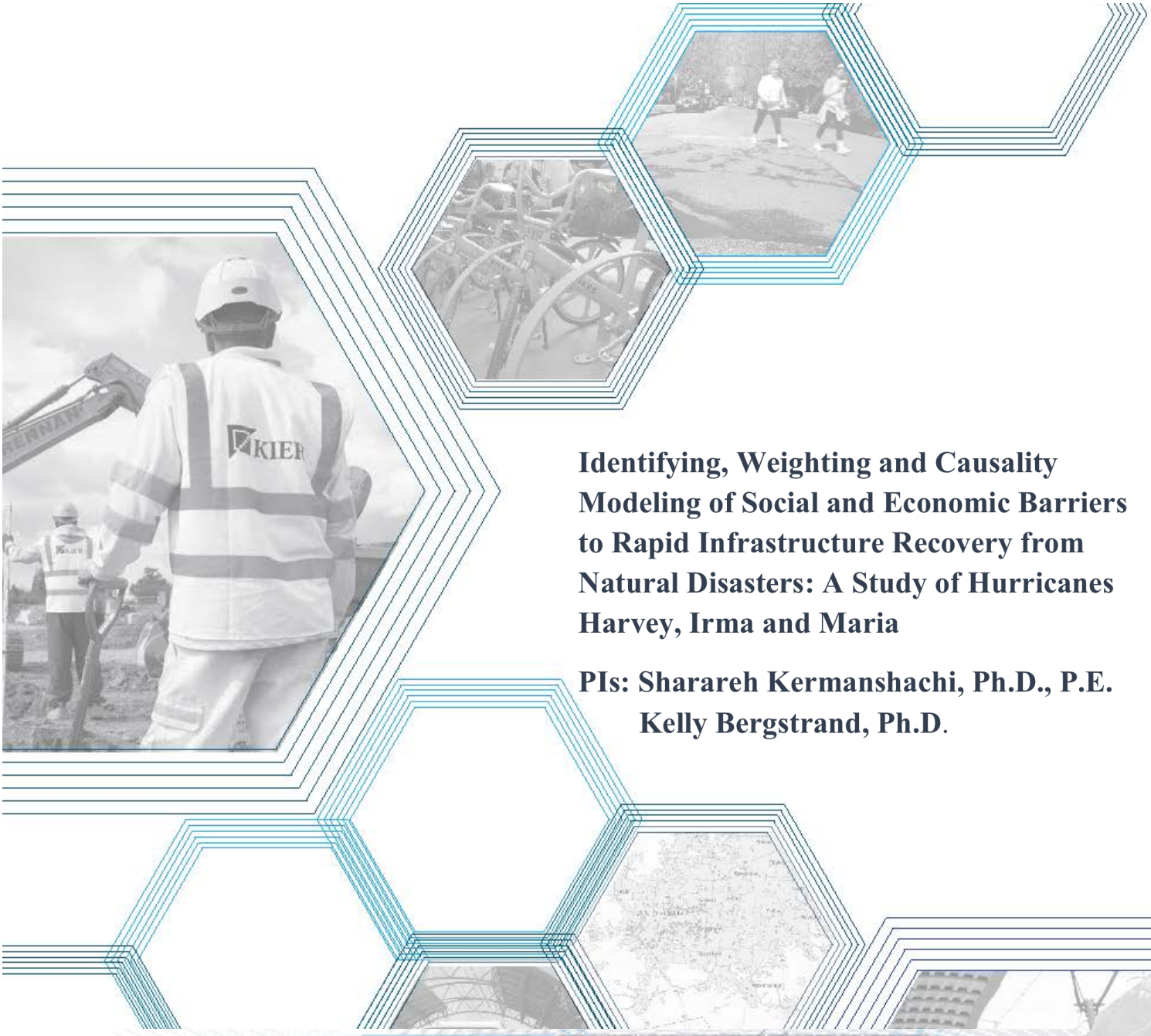

Identifying, Weighting and Causality Modeling of Social and Economic Barriers to Rapid Infrastructure Recovery from Natural Disasters: A Study of Hurricanes Harvey, Irma and Maria

PIs: Sharareh Kermanshachi, Ph.D., P.E.
Kelly Bergstrand, Ph.D.

FINAL

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IDENTIFYING, WEIGHTING AND CAUSALITY MODELING OF SOCIAL AND ECONOMIC BARRIERS TO RAPID INFRASTRUCTURE RECOVERY FROM NATURAL DISASTERS: A STUDY OF HURRICANES HARVEY, IRMA AND MARIA

FINAL PROJECT REPORT

by

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16. Abstract

Natural disasters occur frequently in the U.S. and yield significant damages to critical infrastructures and communities. Many studies have focused on identifying disaster recovery indicators and reconstructing resilient communities. Although achieving communities resilient to natural disasters has been an ultimate goal for the decision-makers, it takes various timeframes for communities to recover from similar disasters, due to their different pre-disaster and post-disaster conditions. In this regard, many social, economic, environmental, etc. conditions, and their dynamic relationships and interaction should be considered to understand how they cause delays. Different aspects of disaster recovery have been studied within recent years, through which a variety of barriers relative to different prespectives were determined; however, barriers to effective and timely post-disaster recovery have not been studied in detail. This research aims to identify timely post-disaster recovery factors, investigate how the barriers to disaster recovery affect the recovery processes, and determine the relationships among the identified factors. To achieve these objectives, a comprehensive review of more than 300 scholarly papers in this area was performed, and potential post-disaster recovery barriers (PDRBs) were identified. Then, based on the potential PDRBs, a survey was developed and distributed to the experts and the public. The survey results were then analyzed, and the list of significant PDRBs was finalized, categorized, and prioritized. The results were used to develop a model to determine the relationships and interdependencies among preventive rapid post-disaster recovery variables. The 85 identified barriers were presented in economic, social, environmental, policy and legal, and infrastructure and transportation categories. Policy and legal barriers were recognized as fundamental causes of delays in timely post-disaster recovery; thus, these barriers were comprehensively investigated and their sub-categories were presented. This research contributes to understanding how the PDRBs delay the post-disaster recovery processes. In addition, as this study has identified the relationships and interdependencies among various PDRBs, decision-makers can use the results to establish effective post-disaster recovery practices and to achieve more resilient communities.

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INTRODUCTION

1.1.Problem Statement

Catastrophic natural disasters often cause a major loss of resources in a community due to calamitous destruction of the built environment and interruption of normal human activities (Brown et al., 2008; Arendt and Alesch, 2015). It is wise to properly invest in and adequately allocate resources to alleviate the unintended consequences of all PDRBs; however, all nations, including the U.S., have limited resources (Moatty and Vinet; 2016; Rouhanizadeh et al., 2019a). Therefore, many recent studies have focused on identifying disaster recovery barriers (Arendt and Alesch, 2015).

Investigation of consequences of previous disasters revealed that communities recover at different paces (Fatemi et al., 2017), and post-disaster recovery due to natural extreme events usually takes longer than the initially planned timeline. Delayed post-disaster recovery yields many significant consequences that cause permanent damage to affected communities and areas (Hwang et al., 2014; Peacock et al., 2018). An example of this is the postponement of non-governmental developments, as investors hesitate to contribute in unstable situations (Cutter et al., 2008; Djanatliev et al., 2012). Furthermore, late recovery causes permanent migration of the affected communities and bankruptcy of small businesses in these areas. All of these factors can cause abandoned houses (El-Anwar et al, 2010; Peacock et al., 2018), increased poverty and theft (Rouhanizadeh et al., 2019b), and further economic crises that will impact the growth of the area for years, if not decades. One challenge to achieving timely recovery is that the recovery environment is a dynamic atmosphere (Masurier et al., 2008) that does not follow a defined path, and the process is not systematically uniform across all sectors of society (Hwang et al., 2014; Kermanshachi et al., 2016). The availability of resources and operations to allow shifting into a disaster mode is another challenge that leads to delays in post-disaster recovery (Kermanshachi et al., 2018). Increasing urbanization and growth in the number of infrastructures are widely recognized as additional factors in late post-disaster recovery (Moatty and Vinet, 2016). Therefore, as late post-disaster recovery imposes substantial direct and indirect costs to the communities, societies, and nations, it is necessary to identify timely PDRBs and determine strategies for addressing them at the national, state, and local levels.

One challenge to achieving timely recovery is that the recovery environment is a dynamic atmosphere that does not follow a certain defined path, and the process is not systematically

uniform across all sectors of society. Therefore, as late post-disaster recovery imposes substantial direct and indirect costs to the communities, societies, and nations, it is necessary to identify timely PDRBs and determine strategies for addressing them at the national, state, and local levels.

1.2. Objectives

This study addresses the question of how the PDRBs affect the timeliness of the recovery process of the affected communities. The goals of this study were identifying PDRBs, determining their impact on the duration of the recovery, and modeling the PDRBs and their causality relationships. This research will add to body of knowledge about post-disaster recovery by addressing gaps in the existing literature on integrated analysis of PDRBs. The research outcome is expected to assist policymakers and officials with appropriate restoration planning to minimize the duration of post-disaster activities. To address the mentioned gap in the literature, this study articulated the following three research objectives: (1) identify and categorize the PDRBs; (2) determine the impact weight of each of the identified PDRBs, and prepare a prioritized list of PDRBs that hinder proactive disaster mitigation; and (3) develop a causality model, determining the relationships and interdependencies of exogenous and endogenous PDRBs.

1.3. Layout of the Report

Existing post-disaster recovery studies, which include a comprehensive literature review and content analysis of the reviewed literature, are presented in the second chapter of this report. Chapter 3 presents the methodology through which the framework and the statistical methods used in this study are introduced and presented. Chapter 4 presents the identified and categorized potential PDRBs found in the literature, as well as the weight of all categories, based on the number of PDRBs of each category. In the fifth chapter, survey development, distribution, and analysis, along with the weighting and prioritizing of all PDRBs except the ones of policy and legal category, are presented. The sixth chapter presents the analysis of legal and policy PDRBs, and recommendations for managing them. The seventh chapter is devoted to model development and determination of interconnectivity of PDRBs. Conclusions of the research project, as well as recommendations, are presented in the eighth chapter. References and the appendices are presented at the end of this report.

IDENTIFICATION AND ANALYSIS OF EXISTING POST-DISASTER RECOVERY STUDIES

2.1. Post-Disaster Damages and Recovery Processes

This chapter describes two major steps. In the first step, the authors collected relevant papers, using a keyword search in search engines such as JSTOR, Google Scholar, and Scopus, etc. More than 150 papers were collected, with approximately two-thirds of them being journal papers. The remaining papers were primarily conference proceedings, with a few books, research reports, and dissertations. In the second step, all of the collected papers were carefully reviewed, and important information (journal name, disaster type, year of study, continent of origin, and data collection method) was documented. Figure 2.1 shows the abovementioned process.

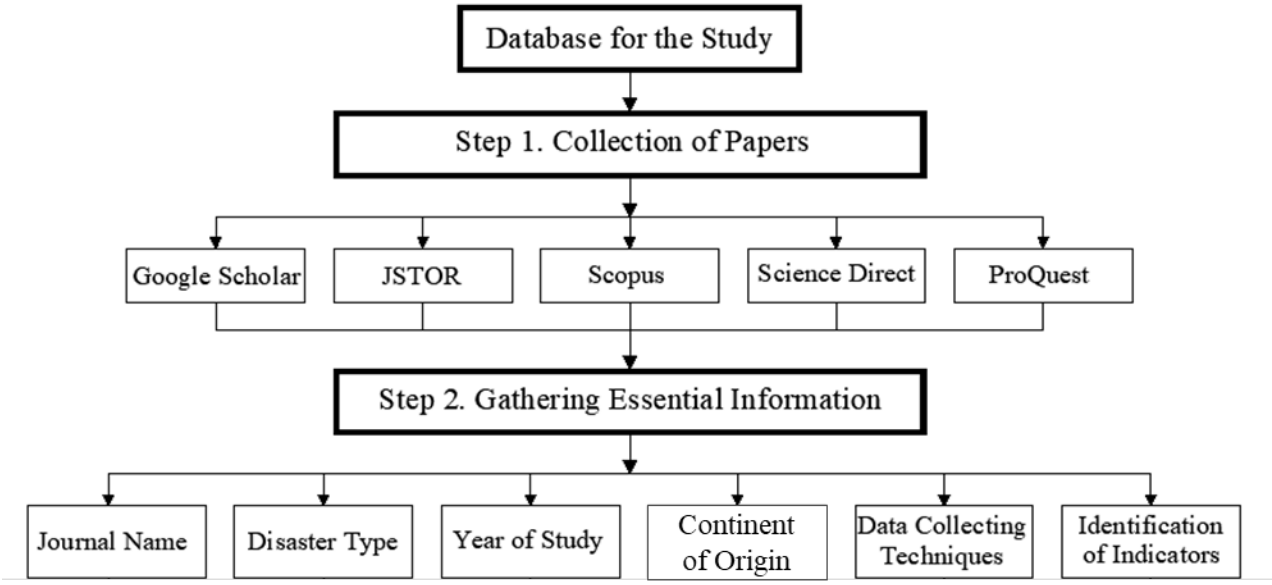


Figure 2.1. Steps for literature review

Devastating natural disasters such as hurricanes affect the U.S. severely, invoking the communities to strive for timely recovery so that they can return to normal life. In most cases, overlooking natural disasters makes communities more vulnerable to them, and eventually results in delays in achieving recovery and sustainable development after a disaster (Fothergill & Peek, 2004; Ingram et al., 2006; Rouhanizadeh and Kermanshachi, 2019a). Recovery is the most important and least understood phase in measurement of the degree of a disaster impact (Hettige et al., 2018). In recent years, many disaster recoveries have been delayed by man-made causes. Since the occurrence and magnitude of natural disasters have significantly increased, a single country may need to utilize limited financial, machinery, and human resources to perform recovery activities simultaneously in multiple urban and rural areas. Post-disaster recovery, as an emergency management action, is

defined as the restoration of a damaged area to its pre-disaster condition. Post-disaster recovery is not understood practically or scientifically due to the dynamicity of the factors impacting the process (Smith and Wenger 2018). The process of disaster recovery is unique, and depends upon the location, affected population characteristics, and many other factors impacting the resiliency of a community. Recovery policies, modification prior to disruptive events, and nature or type of disruption are very important to all PDRBs (Barabadi & Ayele, 2018; Nipa et al., 2019).

Delays in the recovery process can diminish the effectiveness of the recovery and make it difficult to achieve the objectives (Tagliacozzo, 2018; Rouhanizadeh and Kermanshachi, 2019b). Rapid restoration of disaster-affected areas has been an important challenge for decision-makers because late recovery results in high costs for them. Thus, optimizing the duration of the recovery process, as well as effectively allocating and utilizing the resources, has attracted many researchers' attention (Pena-Mora et al. 2012). For example, Arora et al. (2010) conducted a resource allocation study on cost constrains, and indicated that delays in resource allocation decisions lead to late recovery and increase the corresponding costs. Cole (1989) developed a lagged expenditure model, and Rose et al. (1997) conducted research on minimizing economic losses to optimize recovery. Haas et al. (1977) presented a conceptual recovery framework that introduced a four-stage recovery model. Delays in the recovery of damages are a consequence of high-intensity natural disasters, and can have short-and-long-term cascading and unrecoverable effects. The short-term recovery phase has been thoroughly investigated to find the causes of the delays, but the long-term recovery phase has not been studied in much detail (Hettige et al., 2018). Long-term disaster recovery begins when the affected area is cleared from chaos, crowds, and vehicles, and the process for rebuilding and reconstruction initiates. At this stage, sufficient resource allocation is particularly important to the speed of recovery. A shortfall of disaster recovery funds causes delays in the developmental investments and eventually delays the recovery (Wein et al., 2011). Delays in the recovery cause improper allocation of the resources and lead to inefficiency in the governmental response (Siriwardana et al., 2018). Furthermore, delays increase the vulnerability of the community to future disasters (Ferreira et al., 2016).

According to the preparation time and area of focus, recovery plans cover two time periods: pre-disaster and post-disaster (Boyd et al., 2014). Pre-disaster recovery planning commonly includes the integration of local planning efforts, coordination of community priorities, assignment of roles and responsibilities, and rapid implementation (Schwab, 2010). Post-disaster recovery and

reconstruction is a continuation of pre-disaster planning and is vital to achieving sustainable development (Schwab, 2010). Many of the researchers argue that post-disaster recovery is a dynamic, multivariable, political, and social process, and is not limited to the reconstruction of the buildings and the living environment (Tierney, 2012; Zhang et al., 2017).

To mitigate the consequences of extreme and disruptive events, it is crucial to have an accurate understanding of the influencing factors and their relationships. In the area of disaster recovery, some researchers (Boyd et al., 2014) focused on single or multiple indicators. Based on the literature, the availability of economic resources, including loans, governmental aids, and donations, is one of the most important determinants of the duration of post-disaster recovery (Siriwardana et al., 2018). Employment, income, and the number of active businesses that remain after a disaster (Ferreira et al., 2016) are other factors that have been studied. Although these factors are commonly interrelated with existing and new policies, the integration of them has been rarely studied. Social recovery includes a number of outcomes, such as quality of life, civic engagement, and societal connections (Pena-Mora et al. 2012). To accomplish social recovery, amenities such as shops, schools, recreational facilities, and worship places must be reconstructed (Zorn and Shamseldin, 2015). This is an indication that physical and social recoveries are two interconnected aspects of the restoration process. Firdhous and Karuratane (2018) recognized the temporary loss of learning opportunities and the breakdown of traditional family support, respectively, as short-term and long-term impacts of delays in post-disaster recovery.

Planning and policymaking for disaster recovery are developed by both the local and federal governments, and enhance the quality and timeliness of the recovery (Burby, 2006). State agencies often authorize implementation of federal laws and regulations for disaster management (Boyd et al., 2014). Local recovery plans deal with controlling general local conditions, coordinating control of resources, measuring opportunities and obstacles, and managing public input (Amaratunga et al., 2018). They present their vision of the recovery and the way that the recovery progress will be measured. Delays in the recovery postpone the actualization of disaster risk reduction programs, one of the short-term goals of a disaster recovery program (Amaratunga et al., 2018).

