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Performance Measures to Assess Resiliency and Efficiency of Transit Systems

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Local transit agencies can employ remote sensing in assessing post-disaster performance of infrastructure.

Transit agencies, like other transportation agencies, are interested in assessing the short-, mid-, and long-term performance of their infrastructure with the objectives of making better decisions that will enhance resiliency and efficiency. This report addresses three distinct aspects related to the resiliency and efficiency of New Jersey's Transit System: 1) resiliency of bridge infrastructure, 2) resiliency of public transit systems, and 3) efficiency of transit systems with an emphasis on paratransit service.

Study Methods

Resiliency of bridge infrastructure: This project proposes a conceptual framework to assess bridge infrastructure performance and resiliency before and after disasters using Structural Health Monitoring (SHM), Finite Element Analysis (FEA), and Interferometric Synthetic Aperture Radar (InSAR). SHM and FEA can, conceptually, be applied to assess damage and degree of resiliency post-disasters and InSAR technology can acquire quantitative damage information to assess the impact on bridge performance.

Resiliency of public transit systems: Various data-driven models were used to quantify a series of transit network performance measures. Diverse traffic, events, infrastructure, and web-based sources of Big Data were analyzed. Due to the sparsity of public transit measures for vulnerability, recovery and resiliency, many measures from existing literature were adapted to public transit. An estimate of the reliability of specific bus routes on the NJ Transit bus network was then made. Following Hurricane Sandy, the NJ Transit bus transit network recovered much faster than the rail network, as the most critical link for NJ Transit buses remained intact despite loss of power for driving and signaling rail and subway systems.

Efficiency of paratransit service: Current and future demands for trips, based on available NJ Transit data, were investigated to improve the efficiency of paratransit service and to optimize its costs. This study first identified the generators of Access Link trips at a macro level by analyzing data at the census block group level. Subsequently, it focused on the establishments located in the immediate vicinity of drop-off sites to identify the generators of Access Link trips at a micro level. Factors associated with the efficiency of paratransit, such as travel time and trip delay, were discussed as were travel time and congestion.

Findings

Resiliency of bridge infrastructure: The proposed framework for assessing bridge resiliency would enable timely damage assessment for numerous bridges on a bridge network

basis, thus providing a rapid, optimized, and cost-effective management of road and bridge network conditions, post-disaster. With the proposed approach, transit agencies could assess the load carrying capacity of their bridge structures promptly and efficiently.

Resiliency of public transit systems: The distribution and duration of Sandy-related events were analyzed for the bus transit network. The ten routes with most Sandy-related critical events were located along the coast in the southern and eastern parts of NJ. The increase in travel times ranged from 2.8% to 21% among alternate routes. Recovery of the rail network took 2~32 days, whereas more than 65% of bus network was restored to full service in two days. One primary reason that the bus system recovered faster than other NJ Transit rail services is that the Lincoln Tunnel was not affected by the storm. The recovery of the light rail was closely correlated to the recovery of road infrastructure as well as the recovery of traffic systems such as signal control, power supply, etc. Recovery of underground subway systems, such as the PATH system and the NYC subway, were very dependent on the extent of flooding of the underground tunnels.

Efficiency of paratransit service: The growth of elderly persons is a key factor influencing the future demand for the Access Link service. While persons age 65 and over constitute 14% of the population, 52% of the Access Link's clients are 65 and over, and their trips constitut 21% of total trips. It is anticipated that the population of persons age 65 and over in NJ will increase 60% by 2030 (1.14 million in 2010 to 1.82 million in 2030), thus creating more demand in the future. When comparing service efficiency in the six Access Link regions, Region 5 appeared to have more trip delays than the other five regions. NJ TRANSIT needs to consider Region 5 to be the top candidate for realignment of service regions. Crashes and a number of other location-related, trip-related, and seasonal factors can influence paratransit's travel-time variability. However, utilization of geocoded crash data for trip-scheduling purposes can enhance paratransit's travel-time reliability, customer satisfaction, and efficiency.

Policy Recommendations

Three main recommendation are derived from this research. First, the bridge SHM system and InSAR technology would be effective tools for evaluating the resiliency of bridges, post-disaster. Second, agencies can utilize the proposed performance measures to reroute affected bus routes and improve the resiliency of the local public transit network. Last, but not least, report findings can help local transit agencies optimize the costs of paratransit service and improve the efficiency of paratransit service based on the data-driven models.

About the Authors

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To Learn More

For more details about the study, download the full report at ***transweb.sjsu.edu/project/1242.html***

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