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THE EFFECT OF SOCIAL CAPITAL ON HOUSEHOLD RECONSTRUCTION: PUERTO RICO RECOVERING FROM HURRICANE MARIA

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Abstract: Hurricane Maria on September 20, 2017 was stronger and more devastating than anticipated, particularly for the people living in the line of impact. When these events occur, housing reconstruction is at the forefront of residents' minds as they look to resume normal daily life and protect the safety of themselves and their family. In light of this, it is imperative to understand how some communities are able to reconstruct when the official process becomes difficult or impossible to navigate. This study takes the perspective of social drivers to reconstruction outside of the formal process and focuses on the relationship between self-reported social capital and informal reconstruction processes. These processes include unlicensed labor, reusing scrap materials and overusing temporary fixes. This study asks the question, *what effect does social capital have on the level of household informal reconstruction in Puerto Rico after Hurricane Maria?* Door to door household surveys (N=163) were gathered in the rural municipality of Loíza in Puerto Rico between December 2018-January 2019. Results suggest a correlation between bridging social capital and percentage of informal reconstruction used which suggests that connecting resources across communities is important to ensure widespread access. Theoretical implications include a further understanding of the importance of social capital past the initial response phase such as distributing food after a hazard event, but in fact it extends into the long-term permanent housing reconstruction phase.

1 INTRODUCTION

Puerto Rico was devastated by Hurricane Maria on September 20, 2017. The disaster quickly became a humanitarian crisis as the official reconstruction process became difficult to navigate and inaccessible to many. Strict requirements imposed on the largely unregulated context and inadequate formal recovery mechanisms are leaving vulnerable populations without adequate shelter, increasing susceptibility to health and safety risks and growing mental health issues (Acevedo & Pacheco, 2018; Dickerson, 2017). The devastation is extensive and widespread – 400,000 houses are in need of reconstruction and repairs which represents a third of the 1.2 million houses on the island (Brown, 2018). The recovery process has been strained and issues like ambiguous and inadequate funding processes have especially affected many communities where institutional support and resources are more scarce (De La Rosa, 2018). Only 40% of Federal Emergency Management Agency (FEMA) financial assistance applications have been approved (Acevedo & Pacheco, 2018) and 80% of appeal cases are either pending or denied as of the most recent statistics from July 2018 (Acevedo, 2018). As a result, many households and communities have relied on their own resources and efforts to reconstruct their houses (Portal, 2018; Viglucci, 2018). This kind of self-reliance has widespread precedents in pre-Hurricane Maria informal reconstruction. Housing units considered 'informal' are more common in rural communities; where residents often sell or inherit properties through informal agreements, subdivide land without completing the title process, occupy government owned land to build homes, or build a house without completing the construction permit process. Informal reconstruction is defined in this research as design and construction actions carried out by community

members in establishing permanent features of housing (e.g. design decision, physical labor) without following formal construction procedures and codes. Estimates of informally built houses present on the island before Hurricane Maria range from 260,000 to 700,000 homes – the latter constitutes 60% of total homes on the island (Brown, 2018; Florido, 2018). Since the 2017 hurricane season, Puerto Rico has seen a significant wave of reconstruction using informal methods to recover their homes on their own terms (Viglucchi, 2018), such as family providing labor, building without inspections, or reusing scrap material. It is important to understand drivers behind this decision-making and methods of accessibility when regulated requirements are inaccessible to gain a holistic perspective regarding practical difficulties and decision making towards an accurate picture of recovery options. This research hypothesizes that social capital can increase access to resources and continue the reconstruction process, and examines the social drivers behind household reconstruction from a social capital perspective. To understand how communities are able to build back on their own in times of vulnerability using social connections, this study asks, *what role does social capital play in household use of informal housing reconstruction practices in Puerto Rico after Hurricane Maria?*

This question is explored through door to door household surveys (N=163) in one rural, low income municipality of Puerto Rico. Surveys gather indicators for informal reconstruction processes and social capital, and data analysis includes correlations to understand the interaction of each type of social capital and the percentage of the reconstruction methods reported as informal, used in a household.

