Commuter Adaptation to Transportation Disruption in Hurricane Sandy's Aftermath

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While work on the assessment of transportation infrastructure and the network configuration's ability to withstand and recover from shocks has been of interest recently, little empirical data is available on the traveler's ability and willingness to adapt to the disruptions and recovery steps taken by transportation and transit authorities and the stress (and other utility loss) associated with this. It is fairly well accepted that demand would change when such disruptions occur; however, the details of this change are unknown. Traveler adaptation is likely to vary as the transportation authorities adapt their services to the state of the infrastructure and anticipated demand. Moreover, these disruptions impose psychological costs on commuters. It is important to collect the information quickly before commuters forget what their choices, behaviors, and attitudes were on particular days due to the dynamic nature of the infrastructure, policies, and transit services as the authorities seek to restore full operations to the multi-modal transportation system.

The main purpose of this study is to collect data on commuter adaptation to the transportation disruptions (all modes) related to Hurricane Sandy in the New York City/northern New Jersey area. This data was collected primarily through a phone based survey and yielded 397 records that are currently being analyzed, with statistical and discrete choice modeling to follow. Initial summaries of selected questions are provided in Table 1. Among the survey respondents, it appears that the closure of the workplace or altered hours (68%) impacted more people that damage to their residences (17%). Schools and daycare centers were also frequently closed, affecting 83% of respondents with children. Disruptions to the different transportation modes and structures affected varying percentages of respondents, as shown in Table 1. Gasoline restrictions affected the largest percentage (50%), followed by subway disruptions at 34%. Without considering a specific mode, congestion/crowdedness and delays affected 43%.

Only 26.2% of respondents indicated that they did not alter their commute patterns as a result of the disruptions or recovery actions associated with Hurricane Sandy. Figure 1 provides information on the day that respondents returned to their normal work schedules and locations and the length of commuting disruptions. For both measures, the greatest percentage of respondents who were affected indicated returning to normal a week after the hurricane, which is when NJ Transit provided emergency bus service; free parking, bus, and ferry service were available at Liberty State Park; HOV3+ restrictions had been lifted for the Brooklyn, Manhattan, Queensboro, and Williamsburg Bridges; the Queens Midtown Tunnel had one lane open for buses; the Long Island Rail Road had restored additional service; and some subway service had been restored. Gasoline access (even/odd license plate) had not yet been restricted. In an open ended extension of the second question in Table 1 about other factors that influenced work activities post-Hurricane Sandy, 6% indicated gasoline issues and 16% offered lack of electricity.

