IDENTIFICATION AND SPATIAL ANALYSIS OF LOGISTICS CLUSTERS IN SOUTHERN CALIFORNIA

Avijit Sarkar, School of Business, University of Redlands, 1200 E. Colton Avenue, Redlands, CA 92373, 909-748-8783, avijit_sarkar@redlands.edu
Martin Wong, University of Redlands, 1200 E. Colton Avenue, Redlands, CA 92373, (909) 748-8378, martin_wong@spatial.redlands.edu
Anne Desmarais, University of Redlands, 1200 E. Colton Avenue, Redlands, CA 92373, (909) 748-8381, anne_desmarais@redlands.edu

ABSTRACT

This research provides a geographic information system (GIS) based framework to visualize warehousing and transportation facilities located in southern California (CA) relative to the region's transportation infrastructure. It identifies which regions (cities) in southern CA have evolved as logistics clusters, specifically which regions are hotspots of warehousing facilities, as well as truck, rail, and air transport facilities. Further, this work spatially analyzes the proximity of warehousing locations in different regions to truck, rail, and air transport facilities by computing accessibility indices. The results obtained provide spatial intelligence to local businesses and government which can view and analyze the logistics landscape of southern CA to inform business planning, policy planning, and decision-making.

Keywords: logistics, transportation, warehousing, geographic information system

INTRODUCTION

Southern California, specifically the eight county region comprised of Los Angeles, San Diego, Riverside, Orange, San Bernardino, Kern, Imperial and Ventura counties is home to approximately eight hundred and fifty thousand businesses [3]. Several thousands of these businesses require, supply, and/or produce raw materials, semi-finished or finished products, assemblies and sub-assemblies, etc. in various shapes and form. The role of warehouses and storage facilities for storing the goods, merchandise, etc. worth millions of dollars, keeping them secure, and distributing them in a timely fashion is extremely crucial. In order to facilitate the movement and distribution of goods and/or products along a supply chain, warehouses and storage facilities provide a range of services, often referred to as ***logistics*** services, related to the distribution of goods.

The term logistics originated in the military which was concerned with the movement of personnel and materials during times of emergency. It was later adopted by businesses and became a part of commonly used terminology in professional societies and academic programs. According to the Council of Supply Chain Management Professionals, *logistics management* is "that part of supply chain management that plans, implements, and controls the efficient, effective flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements". In summary, companies depend on their logistics systems to move materials, goods, equipment and people among supply chain partners. Logistics covers a wide range of business functions [2] including transportation, warehousing, material handling, packaging, inventory management, and logistics information systems. Logistics services can include "labeling, breaking bulk, inventory control and management, light assembly, order entry and fulfillment, packaging, pick and pack, price marking and ticketing, and transportation arrangement" [5]. It is worth mentioning in this context that freight movement typically absorbs one-third to two-thirds of total logistics costs for most firms [1].

It is intuitively understood that efficiency in goods movement is impacted by access to transportation infrastructure. The 8-county region mentioned earlier is crisscrossed by at least a dozen major interstates apart from dozens of state routes and is home to two of the nation's largest ports (in terms of annual cargo volume) and several airports catering to freight transportation. Hence it is fair to conjecture that by virtue of access to transportation infrastructure, several regions within Southern CA and the Inland Empire (San Bernardino and Riverside counties) have the potential to evolve as major hubs of transportation and logistics.

To that end, this research project -

1. provides a framework to visualize warehousing and transportation facilities relative to the region's transportation infrastructure,
2. identifies which regions (cities) in Southern CA have evolved as logistics clusters, specifically which regions are hotspots of warehousing facilities, as well as truck, rail, and air transportation facilities, and
3. analyzes the proximity of warehouses in different regions (cities) to truck, rail, and air transportation facilities by computing accessibility indices.

METHODOLOGY

A geographic information system (GIS) combines computer hardware, software, and geographic data for capturing, managing, analyzing, and displaying all forms of geographically referenced information [3]. It is used by businesses to provide solutions related to customer analysis, market analysis, site selection, risk analysis, territory management, facility/property/asset management, supply chain management, and logistics. This research focuses on the transportation-warehousing industry in an 8-county region of southern California spanning Los Angeles, San Diego, Riverside, Orange, San Bernardino, Kern, Imperial and Ventura counties (shown in Figure 1). This region is home to approximately 850,000 businesses and population growth has been a key driver of economic activity in this region. The California Labor Department reports that approximately half of the state's population and jobs are concentrated in the 5-county area of Los Angeles, San Bernardino, Riverside, Orange, and Ventura. Using a GIS framework, this research attempts to (a) visually locate warehousing facilities and various modes (trucking, air, and railroad) of transportation facilities in the study area, (b) identify clusters of such facilities in its immediate proximity thereby discovering strategic partnership opportunities or competitive threats for businesses in the study area, (c) determine if cities in their vicinity are specialized in transportation-logistics by comparing location quotients [4] and (d) compare warehouse locations based upon their accessibility to different modes of transportation. Warehouse and freight transport point location data are obtained from InfoUSA Business Listing data in ESRI's ArcGIS© Business Analyst©. Freight transportation and warehousing and storage business locations have been retrieved by using the North American Industry Classification System (NAICS) codes. Spatial analysis is performed using ESRI's ArcGIS© and its various extensions.

