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# Sources of Organizational Resilience for Sustainable Communities: An Institutional Collective Action Perspective

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**Abstract:** Scholars in the field of sustainability have often argued that the purpose of establishing and maintaining interorganizational collaboration is to overcome internal limitations of organizations and to strengthen organizational capacity. To examine structural effects of inter-organizational collaboration regarding the ability of networked organizations to effectively manage disasters, this study uses an institutional collective action framework to design a critical lens to objectively analyze collective action issues in inter-organizational collaboration networks. Results, based on the Heckman selection model with two stages, provide evidence that networked organizations holding a central position between two other actors perceive a higher level of disaster resilience. The finding implies that local organizations with a bridging strategy can enhance their capacity to recover from a catastrophic event by securing access to critical resources and information through comprehensive emergency preparedness such as joint response and recovery planning.

**Keywords:** sustainable communities; organizational resilience; self-organized collaborative network; Heckman selection model with two stages

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## 1. Introduction

Scholars in the field of sustainability often argue that the purpose of establishing and maintaining inter-organizational collaboration is to overcome internal limitations of organizations and to strengthen organizational capacity [1,2]. It is assumed that working together allows organizations to build joint capacity and minimize the impact of unexpected catastrophic events, which increases their ability to recover and return to normalcy [3]. Quarantelli, Lagadec, and Boin (2006), for example, emphasize that inter-organizational collaboration has become an indispensable part of sustainability due to the nature of disasters [4]. Drabek and McEntire (2002) also indicate that because effective and timely resource coordination for response operations is often problematic, multi-organizational collaboration across sectors provides clues to effectively managing organizational capacity [5]. As Phillips, Neal, and Webb (2012) highlighted, developing inter-organizational partnerships among sectors under all aspects of emergency management should be a top priority for building viable sustainable communities [6].

To examine the effect of organizational collaboration on the ability of an organization to effectively manage disasters, this study used the institutional collective action (ICA) framework, which enabled analysis of collective action issues embedded in inter-organizational collaboration [7,8]. An empirical analysis to test sources of organizational resilience is presented in the section on research site, data, and methods. The results, based on the Heckman selection model, provide evidence for the general argument that organizations holding a central position between two other actors perceive a higher level of organizational resilience, thus supporting the bridging hypothesis. The finding implies that organizations with a bridging strategy can enhance their capacity to recover from a catastrophic event by securing access to critical resources and information in an effective and timely manner. It is also

argued that sources of organizational resilience can be acquired through comprehensive emergency preparedness and hazards mitigation processes such as joint response and recovery planning.

This study is organized in the following manner. The next section defines the concept of resilience before discussing theoretical framework to determine factors explaining organizational resilience. The third section presents research design, data collection procedures, and methods of analysis. The final section provides the conclusion.

## 2. Theoretical Consideration

### 2.1. Organizational Resilience

In emergency management, the concept of resilience can be understood as “bouncing back from disastrous events” [9,10]. The concept includes the capacity to plan and ability to respond to threats of disasters. Cox and Perry defined the concept as “the capability of a community to face a threat, survive and bounce back or, perhaps more accurately, bounce forward into a normalcy newly defined by the disaster related to losses and changes” [11]. The NRC (2010) added and explained resilience as a continuous capacity of communities to manage their resources during and after disasters [12].

Currently, there are two dominant theoretical approaches to studying resilience. The first approach frames issues as social-ecological systems, and the second one relies considerably on institutions and governance derived from social science disciplines (i.e., psychology, anthropology, political science, and urban politics) that generally view resilience in terms of rules permitting and constraining social interaction. Both approaches view resilience as either a set of attributes assisting a community to cope with disaster or an outcome reflecting the ability of a community to recover from external shock.

A social-ecological system approach reflects various aspects of ecological systems. It is among the first perspectives to dismiss the concept that there is a pristine ecosystem and the goal of management should be to restore systems so the ecosystem can return to its previous condition [13,14]. Berkes, et al. (2003) provided a shift in perspective on resilience: from a pristine ecosystem approach to a social-ecological system perspective [15].

An institutions and management perspective, on the other hand, adopts an institutions and governance perspective to cull various factors promoting resilience. In this approach, the concept of institutions is defined as rules structuring interaction among organizations as a set of agents, and governance refers to various forms of institutions and inter-organizational structures that shape the process responsible for action and inaction (i.e., processes facilitating decisions and actions that are taken by organizations) [16,17]. Based on these perspectives, several lines of research can be identified (i.e., social vulnerability, social capital, social support and engagement, and grass-root participation in disaster planning).

In this study, the term “organizational resilience” is defined as an actual or potential public resources improvement capability of an organization with a strong willingness to manage emergency events to enable recovering to its original condition. Examining resilience at the organizational level is critical because organizations tend to work together in minimizing operational disruptions and coordinate critical resources across administrative boundaries to aid local communities [18]. The definition implies that inter-organizational collaboration enables organizations to assist others during disasters and, at the same time, perform core functions and manage disasters. Consistent with the ICA framework, the conceptual definition also suggests that collaboration and the ability of organizations to manage disasters depend on the strong willingness of individual organizations to internalize coordination costs contributing to organizational cohesiveness in emergency response [19,20]. It is assumed that organizational cohesiveness demands individual organizations to prepare for disasters as a collective to effectively minimize operational disruption.