Dynamic modeling has been widely accepted for its ability to efficiently consider, imitate, and analyze systems with complex and nonlinear properties (Pena-Mora et al. 2012). Post-disaster recovery is a complex and dynamic process because it involves interdependent activities that

change over time (Hwang et al., 2015). MacKenzie and Barker (2012) utilized an input-output dynamic model that quantifies the resilience of a critical infrastructure sector in post-disaster condition. Dynamics of the process of recovery have rarely been studied, even though there are several researches that focus on modeling losses due to disasters. Thus, due to the dynamic interrelation among different causes of late recovery, and for a rapid and sustainable post-disaster recovery, the conditions that hinder communities from achieving a fast recovery need to be accurately considered and analyzed in an integrated manner (Hwang et al., 2015). A model employed to measure the rate of recovery and the delays in the recovery process should capture the impact of each of the factors, as well as consider their integrated influences on the rate of recovery. Modeling the dynamic impact of such factors is useful to a timely recovery.

The primary focus of the previous literature relevant to recovery modeling was on strategies for resource allocation under various conditions. Most of the literature pertaining to the restoration process was adapted toward learned lessons and management results, and/or methods that are limited to location (without new comprehensive model development) (Zorn and Shamseldin, 2015). To address this gap, this paper aims to investigate the correlation of the relationships between different PDRBs and the timely post-disaster recovery process, and present a conceptual model that portrays them. This causality model will help policy makers to timely assess the short-term recovery barrier factors in rural areas and address the preventive factors, based on their associated impacts.

2.2. Database Content Analysis

In this step, an analysis was performed of the approximately 300 papers gathered in the database and after exclusion, 218 of them were used in the process of literature review. Not all of the reviewed papers included barriers to timely post-disaster recovery or barriers affecting this situation. Many of the papers from the Disasters journal (70%), presented information about the recovery barriers. In the following, extracted information regarding journal name, disaster type, year of study, continent of origin, and paper type are presented.

2.2.1. Journal Name

The number and percentage of articles from all of the journals that the authors used for identifying the barriers are presented in Table 2.1. As shown, these include journals from different

engineering, management, and social science disciplines, since the effects, degree, and pace of recovery depend on a variety of factors. The first seven listed journals represent more than half (52%) of all the selected articles in this research. The Disasters journal, published on behalf of the Overseas Development Institute, ranks first in this list, accounting for 19% of the total number of the selected papers. This journal covers various subjects of disasters and publishes works from both academicians and practitioners. The Natural Hazards Review, an ASCE journal that follows an interdisciplinary approach towards different types of disasters, ranks second in this list (7%).

Table 2.1. Frequency of Articles Based on Journals for Recovery Barriers Study

Journal Name	Frequency	Percentage
Disasters	42	19%
Natural Hazards Review	16	7%
International Journal of Disaster Risk Reduction	12	6%
Disaster Prevention and Management: An International Journal	10	5%
Procedia Engineering	10	5%
International Social Work	10	5%
Transportation Research Record (TRR)	10	5%
Journal of Housing & Built Environment	7	3%
International Journal of Strategic Property Management	7	3%
Risk Analysis	7	3%
Journal of Management in Engineering	7	3%
Journal of Infrastructure Systems	6	3%
Natural Hazards	6	3%
Procedia Economics and Finance	6	3%
Emergencies and Disasters Quarterly	6	3%
Journal of Construction Engineering and Management	6	3%
Applied Geography	5	2%
Transportation Research Part A: Policy and Practice	5	2%
Journal of Homeland Security and Emergency Management	3	1%
Social Science Quarterly	3	1%
International Journal of Mass Emergencies and Disasters	3	1%
The Professional Geographer	2	1%
Environmental Impact Assessment Review	2	1%
Other	27	12%
Total	**218**	**100%**

2.2.2. Disaster Type

Disasters can be classified by considering several factors. Some disasters, such as a hurricane, have a sudden impact on society, while others, such as drought, influence communities slowly. Different strategies can be implemented for timely recovery, depending upon the type of disaster. Due to the importance of accurately classifying disasters, the papers gathered for this research were assessed

with this focus. Figure 2.2 demonstrates the percentage of distribution of the articles considered in this study, based on the type of disaster they studied. It should be noted that several papers studied multiple types of disasters at the same time to analyze their respective data. As indicated in Figure 2.2, most of the reviewed papers focused on hurricanes, tornadoes, cyclones, and typhoons (30%), followed by earthquakes (19%). These types of disasters were studied in almost half (49%) of the papers considered in this research, which demonstrates their importance. In addition, these disasters have sudden impacts on the affecting environment, thus need immediate considerations for timely recovery. Because of the lack of research on recovery from disasters such as river erosion, bushfires, landfalls, tidal surges, bridge collapses, railway accidents, shipwrecks, aviation accidents, etc., these studies were categorized as "disaster in general."

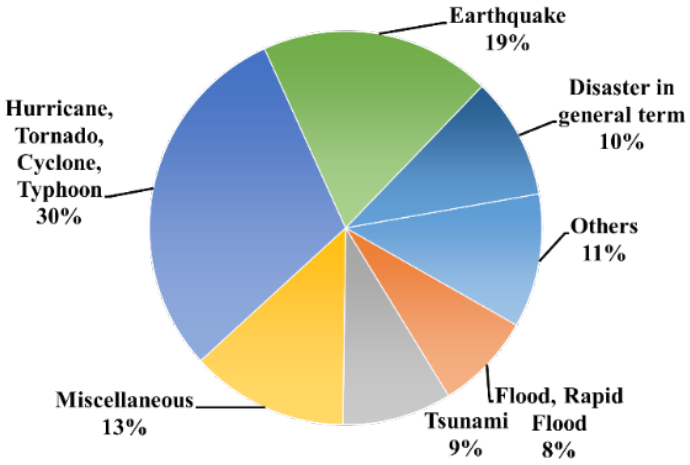


Figure 2.2. Distribution of papers according to the disaster type

2.2.3. Year of Study

Researchers have been studying disasters for more than a century. The oldest paper studied in this research was written in 1963; however, as shown in Figure 2.3, the number of researches focusing on disaster recovery increased significantly after 2005, and almost 76% of all the reviewed papers in this area were for the period of 2005-2018. In fact, from the start of the 21st century, researchers have been focusing on the recovery process of disasters due to its importance. Population growth, along with global climate change, has led to an increase in the number of natural disasters, which is one of the primary reasons that researchers have been and continue to be investigating post-disaster recovery and its corresponding issues from a variety of aspects.

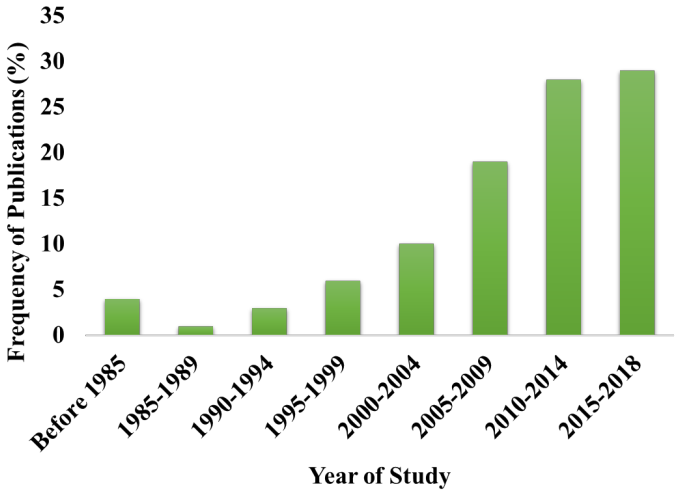


Figure 2.3. Distribution of journal articles according to the year of study

2.2.4. Continent of Origin

Approximately 72% of the studied articles that discuss one or more disasters mentions the places where the disasters happened. In Figure 2.4, distribution of these disasters is shown, based on the region of occurrence. According to Figure 2.4, the major two disaster-originated continents were North America (46%) and Asia (37%), where hurricanes and floods are fairly common disasters, respectively. The geographical conditions of North America, including the U.S., is the main reason that this area is highly prone to natural disasters. Over 600,000 deaths were reported due to weather-related disasters from 1995 to 2015 in the U.S.

Figure 2.4. Distribution of disaster papers according to the continent of origin

2.2.5. Data Collection Methods

Various methods of data collecting from literature can be employed, and they can generally be categorized as qualitative or quantitative methods. Some of the methods are based on experiments and clinical trials, while some are based on obtaining data from previous works. Interviews, surveys, case studies, Delphi surveys, field observations, and literature reviews are the most popular methods for this purpose. Each of these methods might include different sub-approaches as well. As shown in Figure 2.5, literature reviews, interviews, and case studies were the top three methods of data collection from literature.

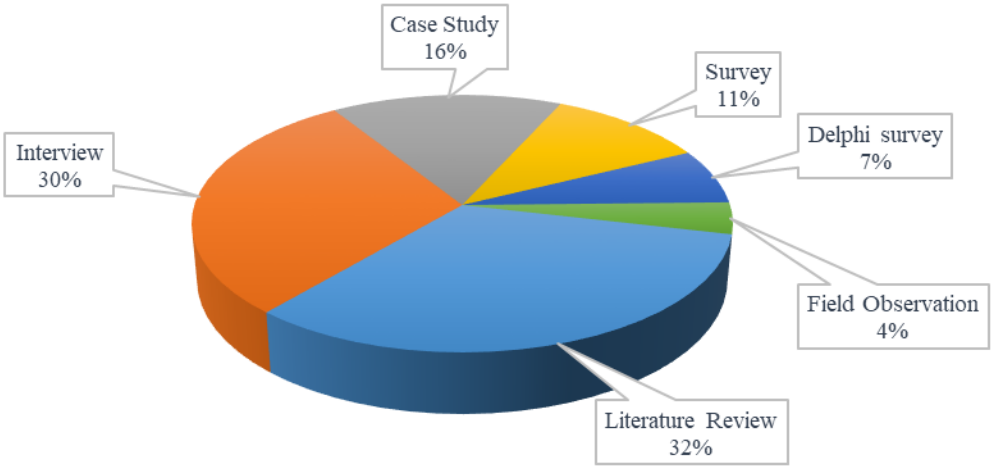


Figure 2.5. Data collection methods

RESEARCH APPROACH

3.1. Research Framework

To successfully achieve the objectives, this study utilized the triangulation technique, combining both qualitative and quantitative methods, and formulated the following seven-step methodology (Figure 3.1). The first step in this study was to review the existing literature comprehensively. Different databases from national and international sources, as well as case studies from previous hurricane-based disasters such as hurricanes Katrina, Sandy, Matthew, Harvey, Irma, Maria, Florence, and Michael were thoroughly searched. To analyze the PDRBs, other databases such as Engineering News Report (ENR) and Natural Disasters News were studied, and the impact of each of the identified PDRBs on the duration of the recovery was examined and assessed. In the second step, the reviewed literature was summarized, and potential PDRBs were identified. In the first part of the third step (step 3a), the 85 identified PDRBs were categorized based on their attributes and frequency of citation. The categories included economic, social, policy and legal, environmental, and infrastructure and transportation. The policy and legal category included 58 PDRBs, and due to their importance in the recovery process, we classified them into seven sub-categories in the second part of the third step (step 3b). The categories included coordination, construction and infrastructure, location, social and community participation, resources and documentation, finance and economic, and approach and attitude. The outcome of this step established the groundwork for the development of the survey, as described in subsequent steps.

The fourth step of this study consisted of two parts. In the first part (step 4a), the PDRBs were statistically analyzed. For this purpose, a customized online questionnaire was developed that focused on potential PDRBs. The questionnaire had two sections, including demographic questions and determination of the importance of PDRBs to timeliness of the recovery process. Initially, the questionnaire survey was pilot-tested to ensure the clarity of the questions. According to the literature, 10 to 30 participants in a pilot study are required; thus, 15 pilot tests were conducted. Then, each questionnaire survey was distributed to potential respondents, including (1) the public; (2) experts, officials, and technical individuals such as engineers, project managers, etc. The prospective policymakers and experienced workforce and practitioners were identified and asked to engage in the process of data collection. Officials from cities, directors from Departments of Transportation, local agencies, academicians, NGOs, private consulting firms, and residents in the local communities were asked to participate in the survey. The reason we asked people from different levels of local, state, and national entities was to so that we could perform a

comparative analysis of the obtained results that would lead to a more sustainable recovery. The outcome of this step was a modified list of the PDRBs that were identified in the first and second steps. We also contacted members of local, state and federal government agencies; disaster-affected citizens; media; businesses and corporations; universities and research institutions; non-profit agencies; the American Society of Civil Engineers (ASCE); the Construction Management Association of America (CMAA); and the Design-Build Institute of America (DBIA), asking them to send out the survey announcement to the potential respondents. To receive a satisfactory number of responses, we closely monitored the completeness, reliability, and validity of the returned questionnaires, and followed up with the recipients of the questionnaires several times. The participants included 39 experts and 195 individuals from the public sector. To test the significance of the survey results, we conducted the Kruskal-Wallis test. In the second part of step 4 (step 4b), the policy and legal PDRBs were qualitatively analyzed.

The fifth step included two parts. In step 5a, the results of the statistical analyses performed on the input of the experts' and public's responses were compared. In step 5b, the legal and policy PDRBs were ranked, using 30 of the experts' responses to the survey.

In the sixth step, to identify the impact factor of each PDRB on the duration of the recovery, the weighted impact of the identified PDRBs were determined. For this purpose, the Chi Epsilon method was utilized. After the results were collected, they were analyzed, and the final weighted list of PDRBs was generated.

In the last step of this research, an integrated causality model of the identified PDRBs was developed. All of the PDRBs from different categories, as well as the corresponding interactions, were considered. First, a social network analysis (SNA) was performed to identify the direction and magnitude of the relationships of the factors. The network modeling technique of system dynamics was implemented for conceptual modeling. The system dynamics modeling technique includes an approach to understanding the nonlinear behavior of complex systems over time, using a mathematical modeling technique. Capturing the interactions and consequently the feedback loops creates a causal loop diagram that reveals the structure of a system. To perform the SD process, the system of identified barriers was represented as a causal loop diagram, and all of the constituent components and their interactions were mapped. This causality model helps policymakers make a timely assessment of the PDRBs and address the preventive factors, based

on their associated weight impacts. In the following, the methods utilized in this research will be described.

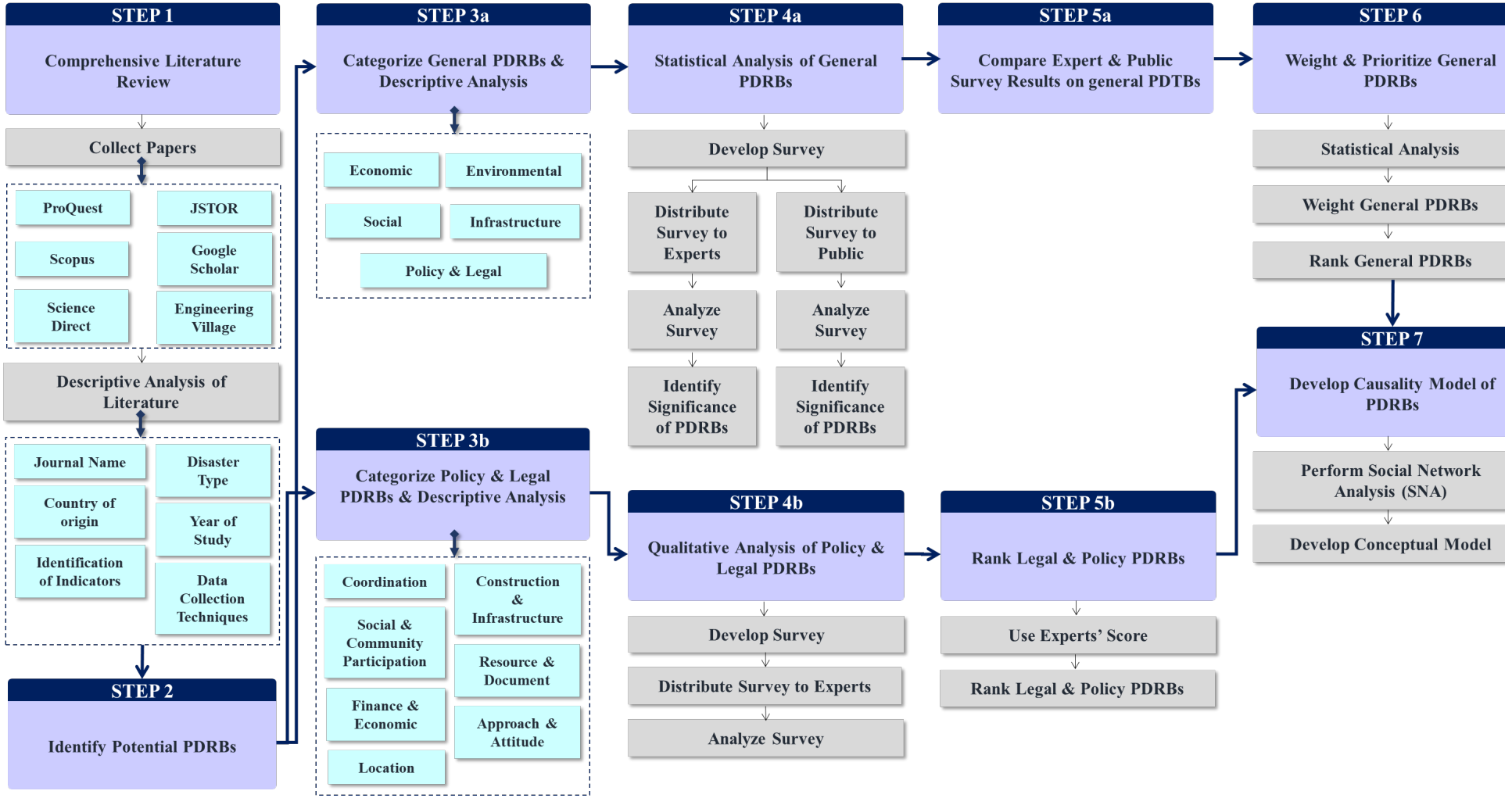


Figure 3.1. Research methodology roadmap

3.2. Social Network Analysis Method

The Social Network Analysis method was utilized to better understand the importance of the barriers and to determine their interconnection. The concept of centrality was determined to be the most accepted method for SNA for this study. SNA is a mathematical approach based on graph theory that measures a network's behavior, considering the interconnectivity of their elements (Otte and Rousseau, 2002). A network includes nodes and edges that connect the nodes (Ahuja et al., 2003). Social network behavior was first applied by Bavelas (1948). Social and political relationships were the primary studies implementing SNA (Moreno, 1960; Chinowsky et al., 2008); however, because it is well-known for analyzing any network holistically, it is now utilized in many other areas such as health care, information technology, business, transportation, construction safety, etc. (Lusher et al. 2013). The centrality concept is used to describe the influence and the intensity of a node, based on its connectivity to other nodes, and is a measure of the level of connectivity of one node to others. The more ties a node has, the more alternative paths it has to reach its goals, which means that it is more important to the network.

