homogeneous industrial parks distribution. Finally, in the Federal District, industrial parks are mainly in the Vallejo industrial area, in the municipality of Azcapotzalco.

Detailed information was obtained for each area and corridor. For example, the I&LP in the metropolitan area of Toluca, the Toluca-Lerma corridor and the south part of Toluca, form the following nine clusters:

i. the Toluca-Lerma Industrial corridor,
ii. the Cerrillo Industrial Park I,
iii. the Cerrillo Industrial Park II,
iv. the Santiago Tianguistenco Industrial Park,
v. the Exportec Industrial Park I,
vi. the Exportec Industrial Park II,
vii. the San Antonio Buenavista Industrial Park,
viii. the Tenango Industrial Park, and
ix. the Toluca 2000 Industrial Park.

3. Identification of Territorial Clusters with Logistics Activities

Several distribution centres and clusters of facilities dedicated to logistical activities were identified within the Central Region of Mexico. This identification was based on: a detailed review of web pages of the main real estate developers and industrial and commercial leaders, and field work undertaken for some case studies. Then, each facility was geo-referenced in a GIS, and its attributes were included in a database.

The information search focused on the major real estate developers of logistics infrastructure: Corporate Properties of the Americas (CPA), FINSA, Friso, GICSA, Grupo Acción (now AMB Property Corporation), Grupo O’Donnell, Prologis, Tlanepark and Vesta.

Fifty real estate logistics developments were found; 44 of them in Mexico State, two in the Hidalgo State, and one in Puebla, Tlaxcala, Morelos and Federal District each. Table 2 shows the number of facilities according the real estate developer.

As shown in Figure 2, many of the logistics real estate developments are located in the northern part of the MZMC, mainly in the San Martín Obispo, Cuautitlán-Tultitlán-Tepotzotlán and Tlalnepantla areas and on the Toluca-Lerma corridor.

Interesting information concerning the dimensions and current use of logistical facilities in the San Martín Obispo area, based on field work, was found:

- San Martín Obispo was consolidated because of: a) the construction (in 30 acres) of the Wal-Mart Distribution Centre for perishable goods, b) the development of a set of logistical facilities by Grupo Acción and Grupo O’Donnell, occupying 87 hectares and more recently, c) the acquisition of 157 acres at the head of the urbanized area by Corporate Properties of the Americas.
- The FINSA development has a surface of 1.64 hectares, 0.75 of which are urbanised. Its vessel has a height of 9.14 m, space between columns of 15.24m x 15.24m and 8 platforms with a height of 1.22 m.
- The development by the Grupo O’Donnell Matel has an urban area of 2.42 hectares.
- Corporate Properties of the Americas (CPA) has two developments:
  ○ San Martín Obispo I includes a total area of 33.26 hectares (10.77 of them are urbanized); it houses the Michelin Distribution Centre, which has a surface of 50,000 m2, a height of 10 m, and a space between columns of 12mx18m; and
  ○ San Martín Obispo II, which is the largest development in the zone, has a total area of 124.47 hectares.
Table 2 Number of logistical facilities of each real estate developer

<table>
<thead>
<tr>
<th>REAL ESTATE DEVELOPERS</th>
<th>LOGISTICAL FACILITIES</th>
</tr>
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<tbody>
<tr>
<td>Grupo Acción</td>
<td>11</td>
</tr>
<tr>
<td>Vesta</td>
<td>10</td>
</tr>
<tr>
<td>CPA</td>
<td>6</td>
</tr>
<tr>
<td>Grupo O’ Donnell</td>
<td>6</td>
</tr>
<tr>
<td>Gicsa</td>
<td>5</td>
</tr>
<tr>
<td>Prologis</td>
<td>5</td>
</tr>
<tr>
<td>Finsa</td>
<td>3</td>
</tr>
<tr>
<td>Frisa</td>
<td>3</td>
</tr>
<tr>
<td>Tlanepark</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 2 Location of logistical facilities in the Central Region of Mexico

4. Case Studies on the Main Distribution Centres within the Metropolitan Zone of Mexico City, Recently Developed by Leading Companies

The Central Region of Mexico has the largest number of distribution centres in the country. In particular, the Teoloyucan-Huehuetoca-Tepeji del Río area has achieved importance due to its saturation with suitable sites for distribution centres inside the southern zone of the toll gate (Tepotzotlán) and the new mobility options produced by two new roads (Vialidad Mexiquense and Libramiento Arco Norte).