There are examples where local governments redirected evacuees away from their jurisdiction rather than assume responsibility for assisting evacuees. Tierney, Lindell, and Perry (2001), for example, assert that local governments are likely to neglect residents of a catastrophic event because of functional

failures resulting from deficiencies in resource mobilization and risk communication. As Brunnsma, Overfelt, and Picou (2007) emphasized, persistent inequities of cities as well as suburban areas in New Orleans were revealed to scholars and practitioners [21]. Hurricane Katrina overwhelmed the internal capacity of New Orleans, and therefore the government terminated efforts to protect victims and residents. As a result, even neighboring municipalities such as the Crescent and Gretna rejected refugees from New Orleans at gunpoint in the aftermath of Katrina [14]. In the aftermath of a catastrophic event, small cities in the U.S. that did not have adequate resources, could not assist evacuees from neighboring cities.

Other examples can also be found internationally. After the devastating Japan earthquake in 2010 for example, local governments were overwhelmed and therefore relinquished efforts to assist victims from other communities [22]. This reluctance to assist others is not uncommon. That is because of a failure to build prior commitments and shared arrangements to jointly respond effectively and in a timely manner to disasters [23,24].

## 2.2. Institutional Collective Action Framework

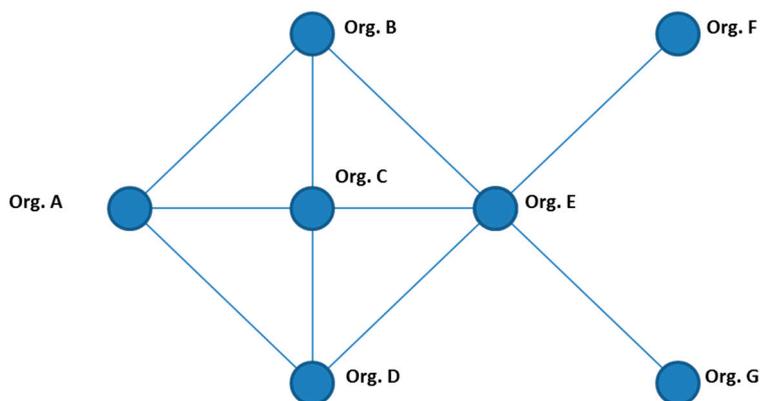
The institutional Collective Action (ICA) framework was built on actor-centered preference integration and the Institutional Analysis and Development (IAD) framework introduced by Ostrom [25,26]. However, the IAD framework considers joint agreement or composite action grounded on individuals' rationality; it has limitations if applied to collective action at the organizational level. The ICA framework uses similar logic if examining fragmented authority among multiple government units and collective action dilemma at the local or institutional level. In the institutional collective action dilemma, each organization is assumed to conduct risk assessment. They also have incentives if they participate in response and planning. Also, organizations may encounter high transaction costs exacerbating ICA dilemma [25].

The ICA framework provides four general guidelines to understand collective action dilemma: (1) nature of the dilemma, (2) authorities directly or indirectly involved in the policy arena, (3) potential risks linked with action and inaction, and (4) incentives explaining the motivation of actors [25]. First, the nature of the dilemma from collective action literature is to identify a collective action issue embedded in inter-organizational collaboration in which individual incentives of organizations may lead to inappropriate collective outcomes not desired by individuals [25,26]. Second, authorities directly or indirectly involved in the policy arena focus on established tools and goals by collective decisions including all participants, who are involved in ICA dilemma (Williamson, 1985; Feiock, 2013). Third, potential risks and uncertainty derived from action and inaction is closely linked to transaction costs involved in a spillover effect among control, efficiency, political representation, and self-determination of organizations [7,8]. Last, incentives for the motivation of organizations indicate systematic means, e.g., regulations and monitoring mechanisms, to resolve ICA dilemma by considering barriers that prevent authorities from achieving coordinated decisions [25,27].

From the ICA framework, collaboration and the ability to effectively manage disasters depend on the willingness of individual organizations to internalize coordination costs contributing to organizational cohesiveness in emergency response [3,20]. Organizational cohesiveness demands that individual organizations must prepare for disasters as a collective to minimize operational disruptions. While collaboration in emergency management is often perceived as a "good thing", equally puzzling is the motivation of organizations to collaborate despite potential hardship in acquiring resources during disasters and functioning effectively after disasters. But, the question remains: "with whom" do they collaborate to improve the likelihood of recovering from devastation caused by disasters? To enhance the level of resilience, an organization could position itself to collaborate with a central actor to gain access to information and resources not available locally (bridging); it could also work closely with other organizations that are closely linked with each other to pool and share redundant resources (bonding). If such a strategy would generate tangible outcomes is not well understood, however.

### 2.3. Structural Effects on Organizational Resilience

Before presenting the general hypotheses about the effects of inter-organizational collaboration on the resilience of an organization, this study presents a hypothetical network structure representing inter-organizational collaboration (see Figure 1). Following Andrew and Carr (2013), the network structure has seven organizations with a total of 10 links. The connections are defined as inter-organizational collaboration [20].



