



METROFREIGHT

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NETWORK ANALYSIS OF THE MULTIMODAL

FREIGHT TRANSPORTATION SYSTEM IN NEW YORK CITY

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STUDY OVERVIEW

The efficiency and effectiveness of transportation networks plays a vital role in moving people and circulating goods. This research is aimed at examining the multimodal freight transportation network in the New York metropolitan region to identify critical links, nodes and bottlenecks that affect last-mile deliveries. More specifically, the objectives of the research are to: understand and document the inventory of the multimodal freight transportation network in the region; measure the performance of the network from the supply side; and identify critical nodes, links and terminals that affect last-mile deliveries. Three categories of numeric measures were developed for the highway network that carries the majority of last-mile deliveries. Multimodal freight terminals were selected and evaluated in terms of their accessibility to freight demand generators.

The study area is consisted of 7 counties, including Bronx, Kings, New York, Queens, Richmond County in New York state, and Bergen and Hudson County in New Jersey state. The highway network selected includes interstate, state and regional highways, including Interstate Highways I-278, I-478, I-678, I-495, I-695 on the New York side, and I-95, I-78 on both the New Jersey and New York sides. More than 5,400 links on the original map were merged to less than 1,000 links. In addition, there are 508 actual intersecting highway nodes that connect at least two different highway segments. Traffic analysis zone (TAZ) generation data and warehousing establishment data are used to evaluate accessibility. The researchers also examined warehouse locations and operation strategies that affect the generation, distribution, mode choices and traffic assignment of freight demand.

FINDINGS

The vast majority of the warehousing establishments (93.6%) were found to be General Warehousing and Storage. Almost 90% of warehouses were found to be small businesses with less than five employees (67.6%) or with greater than five and less than 20 employees (21.7%).

Three types of network measures were calculated to quantify the highway network inventory from different aspects. They are network descriptive measures that show the basic characteristics of the highway network, network structure measures that indicate connectivity, and accessibility related measures that represent the ease of a highway node to be accessed by the system. The road density, calculated as the total length of highway links divided by the area size of the study region was found to be 1.58 km per km². New York County and Bronx County were found to have the highest roadway density values. The existing highway network only provides limited connectivity to freight demand. In order to reach final destinations, the freight demand still needs to rely on arterials and local streets that often experience low travel speeds and long traffic delays in the urban setting.

For each highway node, total connectivity was calculated by using topological distances between nodes. Most of the well-connected nodes with high connectivity scores in Queens County are located where Interstate Highway I-678 meets Long Island Expressway and Grand Central Parkway. Those in Manhattan are located at the boundary highway edges where Bronx County meets New York County.

We propose that the degree of circuitry for a specific node to be the standardized value of absolute differences between network distances and Euclidean distances of all paths originated at that node. Degree of circuitry indicates the efficiency of a roadway network in connecting locations. The larger the value is, the longer the actual network distance is than the airline distance, and thus the less efficient a node or a network is. The least efficient highway nodes were found to be located on the boundaries of the study area and far away from the major demand generators such as Manhattan. As for the entire highway network, the degree of circuitry, or the average degree of circuitry for all node pairs, was found to be 1.23 - similar to past estimates. The average shortest path length for our study area was found to be 24.6 km given that only highways are used for freight shipments.

Accessibility measures the ease of reaching goods, activities and destinations. The most accessible nodes are clustered around bridges and tunnels connecting Manhattan and Long Island. Railroad and marine port terminals have higher accessibility to warehousing establishments than air and truck terminals in general, with accessibility scores of 23 and 28 on average, respectively.

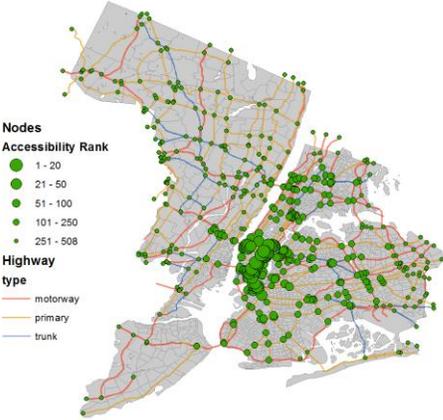


Figure 1: Accessibility ranking of highway nodes

In conclusion, the highway network in the region was found to provide limited connectivity for freight activities. Arterials and local streets are very important supplements for freight to reach final destinations. Major multimodal freight demand generators were found to have better accessibility to railroad and marine port terminals than air and truck terminals in general. The network measures and findings in the research can be used to understand the inventory of the freight network in the system and to conduct future freight travel demand forecasting analysis.