Embeddedness in cross-agency collaboration and emergency management capability: Evidence from Shanghai's urban contingency plans

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ABSTRACT

Governments are increasingly emphasizing emergency management in response to public emergencies that cause extensive consequences and involve multiple government agencies. One of the influential measures adopted by governments is the establishment of cross-agency networks. Scholars have validated the importance of cross-agency collaboration and networks, but only a few studies have examined cross-agency information sharing and utilization mechanism of joint emergency actions. Inspired by the theory of network embeddedness, we study the joint effects of informational and task attributes of embeddedness and absorptive capacity of the leading agency on collaborative emergency capacity. Our data consist of 110 local government contingency plans collected from F District in Shanghai, China. We found that a well-structured cross-agency network and a leading department with great information accessibility will significantly affect the efficiency of emergency collaborations. The capacity to absorb information significantly enhances the improvement of emergency collaboration.

1. Introduction

The underlying factors that affect the unpreparedness and ineffectiveness of local government authorities during emergency responses are identified in this section. Xiong (2010) indicated key points of current problems, such as unreasonable allocation of resources and power, ambiguity of duties among departments, imperfect construction of emergency response centers, and lack of community and social participation. The joint operation of resources, jurisdictional overlap, and multiple organizational participants challenges the ability of government branches to work together. The concept of collaborative emergency management originated from collaborative governance. The essence is collaboration, which means that several sectors exert joint actions in favor of public interest (Bardach, 1998). The concept of governance highlights interorganizational or cross-agency joint decisions and a series of law and regulations (Ansell & Gash, 2008). Emergency collaboration is an essential element that leads to efficient response and rescue. To respond to large public emergencies that cause extensive consequences, such as industrial accidents, government agencies have started working in formal collaborations, wherein regular emergency response centers or institutions are established for joint emergency conferences. Some big cities have integrated urban management systems and coordinative emergency response, shared information among emergency centers from the local level, and improved the allocation of emergency resources.

Cross-agency collaboration is a crucial dimension in interorganizational integration research (Kahn & Mentzer, 1996). A stream of literature has examined the influential factors of organizational performance under complex environment, such as cross-agency horizontal integration's impact on organizational output, efficiency, and flexibility (Kahn & Mentzer, 1996). A high level of organizational flexibility in taking on unplanned non-routine tasks and working with unexpected new partners can be highly desirable in performing tasks in emergency responses (Provan & Lemaire, 2012). Network flexibility in switching from centralized coordination to emergent self-organizing coordination (Berthod, Grothe-Hammer, Müller-Seitz, Raab, & Sydow, 2017) is likely to be contingent on the stages of a crisis, its ambiguity and turbulence, and shifting scope and affected populations, such as in terrorist attacks, infectious disease outbreaks, and hurricanes. Trust is necessary in these fluid situations to implement effective collective actions (Moynihan, 2009a, 2009b). Relationships among agencies in emergency management scenarios are essentially collaborative because they require multiple emergency responses and recovery organizations to work collaboratively and efficiently to address the multifaceted and cross-boundary consequences of public emergency incidents (Kapucu & Garayev, 2013). Collaborative emergency management is a process

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wherein two or more organizations take joint urgent actions through knowledge sharing, information communication, and resource integration to accomplish a temporary task (Eom, Hwang, & Kim, 2018). The essence of government emergency management is the process of collaboration, which is the highest level of interaction from the interorganizational relationship perspective (Kapucu & Garayev, 2013). The communicative and collaborative relationship among government departments is crucial to the improvement of flexibility in emergency responses (Kapucu, Arslan, & Demiroz, 2010).

Researchers and emergency managers have been seeking methods to evaluate and enhance the performance of emergency responses and the entire emergency management system. Measurements, such as response time (timeliness) and survival rates, are commonly utilized (Braun, 1993; Tengs et al., 1995). Emergency response capability creates a collaborative power to match the size and deployment speed of resources committed with the changing needs of emergency, which is critical for effective emergency responses. However, the current research designs rarely provide systematic measurements for the capability or performance of collaborative emergency management, although the importance of cross-agency coordination and information sharing in improving organization effectiveness has been long recognized (Huang, 2014). Meanwhile, a variety of relational patterns, such as dense or sparse networks, emerges from the continuous interaction and cooperation among departments (Granovetter, 1985; Kapucu & Garayev, 2013). Therefore, cross-agency relationships in emergency collaborations can be considered networks among government departments. This study draws from the network perspective and extends rich research insights from the studies on supply chain networks to collaborative emergency management.