First, a reference matrix is formed and, then, an adjacency matrix is established by multiplying the reference matrix by its transpose, as well as by replacing the resulting matrices' diagonals by zeros. A normalized degree of centrality is used to compare different networks. Using the consequence matrix, the degree of centrality can be obtained by using the eqs. 3.1 and 3.2. The adjacency matrix shows the interrelationships among the parameters and barriers in this research.

$$D_i = \sum_j y_{i,j} \qquad \text{(eq 3.1)}$$

$$Normalized\ D_i = \frac{D_i}{Max(D_i)} \qquad \text{(eq 3.2)}$$

Where D_i is the degree centrality of the ith element, and $y_{i,j}$ is the value in row i and column j of the adjacency matrix.

3.3. Kruskal-Wallis Test

The Kruskal-Wallis or one-way ANOVA test is a non-parametric method to test whether the samples originate from the same distribution, and is utilized for comparing two or more independent samples of different or equal sizes. Although a Kruskal-Wallis test shows that one sample dominates the other one, it does not identify where the dominance occurs. Because this

method is non-parametric, it does not assume a normal distribution of the residuals. This test is normally used for Likert data, which does not follow a normal distribution. Most commonly, the Kruskal-Wallis test is used when there is one nominal variable and one measurement variable, and is an alternative to a one-way analysis of variance. In this method, the test statistic will be obtained using eq. 3.3.

$$H = (N-1)\frac{\sum_{i=1}^{g} n_i(\bar{r}_i-\bar{r})^2}{\sum_{i=1}^{g}\sum_{j=1}^{n_i}(r_{ij}-\bar{r})^2} \quad \text{(eq 3.3)}$$

Where n_i *is the number of observations in group* i,

r_{ij} *is the rank,*

N *is the total number of observations in all groups,*

$\bar{r}_i$ *is the average rank of all observations in group* i, *and* $\bar{r}$ *is the average of all* r_{ij}.

3.4. Chi Epsilon Method

Epsilon squared measures the effect size and is one of the least common measures of effect sizes, namely omega squared and eta squared. This method is defined as another name for adjusted R^2. The effect sizes will be computed utilizing eq. 3.4.

$${E_R}^2 = {H}/{(n^2-1)/(n+1)} \quad \text{(eq 3.4)}$$

Where H is the obtained value from the Kruskal-Wallis test,

n is the total number of observations,

${E_R}^2$ is Coefficient assumes the value from to 1.

IDENTIFICATION AND CATEGORIZATION OF POTENTIAL PDRBs

4.1. PDRBs Identification and Categorization

An exhaustive search of selected articles was performed, considering recovery barriers from each of the articles. Then, the authors carefully collected barriers of disaster recovery and listed them in categories, namely economic, social, policy and legal, environmental, infrastructure and transportation (Figure 4.1). After listing the barriers in the relevant categories, barriers with similar meanings were combined, and the frequency of their citation was listed.

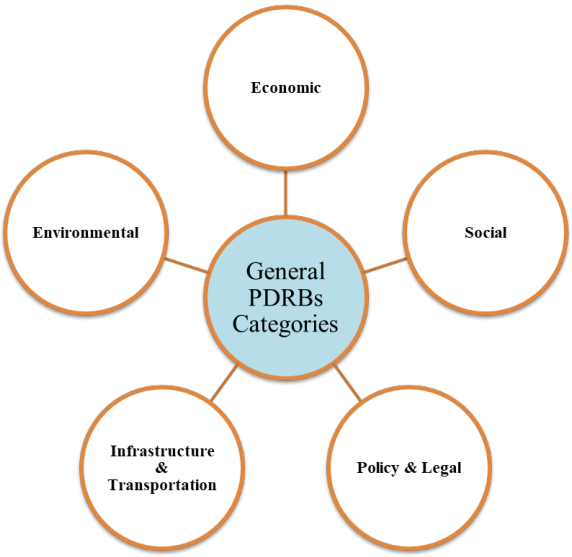


Figure 4.1. PDRB categories

4.1.1. Economic Barriers

Across the existing literature, researchers used varieties of factors to measure the economic recovery of society. Among them, the most discussed factor was average household income, which shapes recovery in many ways. For example, according to Liu et al. (2010), a locality with a small monetary gap between annual incomes of the citizens is able to overcome the sudden economic shock better than the society where the gap between the low-income group and the high-income group is larger. Another widely used barrier of disaster recovery is the number of active contractors after the disaster (Jordan and Javernick, 2013). The existence of the same number of active contractors after a disaster as before the disaster is a good indication that the society is restoring itself (Jordan and Javernick, 2013). As construction and reconstruction environments are complex situations which need to be handled effectively (Kermanshachi et al., 2016), researchers suggest that stakeholders adopt management strategies and best practices, which improve the flow of information among project participants (Kamalirad et al., 2017) and reduce the unintended

consequences of a reconstruction congested atmosphere (e.g., elevated volume of rework in the execution of post-disaster recovery projects). Rework not only increases the duration of the construction and reconstruction projects directly (Habibi et al., 2018; Safapour and Kermanshachi, 2019), but also decreases the productivity of labor and staff involved in every project (Kermanshachi et al., 2018). In addition, the socioeconomic status and standard of living of the community also affect disaster recovery in many ways (Cutter et al., 2003). Throughout the literature, employment and employment sources were acknowledged as measuring dimensions for disaster recovery (Jordan et al., 2013). The next most important barrier is housing numbers, values, quality, and characteristics. For example, costly houses are hard to replace, but are more resilient than mobile homes, which don't have enough strength to withstand hazards (Cutter et al., 2003). The other two most frequently discussed barriers are the government revenue and average lost businesses income, the latter of which is a very common term for economists and policymakers (Farrokhi et al., 2016). Table 4.1 shows the economic barriers, along with their category, frequency, and ranking.

Table 4.1. List of Economic Barriers with Category, Frequency, & Ranking

PDRBs	Frequency	Ranking
B1: Average household income	33	1
B2: Number of available active contractors after a disaster	23	2
B3: Unemployment levels	22	3
B4: Average housing value	16	4
B5: Average lost household income	13	5
B6: Average revenue of the local government (e.g., City, etc.)	12	6
B7: Average lost business income	10	7
B8: Diversity in types of industry or employment sectors	7	8
B9: Number of active small businesses after the disaster (e.g., food providers)	6	9

4.1.2. Social Barriers

The first most discussed barrier of this category is the voluntary public participation in the recovery process; that is, the participation of business organizations, government, non-government organizations, volunteer groups, international agencies, civil society, and affected community (Sridarran et al., 2018). Stakeholders provide many advantages, such as knowledge of the locale, and through participation, they enhance the recovery and mitigation phase of the disaster cycle (Moreno, 2018). The second most discussed barrier is the average level of education of the residents, which creates knowledge and behavior divisions and acts as a barrier to the disaster

recovery (Cutter et al., 2003). The third most discussed barrier is the availability of medical services after the disaster, followed by the availability of disaster recovery public training. Social services, including medical and social welfare services, are significant factors that shape the recovery process, both in the immediate and long-term recovery phases (Cutter et al., 2003). Experience in having faced a similar kind of disaster is also very important to the recovery process, and actions related to disaster recovery that resulted from natural instincts that were passed down through generations have often been more effective than simply obeying the authority (Moreno, 2018). Having close family members and/or relatives in times of disaster helps people recover mentally (Bolin, 1993). Another important barrier of this category is population density, which acts as a catalyst for innovation and self-protection (Hu et al., 2018). Table 4.2 shows the social barriers, along with category, frequency, and ranking.

Table 4.2. List of Social Barriers with Category, Frequency, & Ranking

PDRBs	Frequency	Ranking
B10: Lack of voluntary public participation in the recovery process	27	1
B11: Low education level of residents	20	2
B12: Unavailability of medical services after the disaster	14	3
B13: Unavailability of disaster recovery public training	9	4
B14: Lack of family or friends who can help them financially	5	5
B15: Lack of family or friends who can help them emotionally	5	5
B16: Lack of a community that looks out for each other	5	5
B17: High population density	4	6

4.1.3. Environmental Barriers

Researchers found that air quality, erosion rate, water quality, and amount of debris are environmental recovery barriers (Jordan & Javernick, 2013), with debris as the most cited barrier. Some researchers stated that timely removal of debris is very important for both mental and psychological health. Every natural disaster creates debris and, based on the amount, it can take weeks, or even months to remove it and begin the reconstruction work (Hass et al., 1977). As the amount can vary, the party/parties responsible for removing it from public and private property should be mentioned clearly. Table 4.3 shows the environmental barriers, along with their category, frequency, and ranking.

Table 4.3. List of Environmental Barriers with Category, Frequency, & Ranking

PDRBs	Frequency	Ranking
B18: Timely debris and erosion removal after the disaster	11	1
B19: Timely resolution of air and water quality issues after the disaster	6	2
B20: Environmental harm that affects industry, such as lost natural resources that reduce fishing or tourism	6	2
B21: Environmental contamination, such as reduced water and air quality	4	3

4.1.4. Infrastructure and Transportation Barriers

When an infrastructure suffers from a disaster, it affects the recovery process and causes many negative consequences (Gordon et al., 1998). While infrastructure systems fail in a disaster, due to the network properties of infrastructure, damage in one part will affect service in an extensive area. Damage to residential housing, high-rise buildings, and medical services are the top three most discussed barriers of this category, and can be used to measure the return of the population to an affected area. Many resources are needed for infrastructure and housing reconstruction immediately following a disaster (Kermanshachi and Rouhanizadeh, 2018); thus the availability of resources and competent contractors to handle the resources and construction work for improving community infrastructure are other important recovery barriers (Chang et al., 2012; Jordan & Javernick, 2013). Damage to major infrastructure systems is another important barrier; thus having a development plan can have positive impacts on the quality of recovery. The restoration of major infrastructures helps in planning the allocation of resources following a disaster. The next most important barrier is highway traffic volume after the disaster. The loss of access can harm the business sector by making the business location inaccessible for the employees, or it can make it difficult for the contractor to bring the resources that are necessary for the reconstruction to the site. The volume of traffic on the highways is also a measurement of a community's recovery, and unless the community returns to its pre-disaster level, the traffic volume will not be stable. Building infrastructures that withstand disasters help reduce negative impacts, such as spills of hazardous materials, debris from damaged structures, and the carbon footprint of reconstruction activities, which were discussed in the environment barriers section. Table 4.4 shows the infrastructure and transportation barriers, along with their category, frequency, and ranking.

Table 4.4. List of Infrastructure & Transportation Barriers with Category, Frequency, & Ranking

PDRBs	Frequency	Ranking
B22: Damage to residential housing	9	1
B23: Damage to high-rise buildings	6	2
B24: Damage to medical services, like hospitals	3	3
B25: Improving community infrastructure	3	3
B26: Damage to major infrastructure systems (e.g., airports, etc.)	3	3
B27: Highway traffic volume after the disaster	2	4

4.1.5. Policy and Legal Barriers

Four main categories of federal laws are initiated for disaster management: mitigation, preparedness, response, and recovery. The Federal Emergency Management Agency (FEMA) is one of the primary entities that implements these legislations. These regulations are relative to transportation, housing, small businesses, funding, the environment, and other areas in which emergency provisions aim to accelerate the recovery process and return the society to its normal state. For example, the Post-Katrina Emergency Management Reform Act, 2006, consisted of a national framework through which adjustments were made to previous disaster management systems. Some of the identified PDRBs relate to the post-disaster period, and some relate to the pre-disaster period. The identified PDRBs in the policy and legal category have been categorized under seven sub-categories, including coordination, construction and infrastructure, location, social and community participation, resource allocation, finance and economics, and approach and attitude (Figure 4.2).

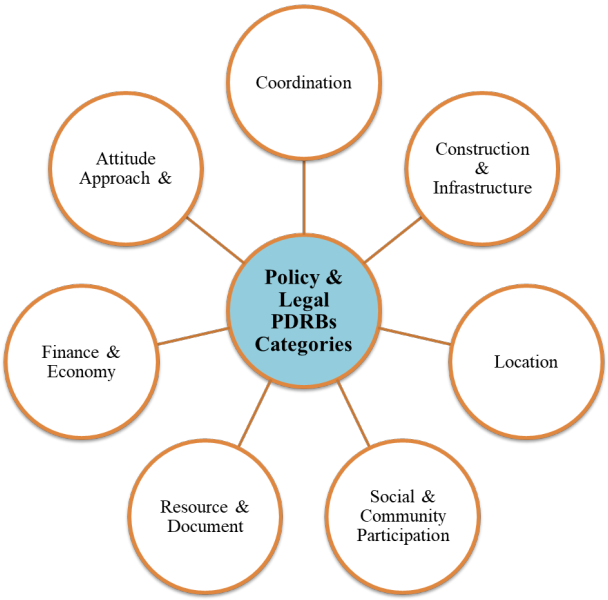


Figure 4.2. Policy and legal PDRBs categories

It is worth mentioning that the policy and legal PDRBs were not discussed in the literature as much as the other four categories. The percentage of each category, per the reviewed papers, is presented in Figure 4.3. As shown, 31 percent of the studies focused on social PDRBs, while coordination, resource and document, and approach and attitude were addressed in only 16 percent of the reviewed studies altogether (almost 5 percent each). The PDRBs of the finance and economic category were discussed in 19 percent of the literature. The categories are presented and described below.

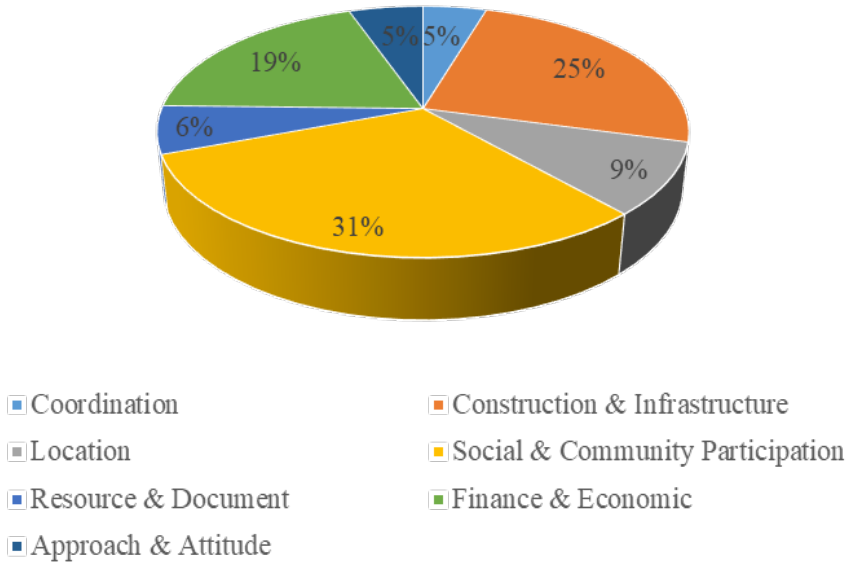


Figure 4.3. Percentage of studied papers based on each category

4.1.5.1. Coordination

A strong and reliable outcome requires coordination of all of the segments of a system. Communities are increasingly taking greater responsibility for disaster management, and are more engaged in the process of disaster management policymaking (Walker et al., 2010). Pre-disaster recovery policymaking and consultations with residents, in all steps of the planning process, to discover their experiences and viewpoints, help constitute a weighty recovery plan and reduce the likelihood of delays in post-disaster recovery (Kamel & Loukaitou-Sideris, 2004; Berke & Campanella, 2006). Research findings show that a broad participation of disaster-affected stakeholders in recovery policymaking and planning results in more effective and successful mitigation plans and policies (Burby, 2006; Hanger et al., 2018). The participation of communities, specifically regarding collaborative actions, leads to their gaining the resources, such as social

connectedness, that are needed for resiliency (Hanger et al., 2018). The participation of those suffering from the impacts of disasters can have significant implications. In fact, their involvement with the local issues and their experiences provide an awareness to the decision-makers that helps them avoid delays in recovery. In addition, considering the individuals' opinions pertaining to policymaking leads to decreased tensions and disagreements between people and government agencies in the recovery phase, thereby reducing the likelihood of delays.

Post-disaster recovery policies and legislation are considered by several researchers as necessary for efficient and timely coordination of the reconstruction process (Birkland, 2006; Masurier et al., 2008). For example, after Hurricane Katrina in 2005, it was demonstrated that without pre-existing legislation and policies, speedy recovery was not possible because there was no coordination among the different entities (Zuo et al., 2008). Improper legislative and governmental systems can also extensively restrict the recovery progress and hinder the use of reconstruction resources, causing delays in the recovery practices (Lyons, 2009). Table 4.5 shows the PDRBs that are related to the coordination category.

Table 4.5. List of Policy & Legal PDRBs of Coordination Category

PDRBs
B28: Lack of consultation with community for recovery policymaking
B29: Poor coordination between federal and state agency recovery programs
B30: Weakness of pre-existing legislation pertaining to post-disaster recovery
B31: Inappropriate governmental system and organization for recovery
B32: Lack of proper coordination among administrative officers in provinces, districts, and sub-districts; NGOs; and volunteers

4.1.5.2. Construction and Infrastructure

Most homeowners are not willing to relocate after a disaster because of their concern about unknown risks that may be encountered by relocating. Their resistance, however, leads to delays in recovery (Bukvic et al., 2018). Therefore, it is important to be very tactful in communicating with the homeowners, renters, and business holders, when presenting post-disaster buyouts or relocation programs, to prevent any conflicts that would lead to delays in the process of recovery. In post-disaster conditions, an increase in the need for construction labor and materials is normal (Labadie, 2008). The demands for undamaged housing and commercial space also significantly increase (Vahanvati & Mulligan, 2017). Therefore, additional support by local governments or

other recovery associates, such as non-governmental organizations and the Red Cross, is required to ensure that relocations occur smoothly. In addition, low-income homeowners, the elderly, and minorities have their own special issues that can slow down the recovery process. Many social and environmental justice arguments may emerge and need to be handled sensitively by the policymakers to avoid delays in the recovery. Table 4.6 shows the identified PDRBs that are related to the construction and infrastructure category.