2 RESEARCH RATIONALE

2.1 Informal Reconstruction

Informal reconstruction is rooted in the literature on self-recovery, or ‘self-build’ and ‘self-help’, which represents communities organizing to rebuild or repair damaged or destroyed homes using their own resources (Parrack et al, 2014; Flinn, Schofield & Morel, 2017; Hendriks, Basso, Sposini, van Ewijk & Jurkowska, 2017). This often creates access to reconstruction that has become unavailable to many and these unregulated, or ‘informal’ methods allow vulnerable populations attempt to return to daily life as quickly as possible using the limited resources available to them. These methods have been critical for survival and mitigation of vulnerabilities as they offer a solution when disaster victims do not have the financial resources, time, or physical mobility to use other options and introduces significant control and agency (Flinn et al, 2017). This has been seen in historical and recent disasters, such as in the Philippines after Typhoon Haiyan (Flinn et al, 2017), and Gujarat India after the 2001 earthquake (Ahmed, 2011) with great success. These solutions have allowed families to rebuild with a faster timeline, are less financially and resource intensive and allows them to rebuild according to their own needs and preferences.

Current response practices provide for roughly 10% of the shelter needs within the first year, therefore it is ‘inevitable’ that communities build back on their own especially in developing communities where resources are scarce (Parrack et. al, 2014). Previous work on self-recovery has primarily discussed the importance of self-recovery for communities’ response and safety concerns of self-recovery (Flinn et al, 2017). However there is still a lack of understanding of what drives these actions. By examining the reasons behind informal reconstruction actions and decision making, post disaster recovery literature can be expanded by understanding the intricacies of the daily decisions households must make.

Puerto Rico has seen staggering statistics for informal housing and construction practices before Hurricane Maria – as much as 55% of construction for residences and commercial buildings on the island could be considered ‘informal’ (Brown, 2018). While Puerto Rico official building codes are some of the strictest in the world, these codes are not well enforced during construction, increasing the vulnerability to damage during disaster events (Nonko, 2017). Furthermore, these houses are not eligible for FEMA assistance because they do not have the appropriate paperwork and proof of tenure (Florido, 2018), adding to the fragility of local livelihoods and residents’ suffering and despair when resources to rebuild are needed.

In current literature, post-disaster reconstruction, specifically informal reconstruction, considerations tend to be seen through economic and political viewpoints. Previous studies have found social capital to be important in recovery (Aldrich, 2012), however there is a lack of understanding in how integral these connections are to successful reconstruction. This view will aid in gaining a holistic perspective of informal

reconstruction that extends further than the technical, financial and political components and includes the essential yet oft overlooked social and cultural perspectives.

It is well documented that mobilization of social capital to supply urgent needs and temporary shelter is effective (Rahill, Ganapati, Clerisme & Mukherji, 2014; Kim, Nakanishi, Blackman, Freyens & Benson, 2017). However, there is a lack of understanding about what happens to the ability to use those resources when recovery enters the long-term housing phase.

Furthermore, there is a lack in current literature of quantitative studies exploring the impact of social capital in post-disaster contexts. As desperate households rebuild in whatever ways they can, and as we look to mitigate destruction in future events, it is imperative to fully understand available resources. This includes a calculated view of vulnerable communities and their ability to use ingrained social resources to rebuild using more 'untraditional' methods.

2.2 Social Capital

The research is based in social capital theory to explain how social relationships influence a community's decision making processes through vital connections which can facilitate or impede information sharing, participation and collaboration between community members (Coleman, 1988; Aldrich, 2012; Portes, 2000). These community features are essential, especially in post-disaster contexts where people need to mobilize resources (Bolin & Stanford, 1998; Shaw & Goda, 2004). Social capital represents the relationships and networks that people create to bring benefit to themselves and others (Portes, 2000), as well as "features of social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit" (Putnam, 1995). A comprehensive framework describing the different features of social capital includes bonding, bridging and linking social capital (Aldrich, 2012). *Bonding social capital* is characterized by horizontal connections between individuals within a similar community, such as ethnic, identity, language, family or neighborhood groups. *Bridging social capital* is characterized by horizontal links between communities of similar characteristics such as ethnic, religious, language, and community proximity. *Linking social capital* is characterized by primarily vertical links with an explicit, formal and established organizations (Aldrich, 2012), such as between an individual and their government.

These relationships have been considered extensively in post-disaster recovery and are known to improve a community's ability to adapt after a disaster (Tan & Pulhin, 2014; Aldrich, 2012; Bhandari, 2014; Mukherji, 2014; Bankoff, 2007; Hawkins & Maurer, 2010). These forms of capital affect post disaster recovery as they limit or facilitate access to resources and information. For example, linking capital facilitated grass-roots efforts with distant, larger organizations following Hurricane Katrina in New Orleans (Hawkins & Maurer, 2010) while bonding and bridging capital allowed residents in multiple communities in the Philippines to maintain mutually beneficial agreements, collective action and other forms of security (e.g. collective community building of dams to protect from flooding) (Bankoff, 2007). This past work has especially emphasized the importance of resource mobilization during post-disaster recovery. This research hypothesizes that strong bonding and bridging capital correlates with high levels of informal reconstruction because households have a unique arsenal of resources and expanding bonding and bridging capital expands reach for resource access through those around you.