In practice, the Chinese government has built an emergency coordinating system, which includes institutions, working mechanisms, and a legal system based on government department duties. The system reflects multiple sets of contingency plans, which are drafted and dominated by different government agencies. The content of the plans is closely related to the structure of the Chinese government and shows vertical and horizontal integration among government agencies, which forms cross-agency networks (Liu, 2012). The information conveyed through the networks ensures the validity and completeness of emergency managers' comprehension of the situation, which leads to appropriate actions (Perry & Lindell, 2003). Nevertheless, the Tiao–Kuai segmentation in all levels of Chinese government caused a malfunction in the network because Tiao and Kuai built different emergency information systems, please see Fig. 1. On the one hand, the Tiao system refers to different administrative levels with the same functionality, in which a lower bureau is not governed by the local government but by higher levels with same functionality vertically. On the other hand, the Kuai system denotes that bureaus in the horizontal level are administrated by the local government rather than the higher levels with certain functionalities. However, the emergency response process requires a unified leadership and agency collaboration across the Tiao and Kuai systems. Many leading departments of emergencies, which are derived from the Tiao system, such as fire departments, earthquake bureaus and others, are unauthorized by the higher levels to share information to other departments in the Kuai system, although they are in the same tier of the municipal government. Taking fire emergency as an example, the response requires collaboration between the fire department and municipal subordinate agencies, such as hospitals and police stations. Thus, the current contingency plans are deemed inflexible, costly, and inefficient to launch and are apt to form multi-channel management (Liu, 2012). Each related agency in charge of rescuing tasks in an emergency incident is facing strict accountability from the administration and citizens regardless of the administrative authority on the agency. As such, the embeddedness pattern between the Tiao and Kuai systems for collaborative emergency is an important research issue.

This study examines 110 contingency plans of a Chinese city and analyzes the attributes of embedded emergency collaboration networks. We focus our examination on the mechanism of how the cross-agency network structure influences collaborative emergency capability based on embeddedness theory and multilinear regression.

2. Theory and hypothesis

Scholars have realized that government emergency management and business supply chain management share an interorganizational collaboration focus, which results in the borrowing of performance metrics (Gunasekaran, Patel, & McGaughey, 2004) from the supply chain management to emergency management (Fan, 2013). In the public domain, an interorganizational network is a group of organizations that exchange information and undertake joint activities while their individual autonomy remains intact Kapucu et al., 2010. However, in the industrial domain, supply chain is a networked complex adaptive system (Carter, Rogers, & Choi, 2015), which consists of complex interconnections between multiple actors, such as suppliers, manufacturers, and distributors (Pathak, Day, Nair, Sawaya, & Kristal, 2007). In studies on supply chain, cross-actor collaboration refers to the process where multiple interdependent organizations share joint production, shipment, and delivery actions (Stank, Keller, & Daugherty, 2001). The network perspective is appropriate for studying emergency management scenarios due to the overlapping borders among government departments, businesses, and non-profits. Uncertainties and risks rapidly rise in densely populated urban environments during emergency incidents, such as infectious disease outbreaks, mass transit accidents, and terrorist attacks. Thus, public and private agencies depend on each other and establish increased interactions through information sharing and joint decisions so that resources can be shared and mutually beneficial ends can be reached. This process facilitates the indispensability of collaboration during emergency preparation, response, and recovery (Kapucu et al., 2010; Kapucu & Garayev, 2013).

This study draws from the theory of network embeddedness and insights from supply chain emergency management to study collaborative emergency management. From the perspective of emergency collaboration network, organizational actors are embedded or nested in an interorganizational network structure that comprises patterns of presence or absence of different types of interactions, such as joint training, technical assistance, and collaboration in administrative or legislative advocacy. In this manner, multiple independent government agencies and nongovernmental organizations become connected or divided (Huang, Chen, Yang, & Zou, 2019). This generic idea gained powerful traction in the supply chain research literature. A major extension is that the emergency management capacity of a supply chain is influenced by its overall structure, core enterprise's emergency management capacity, and chain-wide holistic collaboration capacity (Bellamy, Ghosh, & Hora, 2014; Zhao, Huo, Flynn, & Yeung, 2008).