It was found that among the most important distribution centres in this area are the following:

i. The MABE’s distribution centre, in the Huehuetoca Logistics Centre developed by CPA in the municipality of Tepeji del Río in Hidalgo, on the road to Tula;
ii. The LIVERPOOL’s distribution centre, located within the Huehuetoca municipality in Mexico State, on the Jorobas- Tula road;
iii. The COTSCO distribution centre, in the Tepeji Industrial Park in Hidalgo, on the road to Tula; and
iv. The Chedrahui’s distribution centre, in the Teoloyucan Logistics Centre (property of CPA), within the Teoloyucan municipality in Mexico State, at the intersection of the Cuautitlan-Teoloyucan road and the Vialidad Mexiquense highway.

Interviews with logistics managers of these companies where carried out in order to discover the reasons for their choice of the locations.

5. Identification of Logistics Nodes within the Central Region of Mexico

The decision making process for determining the possible locations for logistics facilities, at inbound and distribution centres levels, takes into account the following: stakeholders in the supply chain (including the relative power of the goods producers, the dominant role of large commercial distributors and the 3PL “manoeuvre” margin) and interviews with managers of real estate companies and the land use management public authority.

A set of high-priority logistics nodes were identified, based on the processing of multispectral and panchromatic SPOT satellite images and field work. Their locations were verified by means of field work using GPS. Then, Reserved Areas for Logistical Activities (RALA), related to the hinterland of connections to new freeways (essentially, Libramiento Arco Norte, Vialidad Mexiquense and Libramiento de Toluca, toll highways), were proposed (as shown in Figure 3).

The preliminary explored nodes were:

i. Four nodes inside the Metropolitan Zone of Toluca (MZT),
ii. Four nodes inside the Western Zone of the Arco Norte highway,
iii. Three nodes inside the Northern Zone of the Arco Norte highway,
iv. Two nodes inside the Metropolitan Zone of Puebla-Tlaxcala,
v. Two nodes inside the Metropolitan Zone of Cuernavaca-Cuautla (see Figure 4), and
vi. Four nodes inside the Metropolitan Zone of Mexico City (MZMC).

Figure 3 Identification of logistics nodes within the Central Region
Figure 4 Example of the identification of strategic logistics nodes inside the metropolitan zone Cuernavaca-Cuautla, on a spot satellite image

In order to identify suitable plots for RALAs, empty polygons in each node were scanned and their connectivity was analysed. An example is shown in Figure 5 and Figure 6, for Node 3 of the Metropolitan Zone of Mexico City (MZMC3).

Figure 5 Two explored areas at Node 3 MZMC3 on a satellite image
6. A Set of Projects for the Development of New Logistics Centres within the Central Region of Mexico

We propose a set of strategic projects for different types of logistics centres in the Central Region of Mexico. They are described as follows.

6.1. The integration of a set of projects (portfolio of projects) for logistics centres to innovate the physical distribution of goods, belonging to specific industrial sectors, inside the megalopolis

Strategic proposal 1: To promote, based on a previous marketing study, a project for a Logistics and Transportation Service Centre (LTSC) for different segments of the footwear industry (men, women fashion, children, student and sport). Footwear is produced in Guanajuato (outside of the Central Region) and commercialized in the Central Region. The LTSC would be located next to the intersection of Mexico-Querétaro freeway and Arco Norte or Vialidad Mexiquense highways.

Strategic proposal 2: To promote, based on a previous marketing study, a project for a LTSC and/or a Corporative Logistics Centre (CLC) for facilitating the distribution of hardware store items, plumbing items, furniture and lining for bathrooms and kitchens, and electric equipment and materials. This facility would be located next to the intersection of Mexico-Querétaro freeway and the Arco Norte or Vialidad Mexiquense highways, or in Tepeji del Río area (inside the MZMC) and/or in the MZT.

Strategic proposal 3: To promote, based on a previous market study, a project for a LTSC and/or a CLC for the distribution of hardware store items, plumbing items, furniture and lining for bathrooms and kitchens, and electric equipment and materials. This facility would be located next to the intersection of México-Querétaro freeway and the Arco Norte or Vialidad Mexiquense highways, or in Tepeji del Río area and/or in the MZT.

Strategic proposal 4: To promote, based on a previous marketing study, an Urban Logistics Micro-Platform (ULmP) for the clothing industry in the Historic Centre of Mexico City.

