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The Impact of a Strong Commitment on Disaster Resilience: A Longitudinal Study of the 2012 Korean Typhoons

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Abstract:

Natural and technical disasters are abrupt and have a huge impact on relatively broad regions, yet little research has examined how local organizations overcome institutional collective action dilemmas in collaborative emergency management. Since simply participating in collective agreements and adopting coordination plans are inadequate for achieving effective collaboration in emergency situations, this research aims to test whether organizations' decisions to engage in joint emergency programs are sufficient for building resilient emergency response networks. We systemically design a Heckman selection model with two stages by utilizing data derived from the 2012 and 2013 emergency management surveys conducted before and after the 2012 Korean typhoons. The results demonstrate how a strong commitment through participation in joint exercises significantly influences disaster than formal planning and network affiliations. The findings imply that network interactions forged by such full-scale exercises reduce transaction costs of collaboration and improve community resilience.

Keywords: disaster resilience, full-scale exercise, interorganizational emergency management, Korean typhoon, strong commitment

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Introduction

To achieve effective interorganizational collaboration during emergency situations, simply adopting emergency planning programs or signing agreements for collaboration willingly may not be enough. Joint agreement may not enforce a workable mechanism for a strong commitment. Due to the unique nature of disasters, a rapid response and proper allocation of resources are required to mitigate further damage to the affected area; thus, the role of an inter-organizational collaboration in emergency management has received significant attention from both scholars and practitioners. In the Department of Homeland Security report, the "whole-of-government" approach has been extended to a "whole-of-society" approach because research has shown that numerous actors, governmental and non-governmental, are involved in responding to disasters (Stavridis and Farkas 2012). What is lacking, however, is research on the quality of this collaboration. The range of collaborative actors has expanded, but our understanding of the quality of this collaboration remains limited.

Despite the importance of inter-organizational or intersectoral collaboration, empirical works examining how institutional collective action dilemmas affect the operation of emergency management are few limited (Andrew 2007; Comfort 2007; Cox and Perry 2011; Rivera and Settembrino 2013). Even though collaboration risk is likely to make actors change their decision about commitment even after affiliation, the previous literature has focused on the network alliance itself as the mechanism to ensure participation in collaborative emergency management. The concept of a commitment has thus been simply discussed as bridging or bonding the strategies in emergency networks (Andrew and Carr 2013), which only means membership or affiliation and not an actual resource exchange. Although each organization voluntarily adopts the emergency plans or joins programs depending on their benefits, the problems of whether to make tangible commitments may be subjective. In other words, the emphasis on the credible commitment among inter-organizations may be relatively limited, even when strong commitment is needed for emergency network performance.

Regarding interorganizational collaboration after a disaster strikes, complex and adaptive systems have been dramatically evolved by environmental demands and intensity of disasters (Comfort and Kapucu 2006). Developing reciprocal relationships may increase a chance to build a strong commitment in emergency networks; the more members interact with each other, the more they have a chance to tightly bind together as

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they perceive high opportunity cost of defection (Feiock 2013; Feiock and Scholz 2010). In advance, the local government needs to consider whether or not to adopt collaborative emergency planning programs given the external and internal limitations to overcome disaster situations (Kickert, Klijn, and Koppenjan 1997). Cooperation through local emergency planning could be understood as a first step in achieving a higher level of disaster-resilient community. Next, a credible commitment of members in the emergency planning affiliation needs to be examined to enhance disaster resilience as it decreases collaboration risks. The local governments and their agencies can develop inter-organizational trust through active participation and strong engagement among the stakeholders along with established information and resource transmission sharing; this collaboration can lead to a resilient community. Like any physical or technical resources, disaster resilience can be crucial as it lessens the impact of disasters and facilitates the smooth flow of resources or information. It may be considered as an abstract concept but we believe that disaster resilience is an invaluable and effective response to disasters.

This research aims to examine whether a strong commitment derived from organizational decision to join full-scale exercises can be sufficient for building disaster-resilient communities. This research proceeds in six sections. The first section describes the institutional collective action framework, and the following section outlines the theoretical arguments in terms of collaboration risk to participate in collaborative emergency management and disaster resilience. The third section examines the role that strong commitment plays in enhancing disaster resilience. The research design, data collection, and measurements are presented in the fourth section. The fifth section reports the findings with discussion, and the conclusion discusses the limitations and suggestions for future research.