**Figure 1.** Hypothetical Network Structure.

According to the bonding effect, organization C has a high level of organizational resilience. On the other hand, according to the bridging effect, organization E has a higher level of organizational resilience (*discussed further below*). An organization's social position is conceptualized to have a high closeness score if the organization has the most number of connections with organizations that also are closely connected. On the other hand, an organization with the highest betweenness score is one that is positioned with the shortest path between any two other actors within a network [28,29]. Based on the hypothetical network structure, organization C has the highest closeness score while organization E has the highest betweenness score.

**Bonding Effects.** Organizational collaboration embedded in a bonding structure can enhance organizational resilience for several reasons: First, it provides individual organizations with associated benefits, which can increase inter-organizational trust, sharing of resources, and transmission of reliable information [20,30]. Second, the advantages of being part of a closely knit group can be realized through building organizational credibility and reputation. This is because if there is a strong sense of commitment, obligation, and duty, the ICA framework predicts that an organization is likely to avoid behaving contrary to the expectation of group norms. An organization can also minimize the risk of not receiving assistance if the bonding structure is expected to provide mutual support. For example, the organization that provides assistance can expect similar assistance from others, which increases its ability to manage, recover, and return to normalcy after disasters [18].

In emergency management literature, inter-organizational cohesion provides frequent interaction and facilitates trust by sharing operational cognition [31]. The bonding effect strategy leads to a close-knit structure of organizations engaged in emergency management [5,32]. Owen (1985) also reveals that the stronger the sense of community, the more social cohesion, which generates interlocal cooperation and participation [33]. According to Vasavada (2013), who studied a structure of networks after the Gujarat earthquake of 2001 in India, leading organizations in a densely clustered structure are most effective in achieving network-level outcomes [34]. This is because a high density of trust among various types of organizations can be produced through a close-knit structure. A similar conclusion was made by Sylves (2008), who asserts that inter-organizational agreements for sharing resources facilitated local organizations to effectively respond to and recover from a disaster [35]. Therefore, this study hypothesizes that:

**Hypothesis 1.** *Organizations closely linked to other actors in a network have a higher perception on the level of organizational resilience.*

*Bridging Effects.* The bridging effect presents a different perspective on sources of organizational resilience. First, an organization positioned as a “gatekeeper” or a bridge between unconnected organizations is better positioned to coordinate and distribute resources such as key personnel and equipment. This organization is assumed to have better access to reliable information in to facilitate coordination of joint activities [20,28,36]. Second, from the ICA framework, being centrally positioned not only provides the organization with an opportunity to gain access to information and resources, but also the ability to minimize the possibility of organizational failure. Even though the organization can establish formal arrangements to share and coordinate resources, the organization seldom can specify outcomes of the agreement without incurring substantial transaction costs in crafting and enforcing the agreement [18]. Subsequently, organizational resilience can be enhanced because the organization acts strategically by establishing relations with those outside its circle.

The bridging effect can be found in several examples. In the U.S., for example, the nature of a disaster is such that it requires organizations to interact with the central actor such as state-level agencies and the regional headquarter of the Federal Emergency Management Agency (FEMA). The structure is purposely designed to coordinate critical information and resources [5,24]. Building bridges across different levels of government results in a “spider-web” emergency structure and if this coordination is effectively facilitated, it can boost organizational resilience. For example, Quarantelli, Lagadec, and Boin (2006) argues that structural bridges play a significant role in mitigating hazards and responding to modern disasters faced by organizations [4]. The structure may arise because of administrative mandates imposed by upper levels of government through grants, financial aid, and/or programs [37]. The central “hub” is assumed to have the ability to coordinate tasks and activities, and therefore produce an effective way to enhance organizational resilience. Therefore, this study hypothesizes that:

**Hypothesis 2.** *Organizations positioned as a central actor in a network have perceived a higher level of organizational resilience.*

*Previous Interaction Effects.* A commitment to participate in emergency management exercises can enhance organizational resilience for the following reasons: First, pre-established mutual agreements for providing resources allows organizations to make connections prior to disasters [3,19]. The emphasis is on the development of shared goals leading to a reduction in coordination costs. Comfort (2007) contends that interactions accelerate the possibility of building a common cognitive management system [31].

Second, scholars in the emergency management field also suggest that emergency table-top exercises and drills signal the credibility of an organization to build trust for sharing resources [38–40]. Before a disaster, emergency exercises involving core organizations provides opportunities to learn from experience. Previous experience and frequency of interaction allow organizations to effectively coordinate and mobilize their resources during emergency response operations [41]. For example, emergency medicine residency programs in the U.S. highlight the benefits that stem from participating in high-quality medical disaster exercises within the time of disaster response [42]. Kapucu, Arslan, and Demiroz (2010) also point out that frequent interaction through emergency exercises before a disaster contributes to strengthening response capabilities and enhancing organizational resilience [43]. Therefore, this study hypothesizes that:

**Hypothesis 3.** *Organizations with previous interaction during emergency exercises have a higher level of organizational resilience.*

#### 2.4. Emergency Management in South Korea

This empirical study examined within the component of emergency preparedness, the pattern of inter-organizational collaboration in South Korea. Currently, the National Emergency Management Agency (NEMA) is the central agency responsible for developing and coordinating a comprehensive emergency management system. Established in 2004, NEMA is authorized by the Basic Act on Emergency and Safety Management (2004) to implement and develop a national emergency management system that is comprehensive, risk-based, and adopts an all-hazards approach [44].