Strategic proposal 5: To promote, based on a previous marketing study, a project for a LTSC for the CD and DVD industry and the publishing industry. This facility would be located in the San Antonio-Observatory area inside of Mexico City, next to the intersection of the México-Querétaro freeway and the Arco Norte or Vialidad Mexiquense highways, or in the Tepeji del Río area and/or in the MZT.
6.2. The integration of a set of projects for logistic centres in the central region, in order to innovate the operation of transport services, and lead it towards a more integral supply of logistical services

Different types of Merchandise Centres (MC) and INTERPORTS can be integrated based on two basic modules of logistics centres (see Figure 7 and Figure 8). Both modules, adapted to the market needs of the Central Region, require available land surfaces of 30-60 hectares. Note that the INTERPORT (Figure 8) has a relationship with a MC (Figure 7), i.e. basic module I is integrated with basic module II.
7. Bases for the Design of Public Policies for the Promotion of Logistics Centre Projects

The results of this research and the knowledge of the real situation in the Central Region allow us to propose the following recommendations:

7.1. A logistics platform for the central region of Mexico

Promoting the creation of a partnership (association) called “Region Centro Mexico Plataforma Logistica (RCMEX PL)” in order to impel the competitive logistical territorial management within the Central Region of Mexico, by means of a strategy for the development of logistics centres.

This association will be responsible for:

- the exchange of privileged information about projects and initiatives of the sector;
- the design of the bases of public policies for stimulating the sector; and
- the promotion of events to make “logistics real estate” stronger by means of exhibitions, courses and seminars.

The Logistics Platform of the Central Region of Mexico will be composed of: FIDCENTRO; Ministries of Economic Development and/or Finances of the involved States; the municipalities where the RALAs are located (inside the relevant nodes of the Central Region); concessionaires of toll roads in the Central Region; rail companies (KCSM, FERROMEX, Ferrosur, FERROVALLE); truck associations (CANACO, ANTP); truck companies (line-haul transportation and urban distribution); logistics operators (specialized, global integrators); administrations of the Metropolitan Airports System; Hidalgo Airport Company; port captaincies (Veracruz, Tuxpan and Lázaro Cárdenas); the Mexican Council of Logistics; consulting firms of supply chain and logistics; engineering and construction companies; real estate developers; and academic centres which research logistics in the Central Region.

7.2. Regional land fund for the development of logistic centres

The creation of a Regional Fund dedicated to the acquisition of land within the RALAs (Reserve Areas for Logistical Activities) should be promoted.

7.3. New lines in PROLOGYCA for promoting the development of logistics centres for small and middle-sized companies (PYMES)

Creation of lines in PROLOGYCA to support the following:

i. The innovation of logistics processes and operations for the physical distribution of goods in the megalopolis, for the development of distribution centres in logistics centres related to the sector, for PYMES (which belong to the previously described sectors, i.e. footwear, furniture, textiles, clothing, underwear, uniforms, casual clothing). The innovations include: logistical processes and operation consulting, marketing studies, and economic-financial feasibility studies concerning the location in logistics centres, costs of location in logistics centres, and the cost of investment in infrastructure equipment;

ii. The innovation of logistical operations of PYMES, which are dedicated to transportation and logistics services and search for the location of their terminals in the new logistics centres of the Central Region; and

iii. "Reimbursable" financing to facilitate the relocation of PYMES, which are producers of goods or transportation and logistics services, operating within the municipality where a new logistics centre is developed.

8. Conclusion

The use of recent satellite images, Google Earth images, GPS and GIS, has supplied us with useful information about the territory and its relation to the existent road infrastructure and the new toll highways. Field work was required in order to update territorial information. The knowledge of the expertise and new projects of the main real
estate developers was quite useful for the determination of the logistical nodes and the type of facility to be built. Location practice indicates that companies are trying to save money by means of closing distribution centres.

Due to the heavy distribution problems in a megapolitan area, mega distribution centres can be very important for improving the distribution of goods.

The development of multimodal facilities is vital in the Central Region where there is no maritime and fluvial transportation. Interports are needed in the Central Region of Mexico even though the nearest coast is nearly 500 km away.

The real world problems involve many heterogeneous variables and their relationships are difficult to model. Research results provide a guide for designing public policies for promoting a wide set (portfolio) of logistics facilities projects, including freight transportation centres or merchandise centres, which are oriented to truck transportation, intermodal railways platforms and corporative logistics centres.

Acknowledgments

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References