Theoretical Considerations

Disaster Resilience

While much of the current research tends to focus on vulnerability and resilience in communities located in major metropolitan areas (Tobin and Whiteford 2002; Cutter et al. 2003; Berke and Campanella 2006; Campanella 2006; Norris et al. 2008), few have examined how organizations from various sectors within urban and rural communities respond to natural disasters. There are a limited number of empirical studies addressing the factors that explain the ability and capacity of organizations to minimize the consequences of natural and man-made disasters (Norris, Tracy, and Galea 2009; Sherrieb, Norris, and Galea 2010; Rivera and Settembrino 2013; Andrew et al. 2016). As noted by Kapucu, Hawkins, and Rivera (2013), one of the “challenge[s] in developing resilient communities is not only recognizing and anticipating the scope of damages, but integrating multiple agencies, jurisdictions and stakeholder groups in a response to a disaster (Pelling 2003; Ronan and Johnston 2005).” The ability of organization to respond and recover from disasters depends on their ability to coordinate joint activities and share resources across administrative and political boundaries (Crichton, Ramsay, and Kelly 2009; Ainuddin and Routray 2012; Andrew et al. 2016). In other words, interorganizational collaboration is an essential part of assessing resilience-related characteristics of a community.

Resilience in emergency management can be understood as the concept of “bouncing back from disastrous events” (Norris et al. 2008; National Research Council 2011). Likewise, basic concepts of resilience include “bouncing back” or “the capacity to face or respond to threats.” Meanwhile, the term “resilience” has not been specified only in terms of emergency management resources. Like infrastructure, once resilience is established and is supervised continuously for better operation, it can be considered as public goods or resources to overcome disasters. Also, the term “resilience for disaster-resistant community” has been diversely defined as toleration to alternation before operating or reorganizing a more fitted structure or process (Holling 2001; Alberti et al. 2003). Cox and Perry (2011: 395) defined it 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” and National Research Council (2010) added that disaster resilience is the continuous capacity of communities to manage during and after disasters. As seen above, the definition of resilience for disaster-resistant community has not reached to a consensus.

Building on this foundation, we define the term “disaster resilience” as an actual or potential public resources improvement capability of a community condition with a strong willingness to manage emergency events so as to bounce-back to original conditions. The objective of building a disaster-resilient community is to minimize any loss of life and economic damages due to intensive rainfalls or floods. Foster (2012) also examines resilience at the organizational level regarding economic shocks. By using the term High Reliable Organization in the United Kingdom, Crichton, Ramsay, and Kelly (2009: 25) examine organizational resilience as the process to secure appropriate knowledge and resources available from both within its own organization and external actors and to incorporate critical resources into their emergency management system. That is, an

effective disaster response operation can be enhanced by organizations with high levels of resilience in order to respond swiftly to victims and the affected community during catastrophic events (McManus et al. 2008).

Independent efforts of individual organizations to enhance disaster resilience are ineffective because no single actor can do everything in the midst of a disaster. Each community considers the disaster resilience on four dimensions: *Robustness*, *Rapidity*, *Resourcefulness*, and *Redundancy* (Bruneau et al. 2003; Valero, Jung, and Andrew 2015; Jung and Song 2015). These four dimensions adopted in this research are directly involved in the costs of disaster events requiring inter-local collaboration. Disaster resilience for social and physical functioning in a community can be classified into these four categories, which were initially presented by Bruneau et al. (2003) and have been developed by Jung and Song (2015):

Robustness: the potential capacity of strength or continuity to withstand a given intensity of disaster without malfunctioning or suffering degradation of normalcy

Redundancy: substitutable or back-up elements, systems, and resources for withstanding the operation of planned functions (e.g. alternative system for preventing the discontinuity of the disaster management operations and back-up materials)

Resourcefulness: the level of capacity to comprehensively manage situations with secured resources or systems; the ability to apply materials (e.g. information, monetary resources, and reciprocal aids)

Rapidity: the ability to meet time priorities and achieve objectives in a right time

Enhance of comprehensive resilience in a community encompasses a need to: identify the problems, reach a consensus during decision making, and implement appropriate and timely actions. Collective action improves the substantive capacity of local resilience as it helps to reserve backup resources for overcoming the worst situation in disasters. Catastrophic events exceed a community's ability, so effective cooperation with strong commitment is highly required (Harrald 2006). Exchanging or providing resources with other organizations is not easy, especially during a disaster because each one may want to prepare for the potential or secondary impact of disasters. However, an appropriate response is inevitably necessary to save resources and lessen the impact of disasters. For this reason, establishing disaster-resilient community based on a strong commitment is important to accurately transmit resources and information in a timely manner.