2.1. Theory of embeddedness

The theory of embeddedness was proposed by Polanyi (1944) but extensively developed by Granovetter (1985). Refuting the undersocialized assumption of atomistic one-on-one competition among actors in an efficient market, researchers (Granovetter, 1985; Polanyi, 1944) have recognized that economic transactions typically occur within the context of social relationships. Thus, economic relationships, such as buying, selling, and allying, should be understood as critically determined by their embeddedness and trust in the existing network of social relationships, such as professional friends and prior relationships. Actors are embedded within a network to the extent that they have a strong record of repeated transactions with network members.

The theory of embeddedness encompasses quality-of-pairwise-tie perspective (i.e., relational embeddedness) and structural perspective on the positioning of an actor within a broad network, that is, structural embeddedness (Granovetter, 1985; Gulati, 1998). Relational
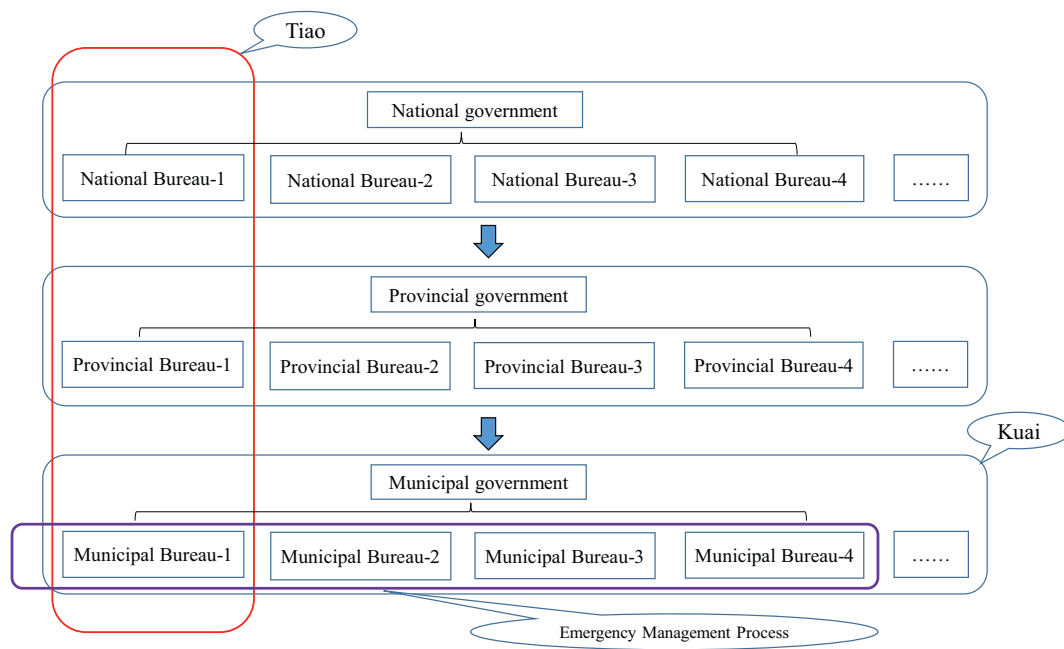
Fig. 1. Tiao–Kuai structure of the Chinese government.

embeddedness focuses on the strength of a pairwise relationship on organizational actions. The existing research shows that strong ties are important for a successful transfer of complex, tacit, and sensitive knowledge (Huang, 2014). Frequent interaction and great familiarity are associated with better communication in disaster response communication networks (Nowell & Steelman, 2014). Trust in strong ties facilitates difficult cross-boundary collaboration (Tortoriello & Krackhardt, 2010), which is common in disaster response networks (Moynihan, 2009a, 2009b). Structural embeddedness focuses on the information and control advantages accrued from a premium position in a network. It assumes that networks are a "hilly social terrain that includes aspects of hierarchy." In a hierarchical network, many organizations enjoy strategic locations and are more important for diffusing information and exerting social control. In operational terms, this concept refers to the centrality of an organization. Network centrality describes the extent to which an organization is connected to other organizations (either directly or indirectly) within the web of exchanges that comprise a network (Diani, 2002). Central organizations are more embedded in the flow of information and resources in the network compared with non-central or peripheral actors and have typically been found to have greater power. In public management research, Provan, Huang, and Milward (2009) found that in a centrally governed health and human services network, an organization's structural embeddedness in the network as measured by its centrality is strongly related to its perceived trustworthiness, reputation, and influence.