3 METHODS

3.1 Research Context

The research context for this study is the rural municipality of Loíza, situated in northeastern Puerto Rico. This municipality was chosen because it had a significant presence of informal construction before the hurricane, reducing the ability of the community to receive official assistance. Additionally, the housing stock in the municipality was significantly destroyed by the hurricane and required major reconstruction. Furthermore, Loíza is considered a lower income area (average annual income is \$17,273, which is below the average annual income in Puerto Rico (US Census Bureau)) and affects the capacity of the households to find the necessary resources to reconstruct.

The municipality of Loíza has a population of roughly 26,000 people with an unemployment rate of 7.9%. Also, 51.9% of the Loíza population live below the poverty line (US Census Bureau). Loíza is situated in the northeastern side of the island, bordering the main airport and in very close proximity to the capital city and main metropolitan area of San Juan.

3.2 Data Collection

Door to door surveys (N=163) were gathered from households within the municipality of Loíza during December 2018 – January 2019, just over one year after Hurricane Maria (September 2017). The first author spent seven days over a length of a few weeks collecting data and was assisted by a Puerto Rican undergraduate research assistant and seven local residents. Surveys were written and administered in Spanish. Surveys were mainly administered orally however at times the surveys were left at houses and collected later in the day to accommodate the time availability of the respondent. The municipality of Loíza is officially split into six neighborhoods (“barrios”), five of which are inhabited, and surveys were administered with homeowners in each inhabited neighborhood. Sampling was first structured by matching the percentage of total participants to the percentage of the population living in each neighborhood, however the amount of damage experienced in neighborhoods (some neighborhoods experienced little to no damage that required significant reconstruction), and safety considerations altered the actual percentages from the representative percentage goal. The following table (Table 1) shows the representative percentage breakdown and resulting participant percentages by neighborhood. Participating households within the barrio were considered if the household owner responded and if their house was damaged from Hurricane Maria significantly enough to require structural (non-aesthetic) reconstruction.

Table 1. Percentage of Survey Respondents from Each Neighborhood

Municipality	Neighborhood	Percentage of municipality population	Survey respondents	Percentage of total municipality respondents
Loíza	Torrecilla Baja	8.00	13	7.98
	Torrecilla Alta	0	0	0
	Medianía Baja	29.21	47	28.83
	Medianía Alta	26.68	74	45.40
	Loíza pueblo	12.89	10	6.14
	Canóvanas	23.22	18	11.04

(Source: US Census Bureau)

First, the survey asked for demographic data, including gender, age, religious affiliation, highest level of education, approximate household annual income, number of adults (specified for employed or unemployed) and number of children that live in the house, and place of birth. Second, the survey asked for indicators about the informality of the house before the hurricane including a question asking if the house was built with permits or if they had ever added on to the house without using building codes. Third, the survey asked respondents to assess the level of damage to their house and where they received different types of resources (physical labor, construction materials, technical expertise, etc.) including specific questions about their interaction with the Federal Emergency Management Agency (FEMA). The survey also asked for the respondent to give a percentage of how much of their reconstruction actions could be considered informal and a definition of that term for this research. Finally, the survey asked questions regarding their household social capital, such as how often they engage with people belonging to different communities or what percentage of their friends live in their neighborhood. Social capital indicators were

adapted from previous literature (Villalonga-Olives, Adams & Kawachi, 2016; Grootaert, Narayan, Jones & Woolcock, 2004; Rodríguez-Rey, Alonso-Tapia, & Hernansaiz-Garrido, 2016; Aldrich, 2012; Aldrich, 2019) to fit the specific context. Bonding, bridging and linking social capital were measured through multiple variables and an overall score for each participant for each form of capital was given. Bonding indicators included such questions as “How would you rate this community as a place to live?” and “How often do you attend community events?” Bridging indicators included frequencies of how often they interact with people from different communities or with a different religion, ethnicity, etc. and included questions such as “How often do you interact with people who live in a different community from you?”. Linking indicators included frequencies of interaction with various authority groups and included questions such as “Do you know anybody personally who works for the local government?”

