Traffic Network Analysis at Times Square

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Introduction:

To examine the street network, we make use of open data sources that recorded a detailed street network and the latest traffic data in New York City. Such data sources provide excellent resolution of urban mobility and cover more than 50 percent of total traffic counted who use taxi and for-hire vehicles daily in CBD. Therefore, taking taxi trip data as a proxy for urban movements and spatial interaction and Times Square, we aim to identify the essential elements of the street network in New York City.

Research Questions:

Street network analysis does not merely relieve traffic congestion but serves for resilience and emergency evacuation purposes.We are seeking for the answer to the following questions: What is the role of Times Square in the street network? How is the spatial distribution of routes connecting Times Square and other places? Which part of the street network is highly likely to be traveled? What is the impact on the street network at Times Square in New York City after infrastructure failure?

Methodology and Data:

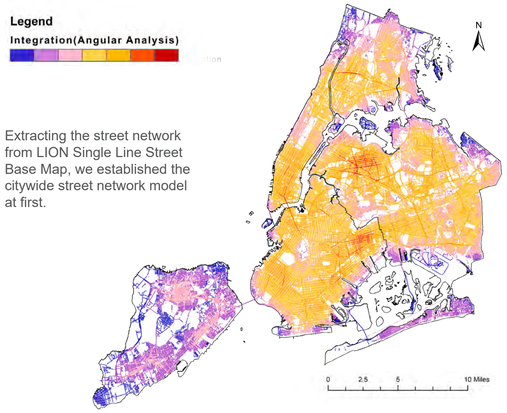
Three phases includes Baseline Analysis, Gathering Routes, and Link Criticality. Each phases will be discussed in details.

Data Set: NYC Dept. of City Planning. New York City Borough Boundary; NYC Dept. of City Planning. LION Single Line Street Base Map; NYC Taxi & Limousine Commission. Yellow Taxi Trip Records, Green Taxi Trip Records, FHV Trip Records, High Volume For-Hire Vehicle Trip Records; NYC Dept. of City Planning. Map PLUTO; NYC Taxi & Limousine Commission. NYC Taxi Zones.

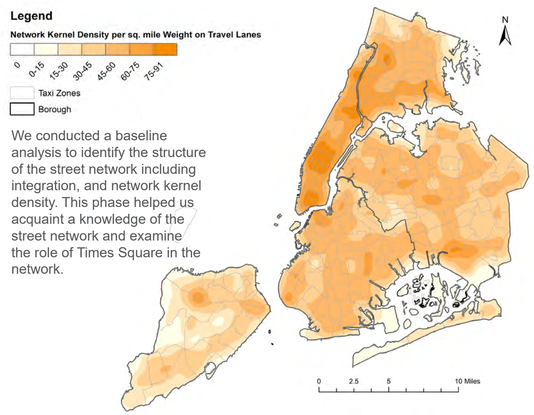
Conclusion:

The results indicate what one might anticipate about Manhattan. The grid offers many alternate routes and thus easily contains the impact of closure of any section. However, possibly due to the shape of the island, lateral street closure had a greater effect than closure parallel to Avenues. Given the unique geometry of Manhattan, future studies might find even lesser or no change if the same analysis is repeated for outer boroughs. However, the research also has limitations. The analysis is a simplified version of a transportation model. Future studies could also account for other modes of transportation and explore travel time and distance disruption with agent-based modelling.

Baseline Analysis:



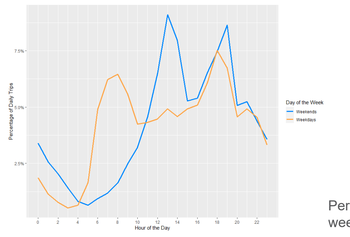
Extracting the street network from LION Single Line Street Base Map, we established the citywide street network model at first.



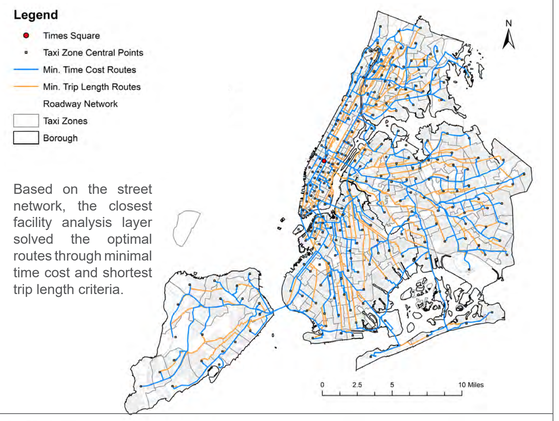
We conducted a baseline analysis to identify the structure of the street network including integration, and network kernel density. This phase helped us acquaint a knowledge of the street network and examine the role of Times Square in the network.