We adopt the perspective of structural embeddedness to analyze emergency collaboration network due to the hierarchical pattern of authority relationships in the Chinese government. Structure indicates the holistic characteristic of the network, such as various densities of supply chains or networks among enterprises or government departments caused by different levels or closeness of relationships (Choi & Kim, 2008; Gulati, Nohria, & Zaheer, 2000; Håkansson & Ford, 2002; Holland & Lockett, 1997). Embeddedness describes the dependence of agents on other entities and their interactions in the network (Choi & Kim, 2008, Holm, Eriksson, & Johanson, 1999). Therefore, structural embeddedness explains the difference in the action and performance of network participants caused by the various densities of nodes and tightness of relationships (Choi & Kim, 2008).

Collaborative emergency management is a form of collaborative governance with a network structure. Contingency plans regulate the manner in which leading departments engage in information sharing and joint actions with other departments and form a network with lead organization orientation. As discussed above, the interorganizational network in an emergency collaboration scenario is similar to a business supply chain network. Thus, measurements, models, and theories can be borrowed from supply chain studies. The private sector focuses on the performance of the supply chain, such as customer query time and cost (Gunasekaran et al., 2004). By contrast, the government is concerned about the capacity to achieve network effectiveness at the community level (Provan and Milward, 2001), such as public perceptions that life and property loss are minimized through timely evacuation in emergency collaborations, which we refer to as collaborative emergency capability.

However, adequate genuine objective data of the effect of emergency collaborations are difficult to obtain because they involve evaluation after an incident occurs. Contingency plans contain pre-arrangements for emergency response procedures and serve as the benchmark for government emergency collaborations. Therefore, we can safely assume that good-quality contingency plans are a result of increased government investments in drawing up documents, which improves performance in actual emergency works. Thus, collaborative emergency capability can be assessed through an in-depth analysis of contingency plans.

The existing literature overlooked the proper measurements of collaborative emergency capacity. Thus, we borrow measurements for business collaboration performance in the supply chain management research. The four important dimensions for business supply chain performance are cost of resources, output, timeliness, and flexibility (Gunasekaran et al., 2004; Okongwu, Deschamps, Lauras, & François, 2011). The cost of resources in the emergency rescue process is a nonsignificant issue to the government compared with the urgency of securing public safety (Fan, 2013). Thus, measuring emergency management should consider the efficiency of collaborative actions (output and timeliness combined) and the flexibility of such actions. In operational terms, efficiency is the capability of a contingency plan to provide timely responses and reliable emergency response services (Gunasekaran et al., 2004). Furthermore, flexibility is the ability of a plan to adjust to the complex emergency environment and exhibit proper reactions (Karimi, Somers, & Gupta, 2004).
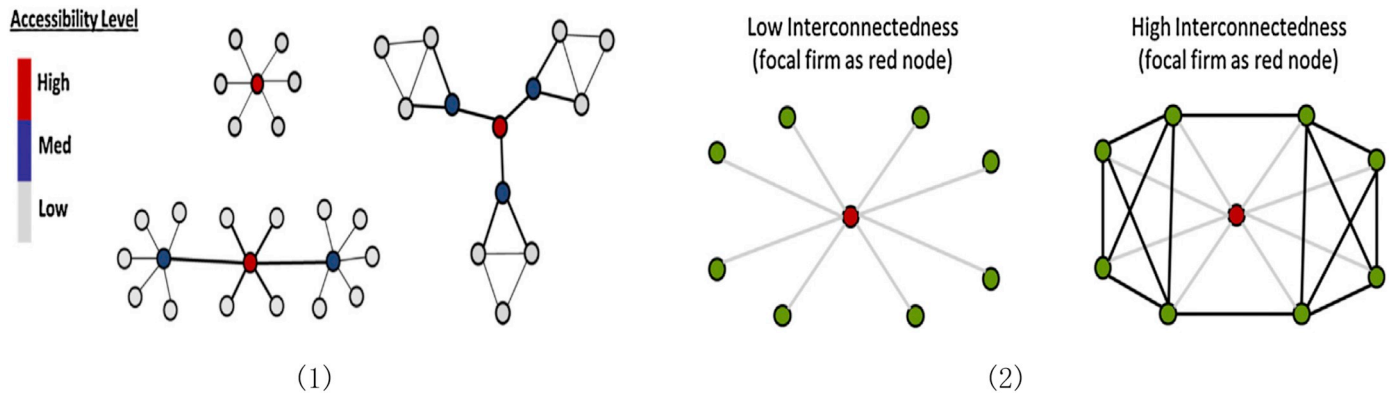
Fig. 2. Accessibility and interconnectedness.

