EMBEDDEDNESS AND COLLABORATION RISK IN EMERGENCY MANAGEMENT: AN INSTITUTIONAL COLLECTIVE ACTION FRAMEWORK

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Abstract

The study aims to investigate the effect of embeddedness, defined as a property of interdependent relations in which organizations are integrated in a network on the level of collaboration risk emerging from relational uncertainty. A case of emergency management including interorganizational collaboration is used as a lens through which to understand to the role of embeddedness in disaster networks to extend the knowledge of collaboration risk within an institutional collective action framework. Despite an effort on understanding structural effects on network governance, risk embedded in collaborative arrangements has yet to be systematically explored. By modeling OLS analysis with 69 organizations engaged in emergency management operations in the Seoul Metropolitan Area, South Korea, I hypothesized and test the effect of relational and structural embeddedness on the level of collaboration risk that an organization perceives. The results show that both structural and relational embeddedness facilitate organizations to mitigate perceived collaboration risk, implying that reachability secures relief of relational risk and commitment relationship binds the participants more tightly.

Introduction

In recent decades, collaborative management has been a primary research focus (Agranoff & McGuire, 2003; McGuire 2006), and has changed the way public services are provided, from a hierarchical system operated by big government to joint mechanisms implemented by multi-layered governments, nonprofit organizations, and for-profit organizations (Provan & Milward, 1995). No single organization can provide a satisfying level of public service, and so collaborative horizontal or vertical service delivery structures have been implemented among different levels of government (Silvia, 2011). Joint collaboration requires interaction with other authorities regardless of how similar the participants are in size, characteristics, and function. The field of emergency management is not an exception to this trend; in fact, even more active collaboration across interorganizational boundaries is required in urgent and unstable situations (McGuire & Silvia, 2010). Ironically, powder-keg situations make response organizations even more vulnerable to relational risk. Although a regularized relationship may be formulated by trustworthy behavior among participants reflecting direct effects of relational embeddedness (Granovetter, 1985: 490), collaboration risk from behavioral uncertainty in the field of public management remains an unsolved problem.

The capabilities of each authority required to operate in collaborative network settings are different from successful managerial capabilities in a single organization (Agranoff & McGuire, 2001b). Traditional management, based on supervision, is less valid in network settings where combined efforts and goals are intertwined with the constraints imposed by a mutual contract. This complex network setting contributes to the relational risk that occurs when behavioral uncertainty exists, although the benefits from collaboration to each organization rely on the choices of the other participants. As a relational arena grows across interorganizational boundaries, systematic mechanisms that secure participants' commitment to collaborative networks have been demanded. Since the behavior of one participant affects the others' payoff (Feiock, 2007; Axelrod & Hamilton, 1981), the relational position of each organization embedded in a network structure may significantly influence the perceived level of collaboration risk.

Institutional collective action (ICA) dilemmas primarily arise from fragmented authorities relying on functional, bureaucratic, or political systems (Feiock, 2009; 2013). The effort to overcome ICA problems begins with the recognition of the interrelations and

interdependencies that affect the actions of other organizations and the assumptions of rational human beings, who join collective action in order to ensure benefits over costs (Feiock, 2013). Rational actors seek to reduce relational risk when the nature of the problem, the preference alignment of the actors involved, or the existing institutions create incentives that impede coordination and fair division or lead to situations where opportunistic behavior or free riding is advantageous (Feiock, 2013: 406). Collaboration for disaster response requires adaptive and improvisatory action in the boundary of emergency management networks, although the connections incorporate meticulous organization and practical planning (Andrew & Carr, 2013). Collaboration for disaster response is not only a structured collaboration, but also operates within a structuring collaboration (Andrew & Carr, 2013; Waugh & Streib, 2006). Simply put, a dynamic disaster context does not provide a network setting that is stable compared to other public service areas, and the importance of mitigating collaboration risk seems crucial to facilitating collaborative arrangements.

ICA-based research predicts that actors will reduce transaction risk by strategically embedding relationships within a network (Feiock, 2013). Empirical work using stochastic network analysis supports this supposition by identifying the propensity to form embedded relationships when the nature of the problem and the preference alignments of actors and existing institutions make collaboration difficult. Research is deficient on the collaboration that occurs, because embedded relationships reduce transaction risks but never directly test the underlying relationship. This analysis fills this lacuna by directly examining whether actors perceive less relational transaction risk based on their structural position within the network.

In addition, although it is identified in the literature how structural social position influences the effectiveness of performance (Jung & Song; Andrew et al., 2016; Andrew & Carr, 2013), it is assumed but not tested whether the causal mechanism is a reduction of collaboration risk. This analysis will investigate how embeddedness affects the level of collaboration risk in emergency management operations.