However, the national emergency management system has been criticized on several grounds. For example, public agencies at the national level are assumed to play the leading role and provide directives to lower level governments, without considering local preferences. They devote more attention to emergency response rather than mitigation and preparedness. According to Jung and Song (2015), the national government is only ready to act if human error or technological hazards cause disasters rather than natural disasters [19]. The national legislation and public programs focus on vertical networks rather than horizontal relations. Therefore, little is done to encourage inter-organizational collaboration across non-governmental, business, and local community-based organizations [3,19].

At the regional level, the pattern of inter-organizational collaboration, arguably, had been influenced much by the country's bureaucratic norms and structure. At the provincial level, for example, regional governments function as an intermediary role between the national and local governments. The intermediary function is not only providing necessary information from localities to NEMA for assistance and emergency aids, but also certifies local emergency operations plans. The plans must be consistent with the provincial government's emergency operations plan. During disaster response, the emergency operations headquarters at the provincial level would coordinate activities between the Central Emergency and Safety Operations Headquarter (CESOP) and localities' emergency operations centers. The provincial government would also coordinate joint response if local governments are overwhelmed by disaster response and, within their respective jurisdiction, could provide directives to local governments.

There is evidence of inter-organizational collaboration at the municipal level. Administrative responsibilities in emergency response are supplemented by local efforts, i.e., formal agreements are established across provincial or metropolitan political boundaries. For example, a bilateral agreement was established in August 2012 between Gangseo City in Busan and Geoje City. The formal agreement was on the development of preparedness and response plans related to emergencies on Geoga-Busan's bridge-tunnel fixed links. Such an agreement was not common in the southeastern region of the Korean peninsula. Another example is a bilateral agreement between Yangsan (city) and the Busan Meteorological Agency concluded in April 2008 with a joint meteorological observation agreement. A multi-lateral agreement has also been established between municipal governments. On August 2010, for example, an agreement was formed between 14 local governments in Busan and the South Gyeongsang province concerning emergencies related to floods caused by the Nakdong River. In emergency management, local governments also established agreements with non-governmental organizations such as the Busan Volunteers Center and the regional branch of an NGO Living Good Movement in Busan.

The nature of inter-organizational collaboration is also consistent with observations in the field. For example, since the introduction of the Local Autonomy Act (1990/1994/1995/1989) and the Local Finance Act (1988) as well as the passage of the Devolution Promotion Act in 1999, there have been a growing number of NGOs established at the local level. Although the national government still plays a significant role in guiding local affairs, as local autonomy expands to include public programs and services, local governments are increasingly coordinating services with community-based organizations and NGOs. An increasing importance of locality-NGO relations has been documented elsewhere. But, more importantly, the concern for civil society has mobilized local leaders and communities to self-organize and pursue a greater local autonomy.

The next section examines the pattern of emergency management practices in South Korea. Although collaboration can enhance the likelihood and scope of regional integration, patterns of inter-organizational collaboration in South Korea are still understudied.

### 3. Research Site, Data, and Methods

To understand patterns of inter-organizational collaboration in South Korea, data collection was conducted in the southeastern region of the Korean Peninsula. The Southeastern Economic Region (SER) comprises Busan and Ulsan Metropolitan areas and South Gyeongsang Province. The region is the most significant industrial region in South Korea as well as the strategic foothold of the national economy. The total population of the SER is approximately 7.94 million, and the Gross Region Domestic Product (GRDP) is approximately \$200 billion [3]. Busan and Ulsan have focused on the manufacturing industry such as automobiles and marine plant factories. Approximately 22% of national industrial clusters are in the SER, and global enterprises such as Samsung, LG, Hyundai, and Kia have their factories there [45]. Recently, the SER has extended its economic outreach by partnering with Asian countries and collaborating with global cities such as Shanghai in China and Hukuoka in Japan. These efforts towards building regional economic development have motivated regional stakeholders to facilitate intergovernmental collaboration.

However, geographical location of the region is vulnerable to natural disasters (i.e., typhoons, floods, and severe wild fires). According to NEMA (2011a), damage from natural disasters, particularly typhoons, have led to storm water overflows in lowlands of SER resulting in an estimated US\$ 4 billion in economic losses (i.e., 23.7% of the total losses to South Korea) from 2001 to 2010 [46].

The region is also highly fragmented. For example, regional governments often assume the role of coordinating organizations during emergency recovery processes. Yet, they are not responsible for establishing short-term planning strategies to mitigate hazards related to natural disasters [47]. The Local Safety Management Committee (LSMC) coordinates local organizations to transmit information and resources by directly communicating with MOPAS and NEMA. Also, the LSMC is only responsible for mapping disaster vulnerability and managing local emergency management funding. The regional headquarters of fire and police administration often perform their duties independent of regional governments and have separate communication channels with local branches.