Gathering Routes:

In this phase, we set a specific scenario when the crowd was gathering at Times Square on a typical July evening. We extracted taxi data from TLC Trip Record Data to represent travel activities related to Times Square with a simplification of the travel activities as links between hotels and Times Square. Based on the street network, the closest facility analysis layer solved the optimal routes through minimal time cost and shortest trip length criteria. All optimal routes will be aggregated together on the roadway network to see whether there is any difference between this most likely network and the abovementioned baseline network.



Percentage of Trips during weekdays and weekends



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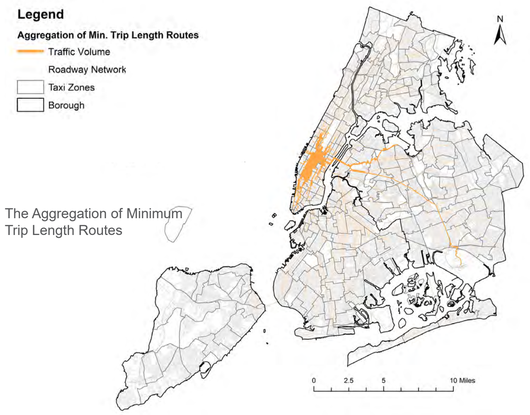
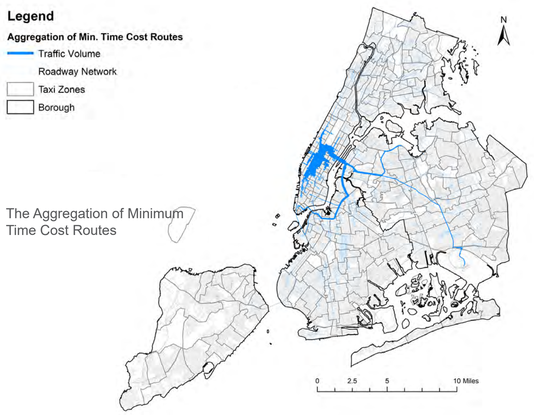
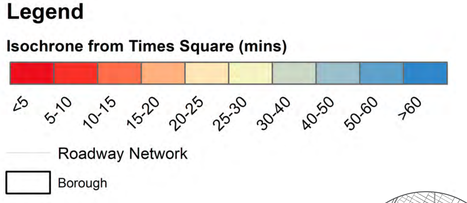


The Aggregation of Minimum Trip Length Routes

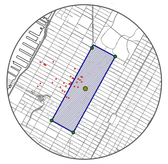


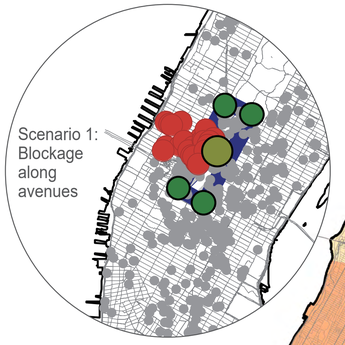
The Aggregation of Minimum Time Cost Routes

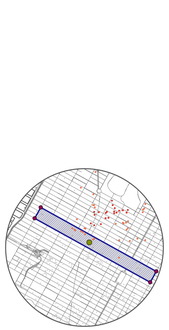
Network Resiliency:

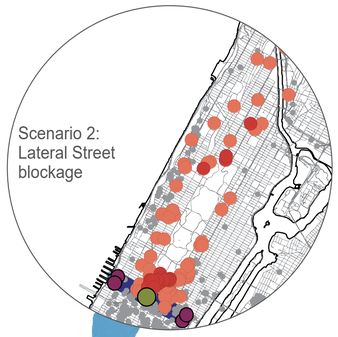


For a hypothetical scenario, we blocked the roads from Columbus circle to 34th Street and 6th Avenue. We assumed that the lateral connections are inaccessible here, and the crowd can leave only through the two corners at 34th street and 58th street. The map shows results of a Hotspot Analysis by Getis-Ord GI test on the difference. Hotspots are located right next to the road blockage i.e the impact is concentrated only on the area just beside Times Square.









Secondly, we assumed a lateral road blockage, from 11th Avenue to 2nd Ave, 47th to 49th streets. The impact of a lateral street closure is much wider, extending uptown till the end of Manhattan. However, hotels in outer boroughs, are not impacted by this. The grid offers many alternate routes and thus easily contains the impact of closure of any section. However, given the shape of the island, lateral street closures had greater effect than closure parallel to Avenues.