Theoretical Considerations

Collaboration Risk

The ICA framework primarily builds on individual actor-based collective action in which the occurrence of joint benefits that derive from the composite equilibrium of interdependent relationships relies on the rational choice of individuals (Ostrom, 2005; Olson, 1965) and expands the approach to institutionally delineated composite actors (Feiock, 2013). Securing the emergence of collaborative activities among the participants in a composite actor is firmly bound up with a strategic incentive mechanism that leads to collective benefits that may not be desired by any of them. The extent of preference integration among interdependent participants who consider collaboration only as guaranteed gains over costs determines the likelihood of collective action (Andrew & Kendra 2012; Scharpf, 1997).

ICA problems primarily begin with the functional fragmentation of authority among different but related organizations, vertically among multiple levels of government, and horizontally among equivalent levels of government (Feiock, 2007). The needs or wishful thinking of individual institutions makes a difference for the occurrence of collective action, but for highly complex social technological problems such as emergency management, collaboration among different but relevant actors is critical. Mechanisms to reduce risk are necessary for the actors to interact with each other for a collective end that otherwise would not be achievable (Feiock, 2009).

Theories of institutional collective action help identify incentive structures encouraging various actors in collective activities and factors reducing transaction risk (Feiock & Scholz, 2010). Feiock writes, "the ICA framework integrates elements of collective action theories, transaction cost theories of organizations, the public economy framework, network theories of social embeddedness, and theories of policy design in political markets" (2013: 399).

Collaboration risk is generically embedded in voluntary exchanges, reflecting the property of the problem, institutional arrangements, and transaction costs in the face of uncertainty and vulnerability (Feiock, 2013). The problems of incoordination (inaction), division (division of costs), and defection (violations of agreements) create transaction risk. Coordination problems emerge when the interconnectedness of activities is necessary for the success of complex tasks, but the likelihood of incoordination risk increases if a heterogeneous or broad array of collective action is to be taken. In order to resolve incomplete or asymmetrical problems, a more encompassing mechanism is required (Andrew & Kendra, 2012). Division problems arise when the consensus or allocation suffers from vagueness despite agreement on

goals. Because rational actors take action for individual gains, instead of collective gains, over costs, the perception of fairness and transaction costs as well as actual expenses must be incorporated. Division costs are subject to the number of actors, functions, or policies, engendering multiple equilibriums of Pareto efficiency. Defection problems occur when opportunistic participants violate mutual agreement obligations, and noncompliance behavior is problematic when one's betrayal puts other participants in a worse condition, although more gains accrue to the renegade.

Collaboration risk encompasses participants' assessment of the possibility that their efforts on collective action will likely fail to produce joint action or fail to effectively resolve ICA dilemmas and manifests these three categories (Feiock, 2013). The mechanism of relational exchange in collaboration risk captures the costs of transactional uncertainty, and an increase in the extent of transaction costs differs from the nature of collaboration and institutional arrangement. Under the general proposition of ICA that "[i]ncentives to participate will favor the type of mechanism that provides the greatest gain for the least cost" (Feiock, 2013: 408), the costs reflecting collaboration risk can be minimized when the range of collective action is confined and enforcement is carried out in embedded social relations.

Embeddedness

Embeddedness, as initially formulated by Granovetter (1985), is "a property of structures in which actors that are integrated in cohesive clusters or multiplex relations of social networks face different sets of opportunities and constraints than those who lack such connections or encumbrances" (White et al., 2004: 98). It stresses structures of dependent relations with others generating trust and behavioral constraints. Actors' behavioral choices are attributed to sets of structural interactions or their named roles (Granovetter, 1985). In situated network literature based on interfunctional or intersectional collaboration, embeddedness is an influencing standpoint for developing broad social science research and theory associated with the concept of social capital. Even though it is utilized most in economic sociology (Baum & Oliver, 1992; Uzzi, 1997, 1996, 1999; Portes & Sensebrenner, 1993; Dhanara et al., 2004; Moran, 2005), the concept of embeddedness has been extensively applied in the description of criminal networks (McCarthy, Hagen, & Cohen, 1998; Baker & Faulkner 1993), public policy (Hollingsworth, &

Boyer, 1997; Knill, C., & Lenschow, 1998), and public management (Provan, Huang, & Milward, 2009; Huang, & Provan, 2007; Berry et al., 2004).

However, despite its significant influence in current research, the theoretical concept suffers from vagueness, and it has yet to be fully developed. Existing empirical studies regarding the use of the terminology of structural and relational embeddedness have not clearly clarified it, and boundaries in embeddedness are obscure, although some scholars have specified that relational embeddedness comes from quality-oriented relationships such as depth, while structural embeddedness is delineated by the configuration of a tie-connection (Moran, 2005; Dhanara et al., 2004; Uzzi, 1997; Moody & White, 2003). Beyond individual behavior, it is even harder to designate the boundaries of embeddedness in organizational collective action. Although relational and structural embeddedness influence one another, as structural position reinforces relational depth and relational embeddedness changes the configuration of network structures, they are still distinct, even at the composite actor level.