#### 3.1. Sample Selection

Data collection was conducted in two stages. During the first stage, a snowballing sampling method was used to identify key organizations involved in emergency management activities in the southeastern economic region of South Korea. Before administering the survey instrument, a pilot test was conducted on 20 public organizations (i.e., five cases in each in Busan and Ulsan and 10 cases in the South Gyeongsang province).

At the initial stage, only 43 local governments were contacted from 16 to 28 July 2012, which identified up to three other organizations they frequently communicated with during emergency response. In the first wave, a total of 130 organizations responded to the survey, which was completed by 43 local governments (33.1%), 34 fire stations (33.3%), 28 police stations (33.3%), and 25 non-governmental organizations (19.2%) in the region. Although considerable efforts were made to solicit response from regional and national level agencies, none agreed to complete the survey. The process produced a total of 170 organizations, which included national, provincial, and local agencies and non-governmental organizations. As shown in Table 1, the rate of frequency in the second column indicates organizations that responded to a snowball sampling of the survey, and a number of others cited reveals organizations provided by survey respondents but that did not respond to the survey. In the process of measuring the structural effects of inter-organizational networks, we have maintained a total number of organizations engaged in collaborative emergency management as 170, including all respondents and cited organizations. They were included in the final networks analysis because they were referred by those that completed the survey.

**Table 1.** Responses and Cited Respondents by Types of Organizations.

Organizational Types	Before Typhoons		After Typhoons	
	Frequency	Others Cited	Frequency	Others Cited
National agencies	-	5	-	5
Regional agencies	-	6	-	6
Local governments	43	-	43	-
Fire stations	34	9	24	19
Police stations	28	15	20	23
Non-governmental organizations	25	5	25	5
Total	130	40	112	58

In the second wave, approximately 86.1% of organizations (112) maintained the associated program, i.e., they had participated in collaborative emergency management (CEM) that facilitates organizations to cooperate with the other organizations managing disasters (Kapucu, 2008; Kapucu, et al., 2010). The data on organizations' decision to participate in CEM were obtained during the first survey in the Southeastern Economic Region (SER), South Korea. During the second wave of data collection, the composition of the organizations was as follows: The total response was 115 organizations consisting of 43 local governments (38.4%), 24 fire stations (21.4%) and 20 police stations (33.0%), and 20 non-governmental organizations (22.3%). Table 1 below presents the distribution of respondents by types of organizations.

### 3.2. Measuring Organizational Resilience

Following Bruneau, et al. (2003), this study uses dimensions of organizational resilience: (1) robustness, (2) rapidity, (3) resourcefulness, and (4) redundancy [48]. First, robustness is the capability of a local community to overcome operational disruption immediately in the aftermath a disaster without suffering degradation. Robustness of a local community is the ability to continue to fulfill its function such as communications and information technology support with other agencies despite serious disruptive conditions. Rapidity is the ability of a local community to provide practical assistance for disaster victims and recovery in an effective and timely manner. Robustness and rapidity are critical attributes of a local community to assist victims and improve recovery time without loss of function [49]. Resourcefulness is the extent to which a local community has adequate resources to meet the needs of disaster victims and recovery. Redundancy is the extent to which a local community has an adequate capability to perform functional requirements and, at the same time, assist victims and their communities to effectively manage disasters. Bruneau, et al. (2003) also indicated that resourcefulness and redundancy are fundamental means for achieving adequate robustness and rapidity of a local community [48].

We use a composite index to measure the perceived level of organizational resilience by using four dimensions: robustness, rapidity, resourcefulness, and redundancy [19,48]. In accordance with organizations' responses to survey questions shown in Table 2 below, the four answers with a five-point Likert scale: 0 (strongly disagree) to 4 (strongly agree), were added. This ranged from 0 to 16. The added scores were divided by 16 and multiplied by 100 to create an index of organizational resilience (Cronbach's  $\alpha = 0.784$ ). The organizational resilience index (ORI) ranged from 0 to 100.

**Table 2.** Survey Questions for the Organizational Resilience Index.

Dimensions	Survey Questions *
Robustness	Would you agree that your [organization] has the ability (or been able) to overcome operational disruptions immediately caused by a disaster?
Rapidity	How would you rank the RAPIDITY of providing assistant to disaster victims with resources that you have?
Resourcefulness	Do you agree that your organization is RESOURCEFUL in order to meet the needs of disaster victims and their communities?
Redundancy	Do you agree that your organization has the ABILITY to carry out routine tasks and, at the same time, help victims and their communities to cope with disasters?

\* Dimensions of resilience adopted by Bruneau, et al. (2003) and developed by Jung and Song (2015) [19,48].

### 3.3. Interorganizational Collaboration

We identify inter-organizational collaboration based on a question in our survey instrument: “Consider the full range of organizational types including national government agencies, grassroots organization, interest groups, NGOs, and local agencies. Please list the organizations that you have collaborated with during emergency situations to provide assistance to disaster victims and their communities.” The question was purposely designed to identify with whom local governments established collaboration in emergency management (preparedness). To determine the nature of inter-organizational collaboration, we managed our data systematically as a directed matrix, of which 170 organizations’ inter-organizational ties were coded as an  $N \times N$  matrix reporting all ties among all  $N$  actors.