Figure 1: 8-county study area with major interstates

RESULTS

The 8-county study area is comprised of approximately 6,600 warehouses and close to 400 businesses involved with goods movement inclusive of trucking, air, and railroad (freight) transportation facilities. A closer inspection of the spatial distribution of warehouses in the study area reveals three major concentrations – (a) the first in Los Angeles and Orange counties, (b) the second further inland at the intersection of San Bernardino and Riverside counties (often referred to as the Inland Empire), and (c) the third in coastal San Diego county (shown in Figure 2). The first concentration of warehouses spanning large parts of Los Angeles and Orange counties is notable for its proximity to two of the nation's largest ports, Los Angeles and Long Beach and also to numerous freeways and CA state routes. The concentration in the Inland Empire is indicative of the region's growing reputation as a hub of warehousing and goods movement. Also note that the east-west orientation of this cluster is virtually parallel to interstates I-10 and I-210 with denser concentrations found around the cities of Fontana and Ontario in San Bernardino County. In fact truck transportation facilities in the study area are also notable for their proximity to major roadways with significant concentration in coastal Los Angeles County. Overall, the proximity of warehousing and goods movement facilities to roadways and other transportation infrastructure is unmistakable and hence is a crucial determinant of site location of such facilities.

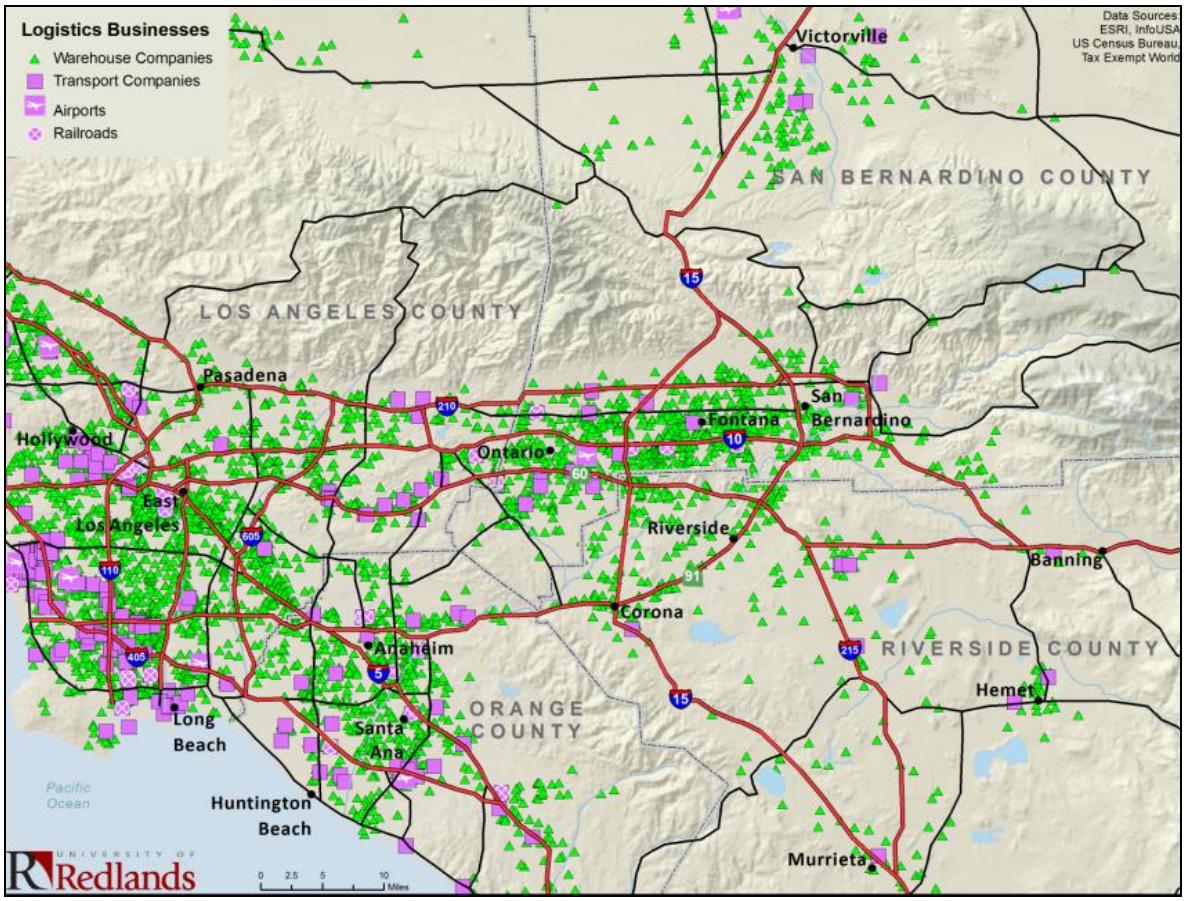

Figure 2: Warehouses and transportation facilities (road, rail, and air) in study area