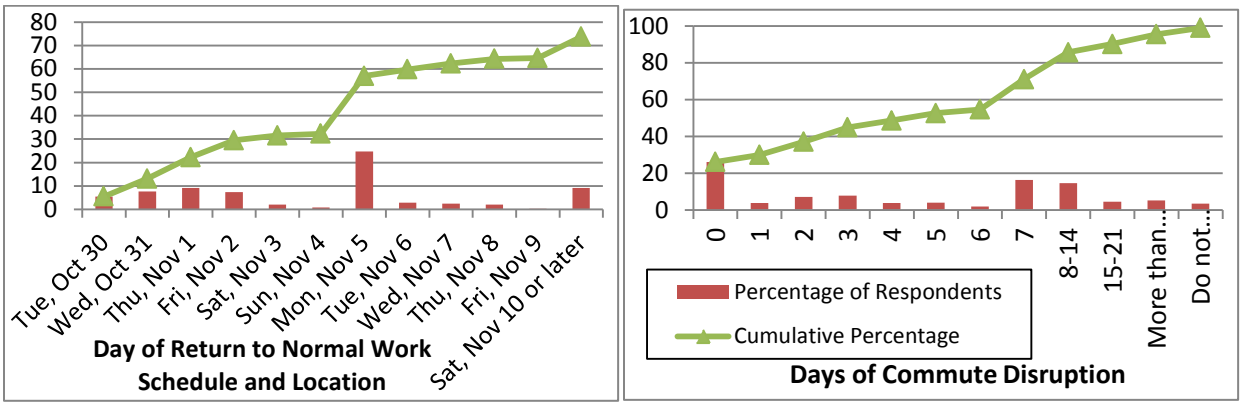

Figure 1 Durations of Work and Commute Disruptions

Table 1 Selected Questions and Responses for Commuting Impacts

Main Question	Sub-question	Answer	Percentage of Respondents
Which, if any, of the following impacts did Hurricane Sandy have on your commute	• Increased travel time on at least one day		57.4
	• Increased cost on at least one day		17.6
	• Made you late for work on at least one day		41.6
	• Increased the distance you had to commute on at least one day		33.8
During the days that you did not work your normal schedule and at your normal location …	• Was your work closed or your normal work hours changed?	Yes	67.8
		No	17.1
	• Was your home damaged?	Yes	16.9
		No	68.3
	• Was the daycare or school closed for children in your household?	Yes	45.6
		No	9.6
		No children	30.5
	• Were bridges, tunnels, or roads you use to commute to work closed?	Yes	45.3
		No	38.5
	• Was the transit you use to commute to work closed?	Yes	39.0
		No	44.8
Was your commute or transportation affected in any way by …	• Closure of the Hugh L. Carey, Holland, or Queens Midtown tunnels	Yes	10.6
		No	89.2
	• Carpool restrictions at the Lincoln Tunnel, Brooklyn, Manhattan, Queensboro, and Williamsburg bridges	Yes	8.8
		No	90.4
	• Gasoline purchase restriction policies	Yes	50.4
		No	49.4
	• Taxi policies	Yes	4.5
		No	94.7
	• Delays or crowding on roads or transit	Yes	43.1
		No	56.7
	• Temporary suspension of PATH rail service	Yes	6.8
		No	92.7
	• Service disruptions of the NYC subway or bus service (MTA)	Yes	33.5
		No	66.0
	• Service disruptions on the LIRR	Yes	4.3
		No	95.5
	• Service disruptions on the MNRR	Yes	3.0
		No	96.2
	• Service disruptions on the NJ Transit bus or rail	Yes	5.3
		No	94.2

Intellectual Merit. Large scale transportation disruption rarely occurs on the east coast, and this project fills an unoccupied niche by collecting unique, ephemeral data. This data will lead to new models of travel behavior and decisions after a major disruption. The data and models will lead to better understanding of commuter adaptability to events that disrupt the transportation system, temporary transportation policies, and fuel shortages, with respect to their mode and timing choices. This understanding, data, and models will guide future, comprehensive transportation resiliency studies by

allowing prediction of demand. Without such demand models for different conditions, resilience studies rely on judgment based demand estimates, many defaulting to the original demand levels, which may lead to an over or under estimate of connectivity and capacity needs. Furthermore, most of the analyses of transportation disruptions focused on the road system, leaving a large gap for transit and multi-modal systems. This leaves heavily transit dependent cities, such as New York City, with few previous studies and tested practices with which to inform their future mitigation and recovery plans. This study helps fill this gap.

***Broader Impacts*.** Better capturing commuter response to disaster aftermath conditions and varied recovery and mitigation policies will have at least three societal benefits. First, more comprehensive resilience assessments may be conducted leading to more accurate assessments of connectivity and capacity needs. Under estimates cause traveler frustration, delays, and lost productivity in an already stressful time. Over estimates lead to excessive expenditures by transportation infrastructure and service providers. Second, the traveler response (and models) to the infrastructure conditions and policies will help guide policies in future events and other locations – successful policies are likely to be implemented elsewhere while failures are not. Third, understanding stress related to transport disruption can help target both public (*e.g.*, free transit service) and private (*e.g.*, workplace flexibility) interventions to improve public health. The research team will publish initial findings quickly with the goal of disseminating the information in a timely manner so that agencies with recovery responsibilities can learn from the Hurricane Sandy aftermath. The team has also recruited a female graduate student, who will use this study as the basis for her thesis. Recruiting women for graduate degrees in engineering and providing them with strong mentoring support will help increase the percentage of female engineering faculty. The research team also anticipates developing more sophisticated models that may be outside the temporal duration of this project. These initial and longer term analyses will lead to additional interactive activities posted on the PI's website.