3.3 Data Analysis

Survey data was examined with statistical analysis to identify the relationship between social capital and informal reconstruction. Correlations using SPSS software analyzes interaction of the independent and dependent variables. The dependent variable of this study is social capital, defined through bonding, bridging and linking variables, and a composite social capital variable representing a combination of the bonding, bridging and linking capital. The independent variable is percentage of informal reconstruction, defined as any action outside of official building codes, processes and use of contractors and inspectors. The independent variable was captured by providing a definition to respondents of what this research considered to be informal reconstruction and asking them to give a percentage of how much of the reconstruction actions they have been doing could be categorized in this way.

4 RESULTS

4.1 Descriptive Statistics

4.1.1 Community Demographics

The sample included a diverse sample in terms of gender (31.3% males and 68.7% females), employment status (55.8% with no employed adults in the house and 44.2% households with at least one employed adult). In terms of ethnicity, 94% of the sample included Puerto Ricans and the rest included mainland USA, and Dominican Republic places of birth. Respondents were between the ages of 18 and 95 with a mean age of 59.

4.1.2 Reconstruction Actions

85% of respondents reported they had begun their process of reconstruction, and 25% had begun within a month of the hurricanes. 68.9% have completed 50% or less of the reconstruction needed on their house, and only 7.9% had completed the entirety of the reconstruction that is needed and 15.2% had not started reconstruction or did not plan to reconstruct. When presented with the definition of ‘informal reconstruction’ as defined in this research, 20.7% of those that responded reported 0% of use of informal practices, 43.6% reported using more than 50% informal reconstruction methods and 27.9% reported 100% use of informal methods.

Over 50% did not have an official inspection during reconstruction and roughly 35% of those who did not report working with a contractor reported they did not refer to any building codes during their reconstruction process.

4.1.3 Social Capital

The following table outlines descriptive statistics for some of the key variables measuring social capital. Table 2 shows the averaged Z scores after compiling social capital indicators for each form of social capital and a composite score bringing together all three types.

Table 2. Social Capital Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
Bonding Capital	-1.35	2.19	-.0131	.54305
Bridging Capital	-1.46	1.66	.0151	.75470
Linking Capital	-.85	2.44	.0088	.48419
Composite Social Capital	-3.04	6.10	.0504	1.34805

4.2 Correlations of Social Capital and Percentage of Informal Reconstruction

Correlations were calculated using Spearman's Rho method to determine the monotonic relationship as the data is not normally distributed. Table 3 presents the correlations between bonding capital, bridging capital, linking capital, the social capital composite, and percentage households reported for informal reconstruction practices. The results show significant correlation between bridging and informal reconstruction (correlation coefficient = 0.247, p value = 0.006) and significant correlation between the composite social capital and percentage of informal reconstruction (correlation coefficient = 0.192, p value = 0.033). The results show no significant correlation between bonding and linking social capital and the reported percentage of informal reconstruction.

Variables	1	2	3	4	5
1. Bonding Capital	1.000				
2. Bridging Capital	.351**	1.000			
3. Linking Capital	.236**	.370**	1.000		
4. Composite social capital	.679**	.863**	.603**	1.000	
5. Percentage of informal reconstruction methods used	.013	.247**	.072	.192*	1.000

Standard errors: * p < 0.05, ** p < 0.01

5 DISCUSSION

Preliminary analysis of bonding, bridging and linking social capital and percentage of informal reconstruction showed significant correlation between bridging and the percentage of informal reconstruction methods used. This research hypothesizes that bridging increases the reach of resources from other communities, allowing households to reconstruct when their immediate community does not have access to the necessary resources. Loíza is a low income area of Puerto Rico reinforcing the idea that bonding capital may not be an important factor if there are already limited resources within the community. This aligns with a previous study that found bonding capital has significant limitations in the long term recovery phase as the immediate community is limited by the same damages from the disaster and state of poverty, and there is often potential for residents within the same community to begin competing for the same scarce resources (Islam and Walkerden, 2014). The study also stated that at the same time, bridging capital was helpful in receiving resources from organizations that did not have enough to supply the entire community as organizations assisted in the situations they knew about (Islam and Walkerden,

2014). Furthermore, results show a statistically significant correlation between the composite social capital and percentage of informal reconstruction, possibly due to the relative strength of bridging capital over the other forms for determining percentage of informal reconstruction.