Institutional Collective Action Framework

The Institutional Collective Action (ICA) has been created to analyze the collective action problem at the institutional level. The ICA combines elements of actor-centered preference integration models (Scharpf 1997) and Institutional Analysis and Development (IAD) framework introduced by Ostrom that considers joint agreement actions grounded on individuals' rationality. ICA considers transaction cost an actual cost for decision making among multiple governments and the collective action dilemma at the local or institutional level. The capacity of institutional units for intentional collective action surpasses that of the individual level (Feiock 2009), and the capacity for collective and strategic action depends on reconciliation of conflict among members.

As the need for diverse organizational collaborations increase, ICA problems have emerged. They often derive from vertical, horizontal, and functional fragmentation based on jurisdictional boundaries, and specific functional disparity. Public service by multilateral collaboration involves collective decisions to collaborate as limited by transaction cost, level of uncertainty, and relations generating benefits (Feiock 2007). More specifically, each organization may either see it as a possible risk or an incentive to their own cause once they participate in the planning; also organizations may treat transaction costs as their expenditures, so higher transaction costs may retard mitigation of the ICA dilemma (Feiock 2013). Unless collaborative relations generate sufficient benefits to offset transaction costs (Feiock 2007, 2009), self-organizing networks based on voluntary adoption of programs or plans would be rarely established. Furthermore, if perceived collaboration risks are high, the collective action would not work in practice even after the organizations join the programs.

The integration mechanisms such as consolidation, delegated authority, mutual agreement or contract, and network embeddedness are available to achieve integrated decision making across fragmented authorities (Feiock 2009, 2013). Depending on transaction cost, risk, and other physical constraints, the most efficient mechanisms will vary. The ICA framework has been rigorously tested in diverse policy arenas, and the largest parts of empirical studies have focused on local economic development (Feiock et al. 2010; Lee, Feiock, and Lee 2012) and on resource management for public service (Schneider et al. 2003; Scholz, Berardo, and Kile 2008). This broadened the pool of collaborative decision making regarding emergency networks (Choi and Brower 2006; Andrew and Carr 2013); economic development through metropolitan governance (Feiock 2009); inter-local partnerships of natural resources (Lubell et al. 2002; Schneider et al. 2003); and governmental service contractors of elder service program (Jang and Feiock 2009).

Mutually binding agreements generate the creation of emergency management networks such as adopting emergency plans. This autonomy of the actors' agreement would establish members' ties and contribute to solving problems, thereby providing answers within a given condition of physical constraints such as time, resources, knowledge, and commitment (Agranoff and McGuire 2003). In one aspect, institution-like emergency plans might be regarded as externally determined, but for the self-organizing networks, the autonomy of whether to adopt the emergency program may require some institutional effort to overcome collective action problems caused by the fragmented authority in local areas.

The ICA dilemmas in binding agreements are generated in two stages: consideration stage that is related to decision costs, and implementation stage that includes enforcement cost (Feiock 2013). Communicative collaborations in response to disasters are generally uncertain and unstable in nature as they are reliant on the uniqueness of the disasters. It is not always based on full-fledged collaboration. Moreover, as organizations choose their partners, they recognize not only the costs of collective activities but also that of oversight, which can be arduous and costly (Koppenjan and Klijn 2004). In the first stage, information cost and bargaining or negotiation cost are compared to the benefit of being members (Kwon and Feiock 2010); however, once the participants decide to be the members of pursuing a shared goal, enforcement or monitoring cost, which can be lowered by mutual trust, matters.

