NWIRP Research Study of Recovery from Hurricane Maria’s Impacts on Puerto Rico

Recovery of Business and Supply Chains Post-Hurricane Maria

Project Leader: Jennifer Helgeson
Background and Motivation

• Project falls under the NWIRP study of the NIST Hurricane Maria Program
• Supply chain linkages between Puerto Rico and the rest of the U.S. in critical sectors (e.g., healthcare) (NAS, 2020)
• Businesses are a critical part of community functions and community-level resilience and recovery capacity.
• 99.7 % of businesses in Puerto Rico qualify as “small” (<500 employees at a location); 68 % of which have annual reported revenues of $250K or less; 75 % are micro-enterprises (less than 10 employees) (SBA, 2018, 2019).
• Project outcomes will support development of methods to assess community-level resilience.
• Focus is on empirical relationships between business functions and physical systems with regard for social systems and decision-making


Background and Motivation: Study Area

- Regions by ZIP code selected as the study unit (NWIRP Projects)
- Municipios selected within the six shaded regions shown below
  - Four common across all NIST projects
  - Addition of Mayagüez and Ponce (concentration of manufacturers)
Project Plan – Overview

1. Sampling and surveying individual small- and medium-sized enterprises (SMEs):
   • Small- and medium-size manufacturers (SMMs) and
   • Small- and medium-sized businesses in the retail and services sectors (e.g.,
     grocery, clothing, and restaurants)
     *(Contractor-supported effort, in progress)*

2. Sampling and interviewing individual firms:
   • Shipping sector
   • Transportation sector
   • Warehousing sector
     *(Contractor-supported effort, in progress)*

3. Connecting spatial-geographic units – across NWIRP Projects
Project Plan – Study Design

Sample from study area(s)

(Non-SMM) SMEs

SMEs

Structured survey

N=200

Semi-structured survey addition: supply chain focus

SMMs

Structured survey

N=200

Semi-structured survey addition: supply chain focus

Shipping and Transport Rep(s)

Semi-structured interviews

N=30

Data Collection Instruments

Recovery analysis results for SMEs

Recovery analysis results for SMMs

Inputs to model of PR supply chain resilience

Project Plan – Study Design

Data Collection Instruments

N=200

(Non-SMM) SMEs

N=30

Shipping and Transport Rep(s)

Recovery analysis results for SMEs

Recovery analysis results for SMMs

Inputs to model of PR supply chain resilience

Sample from study area(s)

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Semi-structured survey addition: supply chain focus

SMMs

Structured survey

N=200

Semi-structured survey addition: supply chain focus

Shipping and Transport Rep(s)

Semi-structured interviews

N=30

Data Collection Instruments
**Project Plan – Analysis**

**Risk Profile**
- Perceived Probability of event
- Perceived risk to life
- Perceived risk to property
- Affective factors
- Risk aversion

**Circumstances**
- Previous experience
- Knowledge/information
- Social influence
- Social norms

**Personal Choice Beliefs**
- Self-efficacy
- Perceived control

\[ p(A^i = 1) \] is the probability that an SME operator takes an Action \( A^i \) in hurricane season 2021;
\[ p^*(A^i = 1) \] is the adjusted probability that an SME operator took an Action \( A^i \) in 2017;
\[ T_{coef}, RA_{coef} \] are Time and Risk Aversion adjustment coefficients.
Recent Progress

Structured survey data collection

- 401 total complete survey responses (May 27, 2022)
- Mail ahead
  - Phone
  - Push to web
- Codebook developed

<table>
<thead>
<tr>
<th>Field</th>
<th>Sample Frame (Retail &amp; Services)</th>
<th>Sample Frame (Manufacturing)</th>
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<tr>
<td>Transportation &amp; Warehousing</td>
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<td>Other (please specify)</td>
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<td>Total</td>
<td>373</td>
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### Recent Progress

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<tr>
<th>NAICS</th>
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<th># Target Interviews</th>
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<td>481/483</td>
<td>Air and Water Transportation</td>
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<td>484</td>
<td>Truck Transportation</td>
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<td>488</td>
<td>Support Activities for Transportation</td>
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<tr>
<td>492/493</td>
<td>Couriers and Messengers / Warehousing and Storage</td>
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*Convenience sample of N=30; Attempts to represent the perspectives of all sectors under study rather than matching it to the characteristics of the population.*

### Interview Guide Sections

1. About the Business Operations and Interviewee
2. Hurricane Maria Impact (Vulnerabilities)
3. Preparedness, Response and Recovery per Impact Category
4. Facilitating and Limiting Conditions per Impact Category
5. Learning per Impact Category
6. Reflections on Preparedness, Recovery Status and Resilience
7. Organizational Characteristics (Demographics)
8. Ports’ Resilience Assessment
Recent Progress

- Overlay of vulnerability and adaptive capacity of businesses within region in respect to community characteristics such as human-social, economic, infrastructure-physical, and environmental.

<table>
<thead>
<tr>
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<th>Economic</th>
<th>Infrastructure</th>
<th>Environmental</th>
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<td>Pop'l'n. over 65</td>
<td>Employment level</td>
<td>Housing profile</td>
<td>Wind exposure</td>
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<td>Pop'l'n. with disabilities</td>
<td>Budget of municipal government</td>
<td>Rural/urban classification</td>
<td>Landslides</td>
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<td>Schools</td>
<td>Disaster assistance funding</td>
<td>Housing density</td>
<td>Rainfall</td>
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<td>Hospitals</td>
<td>Business establishments</td>
<td>Percent outages (DIRS)</td>
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<td>Cell sites</td>
<td>Flooding</td>
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<td>Water distribution</td>
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<td>Census Pop'l'n.</td>
<td>County Business Patterns</td>
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<td>Report to the Governor</td>
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<td>Dashboard</td>
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<td>Hurricane Maria Dashboard</td>
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Sources & Indicators

- USGS
- NOAA
- FEMA Hazus Report
- Hurricane Maria Dashboard
Recent Progress and Next Steps

Recent Progress

• Preliminary analysis on pilot data collected on SMEs (summer 2021)
• Small- and medium-sized manufacturer and retail surveys conducted and codebook prepared (to be completed summer 2022)
• Shipping and Transportation Interview Guide
  • PRA-approved (Apr. 2022)
  • IRB-approval (Pending)
  • Training planned (Jun. 2022)

Next Steps

• Complete all data collections
  o Account for connections to other NWIRP data collections on recovery of social functions and recovery of infrastructure
  o Finalize sample of shippers and transportation companies
  o Semi-structured supply chain interviews conducted and data delivered to NIST
• Data analysis to be completed
  o Quantitative analysis of SME/SMM survey data
  o Qualitative coding of interview data
• Draft “Business and Supply Chain Recovery” full chapter for NWIRP Report
  o Update literature/media review of issues in recovery facing SMEs and supply chains following Hurricane Maria and additional interruptions
  o Incorporate analyses based in econometric modeling of recovery trajectories and SEM modeling of intended mitigation and adaptation behavior
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Project Leader: Jennifer Helgeson

Project Team: Payam Aminpour (PREP Research Associate, Johns Hopkins University), Alizabeth Sánchez-López (PREP Research Associate, Johns Hopkins University; Puerto Rico-based)

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