### 3.4. Bonding Effects

Bonding effects are measured by the closeness centrality index. The index assesses the significance of building trust with actors that are connected to other reachable actors [20]. The standardized closeness centrality index ranges from 0 to 100 [29]. The lower closeness index indicates a lack of resources an actor can secure from networks, while the higher index suggests actors are pooling their resources from other actors directly and indirectly connected to them. Following Wasserman and Faust (1994), the formula (where  $\sum_{j=1}^g d(n_i, n_j)$  is the number of ties in the shortest path connecting actors  $i$  and  $j$ ; and the closeness centrality index depends on  $g$ , the size of a network (Wasserman and Faust 1994)) for the closeness centrality is [29]:

$$C_C(n_i) = \left[ \sum_{j=1}^g d(n_i, n_j) \right]^{-1} \quad (1)$$

### 3.5. Bridging Effects

Bridging effects are measured by the betweenness centrality index. The theoretical underpinning of the measure assesses the strategic significance of being in a central position in a network. The index is based on the frequency that an actor is located on the shortest path between any two other actors in a region. The standardized betweenness centrality index has a range between 0 and 100 [29]. The highest betweenness centrality index indicates the actor has the strongest influence and access to information. The formula (where  $g_{jk}$  is the number of the geodesics connecting the two actors; and  $g_{jk}(n_i)$  is the number of geodesics connecting two actors through another actor [29]) for the betweenness centrality is:

$$C_B(n_i) = \sum_{j < k} g_{jk}(n_i) / g_{jk} \quad (2)$$

### 3.6. Previous Interaction Effects

Organizations’ previous interaction is measured by a survey question, which asks if an organization has been involved in a full-scale exercise, i.e., the survey item asking: “Has your organization participated in a full-size exercise organized by the National Emergency Management Agency (NEMA)?” The variable assesses if organizations invest resources and are strongly committed in their collaboration with other organizations. In general, simply joining the emergency program does not mean actors are committed to sharing resources and information. However, a willingness to participate in the full exercise suggests organizations are working on building trust and reciprocity. The variable is operationalized as having been involved in a full-scale exercise that was coded 1, if the organization has implemented a joint full-size CEM exercise with its collaborators, 0 if otherwise. Table 3 summarizes the concepts, measures, and data sources for control variables.

**Table 3.** Concepts, Measurements, and Data Source.

Variable	Concept	Measurement	Source
Selection	Participation in CEM	Coded 1 if a public organization participated in local emergency management planning, 0 otherwise	2012 SER EM Survey
Outcome	Organizational resilience	Score of the perceived organizational resilience index	2013 SER EM Survey
Full Exercise	Previous interaction	Coded 1 if an organization has implemented joint full-size EM exercise with its collaborators, 0 otherwise	2012 SER EM Survey
Total Emergency Manager	Personnel resource	The number of EM staff	2011 Government Census
Public Safety Expenditure	Financial resource	Percentage of public safety expenditure	2011 Government Finance Yearbook
EM Department	Institutional resource	Coded 1 if a public organization has a specialized EM department	2012 SER EM Survey
Ratio of Senior population	Social vulnerability	Percentage of population older than 65 from the total population	2010 Census of Population
Coastal Area	Environmental vulnerability	Coded 1 if a public organization is located on a coastal city, 0 otherwise	2012 SER EM Survey
River Side	Environmental vulnerability	Coded 1 if a public organization is located on a riverside city, 0 otherwise	2012 SER EM Survey
Local Government	Local EM coordinator	Coded 1 for local government, 0 otherwise	2011 Government Census

### 3.7. Control Variables

Control variables in this model are jurisdictions with a population older than 65, the presence of a separate emergency management department, and location on a coastal region. The disparity of demographical composition includes a variable measuring the percentage of the population older than 65 [50], and the variable accounting for the difference of the institutional structure of local governments is measured by the number of emergency managers, the ratio of public safety expenditure, and the presence of an independent emergency management department [49]. The geographical distinction of local governments by location includes a measure indicating if the jurisdiction is located along the coastal line and riversides.

### 3.8. Methods of Analysis: Heckman Selection Model

This study uses the Heckman selection model in two stages. The model was used because 14 of our total cases never participated in CEM affiliation, and therefore may have potentially led to a biased estimation. They were coded 0 in the first stage of the analysis, which means the data were truncated in the second stage. The selection model is generally adapted for systemically selected samples to correct a selection bias [51]. In the first stage, we included variables representing organizational capacities such as personnel and financial resources. We also included local community characteristics such as social and environmental vulnerability as well as the role of coordinators in local emergency management. The first stage of the selection equation tests factors facilitating organizations to participate in CEM.

During the second stage, the outcome equation analyzes factors explaining the level of organizational resilience as perceived by organizations that were selected during the first stage of the analysis. In addition, the second-stage outcome equation includes variables considered in the first stage (i.e., organizational capacities, community characteristics, and existence of EM department as a coordinator).