Collaboration Risk Embedded in Interorganizational Collaboration

Self-organized collective action entails collaboration risks generated by fragmented authorities (Feiock 2007, 2009; Andrew and Kendra 2012). The collaboration risk reflects "the nature of the problem, existing institutions in place, and the transaction costs local actors face" incorporates the concepts of incoordination, division and defection risk (Feiock 2013). Its level is associated with externally uncertain risks, but our discussion focuses more on relational collaboration. According to Feiock (2013), coordination problems (or incoordination) arise in the process of bringing together more than two the public organizations in a way that provides mutual emergency response arrangement. Coordination is difficult if actors perceive too broad array of activities to be undertaken (Hatley 2010). Division problems are distinguished from coordination in that although each organization agrees on the joint goals for interconnected activities, difficulties arise in dividing the benefits and costs from the joint action (Steinacker 2004). Perception of disproportionate collective output hinders mutual collaboration. Defection risk is different from other risks in that it is post-behavior after joining a collaborative membership when one or more members finds it in their interest to renege on their obligations. Its level is engaged with situational uncertainty, limited information, and the possibility of the others' opportunistic behavior (Brown and Potoski 2005).

In an emergency context, defection risk is of great importance. Even among the members of voluntary emergency networks, the fact that members have agreed to collaborate, does not guarantee effective response to actual disasters. Planned networks assume that the participants will be committed to faithfully follow what they are expected to do. However, the incentive of defection is particularly high during disasters, particularly when the situation is more uncertain and urgent and requires a quick and timely response is relatively high. The result of betrayal is made even worse if it comes at a time with a high number of casualties and economic losses. Similar to a prisoner's dilemma game, maximizing each organization's utility may not correspond with their Pareto optimum. Mutual trust based on credible commitment to a joint agreement is crucial in reducing defection risk in such situations.

Strong Commitment to Disaster Resilience

The implication of fragmented authority among public organizations during disasters has not been fully investigated, especially as it relates to commitment. Creation of network ties, similar to joint affiliation networks, has been emphasized. However, the mechanism of adopting joint action does not always produce the necessary commitment for success. In order to achieve the ultimate goal of collective action, as well as joint participation, strong commitment such as an actual action of providing resources or information should be fulfilled to enhance the level of disaster resilience.

In the ICA approach, the design of institutions depends on the cost of creating, negotiating and overseeing mutual arrangement (i.e. transaction cost) (Feiock and Scholz 2010) and collaboration risks (i.e. incoordination, division problems, and defection risk) (Feiock 2013). Considering the institutional property of self-organized emergency networks, joint memberships and further collaboration in implementation can be discussed in two different stages. As the first stage, creating networks in emergency management is of great importance because it provides the possibility for the enlarged form of multifunctional networks. Nevertheless, the smooth operation

during disasters depends a depth of commitment. After joining the collaborative programs, rational actors seeking more efficient ways to utilize the collective resources or good may act as a free rider. Thus, the second stage has to be considered separately for collaborative affiliation.

Joint association and real operation are distinct moments in time. Constructing networks is generated during the normalcy period of the preparedness stage, but its implementation takes place during actual disasters. Here we cannot even expect to increase the disaster-relevant collaborative managerial capacity when there is a potential catastrophe. More specifically, during a disaster, timely response is critical to mitigate emergency situations especially when the resources in those events are generally limited and insufficient. Implementation requires a high level of mutual trust and understanding to reduce collaboration risks, especially “defection risk.”

In order to facilitate actual interaction or collaboration, the members in emergency management planning programs are required to provide their own resources and information for a better outcome of the collaboration. Emergencies should be effectively and quickly dealt with by relying on inter-sectoral arrangements (Waugh and Streib 2006), and because of its complexity and uncertainty, instant and timely support is seriously required. Hence, its issue is closely connected to the internal commitment in the emergency planning programs.