2.2. Hypotheses

The emergency response system has a network structure, where all concerned departments are embedded. The explanatory framework of the present study is based on the study of Bellamy et al. (2014), which specified that cross-agency network embeddedness has two attributes, namely, information accessibility and information connectedness. Information accessibility refers to the capacity of a department in accessing necessary information and knowledge through other members in the network, such as members with indirect relations. Information connectedness is the interconnectedness of the core department and its direct partners, which is measured by shared connections among partners. Fig. 2 presented the levels of accessibility and interconnectedness.

(1) Impact of information accessibility on collaborative emergency capability

Within an emergency collaboration plan, increased interactions among departments indicate additional information flows in the network and quick transfer of information. The plan has many specific positions that allow corresponding departments (e.g., the leading department) to obtain a high level of accessibility in the network to ensure that they can rapidly spread and gather information (Schilling & Phelps, 2007). Departments with extensive connections are usually called central departments (Kim, Choi, Yan, & Dooley, 2011). According to previous studies, information sharing in supply networks will benefit the network at the operational level, for example, lowering the cost of supply chain, shrinking delivery time (Cachon & Fisher, 2000), and reducing the cost of inventory and stock-outs (Lee, So, & Tang, 2000). Therefore, the center department and its partners in the network in emergency collaboration scenarios will benefit from high information accessibility through a quick gathering of information to conduct proper and timely responsive actions. Thus, we present the following hypotheses:

H1. Information accessibility is associated with collaborative emergency capability.

H1a. High information accessibility (ACC) is associated with a positive impact on collaborative efficiency (EF).

H1b. High information accessibility (ACC) is associated with a positive impact on collaborative flexibility (FL).

(2) Impact of information connectedness on collaborative emergency capability

Information accessibility reflects the effectiveness of a firm to obtain information and knowledge through supply chain networks, and information connectedness indicates the potential information and knowledge resources embedded in the shared relations between a firm and its partners. The connections and interactions among partners in a network can promote the performance of the plan as tight relationships enhance communication, establish common norms, and limit opportunistic actions (Burt, 2009). Inkpen and Tsang (2005) indicated that interconnectedness formed using multiple levels of shared information facilitates knowledge and information exchanges among firms and thereby enhances the flow of knowledge and information among them. Partners will benefit from the high level of interconnectedness through in-depth collaboration, resource, and potential of problem solving, all of which are conducted in tightly connected subgroups (Ahuja, 2000; Henning, 2018; Schilling & Phelps, 2007). Furthermore, several redundant connections will enable the firm to verify the reliability of information from its partners (Ingram and Roberts, 2000). Hence, we propose the following hypotheses:

H2. Information connectedness is associated with collaborative emergency capability.

H2a. High information interconnectedness (INTC) is associated with a positive impact on emergency collaborative efficiency.

H2b. High information interconnectedness (INTC) is associated with a positive impact on emergency collaborative flexibility.

Workflow integration reflects the extent to which leading departments perform strategic collaboration, information sharing, and business integration with other departments in the plan. From the beginning of the 21st century, systematic studies on supply chain integration gradually increased as interorganizational collaboration processes become increasingly important (Zhao et al., 2008). When a disaster strikes, a cross-organizational workflow and an integrated information system should be created to ensure an efficient rescue (Fan, 2013). Therefore, the creation of a collaborative e-government has been an important strategy to guarantee the effective delivery of public services, such as emergency responses (Dawes, 2008; Dawes, Cresswell, Commentators, Bingham, & Caudle, 2009). In the development of e-governance, the integration is divided into three dimensions, namely, strategy, system, and data (Baum & Maio, 2000). However, following the emphasis of empirical research at the initial stage of the development of e-governance, only two distinct dimensions exist in the inter-departmental integration, namely, business integration and information technology (Koh, Prybutok, & Zhang, 2008). This study combines the two dimensions to measure workflow integration as a whole given that this study was conducted in China, where e-governance remains in its early stages.