Table 4.6. List of Policy & Legal PDRBs of Construction & Infrastructure Category

PDRBs
B33: Slow and unorganized mass relocation in recovery process
B34: Relocation from the impacted area to insufficient areas in order to receive temporary government-sponsored housing
B35: Inadequate installed infrastructures to be used in recovery process
B36: Inappropriate infrastructure maintenance policies leading to more vulnerable infrastructures and malfunctioning in recovery process
B37: Policies developed to destroy structures that do not comply with zoning regulations
B38: Illegal construction during peak period of the recovery
B39: Lack of controlling legislation for post-disaster blight

Infrastructure service is defined as a facility that meets public demands (O'Sullivan & Steven, 2003). Frequency of the maintenance of infrastructure is a measure of the level of performance and service provision (Amaratunga, 2018). Even though performing on-demand maintenance is more important, if a regular maintenance interval is not appropriately determined, the infrastructure may malfunction during the post-disaster recovery period, delaying the recovery process. Maintenance procedures and intervals should be controlled and determined by the decision-makers and policymakers. For example, the quality of a road infrastructure is substantially related to the capacity of the local government to maintain the road (Hayat, 2015).

4.1.5.3. Location

Many disasters initiate changes in land use to prevent rebuilding in hazard-prone areas (Schwab, 2014). However, large-scale land use changes rarely take place, even during the post-disaster time period, because the buildings and infrastructure affected by the disaster are not usually in a distinct area (Schwab, 2014). Therefore, conflicts about reconstruction in high-hazard areas may arise between the homeowners and the governor, causing the recovery process to slow down (Ismail et al., 2014). Also, some of the policies developed for controlling the settlements in urban areas are

not powerful enough to prevent the owners from rebuilding in unplanned or unauthorized areas (Etinay et al., 2018). Improper urbanization is one of the reasons for the increase in the number of unauthorized settlements in rural areas that are near big cities (Sridarran et al., 2018). The literature considers increasing urbanization as a source of vulnerability (Moreno, 2018). For example, the collapse of high-rise buildings in the center of urban areas causes the assistance disbursement alongside the area to be slow due to the physical proximity to disaster sites, and rebuilders of mega-projects do not usually consider the redevelopment of neighboring properties. Therefore, policies must be in place to prevent such negligence and to make the redevelopment or reconstruction process as fast as possible. Table 4.7 shows the identified policies and legal PDRBs that are related to the location category.

Table 4.7. List of Policy & Legal PDRBs of Location Category

PDRBs
B40: Improper land-use determination for rebuilding in high-hazard areas
B41: Improper urbanization rules
B42: Policies developed to change land uses that do not comply with zoning regulations
B43: Weakness of the legislation pertaining to unplanned and unauthorized settlements in urban and rural areas
B44: Lack of policies pertaining to neighborhood redevelopment when developing mega projects

4.1.5.4. Social and Community Participation

Equitable and fair distributions of resources are important to attaining resiliency in society (Nakagawa & Shaw, 2004). One of the characteristics of a resilient society is its ability to return to its normal condition as fast as possible (Cutter et al., 2010). This is highly dependent upon the policies and legislation that have been determined by the federal and local governments (Kuwabara et al., 2008). Therefore, the policies for post-disaster recovery should consider social equity, as well as participation of the community, to lessen the probability of recovery delays (Chamlee-Wright & Storr, 2009).

All people, from all social classes, should be treated the same. In this regard, the policies and legislation should be established to distribute the recovery services in an unbiased manner (Lindell & Prater, 2003). Table 4.8 shows the PDRBs that relate to the social and community participation category.

Table 4.8. List of Policy & Legal PDRBs of Social and Community Participation Category

PDRBs
B45: Improper policies that instill fear and distrust of individuals in governmental organizations
B46: Weakness of the policymakers in encouraging people to perform prescribed actions for recovery
B47: Biased recovery service allocation for high-income people due to their ability to negotiate with the system
B48: Ignorance of land use and construction standards in reconstruction process
B49: Negligence of condition of low-income affected people in the regulations for recovery
B50: Weakness of policymakers in receiving public acceptance of legislation changes in the post-disaster condition

The effects of natural disasters are greater on poor social classes, who are more vulnerable to the negative effects of these events (Fatemi et al., 2017). Building codes, as well as land-use policies and other standards, are designed to reduce the effects of disasters and increase the resiliency of a community (McDaniels et al., 2015); however, many poor individuals neglect these codes in an effort to reduce their expenses (Alipour et al., 2015). This may increase the level of devastation, thereby reducing the speed of recovery. On the other hand, due to their social connections, high-income citizens might have the opportunity to directly access the policymakers, and their needs might be met simply because of these direct negotiations. Because the poor are more vulnerable to damages resulting from disasters, a rapid response is more important for them. When this does not occur, the catastrophe expands, and the recovery process extends.

4.1.5.5. Resource and Document

Awareness of the vulnerabilities of residents and the different types of infrastructures, transportation networks, services, and critical facilities results in the generation of various programs that focus on disaster risk reduction, integrated strategies, structural measures, etc. that accelerate the recovery process (Bukvic et al., 2018). One of the most important matters in post-disaster recovery is resourcing (Chang et al., 2012). Table 4.9 shows the PDRBs that are related to the resource and document category. The coordination of resourcing is difficult due to the complexities that arise from a large number of resources and the high demand for them (Telford & Cosgrave, 2007). A comprehensive resource database, prepared by local governments in the pre-disaster period, is a basic requirement for optimized allocation of resources.

Table 4.9. List Table 4.9. List of Policy & Legal PDRBs of Resource and Document Category

PDRBs
B51: Inappropriate federal and local assistance disbursement
B52: Lack of adequate information and awareness for recovery
B53: Weakness of the government in preparing high quality physical and technical assistance
B54: Lack of comprehensive resource database
B55: Inappropriate and uneven resourcing by the policymakers
B56: Inadequate local governments' capacity for producing materials for reconstruction
B57: Lack of list of potentially vulnerable and historic resources and structures
B58: Lack of qualified governmental personnel for damage inspections in post-disaster conditions
B59: Lack of local government resources to perform relocation smoothly
B60: Lack of specific post-disaster land development codes and standards
B61: Out-of-date standards and codes
B62: Lack of clear regulations and standards for repair and reconstruction of historic buildings
B63: Weakness in relocating minorities, elderly, and low-income homeowners

For example, a list of historic and vulnerable structures should be prepared so that resources can be assigned to them immediately after the disaster. Inadequate and uneven disbursement of the resources affects the timing of the recovery negatively.

Documents that specify standards and codes should be continually updated because out-of-date standards that do not conform to the existing condition cause practical problems and slow down the recovery process.

4.1.5.6. Finance and Economy

Over the past decades, the economic effects of disasters have significantly increased despite efforts to improve the resilience of communities (Jordan, 2012). Researchers have long been interested in disaster-related economic and financial issues (Andriansyah, 2015). Many have indicated that a connection to higher levels of government increases a community's ability to withstand the effects of a disaster and to recover very fast (Morrow, 1999). For example, informal settlements, or people living in remote rural areas which are isolated, may be neglected during post-disaster recovery or may receive their resources and assistance later than those living in urbanized areas (Miles & Chang, 2011). Table 4.10 shows the PDRBs that are related to the finance and economic category. In contrast, people who have a connection with the government may be able to access resources quickly, including funds for recovery, technical expertise, or even required training. A community's access to government resources is a critical element in obtaining help (Bolin, 1993).

Table 4.10. List of Policy & Legal PDRBs of Finance and Economic Category

PDRBs
B64: Weakness of local governments in funding
B65: Delay in disbursement of emergency funds
B66: Lack of economic resources for recovery
B67: Lack of long-term recovery funding programs
B68: Policies which lead to income disparity and diversification of livelihoods
B69: Lack of legislation to enable immediate access to emergency capital (loans)
B70: Tough legislative criteria for low-income groups to obtain strong financial assistance
B71: Unavailability of Small Business Administration (SBA) loans to those with lower-than-average incomes
B72: Weakness or inability of housing providers and decision-makers to help the low-income class cope with post-disaster financial demands

Dependence on external sources of funding causes more delays in the process; therefore, long-term recovery funding should be provided by the local governments to accelerate the process (Olshansky, 2005). Since the low-income class needs more funding for reconstruction, policies and legislation should be flexible so that they can receive financial aid and loans promptly. Tough rules prevent the poor from receiving assistance, making their recovery very slow.

4.1.5.7. Approach and Attitude

Planning programs should be prepared for disaster-prone areas in order to accelerate recovery (Xu and Lu, 2012). Technical experts are familiar with many aspects and issues of the recovery process; therefore, neglecting their opinions on the planning process may cause the recovery to be slow (Siriwardana et al., 2018). In addition, each area has its own traditional materials and techniques for construction, according to the environmental and market availabilities (Jordan et al., 2011). In this regard, the standards and techniques should be modified for every area to avoid delays due to the lack of availability of materials or technologies for reconstruction. The delineation of responsibilities should be very clear to avoid any intersection, repetition, and conflict, which all lead to delays in recovery. Table 4.11 shows the PDRBs that are related to the approach and attitude category.

When a disaster occurs, temporary restrictions and moratoria are needed to control the reconstruction and are a political minefield (Ryan et al., 2016). The government is overwhelmed and needs time to perform technical investigations and, by proper risk assessments, define the sufficient construction standards (Brown et al., 2008). Even though this process is required, it is a source of delays in the recovery and should be done as soon as possible. Decisions about the

funding and recovery process usually create conflicts among the decision-makers, especially when they are from different groups. In recovery, the local and federal governments are both responsible, which leads to inevitable conflicts and is obviously a source of delays.

Table 4.11. List of Policy & Legal PDRBs of Approach and Attitude Category

PDRBs
B73: Not employing technical expertise in the planning process
B74: Not considering the traditional technologies and materials in post-disaster construction techniques and standards
B75: Not considering the local comprehensive mandates while working for legislation
B76: Lack of clarity in roles and responsibilities for assistance
B77: Not considering sustainability in recovery planning
B78: Conflicts between local and federal government authorities pertaining to hazard mitigation and funding
B79: Complexity of legislative consenting process for reconstruction
B80: Slow decision-making and lack of proactive approach in recovery process
B81: Lack of institutional post-disaster recovery planning and approach
B82: Lack of moratoria and temporary restrictions
B83: Lack of clarity of moratoria and temporary restrictions
B84: Lack of phase or triaged moratorium - specific to the type of permit, not generic
B85: Lack of considering emergency exemptions in environmental regulation development

4.2. Weighting the PDRBs Categories Based on Number of PDRBs

The recovery phase is very important because it can make society less vulnerable to future disasters (Hass et al., 1977). The majority of our studied articles focused on a particular type and/or a particular category of the recovery phase. Therefore, to determine the most-and-least-discussed categories of those articles, the percentile weight (eq. 4.1) of the categories, based on the number of dimensions that must be recovered to conclude full recovery, was determined (Table 4.12).

$$Category\ Wight\ = \frac{Number\ of\ barriers\ of\ that\ category}{Total\ number\ of\ barriers} \times 100\% \qquad \text{(eq. 4.1)}$$

While counting the number of PDRBs, a barrier with a frequency of 2 or more was considered for each category. Among all of the PDRB categories, policy and legal received the top weight (68.2%), which shows its high importance (Table 4.12). It must be added that due to the importance and essence of the PDRBs of this category, it was evaluated separately in a qualitative manner, and recommendations were made to control the corresponding effects, which will be presented in subsequent chapters. Furthermore, economic and social categories are similar in their number of PDRBs.

Table 4.12. Weights of PDRBs Categories Based on the Number of PDRBs

PDRB Category	Number of PDRBs	Weight (%)
Policy and legal	58	68.2
Economic	9	10.6
Social	8	9.4
Infrastructure & transportation	6	7.1
Environmental	4	4.7
Total	**85**	**100**

SURVEY DEVELOPMNT, DISTRIBUTION, AND ANALYSIS

After finalizing and categorizing the barriers to post-disaster recovery in the previous step, we needed to collect data for casualty modeling of the identified PDRBs. For this purpose, a comprehensive questionnaire/survey was conducted, including questions relative to all the identified PDRBs. The goal was to collect data about the level of importance of each of the barriers to late post-disaster recovery. The significance of the survey results was evaluated, and the PDRBs were weighted and prioritized.

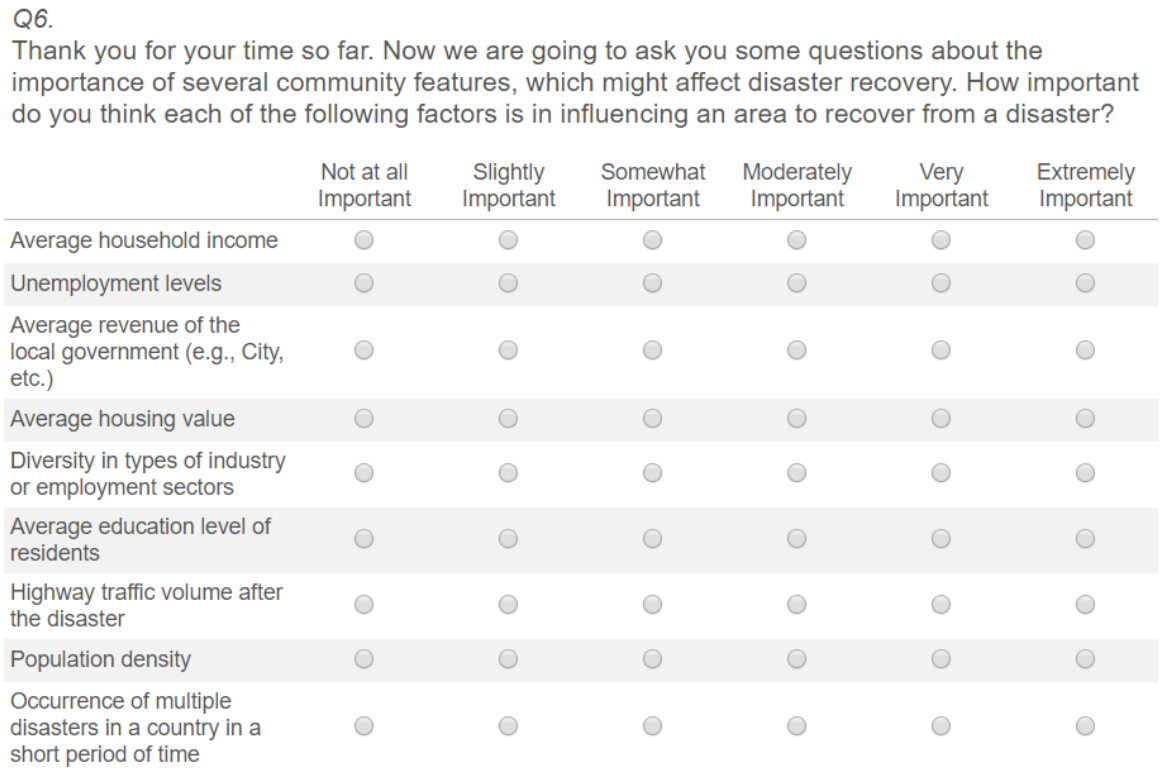
5.1. Survey Development

In this step, data was collected via a comprehensive survey. The list of potential PDRBs identified in the previous step constituted the basis for developing the survey protocol, which was designed to be taken by experts in the post-disaster recovery process and also by the affected communities, the public, in order to collect both insights and perspectives. This survey included 21 questions and additional sub-questions, through which all of the PDRBs were scored by the participants in a 1 to 7 Likert-scale format.

The survey had two sections, including demographic questions and scoring of the PDRBs according to their importance to a timely recovery process. The survey was first pilot-tested to ensure the clarity of the questions. According to the literature, 10 to 30 participants in a pilot study are required; thus, we conducted 15 pilot studies. The survey was distributed to potential respondents, including the public and experts in disaster recovery. The prospective policymakers and experienced workforce and practitioners were identified and asked to engage in the process of data collection. Officials from cities, directors from Departments of Transportation, local agencies, academicians, NGOs, private consulting firms, and residents of the local communities were asked to take the survey. People were invited from different levels of local, state, and national entities so that we could perform a comparative analysis of the obtained results and achieve a more sustainable recovery. To receive a satisfactory number of responses, we closely monitored the completeness, reliability and validity of the completed surveys. The outcome of this step was used in the next step for testing the significance of the identified PDRBs, as well as weighting, and prioritizing them. The survey was created on the Qualtrics.com platform, and was approved by the Institutional Review Board (IRB) before it was available to the public. The link to this survey is provided below:

https://uta.qualtrics.com/jfe/form/SV_72Lizcna9p3ILFr

A sample screenshot from the conducted survey is shown in Figure 5.1, and the survey is presented in Appendix II.



Q6.
Thank you for your time so far. Now we are going to ask you some questions about the importance of several community features, which might affect disaster recovery. How important do you think each of the following factors is in influencing an area to recover from a disaster?

	Not at all Important	Slightly Important	Somewhat Important	Moderately Important	Very Important	Extremely Important
Average household income	○	○	○	○	○	○
Unemployment levels	○	○	○	○	○	○
Average revenue of the local government (e.g., City, etc.)	○	○	○	○	○	○
Average housing value	○	○	○	○	○	○
Diversity in types of industry or employment sectors	○	○	○	○	○	○
Average education level of residents	○	○	○	○	○	○
Highway traffic volume after the disaster	○	○	○	○	○	○
Population density	○	○	○	○	○	○
Occurrence of multiple disasters in a country in a short period of time	○	○	○	○	○	○

Figure 5.1. Sample question from survey

5.2. Experts' Survey Distribution and Analysis

5.2.1. Experts Selection and Survey Distribution

More than 400 experts in the post-disaster recovery process from different organizations and institutes around the U.S., such as FEMA, cities, state emergency management centers, the National Oceanic and Atmospheric Administration (NOAA), etc. were contacted by E-mail and invited to participate in the survey (Appendix I). After several rounds of follow-up E-mails, 39 of the experts responded to the survey. Approximately 90% of the experts who participated in the survey were involved in disasters in North America (Figure 5.2).