During an urgent and uncertain situation, the importance of smooth and quick information or resource flow cannot be stressed enough. The emphasis on homophily, which leads to reduced uncertainty and increased bidding among actors, implies the significance of similarity in finding their partners. Regarding self-organized collaboration from the empirical findings, actors are inclined to make a connection with others who have more in common with themselves as a member of their network (e.g. Comfort and Haase 2006; Lubell 2007; Feiock 2013). The level of interdependence and similarity among actors generates and expands the range of relationship because jurisdiction of the local government is fixed (Feiock 2007), and this attribute accelerates in building the mutual trust among actors (Lubell, Henry, and McCoy 2007). Also, Comfort (2007) contends that iterative interactions accelerate the possibility of building a common cognitive management and operational picture. The shared understanding would facilitate the convergence of diverse preference and decrease a barrier to developing mutually cooperative institutions. Through reiterative interaction, familiarity of communication and mutual dependencies on resources may be improved by a full-scale exercise of sharing the public goal.

Full-scale exercise provides iterative and regular interaction among actors. It creates mutual trust and increases willingness in offering their resources to other members. Moreover, iterative interactions and characteristics of unpredicted disasters bind them tightly, and today’s demander can be a provider later. The uncertain property of disasters might convince actors to put their strong commitment in emergency management programs. Full-scale exercise is also closely related to the concept of homophily, which increases the level of shared understanding. Although the inherent characteristic of each organization derived from individual property or geographical proximity are barely manipulated, homophily can be reinforced by full-scale exercise of emergency management programs, and this training is closely related to building relational similarity and reducing behavioral uncertainty. A strong commitment depends on the level of trust built among members. In other words, the more the importance of collaboration in emergency management is understood, the more willingly the local government will accept the shared goal. As the credibility of collaborative action increases, the belief in mutual aids will be strengthened. It can then facilitate the actors’ commitment with planning programs.

The level of commitment in inter-local collaboration can help manage potential impact of subsequent disasters. The long-lasting and consistent commitment may increase the reaction capability to the emergency situation. For this reason, enhancing disaster resilience can be treated as public resources because it saves both lives and resources during a disaster and even post-disaster when we try to rehabilitate. Relatively high resilience may decrease the recovery time and the amount of resources usage as well. This is required to lessen the emergency events in any stages of disaster situations such as response, mitigation and even recovery. Considering these theoretical arguments, we propose that a strong commitment such as full-scale emergency management exercises play a critical role in building a strong commitment with other organizations to enhance the perceived level of disaster resilience within administrative boundaries.

Research Design, Data, and Methods

Beyond participating in joint agreement, a strong commitment forged by time, investment and efforts on joint drills might affect the level of disaster resilience perceived by public organizations. This research investigates how a strong commitment, organizational capacities and community characteristics influence the level of disaster resilience, as perceived by public organizations involved in collaborative emergency management (CEM).

In this research, longitudinal surveys were conducted in two different time spans i.e. before and after the 2012 Korean typhoons. The data on organizations’ decision whether to participate in CEM was obtained from the first survey on emergency management in the Southeastern Economic Region (SER), South Korea. The

survey was conducted in July 2012 in 43 municipalities. The organizations surveyed consisted of 43 local government, fire stations, and police stations in the region. The survey asked these organizations whether or not they had participated in CEM to cooperate with the other organizations to deal with disaster situations more efficiently. About 89.1% of the organizations (115) have joined the associated program. The 115 organizations were as follows: 43 local government (37.4%), 34 fire stations (29.6%), and 38 police stations (33.0%). The second wave of data on the level of disaster resilience perceived by the initial 115 organizations came from a consecutive survey conducted in January 2013 (See Figure 1).

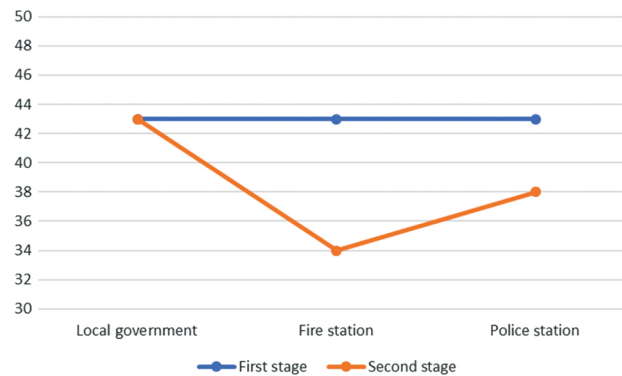


Figure 1: Respondents by Organizational Type.