The embeddedness argument shifts toward a reliable relationship through reciprocity and mutual trust lessening relational risk or transactional uncertainty surrounding exchange and creating the likelihood of opportunities for obtaining goods from others. I define embeddedness as a property of interdependent relations in which organizations are integrated in a network, in this case an emergency management operations network. The concept of embeddedness is divided into two subsets: structural and relational embeddedness. In the context of emergency management networks, structural embeddedness reflects network-positioning opportunities for securing a redundancy route for resources; relational embeddedness captures trustworthy connections based on cohesion or reciprocal relations at the organizational level. The collaborative aspect of emergencies in particular entails much relational uncertainty and situational vulnerability, so formulating trustworthy ties among participants, establishing additional assurance on the extent of sustainable ties, and securing a reduced likelihood of betrayal are critical.

Granovetter (1985) delineates a broad orientation of embeddedness to institution theory, applying economic behavior for action between the undersocialized view that recognizes actors as socially atomized and the utilitarian tradition with its oversocialized view that recognizes actors as cultural puppets. Embeddedness offers a standpoint for criticizing neoclassical accounts, and further, with regard to the motion from an orienting statement to the concrete

hypothetical investigation, Granovetter (1992) delineates and defines the property of embeddedness:

> "Embeddedness" refers to the fact that economic action and outcomes, like all social action and outcomes, are affected by actors' dyadic (pairwise) relations and by the structure of the overall network of relations. As a shorthand, I will refer to these as the relational and the structural aspects of embeddedness. (Granovetter, 1992: 33, italics in original)

Granovetter (1992) further stipulates his idea of embeddedness as the extent that actors are involved in a structurally nested group. The degree of a dyad's mutual contacts or directional connections to each other affects information flow about what the others on a path or in a pair are doing and therefore shapes members' behavior. Cohesive groups are superior for spreading ideas, generating relational structures such as norm and culture, and formulating behavior. Simply put, the capacity of "holding together" or the sense of "weness" (Owen, 1985) are linked to embeddedness.

Granovetter's (1985) argument for the ubiquity of embeddedness in economic engagement is a precursor to the notion of social capital (Moran, 2005). Social capital is defined as a variety of entities with two features in common: "they all consist of some aspect of social structures, and they facilitate actions of actors – whether persons or corporate actors – within that structure" (Coleman, 1988: S98). Such capital is neither simply alienable nor transferable and is rather firmly bound up with the configuration of a network structure and interrelations of actors (Moran, 2005). Social capital is an indispensable asset in a contemporary society where networked social relations and interconnected collaboration prevail, and its value stems from the transmission of or access to information and physical resources at the right time (Granovetter, 1992). The extent of embeddedness in actors' relational engagement engenders different values of social capital.

Beyond the general consensus on the prominence of social capital in an actor's social embeddedness (Burt, 2000), there has been vigorous argument regarding weak ties and closure. Those that derive from forging contacts who are more or less linked to one another have drawn the most attention (Coleman, 1990; Moran, 2005; Bonacich, 1987). The possibility of the infusion of new information into a closed network group is associated with the strength of a weak tie, often called brokerage, which spans structural holes and occupies a superior position of

extensive influence (Granovetter, 1973; Burt, 1992). The interaction flow of brokerage is non-redundant and efficient, but network closure is opposite to brokerage, in that its value is generated from a redundancy that binds members tightly. Granovetter (1983: 209) refers to both strong and weak ties: "strong ties can also have value. Weak ties provide people with access to information and resources beyond those available in their own social circle; but strong ties have greater motivation to be of assistance and are typically more easily available."

Transactional linkages embedded in interrelational networks configure routes of resource transmission, and reciprocal effects of relational and institutional topologies are stressed in activities among diverse participants (White et al., 2004; Giddens, 1984). Coleman (1988; 1990), for instance, stresses the power of network closure, which produces robust collective action. It carries exchange norms and its collaborative routines are solidified. Its relational redundancy enhances the probability of conveying norms of exchange and securing resource transmission. Podolny and Baron (1997) point out that redundant ties among members are frequently recognized as a prerequisite for internalizing a reliable set of expectations that enables the behavior of actors to be effective. Despite the debate surrounding the roles of closure and brokerage, closure generated by network cohesion supports trust building, which reduces the sense of relational uncertainty surrounding exchange. Its structure mitigates the complexity of the risk of a betrayal (Uzzi, 1997). Thus, I hypothesize that:

> ***H_1:*** *The level of structural embeddedness is predicted to have a negative effect on the level of collaboration risk.*
>
> > ***H_{1-1}:*** *The level of in-closeness centrality has a negative effect on the level of collaboration risk.*
> >
> > ***H_{1-2}:*** *The level of out-closeness centrality has a negative effect on the level of collaboration risk.*

> ***H_2:*** *The level of relational embeddedness is predicted to have a negative effect on the level of collaboration risk.*
>
> > ***H_{2-1}:*** *The level of reciprocity has a negative effect on the level of collaboration risk.*

H_{2-2}: *The level of the clustering coefficient has a negative effect on the level of collaboration risk.*

Networked Emergency Management in Seoul, South Korea

The Seoul metropolitan area is one of the most populated and urbanized areas in the world. Urban areas have features that are distinct from rural or suburban areas: densely placed buildings including skyscrapers, high population density, and infrastructure on a larger scale (Song & Jung, 2015). Depending on urban conditions, the same emergency can have a completely different effect: either a disaster or an accident. Put differently, although the larger scale of infrastructure and technological systems enhance the capacity of disaster response, high population density causes vulnerability to the impact of emergencies. Further, the possibility of restructuring old cities is considerably limited once they are constructed, thanks to property rights constraints.

Effective emergency management is essential for mitigating the impact of and recovery from disasters under physical urban constraints, due to the vulnerability that comes with being highly populated. No single organization can completely deal with all emergencies, but networked emergency groups can operate comprehensively. A disaster context demands that collaborative groups be more efficient: quick and reliable. The Seoul emergency network system is composed of a three-tier structure (i.e., national, provincial, and local governments). National-level organizations mainly take a coordination role across the fragmented authorities and comprehensive emergency management operation (i.e., mitigation, preparedness, response, and recovery). Province-level organizations take a bridging or intermediary role, binding national and local organizations. The response capacity of local-level organizations as initial responders determines primary loss or damage in local areas.

The disaster operations of emergency management organizations follow the the Disaster and Public Safety Basic Act enacted in 2004. It delineates the main authority of disaster operation as the responsibility of the national government. Since 2004, the Basic Act has been successively amended to embrace broader actors for better and more organized response and even stipulates the role of citizens as a principal of the city and nation. Structurally, interorganizational cooperation and coordination are stressed (Song & Jung, 2015). The operational authorities of disaster management have been constantly and vigorously delegated to

local or municipalities since the aftermath of 2011 Seoul Floods, but it is still far behind such a fully locally oriented operation as the US system (Ha & Ann, 2009).

Research Design and Methods

Models and Refinement

The ordinary least squares (OLS) method was utilized to investigate whether the network embeddedness generated by emergency management stakeholders has an influence on the level of perceived collaboration risk. The concept of collaboration risk derives from the existence of relational transaction costs, which are distinguishable from the concept of economic transaction costs. It embraces a larger range of transaction costs than the previous literature could cover, and arguments concerning collaboration risk embedded in ICA have been yet to be empirically developed. As a continuous outcome variable, a single collaboration risk index was created based on three sub-dimensions for an empirical testing of the relations with embeddedness.

Despite the lack of empirical testing of collaboration risk, the literature on network social position has been considerably well explored. Social position calculated from structural analysis in networks is engaged in the property of embeddedness in networks, driven from a relational structure (Burt, 2005; Andrew & Carr, 2013). The theoretical variables of embeddedness in this study were measured by the concepts of centrality and cohesion: the index of in- and out-closeness centrality (Burt, 2005; Andrew & Carr, 2013; Andew et al., 2015; Jung & Song, 2014), the reciprocity that provides the number of mutual ties each ego forges (Borgatti et al., 2002), and the clustering coefficient, reflecting the mean of the densities of each actor's neighborhood (Watts, 1999). Those network variables were generated by utilizing the centrality and cohesion routines in UCINET 6.0 (Borgatti, Everett, & Freeman, 2002).

The socio-demographics and environmental features were controlled to reflect the extent of social and environmental vulnerability (Cutter et al., 2008), and the operational capacity of emergency management organizations was set as a control variable (Jung & Song, 2014; Kendra & Wachtendorf, 2003). Based on the independent variables, I generated two separate full models, namely a structural embeddedness model and a relational embeddedness model. The proposed models are as follows:

(1) $C_R = \beta_0 + \beta_1 C_{in} + \beta_2 C_{out} + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon$

(2) $C_R = \beta_0 + \beta_1 C_{reci} + \beta_2 C_{clus} + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon$

where

C_R is a measure of collaboration risk index in an emergency network, ranging from 0 to 100;
C_{in} is a vector of in-closeness centrality;
C_{out} is a vector of out-closeness centrality;
C_{reci} is a vector of reciprocity;
C_{clus} is a vector of the clustering coefficient;
X_3 is a ratio of population over 65;
X_4 is a dummy variable for riverside;
X_5 is a ratio of public safety expenditure;
X_6 is a dummy variable for the emergency management department;
ε is an error term; and
β_i are estimable parameters.