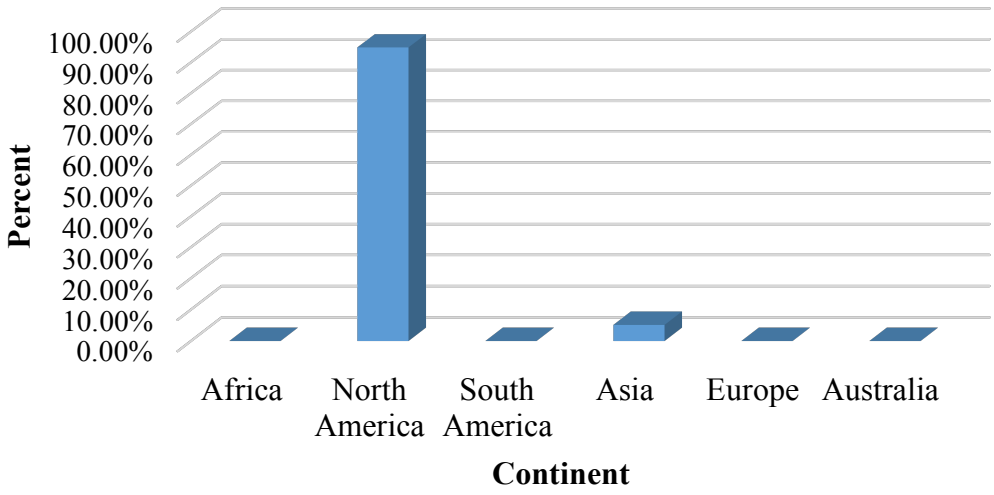


Figure 5.2. Percent of disasters in each continent in which the experts were involved

In addition, the experts were asked to provide their occupation in the demographic section of the survey. Figure 5.3 shows that emergency managers, city officials or staff, and project managers constituted approximately half of the expert panel.

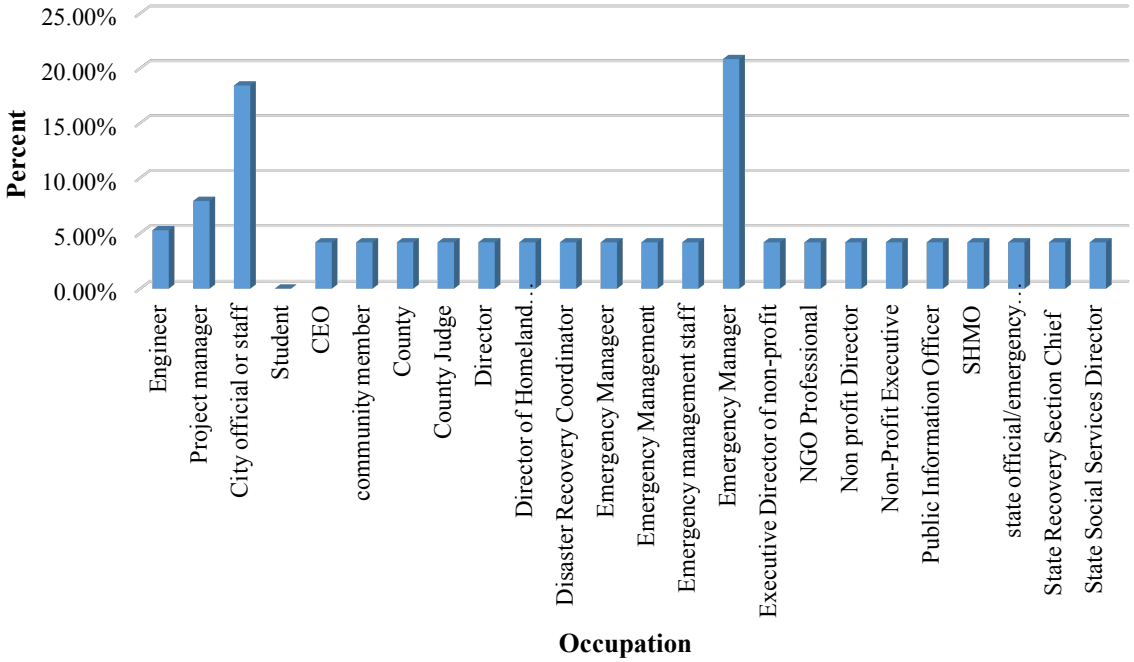


Figure 5.3. Occupation of experts

As expected, all of the experts had a high level of education (from associate college degree to doctoral degree), and almost 40% of them had a bachelor's degree (Figure 5.4).

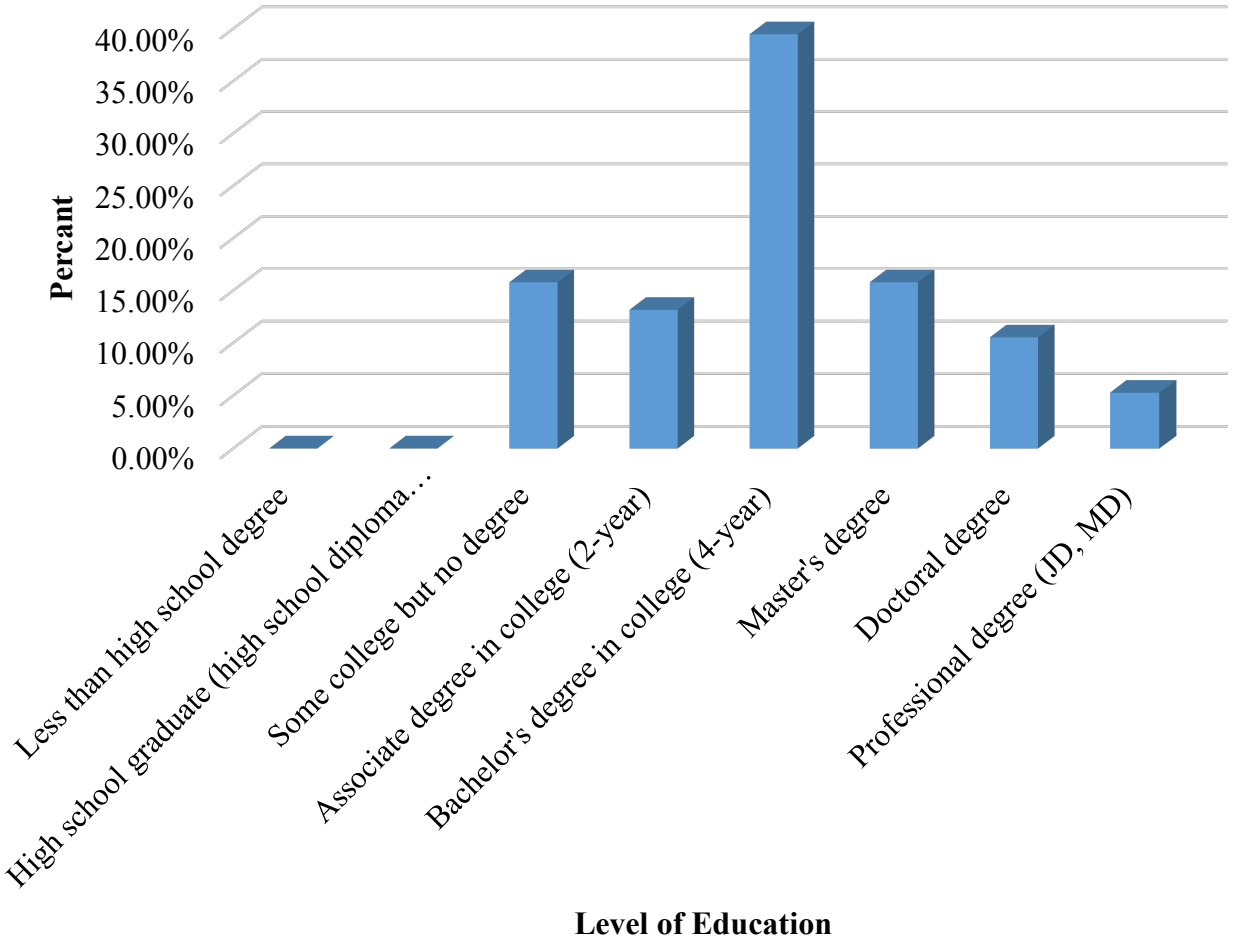


Figure 5.4. Level of education of the experts

Other demographic information pertaining to the experts who participated in the survey, as well as general information about the disasters they had been involved in, are presented in Table 5.1. The different types of disasters they were involved in, the number of times they were involved in a disaster, the severity of the most calamitous disaster they were involved in, the length of the time they were involved in disasters, and their gender and ethnicity are presented in this table.

Table 5.1. Demographic Information of the Experts

Percent of involvement in different types of disasters							
Hurricanes	**Flooding**	**Thunderstorms**	**Tornadoes**	**Earthquakes**	**Tsunami**	**Other**	**Total**
27.27%	27.27%	19.70%	14.39%	4.55%	0.76%	6.06%	100%

Percent of disasters involved						
1	**2**	**3**	**4**	**5**	**More than 5**	**Total**
5.13%	7.69%	7.69%	17.95%	2.56%	58.97%	100.00%

Severity of the most severs disaster involved					
Very low	**Low**	**Medium**	**High**	**Very high**	**Total**
0.00%	5.13%	23.08%	17.95%	53.85%	100.00%

Percent of length of involvement in disasters						
Less than one month	**1-3 months**	**4-6 months**	**7-10 months**	**11-12 months**	**More than one year**	**Total**
10.26%	2.56%	2.56%	0.00%	0.00%	84.62%	100.00%

Gender of the participants		
Male	**Female**	**Total**
59.46%	40.54%	100.00%

Ethnicity of the participants						
White	**Black or African American**	**American Indian or Alaska Native**	**Asian**	**Native Hawaiian or Pacific Islander**	**Other**	**Total**
86.49%	5.41%	2.70%	0.00%	0.00%	5.41%	100.01%

5.2.2. Experts' Survey Analysis

After collecting the data from the experts through the survey, we assessed the significance of the PDRBs, using statistical methods. Since the scores given by the participants were discrete values from 1 to 7, the Kruskal-Wallis test was selected as an appropriate method to evaluate the significance of the PDRBs. Thus, the mean and median of the scores for each PDRB were calculated, then each set of scores related to a PDRB was divided into two samples: the low impact sample, and high impact sample. In the first trial for each PDRB, the mean value of the score set was selected as the separation point; in the second trial, if needed, the median of the set was chosen to divide the data set into two samples. As shown in Table 5.2, for the significance level of 95%, all of the PDRBs were recognized as significant, according to the experts' responses. Since all of the potential PDRBs were found with accurate consideration from peer-reviewed papers and technical reports and documents, it is justifiable that the experts who had experiences with disaster recovery and reconstruction verified and confirmed their significance.

Table 5.2. P-value of the PDRBs According to Experts' Responses

ID	PDRB	Median	Mean	P-value
B1	Average household income	6	6.44	0.0001
B2	Number of available active contractors after a disaster	6	6.33	0.0000
B3	Unemployment levels	5	6.21	0.0000
B4	Average housing value	6	6.16	0.0000
B5	Average lost household income	6	6.16	0.0002
B6	Average revenue of the local government (e.g., City, etc.)	6	6.11	0.0000
B7	Average lost business income	5	6.05	0.0000
B8	Diversity in types of industry or employment sectors	6	6.05	0.0000
B9	Number of active small businesses after the disaster (e.g., food providers)	6	6.00	0.0000
B10	Voluntary public participation in the recovery process	6	6.00	0.0000
B11	Average education level of residents	5	5.92	0.0000
B12	Availability of medical services after the disaster	6	5.89	0.0000
B13	Availability of disaster recovery public training	6	5.86	0.0000
B14	Family or friends who can help financially	6	5.86	0.0000
B15	Family or friends who can help emotionally	6	5.84	0.0000
B16	A community that looks out for each other	5	5.82	0.0000
B17	Population density	6	5.72	0.0001
B18	Timely debris and erosion removal after the disaster	6	5.71	0.0000
B19	Timely resolution of air and water quality issues after the disaster	6	5.71	0.0000
B20	Environmental harm that affects industry, such as lost natural resources that reduce fishing or tourism	6	5.71	0.0001
B21	Environmental contamination, such as reduced water and air quality	6	5.68	0.0000
B22	Damage to residential housing	6	5.67	0.0000
B23	Damage to high-rise buildings	5	5.65	0.0000
B24	Damage to medical services, like hospitals	6	5.62	0.0002
B25	Improving community infrastructure	6	5.50	0.0001
B26	Damage to major infrastructure systems (e.g., airports, bridges, etc.)	5	5.42	0.0000
B27	Highway traffic volume after the disaster	6	5.41	0.0149

5.3. Public's Survey Distribution and Analysis

The survey was distributed online via social media, including Twitter, Facebook, Instagram, etc. to collect data from the disaster-affected public and/or individuals who had experience with the post-disaster recovery process and barriers that cause delays in the recovery process. In addition, hard copies of the survey were generated and distributed to individuals, including university students, who are potentially prone to having experiences in post-disaster situations. After pre-processing the input of the public participants in the survey and eliminating some which seemed

to be inaccurate responses, 195 responses were collected from the public. According to Figure 5.5, over 70% of the public participants were students at a university, and around 15% were engineers or project managers.

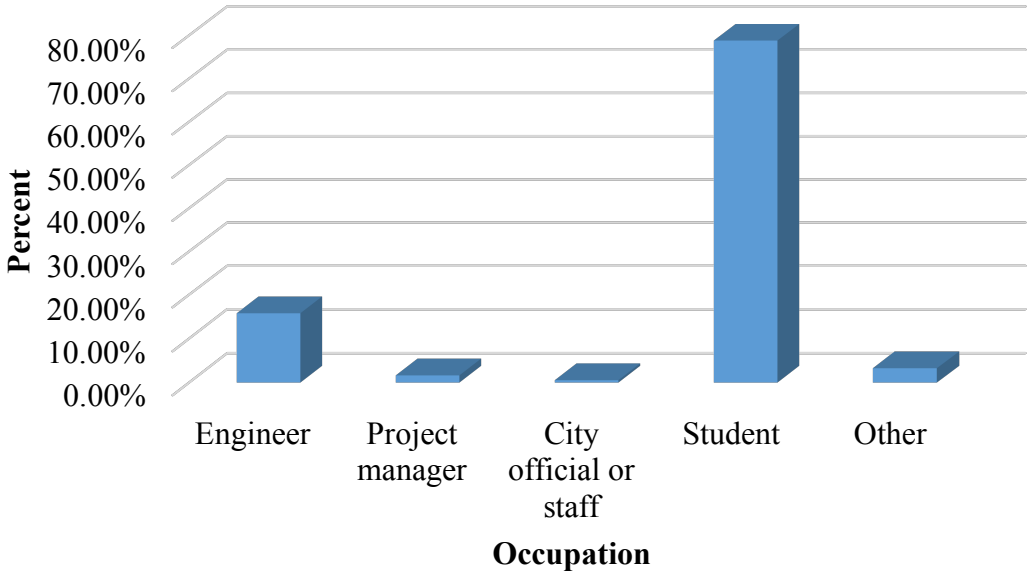


Figure 5.5. Occupation of public participants

Almost 50% of the experienced disasters occurred in Asia, while approximately 40% happened in North America (Figure 5.6), showing that many of the participants were probably originally from Asia and/or had lived there for at least a period of time.

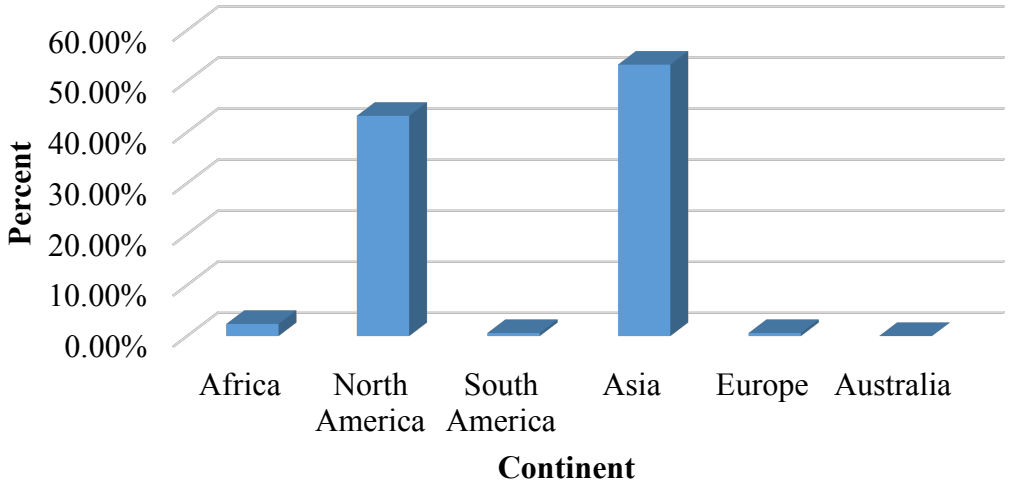


Figure 5.6. Percent of disasters on each continent in which the public was involved

All of the participants had at least a high school diploma or higher level of education, and around 60% of them had a bachelor's degree or higher level of education, indicating that they had sufficient understanding of different socioeconomic issues and could potentially analyze the questions and respond to them accurately (Figure 5.7).

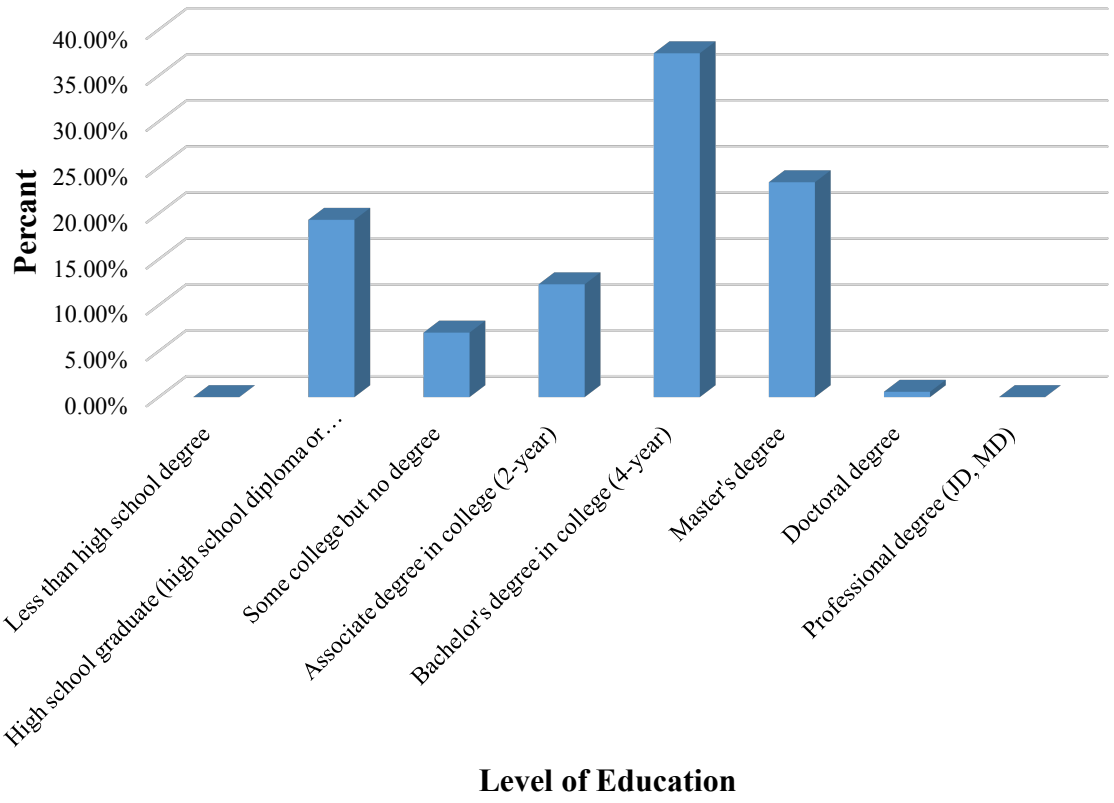


Figure 5.7. Level of education of the public participants

Other demographic information pertaining to the public who participated in the survey, as well as general information about the disasters they were involved in, are presented in Table 5.3. The different types of disasters, the number of times they were involved in disasters, the severity of the most calamitous disaster they were involved in, the length of time they were involved in disasters, and their gender and ethnicity are presented in this table.