Location Quotients (LQs) for the transportation and warehousing industry are computed at the zip code level for the 8-county study area. According to the Bureau of Labor Statistics, LQs are ratios that allow an area's distribution of employment by industry to be compared to a reference or base area's ("county" in this study) distribution. An LQ exceeding 100% indicates an industry with a greater share of the local area employment than is the case in the reference area; hence the area can be considered to be *specialized* for that industry. Figure 3 shows that the cities of Long Beach and Compton (in Los Angeles county), Mira Loma (in Riverside county), and Fontana and Rialto (in San Bernardino county) are specialized in warehousing and transportation and can thus be considered to be logistics "hubs".

It is pertinent to mention that two cities (or zip codes) with approximately similar "warehousing and transportation" location quotients may not be equally accessible by transportation infrastructure. Hence accessibility of warehouse locations relative to truck, rail, and air (freight) transport facilities is also computed using three metrics – (a) Euclidean distance (point-to-point distance measured by a straight line), (b) network travel distance (actual travel distance on a road network) , and (c) network travel time (actual travel time on a road network). Indices of accessibility (using the three metrics) are computed for each warehouse based upon its proximity to truck transportation, rail transportation, and air transportation facilities (within a 50 mile radius) individually. We find that accessibility (measured by Euclidean distance) of warehouses located in Los Angeles county to truck and air transport facilities is higher compared to locations further south into Orange County and further east into San Bernardino and Riverside counties (Inland Empire).

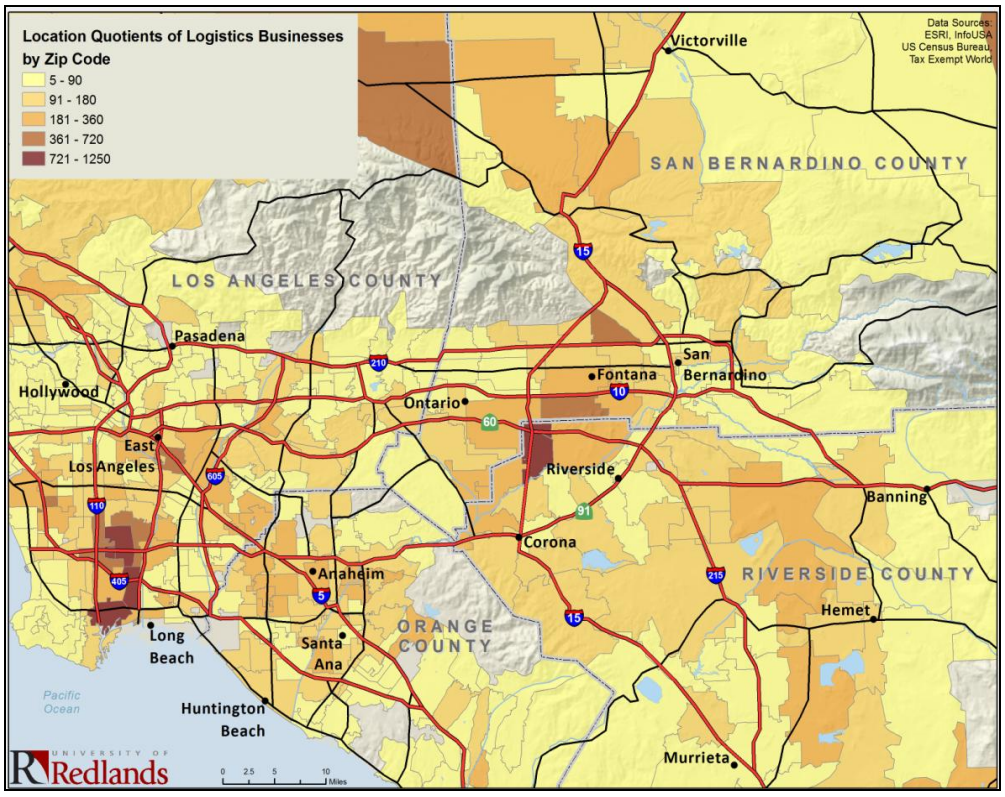

Figure 3: Location Quotients (LQ) by zip code in study area

This makes intuitive sense given the location of the transportation facilities in these counties relative to warehouse locations. Relative to railroad transportation, warehouses located along a north-south corridor parallel to Interstate 5 have highest accessibility; note that rail transport facilities are located at either end of the corridor. Overall it can be concluded from Figure 4 that accessibility of warehouses in Los Angeles County to different modes of transportation facilities is higher than their counterparts further south and east in Orange, San Bernardino, and Riverside counties. While cities in the Inland Empire such as Mira Loma (in Riverside county), and Fontana and Rialto (in San Bernardino county) can be considered to "logistics" hubs, they derive their competitive advantage due to clustering of warehousing and storage facilities, not freight transport infrastructure.