According to Coleman (1990), social capital is sensitive to the uncertainty of its surroundings. This implies that embeddedness can derail the pattern or method of regular collaboration through exogenous shock (Uzzi, 1997). In the face of vulnerability and relational risk, tightly binding to one another, creating trust, creates durable relations. Further, the collaboration risk affecting organizational behavior is not simple but complex, particularly in interconnected emergency management relations, in that emergencies occur at an unexpected moment but requires an intensified response effort at once, using a scarcity of resources. Relational risk therefore entails huge transaction costs compared to other public services when the uncertainty of exchange is directly associated with safety of life and property. In other words, regarding actors' rational choice, transaction costs are already embedded in the set of collaboration risks, and the extent of embeddedness reduces the likelihood of betraying partners and transactional uncertainty.

Based on centrality and cohesion measures, embeddedness, namely structural and relational embeddedness, is captured in the models by in-closeness centrality, out-closeness centrality, the amount of reciprocity, and the clustering coefficient. Beyond the path through brokerage, the emergency context recognizes the importance of redundancy in reaching or receiving benefits from all members during disaster responses. I particularly consider that reachability of all with in- and out-closeness centrality captures structural embeddedness. Additionally, the number of reciprocated ties and the degree of cohesion (clustering coefficient)

can be an indicator of relational embeddedness. The measure of reciprocity captures the number of mutual connections each actor establishes with others that increase the likelihood of trust building and close exchange. The high number of clique-like neighborhoods indicates that actors are embedded in strongly clustered neighborhoods (Watts, 1999), so I also adopt the value of the clustering coefficient as another measurement of relational embeddedness.

Each model includes exogenous vulnerability effects and the internal capabilities of emergency management organizations. The seniority ratio captures social vulnerability; the geographical feature riverside measures environmental vulnerability. Financial capacity is measured by public safety expenditures over total expenditures; personnel capability is captured by the existence of an emergency management department. The two models were generated in order to investigate the relations between collaboration risk and embeddedness.

Data Collection

This study systematically investigated the effect of embeddedness on the level of collaboration risk using the data from the 2015 Seoul Emergency Management Network survey in South Korea. This network data collected in February 2015 were based on 2014 performance in emergencies. The stakeholders of emergencies in the Seoul Metropolitan Area were identified using a snowball sampling method. Our survey was in the third wave, and the primary registration of emergency management organizations was completed in May 2012, taking data from 25 local governments in urban areas, which were asked to identify three institutions that were frequently collaborated with during disasters. The final register of collaborative networks listed 94 organizations, including all levels of government and agencies, as well as non-governmental organizations (NGOs). The response rate for the 2015 follow-up list was 73.4%; 69 of 94 organizations completed the 2015 survey.

Table 1 Concepts, Measures, and Data Sources

Variable	Concept	Measurement	Sources
Collaboration risk index	Collaboration risk	Collaboration index score, based on three dimensions, ranging from 0 to 100	2015 Seoul EM survey
In-closeness	Structural embeddedness	In-closeness centrality	2015 Seoul EM survey
Out-closeness	Structural embeddedness	Out-closeness centrality	2015 Seoul EM survey
Reciprocity	Relational embeddedness	The number of mutual ties ego forges	2015 Seoul EM survey
Clustering coefficient	Relational embeddedness	Clustering coefficient	2015 Seoul EM survey
Ratio of over 65	Social vulnerability	The ratio of population over 65 years old to the total population	2014 government census
Riverside	Environmental vulnerability	Coded 1 if the jurisdiction is adjacent to the riverside, otherwise 0	
Ration of safety Expenditures	Financial capacity	The ratio of net safety expenditures	2014 government finance yearbook
EM department	Institutional capacity	Coded 1 if an organization has a specialized EM department, otherwise 0	

The units of analysis in this study were organizations involved in Seoul emergency response, and the emergency collaboration network consists of 69 organizations that are functionally and hierarchically diverse. In more detail, 22 local governments, 17 fire stations, and 16 police stations are involved in emergency response at the local level. Metropolitan city-level responders include the Seoul Metropolitan Government, the Seoul Metropolitan Fire & Disaster Headquarters, the Seoul Emergency Operations Center, and the Seoul Metropolitan Police Agency. National-level organizations include the Ministry of Safety and Public Administration, the National Emergency Management Agency, the Ministry of Land, Infrastructure, and Transportation, and the Ministry of National Defense. The remaining six organizations are NGOs (see Table 2).