Table 5.3. Demographic Information of the Public

Percent of involvement in different types of disasters							
Hurricanes	**Flooding**	**Thunderstorms**	**Tornadoes**	**Earthquakes**	**Tsunami**	**Other**	**Total**
6.55%	28.36%	26.91%	12.00%	22.18%	1.82%	2.18%	100%

Percent of disasters in which they were involved						
1	**2**	**3**	**4**	**5**	**More than 5**	**Total**
32.73%	26.67%	15.76%	7.88%	9.70%	7.27%	100.00%

Severity of the most severe disaster in which they were involved					
Very low	**Low**	**Medium**	**High**	**Very high**	**Total**
13.53%	24.12%	35.29%	18.82%	8.24%	100.00%

Percent of length of involvement in disasters						
Less than one month	**1-3 months**	**4-6 months**	**7-10 months**	**11-12 months**	**More than one year**	**Total**
50.32%	20.00%	7.74%	5.81%	0.65%	15.48%	100.00%

Gender of the participants		
Male	**Female**	**Total**
84.48%	15.52%	100.00%

Ethnicity of the participants						
White	**Black or African American**	**American Indian or Alaska Native**	**Asian**	**Native Hawaiian or Pacific Islander**	**Other**	**Total**
32.24%	3.80%	0.00%	51.09%	0.54%	10.33%	100.01%

As shown in Table 5.4, the public's responses did not consider diversity in types of industry or employment sectors; average education level of residents; environmental harm that affects industry, such as lost natural resources that reduce fishing or tourism; environmental contamination, such as reduced water and air quality; or improving community infrastructure as significant.

Table 5.4. P-value of the PDRBs According to Public's Responses

ID	PDRB	Median	Mean	P-value
B1	Average household income	6	5.71	0.0000
B2	Number of available active contractors after a disaster	6	5.68	0.0002
B3	Unemployment levels	6	5.67	0.0040
B4	Average housing value	6	5.65	0.0000
B5	Average lost household income	6	5.62	0.0002
B6	Average revenue of the local government (e.g., City, etc.)	6	5.50	0.0100
B7	Average lost business income	5	5.42	0.0000
B8	Diversity in types of industry or employment sectors	6	5.41	0.2900
B9	Number of active small businesses after the disaster (e.g., food providers)	5	5.36	0.0000
B10	Voluntary public participation in the recovery process	6	5.34	0.0000
B11	Average education level of residents	6	5.31	0.1412
B12	Availability of medical services after the disaster	6	5.26	0.0000
B13	Availability of disaster recovery public training	6	5.23	0.0020
B14	Family or friends who can help financially	5	5.21	0.0010
B15	Family or friends who can help emotionally	5	5.18	0.0000
B16	A community that looks out for each other	6	5.16	0.0000
B17	Population density	5	5.14	0.0001
B18	Timely debris and erosion removal after the disaster	5	5.03	0.0000
B19	Timely resolution of air and water quality issues after the disaster	5	4.97	0.0000
B20	Environmental harm that affects industry, such as lost natural resources that reduce fishing or tourism	5	4.92	0.1547
B21	Environmental contamination, such as reduced water and air quality	5	4.90	0.6867
B22	Damage to residential housing	5	4.84	0.0000
B23	Damage to high-rise buildings	4	4.33	0.0000
B24	Damage to medical services, like hospitals	4	4.26	0.0002
B25	Improving community infrastructure+	4	4.18	0.9010
B26	Damage to major infrastructure systems (e.g., airport, bridge, etc.)	4	4.16	0.0000
B27	Highway traffic volume after the disaster	4	4.00	0.0127

5.4. Comparative Analysis of Public and Experts Perspectives

As indicated previously, the survey was taken by both experts and public respondents. Despite the fact that that experts' input to the survey was determinant, comparing their judgment with the public's perception provided insight to how differently they think about PDRBs and their corresponding impact on the timeliness of recovery. Overall, the general population and the experts similarly assessed some of the PDRBs' effect on delays, yet about other PDRBs, significant dissimilarities were observed. For example, the result of statistical analysis of the experts' input

showed that all of the potential PDRBs were recognized as significant, while in the case of the public input, five of the PDRBs were not significant. As shown in Table 5.2, two of these PDRBs related to the environmental category (B20 and B21). This could be justifiable since many of the public are not aware of the effect of environmental issues on the recovery process. The mean score of the two groups is compared in Figure 5.8. Diversity in types of industry or employment sectors (B8) was another PDRB which was not identified by the public as significant. After a disaster, much unexpected material and expertise might be required; thus, there would be a need for diversity. This capacity was probably not seen as significant by the public because the decision-makers are in charge of providing the required resources for the recovery process, hence the public is not informed about the details and corresponding difficulties. The average education level of residents (B11) was the other potential PDRB that was deemed as insignificant by the public. One of the key factors in measuring the socioeconomic status of a community is the education level of its residents. Accordingly, it should not be difficult to find a correlation between education level and the quality of every socioeconomic activity, including post-disaster recovery. But since this factor indirectly affects the recovery process, we should admit that for people who do not view the recovery process from a scientific point of view, this factor might not be considered important. The same justification may be considered for the public's denying that improving community infrastructure (B25) is a significant PDRB. The mean scores of expert and public responses to the survey are shown in Figure 5.8.

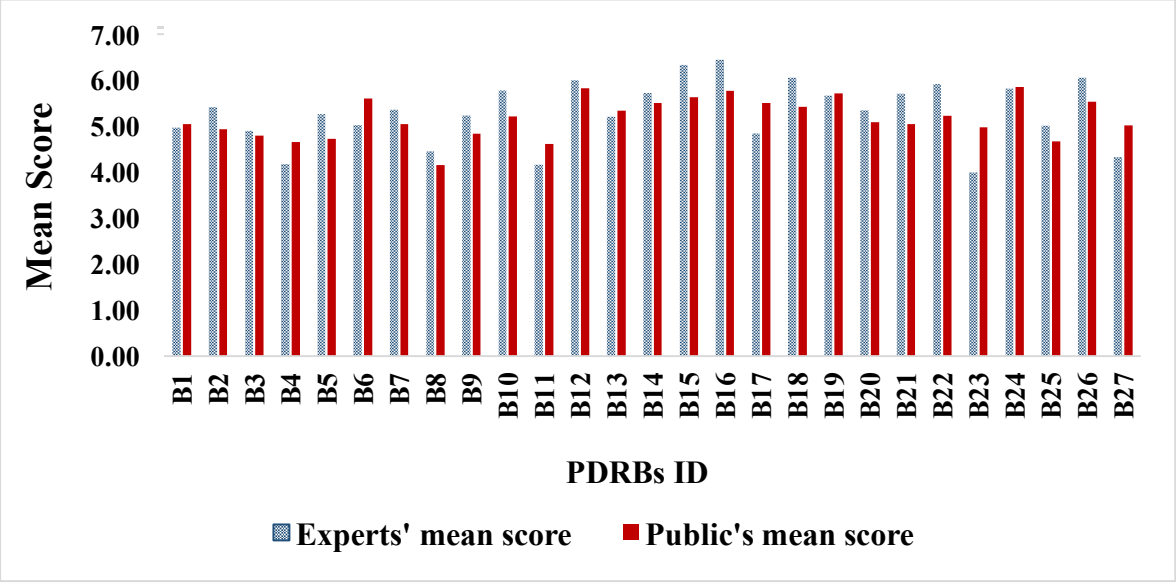


Figure 5.8. Mean scores of expert and public responses to the survey

5.5. Weighting and Prioritizing PDRBs

Prioritizing the PDRBs can provide the decision-makers with insight that enables them to manage post-disaster recovery and avoid delays in the process. For this purpose, the PDRBs should be weighted. Different techniques are available for weighting, and the Chi Epsilon method, which enables comparing the calculated size effects of PDRBs, was selected for this research. The Kruskal-Wallis test was determined as the most fitting test for prioritization, and, as shown in Table 5.5, "*A community that looks out for each other*" was ranked 1 among all the PDRBs.

Table 5.5. Weighting Results

ID	PDRB	Rank Within Category	Cumulative *Rank*	Weight
	Economic			
B1	Average household income	5	16	0.121
B2	Number of available active contractors after a disaster	2	13	0.139
B3	Unemployment levels	6	17	0.119
B4	Average housing value	8	21	0.061
B5	Average lost household income	3	14	0.132
B6	Average revenue of the local government (e.g., City, etc.)	4	15	0.128
B7	Average lost business income	1	11	0.143
B8	Diversity in types of industry or employment sectors	7	20	0.071
B9	Number of active small businesses after the disaster (e.g., food providers)	9	24	0.025
	Social			
B10	Inadequate installed infrastructures to be used in recovery process	6	22	0.059
B11	Average education level of residents	7	23	0.037
B12	Availability of medical services after the disaster	3	5	0.288
B13	Availability of disaster recovery public training	8	26	0.022
B14	Family or friends who can help financially	4	8	0.196
B15	Family or friends who can help emotionally	2	2	0.343
B16	A community that looks out for each other	1	1	0.356
B17	Population density	5	18	0.116
	Environmental			
B18	Timely debris and erosion removal after the disaster	1	4	0.298
B19	Timely resolution of air and water quality issues after the disaster	3	10	0.165
B20	Environmental harm that affects industry, such as lost natural resources that reduce fishing or tourism	4	12	0.141
B21	Environmental contamination, such as reduced water and air quality	2	9	0.185
	Infrastructure & Transportation			
B22	Damage to residential housing	2	6	0.265
B23	Damage to high-rise buildings	5	25	0.023
B24	Damage to medical services, like hospitals	3	7	0.212
B25	Improving community infrastructure	6	27	0.011
B26	Damage to major infrastructure systems (e.g., airport, bridge, etc.)	1	3	0.312
B27	Highway traffic volume after the disaster	4	19	0.092

ANALYSIS OF POLICY AND LEGAL PDRBs

6.1. Qualitative Analysis of Legal and Policy PDRBs

As indicated in Chapter 3 of this report, after determining and categorizing the PDRBs, a survey was developed to evaluate the perceptions of disaster-affected people and professionals of the importance and relevancy of the PDRBs. Since the policy and legal PDRBs were more complicated and needed a high level of experience with the recovery process, we decided to analyze these PDRBs qualitatively and based on experts' responses to the survey. We selected 30 of the experts' responses out of the 39 possible responses. For this selection, we applied the criteria of having at least 5 experiences with disasters caused by hurricanes, as well as a high level of education. The chosen experts were from national and state level organizations such as FEMA and the Red Cross, local emergency management agencies in hurricane-affected states, and other professionals who had extensive experience with disaster recovery (Table 6.1). Table 6.2 shows the level of education of the experts.

Table 6.1. Demographic Information of the Experts Involved in the Survey

Occupation	Total Number of Respondents	Number of State Level Respondents	Number of National Level Respondents
Emergency Manager	8	5	3
Project Manager	6	4	2
City Official or Staff	6	6	
State Social Services Director	5	5	
Chief Executive Officer (CEO)	3		3
State Recovery Section Chief	2	2	
Total	30		

Table 6.2. Level of Education of the Experts

Level of Education	Number of Participants
Bachelor's degree in college (4-year)	15
Master's degree	8
Doctoral degree	5
Professional degree (JD, MD)	2
Total	30

The survey included questions for scoring the 58 PDRBs, as well as demographic questions about the experts' experience. The experts were asked to score the effect of each PDRB on the recovery timeframe, based on a seven point Likert-scale format. The lowest score, indicating no effect, was 1, and the highest score, indicating the highest importance level, was 7. The calculated mean value of the scores for each of the PDRBs is presented in Table 6.3. As shown in this table, the policy

and legal PDRBs were ranked according to their impact on timely post-disaster recovery, within each category and cumulatively. B67, "*Lack of long-term recovery funding programs*" was the PDRB identified by the experts as the most important of all of the legal and policy PDRBs, in all of the categories.

Table 6.3. Mean Score and Rank of the PDRBs in Each of the Categories

ID	PDRBs	Rank Within Category	Cumulative Rank	Score
	Coordination			
B32	Lack of proper coordination among administrative officers in provinces, districts, and sub-districts; NGOs; and volunteers	1	9	6.04
B29	Poor coordination between federal and state agency recovery programs	2	11	5.87
B28	Lack of consultation with community for recovery policymaking	3	12	5.83
B30	Weakness of pre-existing legislation pertaining to post-disaster recovery	4	22	5.54
B31	Inappropriate governmental system and organization for recovery	5	53	4.91
	Construction & Infrastructure			
B35	Inadequate installed infrastructures to be used in recovery process	1	4	6.12
B37	Policies developed to destroy structures that do not comply with zoning regulations	2	5	6.12
B36	Inappropriate infrastructure maintenance policies leading to more vulnerable infrastructures and malfunctions in recovery process	3	23	5.54
B33	Slow and unorganized mass relocation in recovery process	4	24	5.50
B34	Relocation from the impacted area to insufficient areas in order to receive temporary government-sponsored housing	5	25	5.50
B38	Illegal construction during peak period of the recovery	6	54	4.83
B39	Lack of controlling legislation for post-disaster blight	7	56	4.78
	Location			
B40	Improper land use determination for rebuilding in high-hazard areas	1	33	5.29
B42	Policies developed to change land uses that do not comply with zoning regulations	2	34	5.29
B41	Improper urbanization rules	3	41	5.12
B43	Weakness of the legislation pertaining to unplanned and unauthorized settlements in urban and rural areas	4	50	4.95
B44	Lack of policies pertaining to neighborhood redevelopment when developing mega projects	5	55	4.82
	Social & Community Participation			
B47	Biased recovery service allocation for high-income people due to their ability to negotiate the system	1	16	5.62
B46	Weakness of the policymakers in encouraging people to perform prescribed actions for recovery	2	28	5.45
B49	Negligence of conditions of low-income affected people in the regulations for recovery	3	32	5.33
B48	Ignorance of land use and construction standards in reconstruction process	4	35	5.29
B50	Weakness of policymakers in receiving public acceptance of legislation changes in the post-disaster condition	5	42	5.12

ID	PDRBs	Rank Within Category	Cumulative Rank	Score
B45	Improper policies that instill fear and distrust of individuals in governmental organizations	6	51	4.95
	Resource & Document			
B55	Inappropriate and uneven resourcing by the policymakers	1	6	6.12
B62	Lack of clear regulations and standards for repair and reconstruction of historic buildings	2	14	5.70
B53	Weakness of the government in preparing high quality physical and technical assistance	3	17	5.62
B51	Inappropriate federal and local assistance disbursement	4	18	5.58
B59	Lack of local government resources to perform relocation smoothly	5	26	5.50
B63	Weakness in relocating minorities, elderly, and low-income homeowners	6	27	5.50
B56	Inadequate local governments' capacity for producing materials for reconstruction	7	31	5.35
B60	Lack of specific post-disaster land development codes and standards	8	36	5.29
B61	Out-of-date standards and codes	9	40	5.15
B52	Lack of adequate information and awareness for recovery	10	43	5.12
B58	Lack of qualified governmental personnel for damage inspections in post-disaster conditions	11	44	5.12
B54	Lack of comprehensive resource database	12	52	4.95
B57	Lack of list of potentially vulnerable and historic resources and structures	13	57	4.59
	Finance & Economic			
B67	Lack of long-term recovery funding programs	1	1	6.20
B64	Weakness of local governments in funding	2	3	6.15
B69	Lack of legislation to enable immediate access to emergency capital (loans)	3	7	6.12
B65	Delay in disbursement of emergency funds	4	10	5.95
B72	Weakness or inability of housing providers and decision-makers to help the low-income class cope with post-disaster financial demands	5	19	5.58
B71	Unavailability of Small Business Administration (SBA) loans to those with lower-than-average incomes	6	37	5.29
B70	Tough legislative criteria for low-income groups to obtain strong financial assistance	7	39	5.20
B66	Lack of economic resources for recovery	8	45	5.12
B68	Policies which lead to income disparity and diversification of livelihoods	9	47	5.08
	Approach & Attitude			
B80	Slow decision-making and lack of proactive approach in recovery process	1	2	6.16
B83	Lack of clarity in roles and responsibilities for assistance	2	8	6.12
B73	Not employing technical expertise in planning process	3	13	5.79
B78	Conflicts between local and federal government authorities pertaining to hazard mitigation and funding	4	15	5.65
B85	Lack of considering emergency exemptions in environmental regulation development	5	20	5.58
B82	Lack of moratoria and temporary restrictions	6	21	5.55
B75	Not considering the local comprehensive mandates while working for legislation	7	29	5.45
B83	Lack of clarity of moratoria and temporary restrictions	8	30	5.41

ID	PDRBs	Rank Within Category	Cumulative Rank	Score
B79	Complexity of legislative consenting process for reconstruction	9	38	5.23
B81	Lack of institutional post-disaster recovery planning and approach	10	46	5.12
B74	Not considering the traditional technologies and materials in post-disaster construction techniques and standards	11	48	5.08
B77	Lack of considering sustainability in recovery planning	12	49	4.98
B84	Lack of phase or triaged moratorium which is specific to the type of permit (not generic)	13	58	4.57

6.2. Recommendations

Identifying the policy and legal PDRBs of post-disaster recovery led to understanding the deficiencies that can cause delays in the recovery process. Accordingly, some recommendations are provided to alleviate the negative effects of the PDRBs on timely recovery process. For communities, one of the recognizable considerations ahead of an event, the pre-disaster period, is the establishment of a local database of past disaster recovery experiences to increase the awareness of the public and the decision-makers. Based on this database, some pre-disaster exercises can be provided for responsible groups whose duties should be established clearly to avoid conflicts and consequential delays. In addition, the financial requirements for a timely and successful recovery can be identified by looking at costs of previous disasters. Having a list of probable economic necessities allows the policymakers to evaluate the overall preparedness of a resilient community. The database may also be expanded to include a Geographic Information System (GIS) software, with which a comprehensive hazard recovery plan can be conducted. It must be mentioned that the planning should be both local and national to provide a strong preparedness (Schwab, 2014).