#### 4. Results and Discussion

Table 4 shows descriptive statistics with measurements for each variable included in the Heckman selection model. As shown in Table 4, approximately 112 organizations (86.1%) engaged in CEM after the 2012 Korean typhoons. Only 39 out of 112 organizations have activated the full-size exercise with their collaborating partners. The average score of the organizational resilience index was about 77.26. On average, approximately six emergency managers were working in organizations participating in local emergency management.

**Table 4.** Descriptive Statistics.

Variable	N	Mean	Std. Dev.	Min.	Max.
Collaborative Emergency Management (CEM)	130	0.891	0.312	0	1
Organizational Resilience Index	112	77.261	12.778	50	100
Bonding Effects (Closeness)	130	8.942	2.334	0	10.01
Bridging Effects (Betweenness)	130	4.696	7.169	0	37.82
Previous Interaction Effects (Full exercise)	130	0.302	0.461	0	1
Total Emergency Manager	130	6.651	2.439	2	14
Public Safety Expenditure	130	14.691	1.046	12.641	17.429
EM Department	130	0.484	0.502	0	1
Ratio of Senior Population	130	0.145	0.076	0.041	0.308
Coastal Area	130	0.465	0.501	0	1
River Side	130	0.256	0.438	0	1
Local Government	130	0.636	0.483	0	1

Table 5 presents the results of the Heckman selection model. In the first-stage of the analysis, the Heckman selection model examined factors that explain organizational decisions to participate in CEM; and in the second stage, the level of organizational resilience is examined by the patterns of inter-organizational relations and previous interaction effects. The model includes 130 organizations that responded to the first survey conducted before the typhoons, and 18 of the total respondents are truncated by the first selection stage. The Wald  $\chi^2$  test result reveals that this model is statistically significant, rejecting the null hypothesis that all coefficients in the model do not explain both dependent variables. The likelihood ratio test supports the use of the Heckman selection model indicating that there is no non-random selection bias.

**Table 5.** Analysis Results of the Heckman Selection Model.

Variable	Coefficient	Std. Err.
<i>Selection Equation (likelihood of participating in CRM)</i>		
Total EM Staff 2011	−0.146 **	0.106
Public Safety Expenditure 2011	0.745 ***	0.282
EM Department 2011	0.467	0.519
Ratio of Senior Population	0.041	0.027
Coastal Area	−0.016	0.358
Riverside	0.114	0.441
Local Government	6.024 ***	2.521
Constant	−12.348 **	4.998
<i>Outcome Equation (organizational resilience index)</i>		
Bonding Effects	0.881	0.604
Bridging Effects	0.218 **	0.109
Previous Interaction Effects	0.676	2.723
Total EM Staff 2011	−0.487	0.727
Public Safety Expenditure 2011	1.258	1.819
EM Department 2011	5.388	3.374
Ratio of Senior Population	−0.396 **	0.177
Coastal Area	6.508 ***	2.432

Table 5. Cont.

Variable	Coefficient	Std. Err.
Riverside	1.031	2.717
Local Government	4.936 *	2.875
Constant	60.292 *	33.034
N (uncensored)	130 (112)	
Log Likelihood	−475.504	
Wald $\chi^2$	32.81 ***	
LR test of Indep. eqns. (rho = 0)	1.08 *	

Note: Coefficient and standard error of the bonding, bridging, and previous interaction effects in the selection equation are not reported. \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.10$ .

The results provide evidence of the bridging effect that organizations positioning in a central actor between two other actors after the 2012 Korean typhoons perceive a relatively high level of organizational resilience ( $\beta = 0.218$ ,  $p < 0.05$ ). That is, securing a brokerage role leads to the acquisition of essential resources from other organizations after a catastrophic event and therefore holding a central position can enhance their capacity to recover from a disaster. As highlighted by Andrew and Carr (2013), this finding implies that bridging strategy within a self-organized emergency management network plays a critical role in gaining access to other organizations' personnel and financial resources after a disaster [20]. This also reduces uncertainties derived from joint emergency response and recovery operations.

Since organizations after joining collective actions may have incentives to take advantage of higher level government's efforts, the collaboration risk embedded in collective action issues may increase enforcement costs but reduce the level of joint outcome [25]. Based on this logic, the finding highlights that bridging strategy is critical to overcome ICA dilemma, i.e., organizations generally aligned their actions through a central hub after a disaster. Again, organizations can reduce the collaboration risk that may cause failure to jointly respond to a disaster and recover by holding a central position in which they can access timely information and intangible resources from other collaborating partners.

The bonding effect, i.e., organizations closely collaborating with other actors, has a higher level of perceived organizational resilience but this effect is not statistically significant. This hypothesis is based on the belief that some organizations may use participation in local emergency management committees as a tool to share information and intangible resources. Although Murphy (2007) argues that when organizations are affiliated with a strong collaborative group (e.g., fire, police stations, and non-governmental organizations) [52], they can secure essential resources; and, therefore have a better sense of resilience. There is no empirical evidence to support that organizations with a higher closeness centrality have a higher perception of the level of organizational resilience after a disaster.