Table 2 Respondent in Seoul Emergency Management, South Korea

Organizational Types	Frequency	Percent(%)
Local government	22	32
Fire station	17	25
Police station	16	23
Metropolitan-level government	4	6
National-level government	4	6
Non-governmental organization	6	9
TOTAL	69	100

Although the emergency-operations system in South Korea has consistently been devolved to local-oriented authorities, greater delegation is still demanded, to the point of being fully autonomous in locally initiated response (Ha & Ann, 2009). Since the Seoul enforcement ordinance for emergency management was amended in 2012, local governments have gradually modified their municipal ordinances in accordance with it (Song & Jung, 2015). These legal efforts for locally oriented operations can facilitate an effective response from the initial impact of disasters. This does not mean less aid or support from the national government.

Collaboration Risk Index

A survey questionnaire was utilized to measure respondents' perceived collaboration risk, captured in three dimensions: coordination, division, and defection risk (Feiock, 2013). Despite

vigorous investigation of the unfolding theoretical consideration of collaboration risk embedded in collaborative management, the empirical testing of such dimensions has yet to be systematically explored. Working with Feiock and other scholars in this field, I specifically designed the statements in the survey to operationalize the concept of collaboration risk.

The complexity of collective tasks undertaken by the broad range of composite actors contributes to increasing coordination problems. The question on coordination captured the existence of intention or interest to follow through and keep commitments to others. Division problems occur when either composite gains do not ensure that all individuals are better off or there is a difficulty of distributing or dividing benefits gained (Steinacker, 2004). In the question associated with division, respondents were asked about the perceived equality of a distribution produced by collective action. Defection risk is driven by the possibility of a betrayal from one participant that leads to a worse condition for others. It captures the cost when the collaborative partners betray them (see Table 3).

Table 3 Collaboration Risk Index

Dimensions of collaboration risk*	**Survey question**
Coordination	1–1. It is almost always in the interest of all collaborative organizations to follow through with and keep their commitments to their collaboration partners
	1–2. It is almost always in the interest of all collaborative organizations to be willing to sustain a long-term relationship with their collaboration partners
Division	2. The division of the costs of benefits among participants in collaboration is generally unequal
Defection	3–1. There are strong incentives for collaboration partners to abandon their agreements
	3–2. Collaboration partners typically honor their obligations to each other even when it does not benefit themselves

* Adopted from Feiock (2013)
* Because the questionnaire was in Korean the translated English phrasing may be awkward.
* Note: 1–1, 1–2, and 3–2 are reversely coded.

Each respondent was asked to answer the five questions for creating a single indicator of collaboration risk on 5-point Likert scale ranging from 1, “not at all” to 5, “very much”. The scores for the three dimensions were recoded, ranging from 0 to 4. Then the five elements were

summed and divided by 20, which is the maximum possible score, in order to create a single index for each respondent. Then each score was multiplied by 100, making an index ranging from 0 to 100. Higher index scores show organizations perceiving a higher level of relational risk when engaged in collaboration. Based on the four statements in the survey, the internal reliability estimation of collaboration risk shows a relatively high value (Cronbach's $\alpha = .829$).

Embeddedness Measures

Four measurements for interrelational embeddedness were considered: in-closeness centrality, out-closeness centrality, reciprocity, and the clustering coefficient (i.e., the mean density of the actor's neighborhood). Existing empirical studies have often used betweenness centrality for measuring weak ties with privileged access to novel resources (Burt, 2005; Andrew & Carr, 2013; Granovetter, 1973), but considering the uniqueness of the emergency management context, I adopted measures of in-closeness and out-closeness centrality, which capture the minimum geodesic path to all other organizations in collaborative networks. In emergencies, the redundant exchange of resources is frequently valuable, and the reachability of all the other actors is often critical for effective response. The measure of in-closeness centrality captures the shortest receiver distance from all the others; the measure of out-closeness centrality captures the shortest sender distance to all the others. In order to acquire in- and out-closeness centrality scores, network analysis was conducted using UCINET 6.0 (Borgatti, Everett, & Freeman, 2002), which computes both values separately for a non-symmetric matrix. In the directed graph, the geodesic path between two nodes can differ depending on the nodal order (e.g., the value of $d(n_i, n_j)$ might not be the same as that of $d(n_j, n_i)$). The formula for closeness centrality is presented below.

• Closeness centrality: $C_c(n_i) = [\sum_{j=1}^{g} d(n_i, n_j (i \neq j))]^{-1}$

I also utilized reciprocity and the clustering coefficient to capture relational embeddedness. The number of connections to and from an actor is a primitive but important indicator of how actors are structurally and relationally embedded in a network. Building trust or holding together relationships begins with forging ties with others. The reciprocity measure captures the number of mutual ties each ego forges.