The planning should include policy and legislation considerations. Timely post-disaster recovery can be assessed through pre-disaster planning, and the roles of both the local and federal governments can be determined clearly. Through the planning, an urbanization framework should be suggested for the area, to guide the communities in their reconstruction during the post-disaster period. Appropriate planning increases the resiliency of the community by decreasing the risks and delays during redevelopment and rebuilding. In the cases where prior mitigation planning has been performed, it should be revised, based on the updated local database.

Land use planning is one of the important parts of the pre-disaster mitigation planning, as zones of high-hazard risks can be identified to restrict development in the pre-disaster period and restrict

reconstruction in the post-disaster period. In addition, low-hazard zones should be identified for timely relocating, if needed; and all of the land use concerns, such as greenways, where construction is usually prohibited or restricted, should be identified.

Financial allocations should be clearly determined before the occurrence of any disaster. The federal government provides financial assistance for housing to homeowners and renters, which can be used for rental, repair, replacement, and permanent housing construction (FEMA, 2014). Some financial assistance will be fulfilled by FEMA and by state cooperation when affected people have no government and/or private source (FEMA, 2008). Provisions of clothing and household items, such as furnishing and appliances, are examples of such assistance. Since many businesses might stop operating because of disasters, the rate of unemployment increases in a post-disaster situation (FEMA, 2008).

As part of pre-disaster planning, the infrastructure assets, such as the transportation segments, need timely maintenance, reconstruction, and repair frameworks to increase the reliability of the systems when a disaster occurs. Integration of local and national planning also plays a vital role in decreasing any conflicts while dealing with recovery. To take immediate recovery actions, a warning and response system should be designed for all of the areas, and there must be an appropriate connection between the local government and the public, both for planning and recovery, to consider the experiences and viewpoints of the public.

Some preventive structures and infrastructures, such as flood control structures, resilient roads, and resilient water supply systems can be implemented in order to decrease the severity of the devastations caused by disaster, and need to be supported by the local or federal decision-makers. The locations of such structures should be appropriately defined to help the timely recovery and to reduce the loss of life and assets.

Public training on how to be prepared for the disaster, especially for the poor and low-income community, will ensure their safety and will facilitate a faster recovery (FEMA, 1994). Providing property tax relief for home purchases in a post-disaster time period and using fast-tracking approaches for reconstruction are also recommended to avoid slow recovery (Schwab et al. 1998).

MODEL DEVELOPMENT TO DETERMINE RELATIONSHIPS AMONG PDRBs

7.1. Perform Social Network Analysis

Two sources of data were used to form the reference matrices. First, 20 of the reviewed papers were selected, and the frequency of mentioning the identified barriers throughout these papers was determined. Thus, the rows of the reference matrix were the barriers, and the columns were the sources or the papers. The second reference matrix was formed based on the conducted survey. The rows of this matrix were again the identified barriers, and the columns were the average scores assigned by the individuals who took the survey, showing the importance of each barrier. Then, two adjacency matrices were established, based on the formed reference matrices and the normalized degree of centrality of each barrier, ranging 0 to 1, and were calculated using eqs. 3.1 and 3.2.

Table 7.1 demonstrates the detailed normalized degree of centralities of the barriers for both the matrices and their differences. The bigger the value of the degree of centrality is, the more influential or important the barrier is. For example, according to both of the literature-based networks, the availability of medical services after the disaster (B12) is considered as the most influential PDRB to timely recovery, which makes sense. There are, however, some dissimilarities between the results of the networks as well. For example, illegal construction during the peak period of the recovery (B38) was recognized as one of the least important barriers according to the literature-based network, while the other network recognized this as a prominent one. This may be due to the essence of the papers selected for review that discussed this barrier less than the others; thus, adding more number of papers to the literature-based network and distributing the survey to more individuals to collect more data could be helpful to achieving more reliable results.

Obviously, from Figure 7.1, there are similarities between the normalized degrees of centralities of most of the barriers. The highest values for the literature-based network were related to B1, B27, B28, and B21; while for the survey-based network, the highest ones were B1, B14, B26, B28, and. B85. Figure 7.2 demonstrates the difference between the normalized degrees of centralities of all of the barriers in both of the networks. The greatest gaps were seen among B38, B39, and B26.

Table 7.1. Detailed Results of the Social Network Analysis

ID	PDRB	Normalized Degree of Centrality		
		Literature-based Network	Survey-Based Network	Difference
B1	Average household income	0.827	0.881	0.054
B2	Number of available active contractors after a disaster	0.804	0.793	-0.011
B3	Unemployment levels	0.669	0.948	0.279
B4	Average housing value	0.821	0.812	-0.009
B5	Average lost household income	0.806	0.692	-0.115
B6	Average revenue of the local government (e.g., City, etc.)	0.868	0.765	-0.102
B7	Average lost business income	0.818	0.899	0.081
B8	Diversity in types of industry or employment sectors	0.845	0.951	0.106
B9	Number of active small businesses after the disaster (e.g., food providers)	0.838	0.955	0.118
B10	Voluntary public participation in the recovery process	0.855	0.779	-0.076
B11	Average education level of residents	0.841	0.867	0.026
B12	Availability of medical services after the disaster	1.000	1.000	0.000
B13	Availability of disaster recovery public training	0.849	0.876	0.027
B14	Family or friends who can help financially	0.802	0.996	0.194
B15	Family or friends who can help emotionally	0.865	0.867	0.002
B16	A community that looks out for each other	0.814	0.964	0.150
B17	Population density	0.828	0.821	-0.007
B18	Timely debris and erosion removal after the disaster	0.770	0.908	0.139
B19	Timely resolution of air and water quality issues after the disaster	0.849	0.950	0.101
B20	Environmental harm that affects industry, such as lost natural resources that reduce fishing or tourism	0.695	0.941	0.246
B21	Environmental contamination, such as reduced water and air quality	0.910	0.927	0.017
B22	Damage to residential housing	0.692	0.936	0.244
B23	Damage to high-rise buildings	0.758	0.950	0.192
B24	Damage to medical services, like hospitals	0.779	0.904	0.125
B25	Improving community infrastructure	0.727	0.922	0.195
B26	Damage to major infrastructure systems (e.g., airports, bridges, etc.)	0.695	0.991	0.296
B27	Highway traffic volume after the disaster	0.916	0.968	0.052
B28	Lack of consultation with community for recovery policymaking	0.916	0.975	0.059
B29	Poor coordination between federal and state agency recovery programs	0.744	0.953	0.209
B30	Weakness of pre-existing legislation pertaining to post-disaster recovery	0.803	0.882	0.079
B31	Inappropriate governmental system and organization for recovery	0.745	0.922	0.177
B32	Lack of proper coordination among administrative officers in provinces, districts, and sub-districts; NGOs; and volunteers	0.870	0.770	-0.100
B33	Slow and unorganized mass relocation in recovery process	0.811	0.692	-0.120

ID	PDRB	Normalized Degree of Centrality		
		Literature-based Network	Survey-Based Network	Difference
B34	Relocation from the impacted area to insufficient areas in order to receive temporary government-sponsored housing	0.775	0.905	0.130
B35	Inadequate installed infrastructures to be used in recovery process	0.852	0.881	0.029
B36	Inappropriate infrastructure maintenance policies leading to more vulnerable infrastructures and malfunctioning in recovery process	0.798	0.904	0.105
B37	Policies developed to destroy structures that do not comply with zoning regulations	0.659	0.950	0.291
B38	Illegal construction during peak period of the recovery	0.584	0.976	0.393
B39	Lack of controlling legislation for post-disaster blight	0.616	0.964	0.348
B40	Improper land use determination for rebuilding in high-hazard areas	0.687	0.929	0.242
B41	Improper urbanization rules	0.808	0.899	0.091
B42	Policies developed to change land uses that do not comply with zoning regulations	0.884	1.000	0.116
B43	Weakness of the legislation pertaining to unplanned and unauthorized settlements in urban and rural areas	0.822	0.950	0.128
B44	Lack of policies pertaining to neighborhood redevelopment when developing mega projects	0.970	0.904	-0.066
B45	Improper policies that instill fear and distrust of individuals in governmental organizations	0.939	0.975	0.036
B46	Weakness of the policymakers in encouraging people to perform prescribed actions for recovery	0.912	0.922	0.010
B47	Biased recovery service allocation for high-income people due to their ability to negotiate with the system	0.830	0.867	0.037
B48	Ignorance of land use and construction standards in reconstruction process	0.760	0.964	0.204
B49	Negligence of condition of low-income affected people in the regulations for recovery	0.938	0.950	0.012
B50	Weakness of policymakers in receiving public acceptance of legislation changes in the post-disaster condition	0.776	0.936	0.160
B51	Inappropriate federal and local assistance disbursement	0.878	0.881	0.003
B52	Lack of adequate information and awareness for recovery	0.815	0.964	0.149
B53	Weakness of the government in preparing high quality physical and technical assistance	0.837	0.948	0.111
B54	Lack of comprehensive resource database	0.436	0.692	0.256
B55	Inappropriate and uneven resourcing by the policymakers	0.969	0.996	0.027
B56	Inadequate local governments' capacity for producing materials for reconstruction	0.668	0.922	0.254
B57	Lack of list of potentially vulnerable and historic resources and structures	0.680	0.882	0.202
B58	Lack of qualified governmental personnel for damage inspections in post-disaster conditions	0.841	0.976	0.135
B59	Lack of local government resources to perform relocation smoothly	0.687	0.892	0.205
B60	Lack of specific post-disaster land development codes and standards	0.449	0.756	0.306
B61	Out-of-date standards and codes	0.574	0.636	0.062
B62	Lack of clear regulations and standards for repair and reconstruction of historic buildings	0.641	0.709	0.069
B63	Weakness in relocating minorities, elderly, and low-income homeowners	0.624	0.843	0.219

ID	PDRB	Normalized Degree of Centrality		
		Literature-based Network	Survey-Based Network	Difference
B64	Weakness of local governments in funding	0.806	0.895	0.089
B65	Delay in disbursement of emergency funds	0.712	0.899	0.187
B66	Lack of economic resources for recovery	0.813	0.723	-0.090
B67	Lack of long-term recovery funding programs	0.920	0.811	-0.110
B68	Policies which lead to income disparity and diversification of livelihoods	0.804	0.944	0.140
B69	Lack of legislation to enable immediate access to emergency capital (loans)	0.781	0.820	0.039
B70	Tough legislative criteria for low-income groups to obtain strong financial assistance	0.825	0.940	0.115
B71	Unavailability of Small Business Administration (SBA) loans to those with lower-than-average incomes	0.510	0.811	0.301
B72	Weakness or inability of housing providers and decision-makers to help the low-income class cope with post-disaster financial demands	0.505	0.908	0.403
B73	Not employing technical expertise in planning process	0.407	0.765	0.358
B74	Not considering the traditional technologies and materials in post-disaster construction techniques and standards	0.601	0.852	0.252
B75	Not considering the local comprehensive mandates while working for legislation	0.792	0.894	0.101
B76	Lack of clarity in roles and responsibilities for assistance	0.759	0.885	0.126
B77	Not considering sustainability in recovery planning	0.733	0.871	0.138
B78	Conflicts between local and federal government authorities pertaining to hazard mitigation and funding	0.936	0.880	-0.056
B79	Complexity of legislative consenting process for reconstruction	0.848	0.894	0.046
B80	Slow decision-making and lack of proactive approach in recovery process	0.828	0.848	0.020
B81	Lack of institutional post-disaster recovery planning and approach	0.819	0.866	0.047
B82	Lack of moratoria and temporary restrictions	0.722	0.935	0.214
B83	Lack of clarity of moratoria and temporary restrictions	0.891	0.912	0.022
B84	Lack of phase or triaged moratorium - specific to the type of permit, not generic	0.749	0.919	0.170
B85	Lack of considering emergency exemptions in environmental regulation development	0.951	0.964	0.013

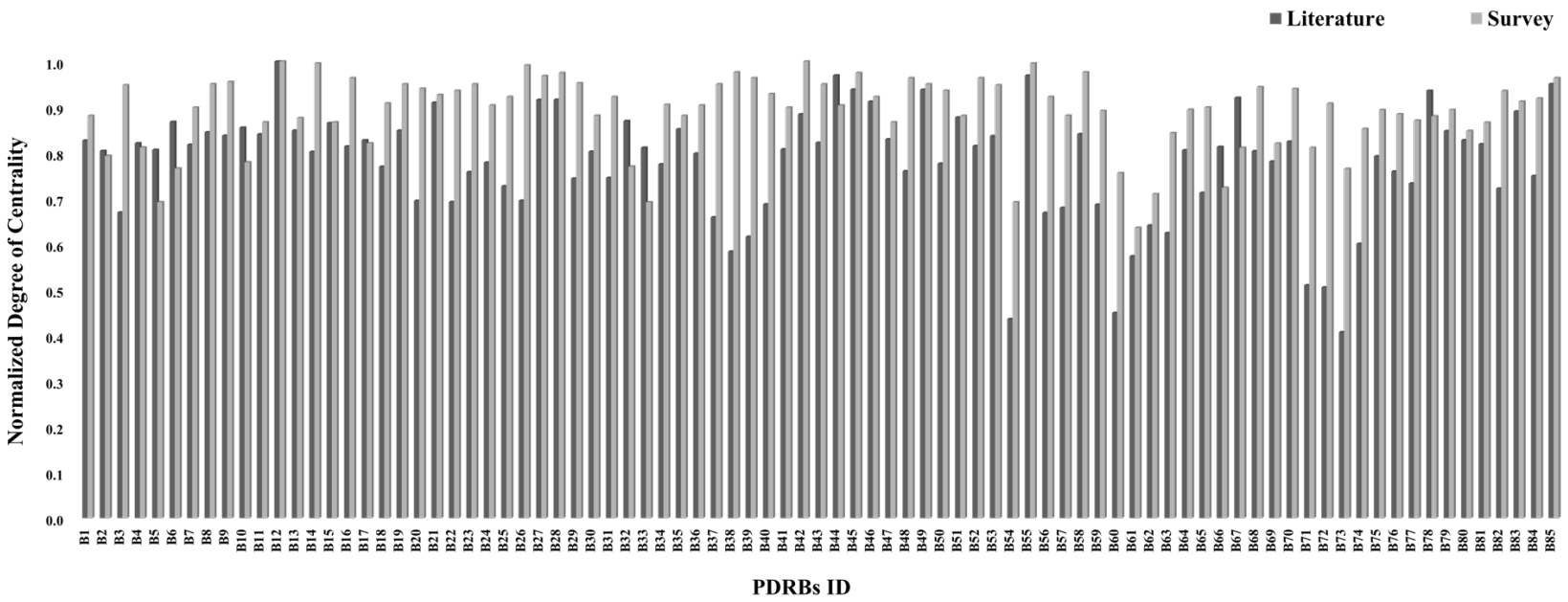


Figure 7.1. Comparison of the normalized degree of centrality of two networks

When logically analyzing the importance of the barriers, it becomes obvious that the survey-based analysis is more reliable than the literature-based one. In fact, even though the literature helps explain the importance of some of the barriers, it focuses on specific barriers, while ignoring others. In addition, for the same reason, the interconnectivity of less-considered barriers with the other barriers cannot be tracked via literature.

7.2. Develop Conceptual Model

A conceptual framework is presented in this section, based on the findings from the SNA. To develop a model that depicts the dynamic relations between different variables, the problem must first be determined. In this study, the problem was how the barriers to timely post-disaster recovery interact and affect each other. A causal diagram was established to represent the dynamic hypothesis of the model, showing the cause-effect relationships among the barriers, (Figure 7.3). The loop diagram shows the pathway through which the system works. The + and – symbols on the barriers show the direction of the impact. For example, when the supply of the material increases, the resource allocation of time increases as well, and vice versa. Thus, the speed of reconstruction increases, leading to a higher rate of recovery and fewer delays in the recovery process. As an another example, the speed of decision making, which itself is related to many other laws and planning, has an direct impact on the duration of recovery and can indirectly impact the resource allocation process, which itself influences the recovery rate. The proposed conceptual framework draws attention to the key PDRBs that affect a timely post-disaster recovery process, and summarizes the relationships identified through the SNA.