This research employs the Heckman selection model in two stages. In 14 of our cases, an organization never joins CEM affiliation, and so they were coded 0 in the first stage and censored in the second stage. The outcome of this equation analyzes the factors explaining the level of disaster resilience perceived by the organizations that were selected at the first stage. The selection model is generally adapted for systemically selected samples in order to correct a selection bias (Heckman 1979).

As discussed in the section of theoretical considerations on resilience, we use a composite index as the dependent variable based on four dimensions of resilience: robustness, rapidity, resourcefulness, and redundancy (Bruneau et al. 2003; Kendra and Wachtendorf 2003; Bruneau and Reinhorn 2006). In accordance with their responses to the survey questions in Table 1, the four survey items with a five-point Likert scale: 0 (strongly disagree) to 4 (strongly agree) were asked by respondents. The sum of four scales has a range from 0 to 16, and thus sum of all four scores were then divided by 16 and multiplied by 100 in order to create an index of disaster resilience (Cronbach's $\alpha = 0.784$). The disaster resilience index (DRI) basically ranges from 0 to 100.

Table 1: Perceived Level of Disaster Resilience Index.

Dimensions*	Survey Question
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 to Bruneau et al. (2003).

To examine the impact of a strong commitment on DRI, at the second stage, a full-scale exercise as a key independent variable is used. Simply joining the emergency program does not mean that all the actors are willing to put their strong commitment in sharing their resources or information. However, willingness to participate in the full-scale exercise is somewhat different as they try to build a mutual trust and reciprocity. That autonomous participation in a full-scale exercise program can be used as an indicator of their willingness to put a strong commitment. In this research, full-scale exercise is operationalized into representing a strong commitment, and it is coded 1 if a public organization has implemented joint full-scale CEM exercise with its collaborators, 0 if otherwise.

In terms of building resilient cities, a strong commitment among public organizations participating in the CEM process facilitates the effective response during disasters. Also in the long-term perspective, disaster resilience is regarded as a collective good to increase the level of capacity to bounce-back from severe stress (Norris

et al. 2008; Andrew and Carr 2013). According to the level of disaster resilience, impact of catastrophic events such as the 2011 Japan Earthquake and the 2012 Hurricane Sandy on communities differ (Kendra and Wachtendorf 2003). These organizations participating in CEM are associated with the level of disaster resilience. The second-stage outcome equation also includes the variables considered in the first stage (i.e. organizational capacities, community characteristics, and existence of EM department as a coordinator).

To investigate the factors facilitating public organizations to engage in CEM at the first stage as well as the impact of a strong commitment on DRI at the second stage, we employed control variables, which are: (1) organizational capacities such as personnel and financial resource; (2) community characteristics in terms of social and environmental vulnerability; and (3) a role of the coordinator in local emergency management. That is, because this research aims to test what factors either facilitated or hindered organizations to participate in CEM at the first stage. When public organizations join to build consensus on CEM and maintain the arranged activities during a disaster are only considered, moreover, the effect of these control variables e.g. the lack of resource mobility and the environmental or social vulnerability that each organization faced may result in the decision of the organizations to collaborate with the others. Table 2 summarizes the concepts, measures, and data sources for the variables considered.

Table 2: Concepts, Measurements, and Data Source.

Variable	Concept	Measurement	Source
Selection	Participation in CEM	Coded 1 if a public organization actually participated in local emergency management planning, 0 otherwise	2012 SER EM Survey
Outcome	Disaster Resilience	Score of the perceived disaster resilience index	2013 SER EM Survey
Strong Commitment	Strong commitment	Coded 1 if an organization has implemented joint full-scale EM exercise with its collaborators, 0 otherwise	2012 SER EM Survey
Total Emergency Manager	Personnel resource	Number of EM staff	2011 Government Census
Public Safety Expenditure	Financial resource	Log of total 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 over 65 years old 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

Results and Discussion

The Heckman selection model examines the factors that influence organizations' decision to participate in CEM at the first-stage selection and the level of disaster resilience at the second-stage outcome. Table 3 shows the descriptive statistics with the measures for each variable included in the Heckman selection model. As indicated above, while approximately 115 organizations (89.1%) had been involved in CEM, only 39 out of 115 organizations activated the full-scale exercise with collaborating partners. The average score of the disaster resilience index (DRI) is about 77.3, and on average about 6 emergency managers were working in the organizations engaged in local emergency management.