• Reciprocity: $R = \Sigma_{i<j} y_{ij} y_{ji}$

The clustering coefficient captures the extent to which one's collaborators are also collaborators for each other (Watts & Strogatz, 1998), so I utilized the clustering coefficient value to measure the mean of densities of the neighborhood.

• Clustering coefficient: $C_i = \frac{number\ of\ neighborhood\ connected\ by\ edges}{number\ of\ neighborhood}$

Results and Discussion

Table 4 reports the descriptive statistics of the models.

I utilized OLS analysis to estimate the effects of embeddedness on the perceived level of collaboration risk. Table 5 presents the results of OLS analysis. Each column in Table 5 represents two separate sub-models that incorporate different combinations of the independent variables. The first column reports the structural embeddedness effects and the second column presents results from the relational model. Both include vulnerability-engaged variables, namely social vulnerability and environmental vulnerability, and organizational capacity-engaged variables, namely financial and personnel capacity. Those two models include embeddedness effects that are delineated more specifically below.

Table 4 Descriptive Statistics

Variable	N	Mean	Std. Deviation	Minimum	Maximum
Collaboration risk index	69	26.159	14.707	0	55
In-closeness	69	5.641	.099	5.42	5.969
Out-closeness	69	48.144	18.542	1.064	93.939
Reciprocity	69	4.826	5.657	0	32
Clustering coefficient	69	.356	.099	.074	.527
Ratio of over 65	69	12.255	1.538	9.679	15.023
Riverside	69	.435	.499	0	1
Ration of safety expenditures	69	.556	.486	.089	2.493
EM department	69	.536	.502	0	1

Table 5 Analysis Results of the OLS

	Model 1 (Structural Embeddedness Model)	Model 2 (Relational Embeddedness Model)
In-closeness	−45.381**	
Out-closeness	−.347***	
Reciprocity		−.908***
Clustering coefficient		5.903
Ratio of over 65	−.243	−.208
Riverside	−6.640*	−6.639
Ratio of safety expenditure	−1.308	−1.657
EM department	10.946*	11.385**
Intercept	299.598**	28.686
N	69	69
F	2.61	4.22
R-squared	.211	.238

*$p < .10$; ** $p < .05$; *** $p < .01$
*Robust standard error adjusted

Noteworthy results are evident from Table 5. First, different properties of embeddedness have negative effects on the collaboration risk level. In other words, the coefficient of reachability to all others with a short path is significant in affecting the perceived level of collaboration risk; the level of reciprocity is statistically significant. I hypothesized a significant relation between structural embeddedness measured by in- and out-closeness centrality and the level of collaboration risk. There is an inverse relation between them. The number of mutual ties representing reciprocity is significant and there is a negative relationship with the level of collaboration risk. In other words, higher levels of structural embeddedness and relational embeddedness significantly lowered the perceived level of collaboration risk in emergency management networks (models 1 and 2).

Structural embeddedness has an influence on mitigating collaboration risk in networked emergency management. An inverse relationship was hypothesized, and the results of the test confirm this: in-closeness centrality was significant at a 0.05 significance level and so was out-closeness centrality, at a 0.01 significance level. These are interesting results, in that the importance of redundancy for reaching or receiving from the actors in the networks reflects the unique property of disaster response operations. In- and out-closeness centrality estimates the shortest geodesic

path to all organizations, reflecting the structural connectivity of emergency management, which requires redundant relations for golden-time response and functionally multiple collaboration at the same time. In such a high-risk situation, securing diverse but shorter paths to be connected with all partners reduces the level of collaboration risk that comes when cooperating with other organizations.

Relational embeddedness has an influence on lessening collaboration risk in emergency management networks. In other words, cohesion based on reciprocity helps mitigate the relational risk that the ego perceives. Put differently, organizations with higher numbers of mutual ties are less likely to perceive risk in collaborating with others. Reciprocity is significant at the 0.01 significance level. Relational embeddedness secures trusting and stable relations, confident of being less likely to be betrayed, and it causes normative patterns of action (Powell & DiMaggio, 1991) and brings thicker information to partner organizations (Larson, 1992; Helper, 1990). However, the clustering coefficient had no effect on actors' perception of collaboration risk, although the mean densities of an actor's neighbors was hypothesized to be significant. This implies that the number of reciprocated ties matters but not the cohesion of each actor's neighborhood when establishing networked emergency management.

Third, the factors of organizational capacity partly relate to the level of collaboration risk. The results of both models show that financial capacity regarding the ratio of safety expenditure over the total is insignificant, while the existence of an emergency department is statistically significant. The higher internal capacity an organization holds, the lesser incentives they have for collaboration risk. Differently put, organizations that already have well-organized and professional departments for dealing with disasters and emergencies in their sub-divisions are more likely to recognize a higher relational risk in collective action. Organizations with the confident capacity of handing emergency situations may be reluctant to take on relational risk, as they perceive it coming at a high cost.