From the ICA perspective, the bonding strategy may provide a source for organizational resilience (Andrew, et al., forthcoming), but this result in the Korean context was not found. It moves our attention to the presumption that organizations must maintain relations with others after a disaster. That is, continuous interaction among local organizations is critical for possessing valuable resources. For example, local governments need to prepare for future disasters by strategically reinforcing reciprocal relationships with other local organizations. To establish a close-knit structure, they should develop plans to mitigate uncertainties and also promote the mutual interests of local organizations [19,20,36].

The analysis results also reveal that if an organization interacted previously through full-scale exercises, the likelihood of having more connection with others in the region is high. This is consistent with other observations [25]. The finding suggests that mutual understanding, shared goals, and strong commitment established before a catastrophic event can encourage capacity building [31]. While organizational resilience is seldom reinforced by a joint full-size exercise as part of emergency planning and preparedness, it may be argued that continuous interaction leads to building mutual trust and understanding and therefore reducing behavioral uncertainty. However, we found no evidence that the previous interaction effect, that resulted from participation in joint full-size exercises with other

organizations, affected the perceived level of organizational resilience. While organizations activating full-size exercises may increase the likelihood of enhancing their ability to return to normalcy, the results did not reveal significant results.

We also found that organizational resilience is linked with social and environmental vulnerability. This study found that organizations serving a larger number of elderly populations older than 65 perceive a lower level of organizational resilience. This finding implies that organizations' capacity to recover from a disaster is likely to be impeded by resources due to vulnerability of its population. That is, the dependency ratio—the ratio of female, children, and elderly people older than 65—may cause an increase in the costs of responding to a catastrophic event [50]. For example, emergency response of local government involves population protection. Despite local governments' effort to protect residents from disasters, the elderly may be reluctant to leave from their homes. They generally take more time to evacuate to temporary shelters. The disparity of demographical composition in local jurisdictions reveals a decreased perception of the source of regional resiliency. However, environmental vulnerability surprisingly has a positive effect on the level of organizational resilience. It can be argued that if an organization is in an environmentally vulnerable area, the organization is more likely to prepare for disasters.

## 5. Conclusions

This study examined the impact of structural effects i.e., bonding and bridging strategy for inter-organizational collaboration on organizational resilience by using a Heckman selection model. That is, the first stage examined factors of organizations' willingness to participate in collaborative emergency management. Based on the Heckman selection model, the model suggests that organizations holding a central position between two other actors perceive a higher level of organizational resilience, therefore supporting the bridging hypothesis. The finding implies that organizations with a bridging strategy can enhance their capacity to recover from a catastrophic event by securing access to critical resources and information. It is also argued that sources of organizational resilience can be gained through emergency preparedness and hazards mitigation processes such as joint response and recovery planning. Organizations holding a central position between other organizations can gain access to relevant information and intangible resources.

This study provides two contributions to the science of structural effects for inter-organizational collaboration in general and emergency management in particular. Despite calls from scholars and practitioners about significance of organizational resilience [2,11,31,37,38,49], previous research has not fully examined inter-organizational factors affecting resilience. Understanding organizational resilience allowed us to explore a broad set of adaptive capacities of an organization by focusing on its ability to mobilize resources and facilitate successful adaption in unpredictable situations. Since resource mobilization and information access are principally derived from inter-organizational coordination, the significance of social positions also provides insight on the sources of organizational resilience.

Second, from a dimensional perspective, this study fills a gap between the concept of resilience and its measurement by using a systemically-designed survey. The dimensions of organizational resilience used in this study allow scholars to measure the concept by using various aspects of adaptive capacity during and after disasters. Robustness, rapidity, resourcefulness, and redundancy, that this study has used, revealed that dimensions are perceived differently by various organizations engaged in collaborative emergency management. To facilitate organizational resilience, national, regional and local principal governments should provide platforms for organizations to interact allowing them to reduce uncertainties.

For best practices, the continuous assessment of organizational resilience within and/or beyond an organization is critical for possessing valuable resources and resulting in positive consequences of emergency preparedness and response. When organizations in local community accurately recognize needs for robustness, rapidity, resourcefulness, and redundancy, they can strategically be reinforcing collaborative relationships with other local stakeholders. That is, they should not only develop

assessment plans to mitigate uncertainties and risks of interorganizational collaboration, but also promote mutual understanding of emergency responses. From this perspective, timely assessing organizational resilience should not be underestimated.

Despite contributions of this study, there are several limitations. First, an entire regional network relies on egocentric measures. Scott (2000) points out that unreported ties may influence different network measures [53]. Second, this study only examined a region in South Korea, and may not be generalized to other regions in the country. Despite limitations, it is hoped that others can build upon the relationship between social positions and organizational resilience by identifying key actors at the local, regional and national level. Future research should focus on formation of ties that explain intergovernmental behavior to overcome barriers to collective action by using an exponential random graph ( $p^*$ ) model. Also, the next step should include the ways of computing the index of organizational resilience by using objective measures derived from secondary datasets about socioeconomic factors. More importantly, an in-depth interview with working professionals such as leadership [54] that fully understand social vulnerability is expected to provide validity of future research.

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