Table 3: Descriptive Statistics.

Variable	N	Mean	Std. Dev.	Minimum	Maximum
Collaborative Emergency Management (CEM)	129	0.891	0.312	0	1
Disaster Resilience Index (DRI)	115	77.261	12.778	50	100
Strong Commitment	129	0.302	0.461	0	1
Total Emergency Manager	129	6.651	2.439	2	14
Public Safety Expenditure	129	14.691	1.046	12.641	17.429
EM Department	129	0.488	0.502	0	1
Ratio of Senior Population	129	0.145	0.076	0.041	0.308
Coastal Area	129	0.465	0.501	0	1
River Side	129	0.256	0.438	0	1
Local Government	129	0.333	0.483	0	1

Table 4 presents the results of the Heckman selection model. The model includes 129 organizations as respondents to both surveys conducted before and after a disaster. 14 of the respondents is censored by the CEM process. The Wald χ^2 test result indicates that this model is statistically significant. The likelihood ratio test result of independent equations indicates that there is nonrandom selection bias between the two stages.

Table 4: Heckman Selection Analysis of Disaster Resilience Index (DRI).

	Coefficient	Std. Err.
Selection equation (likelihood of participating in CRM)		
Total EM Staff 2011	−0.267**	0.133
Public Safety Expenditure 2011	0.439***	0.153
EM Department 2011	0.188	0.537
Ratio of Senior Population	3.777	3.070
Coastal area	0.034	0.408
Riverside	−0.185	0.522
Local Government	−0.450	0.401
Constant	1.383*	0.730
Outcome equation (perceived disaster resilience)		
Strong Commitment	5.139**	2.497
Total EM Staff 2011	−0.504	0.666
Public Safety Expenditure 2011	0.321	0.166
EM Department 2011	5.415	3.307
Ratio of Senior Population	−42.803***	15.905
Coastal area	6.180***	2.393
Riverside	1.315	2.741
Local Government	−1.802	2.312
Constant	79.347***	4.441
N (uncensored)	129 (115)	
Log Likelihood	−475.282	
Wald χ^2	25.83***	
LR test of Indep. eqns. ($\rho = 0$)	2.55*	

Coefficient and standard error of the full-scale exercise variable in the selection equation are not reported.

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

The first-stage selection equation results show that organizational capacity strongly influences the organizations' decisions to participate in CEM. While CEM is likely to be adapted in organizations with relatively a low level of the personnel resources, the size of public safety budget has a positive effect on the likelihood for the participation in CEM. Social and environmental vulnerability such as the percentage of elder populations over 65 years-old, and the population living near the coastal area do not have an impact, implying that there is no statistical evidence that organizations with high levels of vulnerability are more likely to participate in CEM than others.

In the second-stage outcome equation, a significant positive coefficient is reported for the activation of the full-scale exercise, indicating that organizations with a strong commitment in the CEM process perceive high levels of disaster resilience. From this point of view, we find that the strong commitment of organizations with collaborating partners may increase the likelihood that organizations through collaborative emergency preparedness such as joint-disaster response and recovery planning enhance disaster resilience. As argued by Feiock and Scholz (2010), the result from the multiple regression model testing the impact of a strong commitment on the actual outcome i.e. the perceived level of DRI also indicates that the strong commitment, which is self-organized in the CEM process (e.g. establishing mutual agreements through the full-scale exercise), plays

a critical role in personnel and financial resource mobilization during and after a disaster by reducing uncertainties in terms of emergency response and recovery.

The result confirms the argument that disaster resilience is closely linked to diverse vulnerability-factors (Norris et al. 2008). Also, variables for the ratio of population over 65-year-old and the population living in coastal areas are statistically significant in the equation. Organizations that collaborate for fostering a resilient community tend to be impeded by social vulnerability. However, environmental vulnerability has a positive effect on the level of disaster resilience. This could simply mean that the more exposure to environmental hazards, the more communities prepare for facing a specific type of disasters.