CONCLUDING REMARKS

A region's goods movement is often a reflection of its economy. Goods movement services play a critical role in the generation of jobs and economic activity in their own right. This research provides a framework to visualize Southern California's warehousing and goods transportation facilities relative to the region's freight transport infrastructure. The results obtained can be used by businesses for operational decision-making such as route planning, optimization and development of transportation strategy as well as strategic decision-making such as site location, relocation, or facility consolidation. The research provides a rudimentary framework for further research to investigate commodity classes being shipped, popular modes of transportation, volume and value of goods movement, primary sources and destinations of goods in Southern California, etc. and to study economic and environmental impacts of goods movement and other related business logistics issues.

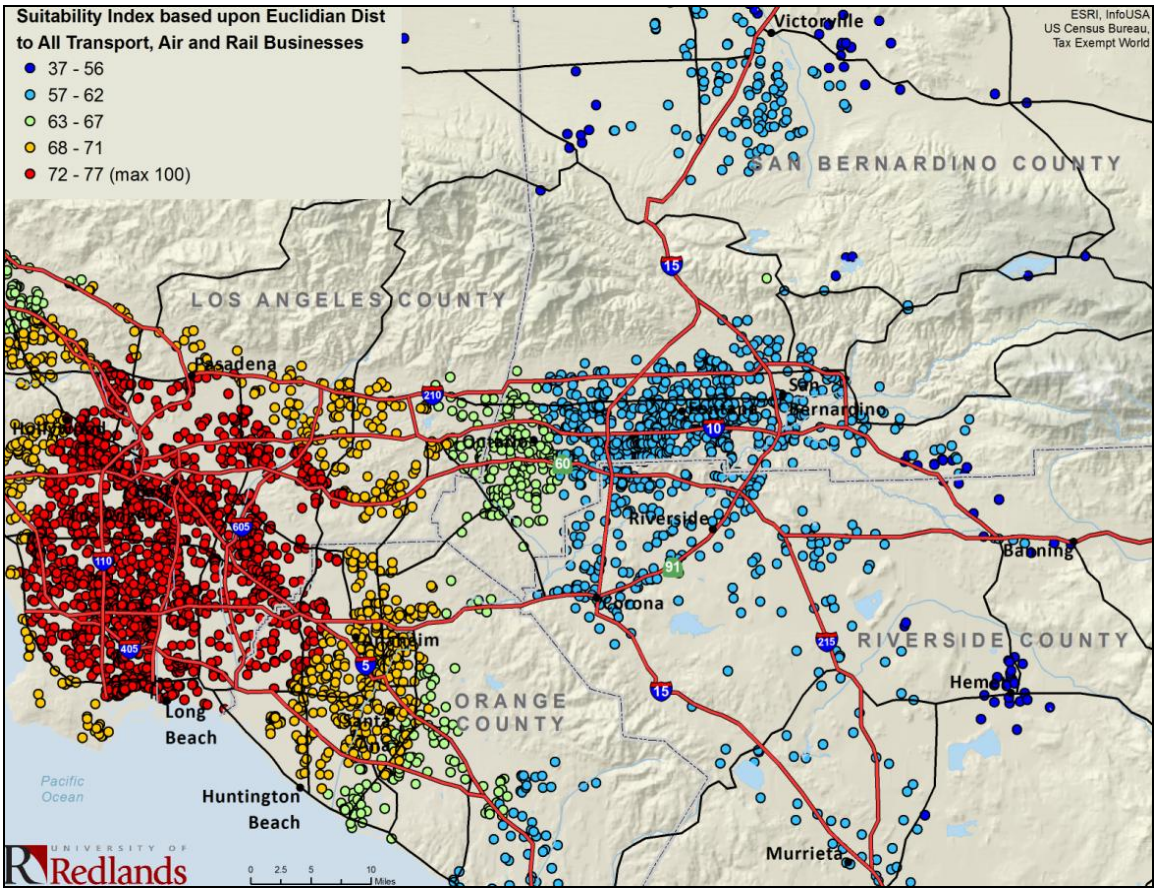

Figure 4: Composite Accessibility Index defined by Euclidean distance metric for warehouse locations in study area

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