

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

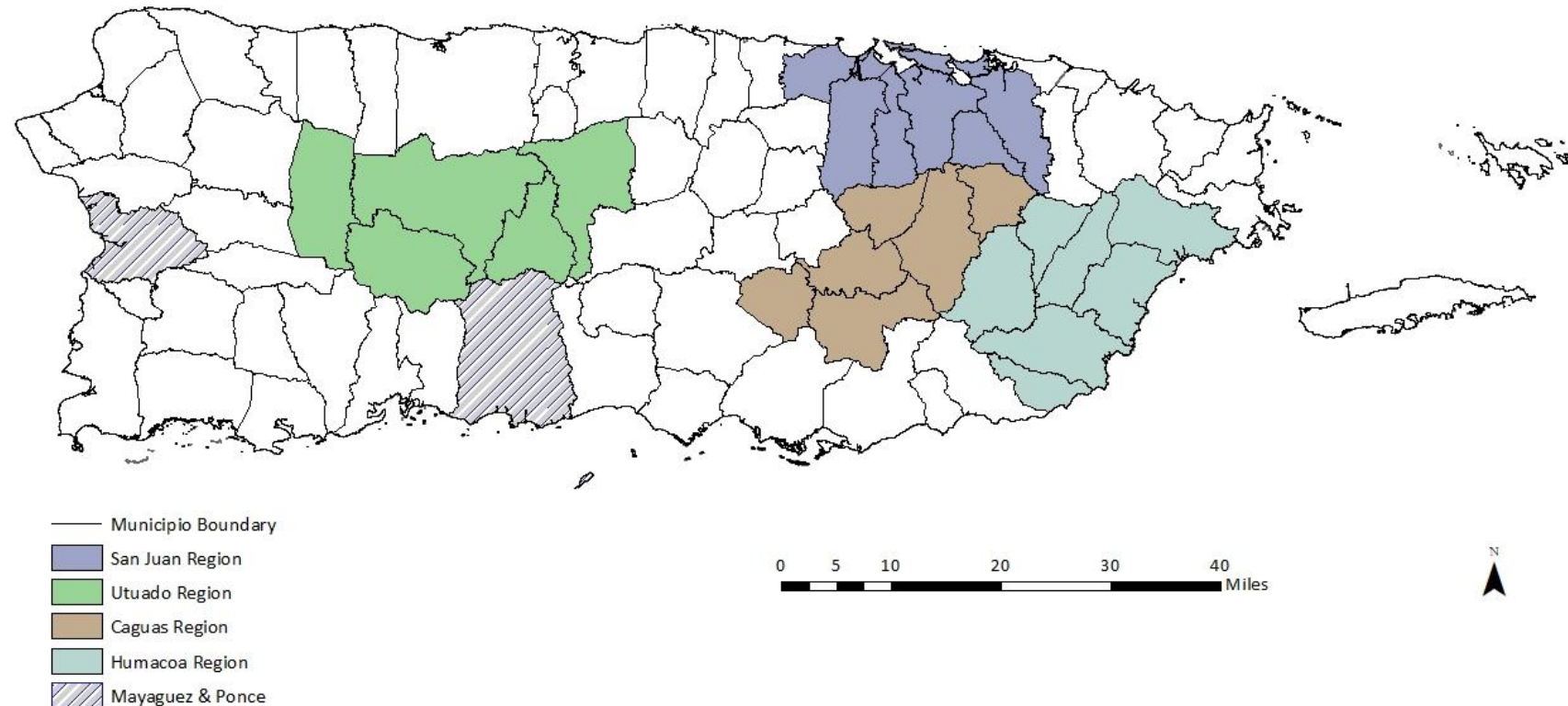
National Academies of Sciences, Engineering, and Medicine. 2020. *Strengthening Post-Hurricane Supply Chain Resilience: Observations from Hurricanes Harvey, Irma, and Maria*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25490>.

Importance of small- and medium-sized businesses in the U.S. (Small Business Administration- Office of Advocacy 2018, 2019)

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)

Study Areas for NIST Hurricane Maria Program



Data Source: US Census Bureau TIGER/Line 2016, FEMA 2017
 Developed: NIST 2020; using ESRI software
 Coordinate System: GCS NAD 1983
 Datum: NAD 1983
 Scale: 1:700,000

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)