Fragmentation of authority generates collective action dilemmas in both entry consideration and commitment in implementation, yet these two ICA dilemmas have not been separately recognized in empirical studies. However, the results imply that it is necessary to examine the transaction cost affecting joint agreement and commitment for joint outcome individually. Joint agreement decisions in emergency networks are shaped by organizational internal capacity, which includes the number of personnel and the size of financial support. Organizations with a low level of internal capacity perceive over benefits from joint agreement. Meanwhile, the financial affordability makes organizations consider investigating for the mitigation or preparation of unpredictable disasters in advance, leading to joining collaborative emergency networks. Thus, joint agreement should be designed in the light of enhancing the organizational capacity in order to increase the rate of membership in practice.

Once they join collective action, organizations have incentives to free-riding, taking advantage of lower costs. The collaboration risks involved in commitment problem decrease the level of joint outcome and increase the enforcement cost. Our finding shows that a strong commitment deriving from participation with others in a full-scale exercise helps to overcome ICA dilemmas. A higher level of disaster resilience is achieved by a strong commitment among local public organizations. This can give an insight to practitioners, that activities such as drills or full-scale exercises requiring strong engagement are necessary for increasing the level of disaster resilience. Enhancing local resilience also strengthen the degree of regional resilience. Likewise, the result of environmental vulnerability indirectly supports our main discussion that being more exposed to a specific disaster may give local communities a chance to raise their practical capacity of disaster response and increasing the level of resilience. In other words, a full-scale exercise based on actual practice with a strong commitment is significant in practice.

Conclusion

Due to the fragmented authorities and diverse interests in each organization, self-organizing affiliation for the disaster response may be hard to achieve. Although the previous experience of disasters enlightens organizations about how important interorganizational collaboration is and emergency incidents induce actors to take a common goal with their autonomous willingness, there are still barriers to working together. The functions of emergency management require more specialized knowledge and technology given the impact of disasters on the whole society generally overwhelms the capacity of a single organization. Thus, the discussion about collaborative emergency network is critical to mitigate collective action problem and to accelerate the willingness of collaboration at the institutional level (Feiock 2009). For this reason, the previous literature has focused more on the adoption of joint agreement at the emergency preparedness and response stages (Norris et al. 2008; National Research Council 2010).

Simply accepting the agreement among the members does not mean effective network collaboration has been achieved; there must be a strong commitment to put their effort in response to disasters. Although members are in the same group of emergency programs, each may hesitate to provide their own resources because the range of the disastrous events is broad. Each organization may want to keep their resources for their preparation of another aftermath of disasters given that their region is relatively less damaged than neighboring jurisdictions. For this reason, the supply of resources is limited compared to the demands.

This research examines effectiveness of strong commitment in operation stage as a second step after investigating joint agreement in consideration stage as a first step. In terms of establishing collaborative affiliation as the first step of generating strong commitment further, the mechanism of how each rational organization is attracted to join the collective action program should be considered. A strong commitment is more of an ultimate goal for forging collaborative networks or affiliation as it reflects more direct and actual willingness to collaborate with the members. This should be understood in different depths with a simple association.

As participants recognize the lack of internal capacity in their organizations, they would take collective action for interconnectedness. However, once joining it, their payoff for maximizing the utility in operation is changed with collaboration risks; thus mutual trust with strong commitment not only lessens transaction

cost and uncertainty but also contributes further to enhancing disaster resilience for resilient society. As such, strong commitment strengthens disaster resilience in pre-, during-, and post disasters. The level of disaster resilience relating with a strong commitment is a long-term collective good, which can be enhanced by actual and reciprocal collaboration. In the context of disasters, a timely response and strong willingness to provide resources are far more important when considering the establishment of disaster management alliances like CEM. This means creating connection among organizations is a critical step to form collaborative network and it should be based on the role of trust-building manifestation.

Perceived resilience level can be different from the actual resilience level, but the public organizations related to CEM are relatively reliable to perceive it objectively. Also, the concept of resilience is amorphous and abstract, since empirical studies for measuring the concept are limited given the concern with disaster resilience is valuable. For this reason, perceived resilience notion has been utilized to present the data in this paper.

Nevertheless, this paper provides new insights to the theoretical concept of “disaster resilience” developed by Bruneau et al. (2003) in the context of a disaster where the high level of disaster resilience is crucial. Further, this empirical study identifies factors to improve disaster-resilient community.

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