Fourth, the vulnerability factor seems to have an influence on the level of collaboration risk. I measured social vulnerability and environmental vulnerability separately, and only environmental vulnerability captured by riverside areas is statistically significant at the 0.10 significance level. Each jurisdiction knows its own vulnerability best, and so the understanding of local geographic features leads to taking more active collective action. Collaboration with other organizations can

relieve their risk level, although relational risk occurs. Simply put, higher levels of vulnerability induce organizations to perceive collaboration risk less.

Conclusion

An implication of the findings is that embeddedness, both structural and relational embeddedness, reduces the risk of collective action. An institutional collective action framework delineates a significant standpoint for understanding joint mechanisms implemented by fragmented authorities in network topologies. Interacting with other authorities regardless of how similar organizations are in function and condition generates relational risk engendered by the uncertainty of exchange among participants. The effort to resolve ICA dilemmas begins with the recognition of interdependencies and the understanding of rational actors who only consider mutual benefits over the costs (Feiock, 2013). In order to reduce the transactional risk that occurs in collaboration, participants were predicted as formulating embedding relationships in a networked structure. This study examines the effect of embeddedness on the perceived risk level for interorganizational collaboration, in accordance with the ICA dilemma.

Stated directly, this study found that structural and relational embeddedness are effective in mitigating the perception of collaboration risk where one of the relational embeddedness variables has no relation with the risk level. The redundant reachability of either from or to all the others is statistically significant. Tight-binding relationships based upon reciprocity in a network are useful elements to relieve the risk level. Beyond individual behavior, structural and relational embeddedness affect organizational attitudes to collective action. The possibility of reachability through redundancy secures the level of collaboration and the strong belief that the organization will not be betrayed or be forced to make a substitution in an urgent situation. Additionally, reciprocated relations with others enhances the willingness to collaborate. Trust building and a sense of holding together (Moody & White, 2003) are generated through direct interaction, and this formation of close relations is more likely to facilitate reliable exchange (Coleman, 1990).

This study makes four contributions to the literature on institutional collective action and organizational embeddedness. First, I investigate and expand the empirical evidence for embeddedness at the organizational level. The prevailing extant literature

focuses on individuals, but organizational interactions across functions and jurisdictions through networks have constantly increased. Despite offering a useful standpoint for social capital literature, embeddedness still suffers from a theoretical ambiguity (Portes & Sensenbrenner, 1993). Uzzi (1997, 1996, 1999), for instance, classifies embeddedness into two groups, namely structural and relational embeddedness, depending on arm's length ties and embedded ties; the distinction derives from the depth of relations at the individual level. In interorganizational interaction embedded in a network it is hard to capture the depth of trust and the proximity of relations; organizational reciprocity or neighborhood relations at least reveal the effort put into building relations with other participants. I therefore captured structural embeddedness with measures of in- and out-closeness centrality; I captured relational embeddedness with reciprocity and clustering coefficient measures.

Second, this study emphasizes the relation of embeddedness using the risk mechanism that participants recognize as a transaction cost in the face of uncertainty and vulnerability. Unlike other empirical studies that have largely worked to advance the understanding of the embeddedness effect on economic action, I focus on the role of embeddedness in the collaboration risk level that is directly associated with transactional linkage, eventually affecting the decision making of each organization.

Third, the collaboration risk embedded in the ICA has been systemically tested in this study, extending the theoretical argument for the framework. Although theories of institutional collective action have advanced my understanding of ICA problems, the concept of collaboration risk engendered from relational uncertainty has yet to be systemically tested. It is a core mechanism of explaining why actors participate in joint networks, and the level of relations risk affects transaction costs that a rational actor estimates by comparing to mutual benefits from collaboration. Based on the three dimensions of Feiock (2013), I calculated an index measure using the perception of organizations in emergency management networks.

Finally, the results of vulnerability and organizational capacity give practical insight into emergency management literature. Beyond the level of embeddedness, the relative level of exogenous vulnerability affects the level of tolerance for collaboration risk. The more vulnerable the jurisdiction, the less the participant perceives transactional risk with others. In the same vein, organizational capacity has a negative influence on collaboration risk. The better the professional emergency

department is, the less incentive organizations have to take a relational risk in joining collaborative networks.

Despite its implications for theory and practice, this study has several limitations. In terms of measuring the level of collaboration risk based on theoretical background, it is still in a nascent stage and somewhat crude. While I have tried to refine and redefine the concept of embeddedness and selected measurements for capturing relational and structural embeddedness in the light of the emergency management context, this needs to be improved in future study. Results from Korean emergency management may not be generalizable and may not apply to the US context, for instance.

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