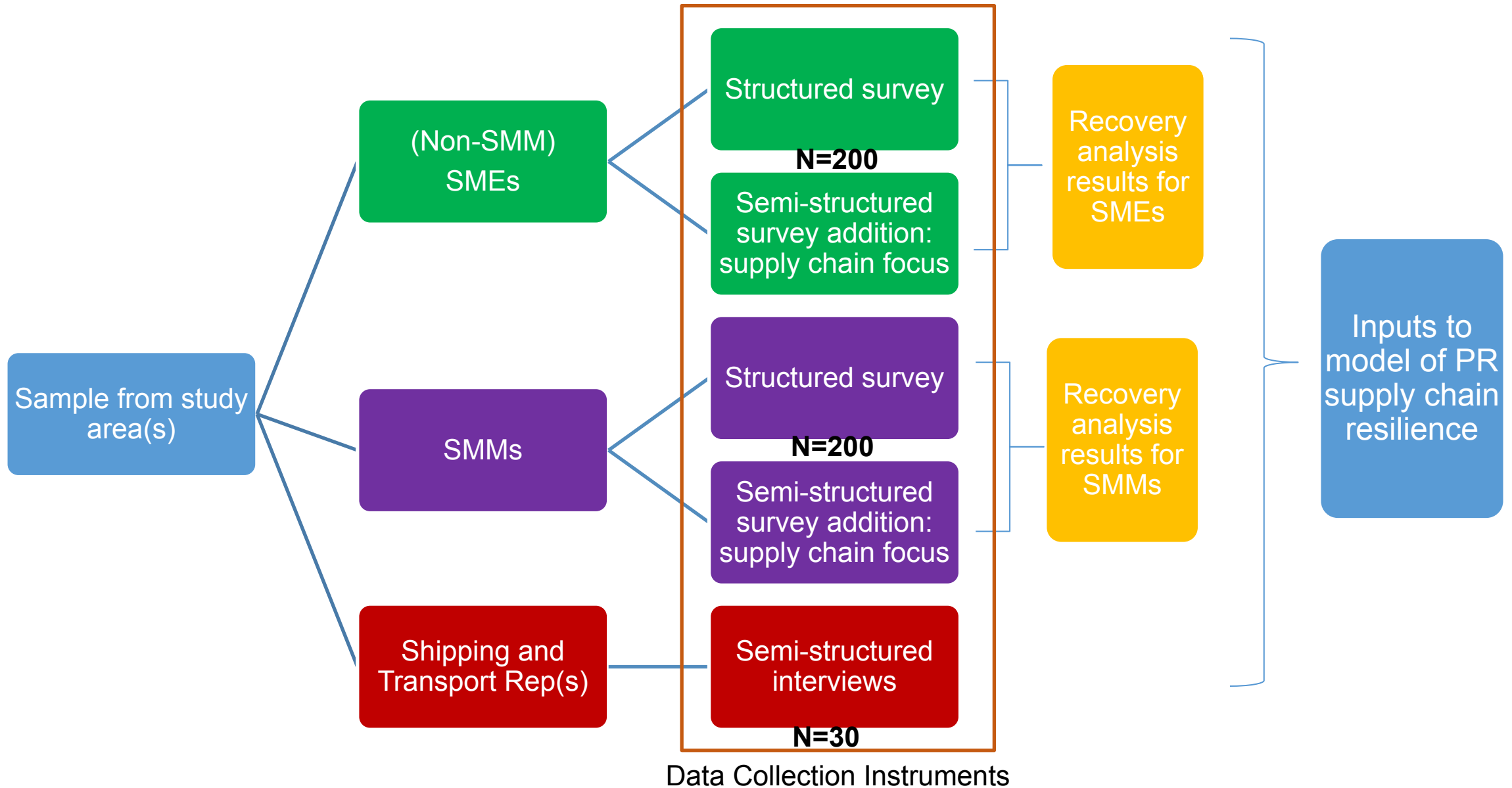
2. Sampling and interviewing individual firms:

- Shipping sector
- Transportation sector
- Warehousing sector

(Contractor-supported effort, in progress)

3. Connecting spatial-geographic units – across NWIRP Projects

Project Plan – Study Design



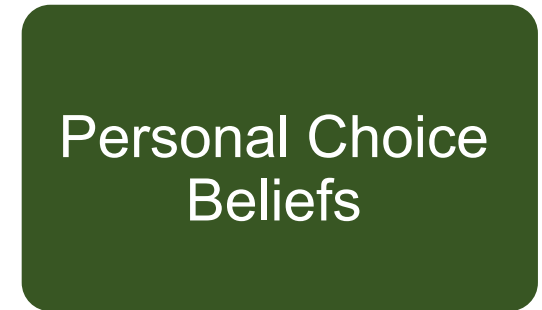
Project Plan – Analysis



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



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



- 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

Field	Sample Frame (Retail & Services)	Sample Frame (Manufacturing)
Construction	21	5
Manufacturing	11	13
Retail Trade	72	1
Service	35	4
Wholesale Trade	7	5
Services	107	7
Transportation & Warehousing	6	0
Other (please specify)	114	8
Total	373	43

Recent Progress

NAICS	Transportation Categories	# Target Interviews
481/483	Air and Water Transportation	4-7
484	Truck Transportation	5-10
488	Support Activities for Transportation	7-16
492/493	Couriers and Messengers / Warehousing and Storage	4-8
<p><i>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.</i></p>		

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.

	Social-Human	Economic	Infrastructure	Environmental
Sources & Indicators	Popl'n. over 65 Popl'n. with disabilities Schools Hospitals Shelters Educational levels	Employment level Budget of municipal government Disaster assistance funding Business establishments	Housing profile Rural/urban classification Housing density Percent outages (DIRS) Cell sites Water distribution Road network	Wind exposure Landslides Rainfall Storm surge Flooding
	Census Popl'n. Social Vulnerability Index Army Corps. Of Engineers Hurricane Maria Dashboard	County Business Patterns Economic Census FEMA Public Assistance Report to the Governor Hurricane Maria Dashboard	PR Planning Board Army Corps. Of Engineers FCC Hurricane Maria Dashboard	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
 - Account for connections to other NWIRP data collections on recovery of social functions and recovery of infrastructure
 - Finalize sample of shippers and transportation companies
 - Semi-structured supply chain interviews conducted and data delivered to NIST
- Data analysis to be completed
 - Quantitative analysis of SME/SMM survey data
 - Qualitative coding of interview data
- Draft “Business and Supply Chain Recovery” full chapter for NWIRP Report
 - Update literature/media review of issues in recovery facing SMEs and supply chains following Hurricane Maria and additional interruptions
 - Incorporate analyses based in econometric modeling of recovery trajectories and SEM modeling of intended mitigation and adaptation behavior

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