5.1 Implications for Theory

The overall theoretical contribution from this research is that social relationships are key to enlarging capacity to reconstruct within systems that can be difficult to access and navigate. Particularly, bridging relationships to other neighborhoods, religious groups, ethnic groups, local organizations, etc. are important in determining levels of informal reconstruction used. Furthermore, these results confirm the hypothesis that social resources are vital for recovery for a much longer timeline in Puerto Rico beyond initial response actions and endure throughout rebuilding permanent housing, as previously seen in other developing contexts (Aldrich, 2012). This is a contribution to recovery theory in understanding how ingrained social resources improve accessibility to rebuilding in a context where many face barriers against recovery. This is expanded in this study to a context where residents have faced significant setbacks when attempting to use official processes, such as traditional construction methods misaligned with FEMA requirements and resource scarcity, than seen in previous studies (Aldrich, 2012; Bankoff, 2007). However, this study cannot comment on the quality of the informally constructed houses or ability to mitigate for future events.

5.2 Implications for Practice and Policy

The practical and policy impacts from this research include specifying households' capacity to reconstruct when resources are scarce, based on a set of social characteristics. This application is critical when considering mitigation and policy adaptation for future events. Improved understanding of alternative methods to access resources and rebuild after a disaster, such as realizing inherent community potential, is important to strengthen resilience policies and procedures. For example, improved methods to connect bridging communities to improve access to resources spread unequally throughout communities, or strengthening measures to help local organizations reach isolated communities. Specific key players and relationships for social capital can be identified, such as community leaders or long-term, socially integrated residents, to improve distribution of resources or gathering of needs and information from the community to report to official process stakeholders. Pathways to improved access to resources can be created in communities using these social capital considerations, such as prioritizing reporting information from FEMA or other organizations to well-known social leaders, or briefing those leaders on reconstruction practices or areas that have materials in stock. In times of need, vulnerable communities will inevitably use any and all resources available to them thus it can be assumed that social resources will become a facet of the reconstruction process. Therefore a way to integrate these social resources to ensure they are guiding households towards the right resources or making beneficial decisions is important to ensure a resilient and comprehensive post-disaster reconstruction plan.

5.3 Future Research Directions

Further analysis using this dataset will include analysing how the use of informal methods affects the reconstruction timeline and if these methods create longer delays or quicker reconstruction processes, in an attempt to further understand the effect of using informal methods on the overall reconstruction effort. In addition to informal methods, the time to reconstruct will also be analyzed with social capital indicators. Beyond this dataset, this research study is one facet of a larger investigation of multiple drivers to informal reconstruction in Puerto Rico after Hurricane Maria. This survey has informed how social capital has been used to further reconstruction efforts and in the process of administration, respondents identified key institutions that have been instrumental to encourage formal and informal processes. The institutions identified in this survey and others that have become stakeholders for reconstruction on the island will be investigated in further detail in the next section of the research, working towards a more holistic perspective of drivers for informal reconstruction. This research showed that while social capital is important in understanding informal reconstruction, there is a piece missing by not understanding the role of institutions in households' reconstruction process. Further research will include an investigation of the institutional drivers to informal reconstruction, specifically in how households navigate institutions to access resources for reconstruction when the formal process becomes inaccessible.

6 CONCLUSIONS

This study focuses on the effect of social capital indicators on the percentage of informal reconstruction methods, defined in this study as any reconstruction action outside of using contractors, permits, trained labor and building codes, or overusing temporary fixes as long term solutions. Households use these actions as they often allow for quicker reconstruction timelines, reduced reconstruction expenses, and ease of access. This research hypothesized that social capital relationships can be a key indicator for the percentage of informal reconstruction used as it increases access to resources when the official process (applying to FEMA, hiring a contractor, obtaining permits, etc.) becomes inaccessible to households.

Preliminary results from this study found that bridging social capital is the strongest indicator for percentage of informal reconstruction used in household recovery. Possible explanations for this could be creating a path for resource sharing with other communities that have more or different resources, and it means there are connections with organizations that do not have enough supply for the entire community and must make decisions about where to distribute their resources.

Limitations in survey design include limitations in face to face surveys with the surveyor asking questions and documenting answers. A variety of the questions included illegal or unsavory options for answers, such as admitting to building without permits or rating your community as a terrible place to live. There is potential for bias being reflected in the answers as some respondents may have felt uncomfortable stating that to another person or felt they may have been reprimanded or reported. Furthermore, working in lower income areas administering the survey door to door limited data collection to daylight hours creating a response bias capturing more of the population who were elderly or disabled as they were most likely to be at home. Data was also collected on the weekend to attempt to capture households with only working members to mitigate this issue as much as possible. Furthermore, there is significant response bias in administering door to door surveys as we were only able to survey people who were home at the times we came by and wished to participate.

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