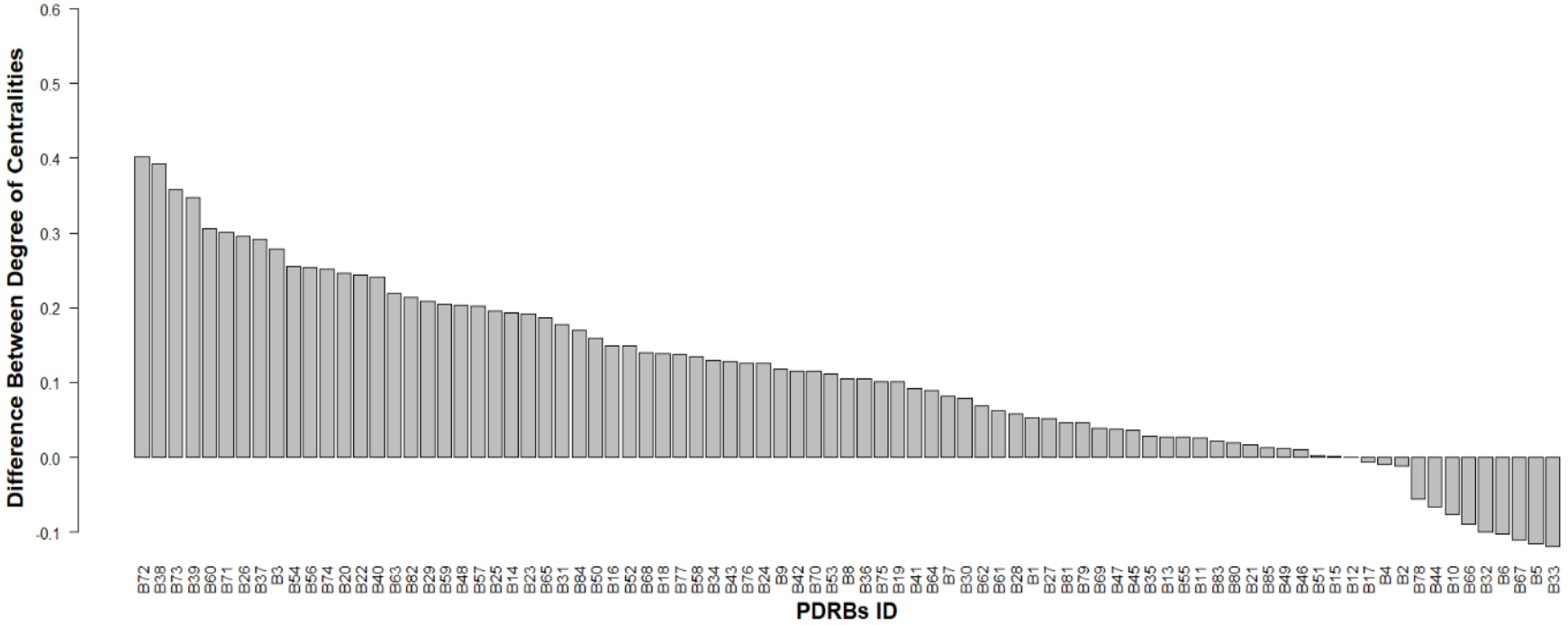


Figure 7.2. Difference between normalized degrees of centralities of the barriers

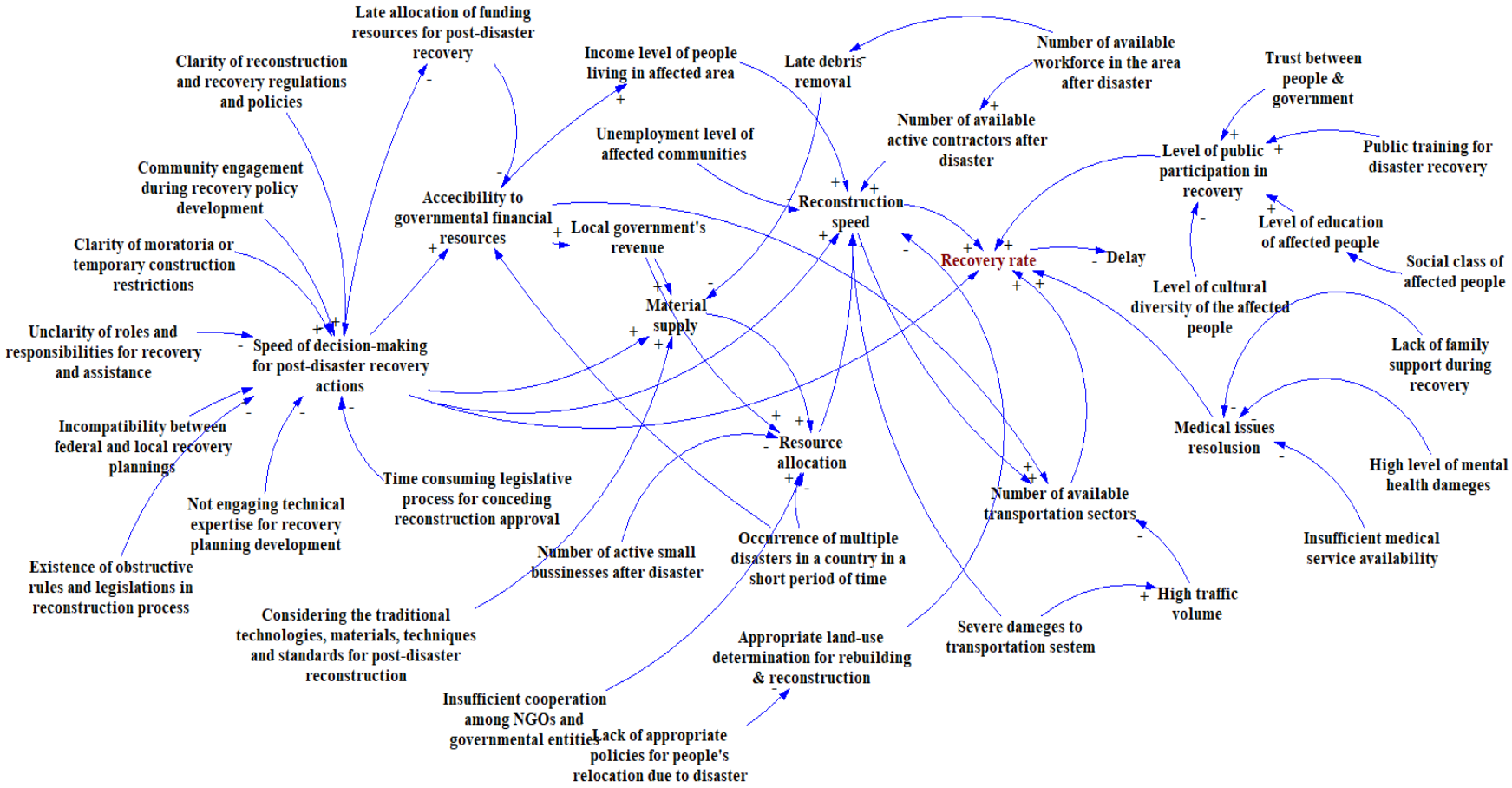


Figure 7.3. Conceptual dynamic relations among PDRBs

CONCLUSIONS AND RECOMMENDATIONS

8.1. Conclusions

Every community should have a prioritized list of sectors to focus on immediately after a disaster so that they can begin the recovery process as soon as possible. This research project strived to advance insight into post-disaster recovery by identifying, categorizing, weighting, and modeling the PDRBs to the timeliness of a long-term, post-disaster recovery process. Through a comprehensive literature review, including studying over 300 scholarly papers, eighty-five (85) PDRBs were identified and placed in one of five categories: economic, social, environmental, infrastructure and transportation, and policy and legal. According to the prominence of policy and legal PDRBs, this category was classified into seven sub-categories: coordination, construction and infrastructure, location, social and community participation, resources and documentation, finance and economic, and approach and attitude.

The PDRBs were weighted and prioritized, using qualitative and quantitative analyses, and a causality model was developed, showing the conceptual relationships and interactions among the PDRBs. The adoption of appropriate policies plays a vital role in returning to a normal state after a disaster. Thus, practical recommendations were presented to lessen the negative effects of the legal and policy PDRBs on timely post-disaster recovery, based on the lessons learned from previous disasters and by interpreting the issues that arose from the policies and planning. Some of the recommendations were related to the pre-disaster period, and some to the post-disaster period.

The results show that the literature can aid in understanding the importance of the barriers to post-disaster recovery, but its usefulness is limited because most of the researches concentrate on specific barriers and ignore others. Furthermore, the interconnectivity of PDRBs was the subject of less focus in the literature, and cannot be tracked via the literature. In addition, the cause-effect relationships between the most important barriers were determined conceptually, showing the positive and negative impacts, and most of the policy and legislation PDRBs relate to the pre-disaster time.

This research will help policymakers achieve sustainable disaster recovery by providing valuable knowledge for evaluation of the PDRBs. In addition, the results of this research will assist decision-makers in prioritizing their plans in case of disaster occurrence.

8.2. Limitations

In the process of conducting this study, there were some limitations that restricted the procedure to some extent. Finding qualified experts and getting them to consent to participate in this study was difficult and time consuming, and resulted in only 39 responses to the survey sent to the experts. In addition, some of the survey-takers, specifically the public, did not answer all of the questions of the survey, which left the database with missing data. Furthermore, because of the lack of mention of policy and legal PDRBs in the literature, a lot of research and analysis was required to compose a comprehensive list of them.

8.3. Future Research

In order to make improvements in the areas where lack of research was detected, and according to the findings of this research, the authors feel that it is important to provide future research directions. Due to the limited number of researches in the area of transportation and transportation barriers, more focus on this topic is required. Other techniques for weighting and ranking the PDRBs should be tested, and in-person interviews with experts should be conducted to validate the research findings. In addition, best practices for managing and controlling the PDRBs can be taken under consideration by scholars in this area, and measurement of the effectiveness of the presented strategies is suggested.

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APPENDICES

Appendix I: E-mail Content Sent to the Participants

Greetings,

You are receiving this letter because we are hoping that you will help us with a very important project. We are conducting a study to better understand barriers to post-disaster recovery and would like to ask you to participate in an online survey. Your expertise and feedback would be valuable as we work to identify current obstacles to help improve recovery efforts. The sponsors of this project are the U.S. Department of Transportation (USDOT) and The Center for Transportation, Equity, Decisions, and Dollars (C-TEDD).

Your participation is voluntary, and your responses to the survey will be kept strictly confidential. If you have any questions or concerns about the study, please feel free to E-mail the Principal Investigator Sharareh Kermanshachi at sharareh.kermanshachi@uta.edu. Any questions you may have about your rights as a research subject may be directed to the Office of Research Administration; Regulatory Services at 817-272-2105 or regulatoryservices@uta.edu.

We hope that you will take the time to answer the questions and return the results to us. Completing the survey should take no longer than ten minutes. Thank you in advance for your help with this valuable study. To begin the survey, please click on the link below.

https://uta.qualtrics.com/jfe/form/SV_72Lizcna9p3ILFr

Appendix II: Survey

.

We are conducting a short, confidential survey of how people and communities recover and rebuild from disasters. The purpose of this study is to identify the barrier factors to the rapid post-disaster reconstruction. The procedures you will follow as a research subject are: 1) To read this paragraph explaining the study, and if you agree to participate, clicking "Next"; 2) To complete several survey questions about your experience with disasters and your opinions about disaster recovery efforts. There are no perceived risks or direct benefits for participating in this study. There are no alternatives to this research project, but you may quit at any time. You must be at least 18 years old to participate.

The sponsors of this project are the U.S. Department of Transportation (USDOT) and The Center for Transportation, Equity, Decisions, and Dollars (C-TEDD).

Any identifiable information will be kept confidential with access limited to the research team. We may publish, present, or share the results, but your name will not be used. For questions or concerns, contact the UTA Research Office at 817-272-3723 or regulatoryservices@uta.edu.

It will take about 10 minutes to participate in this research, and your participation is completely voluntary.

Please click the "Next" button below if you agree to take the survey and are ready to proceed.

NEXT

Q1. What types of disasters have you been involved in? Please check all that apply.

- ☐ Hurricanes
- ☐ Flooding
- ☐ Thunderstorms
- ☐ Tornadoes
- ☐ Earthquakes
- ☐ Tsunami
- ☐ Other

Q2. Approximately how many disasters have you been involved in?

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ More than 5

Done

Q3. How would you rate the severity of the worst disaster you have experienced?

	Very low	Low	Medium	High	Very high
Disaster Severity	○	○	○	○	○

PREVIOUS NEXT

Q4. Thinking again of the worst disaster you experienced, where did it occur?

- Africa
- North America
- South America
- Asia
- Europe
- Australia

Q5. For this worst disaster, how long did the recovery process take?

- Less than one month
- 1-3 months
- 4-6 months
- 7-10 months
- 11-12 months
- More than one year

PREVIOUS NEXT

Q6.

Thank you for your time so far. Now we are going to ask you some questions about the importance of several community features, which might affect disaster recovery. How important do you think each of the following factors is in influencing an area to recover from a disaster?

	Not at all Important 1	Slightly Important 2	Somewhat Important 3	Moderately Important 4	Very Important 5	Quite Important 6	Extremely Important 7
Average household income	○	○	○	○	○	○	○
Unemployment levels	○	○	○	○	○	○	○
Average revenue of the local government (e.g., City, etc.)	○	○	○	○	○	○	○
Average housing value	○	○	○	○	○	○	○
Diversity in types of industry or employment sectors	○	○	○	○	○	○	○
Average education level of residents	○	○	○	○	○	○	○
Highway traffic volume after the disaster	○	○	○	○	○	○	○
Population density	○	○	○	○	○	○	○
Occurrence of multiple disasters in a country in a short period of time	○	○	○	○	○	○	○

PREVIOUS NEXT

Q7.
What types of disaster damages do you think make the recovery process especially difficult or slow?

	Not at all Important 1	Slightly Important 2	Somewhat Important 3	Moderately Important 4	Very Important 5	Quite Important 6	Extremely Important 7
Average lost household income	○	○	○	○	○	○	○
Average lost business income	○	○	○	○	○	○	○
Damage to major infrastructure systems (e.g., airport, bridge, etc.)	○	○	○	○	○	○	○
Damage to high-rise buildings	○	○	○	○	○	○	○
Damage to medical services, like hospitals	○	○	○	○	○	○	○
Damage to residential housing	○	○	○	○	○	○	○
Environmental contamination, such as reduced water and air quality	○	○	○	○	○	○	○
Environmental harm that affects industry, such as lost natural resources that reduce fishing or tourism	○	○	○	○	○	○	○

PREVIOUS NEXT

Q8.
What factors do you think are most important to improve the disaster recovery process?

	Not at all Important 1	Slightly Important 2	Somewhat Important 3	Moderately Important 4	Very Important 5	Quite Important 6	Extremely Important 7
Number of available active contractors after a disaster	○	○	○	○	○	○	○
Number of active small businesses after the disaster (e.g., food providers)	○	○	○	○	○	○	○
Voluntary public participation in the recovery process	○	○	○	○	○	○	○
Availability of medical services after the disaster	○	○	○	○	○	○	○
Availability of disaster recovery public training	○	○	○	○	○	○	○
Timely debris and erosion removal after the disaster	○	○	○	○	○	○	○
Timely resolution of air and water quality issues after the disaster	○	○	○	○	○	○	○

PREVIOUS NEXT

Q9. What policies do you think are important to an effective disaster recovery process?

	Not at all Important 1	Slightly Important 2	Somewhat Important 3	Moderately Important 4	Very Important 5	Quite Important 6	Extremely Important 7
Community engagement during recovery policy development	○	○	○	○	○	○	○
Compatibility between federal and local recovery plannings	○	○	○	○	○	○	○
Appropriate land-use determination for rebuilding and reconstruction	○	○	○	○	○	○	○
Appropriate resource and service allocation and disbursement	○	○	○	○	○	○	○
Clarity of reconstruction and recovery regulations and policies	○	○	○	○	○	○	○
Level of accessibility to governmental resources for short-term response	○	○	○	○	○	○	○
Level of accessibility to governmental resources for long-term reconstruction	○	○	○	○	○	○	○
Cooperation among NGOs and governmental entities	○	○	○	○	○	○	○
Speed of decision-making for post-disaster recovery actions	○	○	○	○	○	○	○
Technical expertise engagement for recovery planning development	○	○	○	○	○	○	○
Consideration of the traditional technologies, materials, techniques and standards for post-disaster reconstruction	○	○	○	○	○	○	○
Clarity of roles and responsibilities for recovery and assistance	○	○	○	○	○	○	○
Clarity of moratoria or temporary construction restrictions	○	○	○	○	○	○	○
Investing in natural buffers, such as coastal wetlands to prevent storm surges.	○	○	○	○	○	○	○

PREVIOUS NEXT

Q10. What barriers do you think slow the disaster recovery process?

	Not at all Important 1	Slightly Important 2	Somewhat Important 3	Moderately Important 4	Very Important 5	Quite Important 6	Extremely Important 7
Lack of appropriate policies for people's relocation due to disaster	○	○	○	○	○	○	○
Illegal construction during peak period of the recovery	○	○	○	○	○	○	○
Late allocation of funding resources for post-disaster recovery	○	○	○	○	○	○	○
Inequality in resource distribution	○	○	○	○	○	○	○
Barriers in the legislative process for conceding reconstruction approval	○	○	○	○	○	○	○

PREVIOUS NEXT

Q11. How important is it for people affected by a disaster to have the following?

	Not at all Important 1	Slightly Important 2	Somewhat Important 3	Moderately Important 4	Very Important 5	Quite Important 6	Extremely Important 7
Family or friends who can help them financially	○	○	○	○	○	○	○
Family or friends who can help them emotionally	○	○	○	○	○	○	○
A community that looks out for each other	○	○	○	○	○	○	○

PREVIOUS NEXT

Q12. Are there any other factors or strategies that you think are particularly effective for facilitating the disaster recovery process?

Q13. Are there any other barriers that are especially hinder the disaster recovery process?

PREVIOUS NEXT

Q14. Some studies have shown that environmental factors, such as forest cover to reduce landslides or coastal wetlands to reduce storm surges, can lessen the severity of disaster impacts. Please answer the following question about the importance of environmental factors in timely disaster recovery.

	Not at all Important 1	Slightly Important 2	Somewhat Important 3	Moderately Important 4	Very Important 5	Quite Important 6	Extremely Important 7
How important are environmental factors in timely disaster recovery, relative to other concerns, like improving community infrastructure?	○	○	○	○	○	○	○

PREVIOUS NEXT

Q15. What title best describes your current occupation?

- Engineer
- Project manager
- City official or staff
- Student
- Other

Done

Q16. What is your year of birth?

Q17. What is the highest level of school you have completed or the highest degree you have received?

- Less than high school degree
- High school graduate (high school diploma or equivalent including GED)
- Some college but no degree
- Associate degree in college (2-year)
- Bachelor's degree in college (4-year)
- Master's degree
- Doctoral degree
- Professional degree (JD, MD)

Q18. What is your sex?

- ○ Male
- ○ Female

Q19.
Choose one or more races that you consider yourself to be:

- ☐ White
- ☐ Black or African American
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Native Hawaiian or Pacific Islander
- ☐ Other

Done

Q20. Are you Spanish, Hispanic, or Latino or none of these?

- ○ Yes
- ○ None of these

PREVIOUS NEXT

Q21. Thank you for your participation! For questions or concerns about the study, you may contact the Principal Investigator Dr. Sharareh Kermanshachi at sharareh.kermanshachi@uta.edu. Any questions you may have about your rights as a research subject may be directed to the Office of Research Administration; Regulatory Services at 817-272-2105 or regulatoryservices@uta.edu.

If you have any comments, additional thoughts or would like to clarify any of your answer choices, you are welcome to do so below. Thanks again!

PREVIOUS NEXT

We thank you for your time spent taking this survey.
Your response has been recorded.

CENTER FOR TRANSPORTATION EQUITY, DECISIONS & DOLLARS

The **Center for Transportation, Equity, Decisions and Dollars (CTEDD)** is a USDOT University Transportation Center, leading **transportation policy research** that aids in **decision making** and **improves economic development** through **more efficient, and cost-effective use of existing transportation systems**, and offers **better access to jobs and opportunities**. We are leading a larger consortium of universities focused on **providing outreach** and **research to policy makers**, through **innovative methods** and **educating future leaders of the transportation field.**

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