Positive strategic partnerships established by a firm and its suppliers in an integrated supply chain will help them understand and prepare for the changing demand of each other. Moreover, exchanged information allows the manufacturer to establish production plans, create products

in time, and improve delivery performance. In terms of contingency plans, information sharing and resource allocation among departments improve the distribution and use of limited public resources, thereby leading to effective and flexible responses during the emergency collaboration process. Accordingly, we cite the following hypotheses:

H3. Workflow integration is associated with collaborative emergency capability.

H3a. High workflow integration (WI) is associated with a positive impact on collaborative efficiency.

H3b. High workflow integration (WI) is associated with a positive impact on collaborative flexibility.

Emergency management requires network and organizational learning (Moynihan, 2009a, 2009b). Although network embeddedness promotes access to external knowledge, organizational learning is a crucial, yet often overlooked, step in translating new external knowledge into revised organizational actions, particularly for the central actors in a network. In this study, we examine organizational learning via the classic concept of absorptive capacity. Absorptive capacity is the ability of a firm to recognize, assimilate, exploit, and develop new information based on its original knowledge. As previously mentioned, information accessibility enables a department to obtain more information from its supply chain partners. Thus, this study proposes that improved absorptive capacity in emergency collaborations will enhance collaborative emergency capability. According to Ernst and Kim (2002), combining information accessibility and absorptive capacity is important to enable a firm to generate innovation from outside information. Absorptive capacity is also correlated to intra-organizational information sharing (Easterby Smith, Lyles, & Tsang, 2008). We take fire emergency as an example. The more necessary information that the fire department gains from hospitals and public safety departments in the network, the more emergency efficiency the collaboration promotes, provided that the fire department assimilates and integrates new information into the standard operating procedures or revises actions to meet the changing needs of the emergency. Therefore, absorptive capacity may positively moderate the relationship between information accessibility and collaborative emergency capability.

H4. Absorptive capacity enhances the relationship between information accessibility and collaborative emergency capability.

H4a. High absorptive capacity (AC) enhances the relationship between information accessibility and collaborative efficiency.

H4b. High absorptive capacity (AC) enhances the relationship between information accessibility and collaborative flexibility.

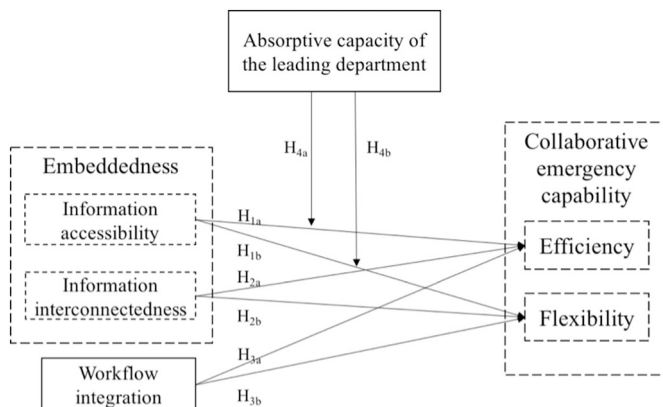Fig. 3 depicts the research framework.

Fig. 3. Framework of research framework.

3. Research method and data

3.1. Research method and process

The research subjects are government contingency plans. A standard plan is composed of the organizational structure and operational mechanism at all phases of the emergency management. It also describes the responsibilities of the concerned departments and actions to take to respond to various levels of emergencies. This study uses a mixed method (Williams & Shepherd, 2017) to analyze a research sample of 110 contingency plans of F District in Shanghai. Data were obtained from the evaluation of the contingency plans in two ways. (1) The traditional Likert scale method measures several attributes of the contingency plan using mature scales from previous studies. (2) Social network method generates attributes from the network structure of the department network in each contingency plan. The network is established by assessing the context of the plan and whether or not two departments have certain interactions, as shown in Table 1. All stated departments in an emergency management office (committee) usually have bilateral interactions with one another. On the basis of this standard, an undirected relation matrix is constructed for each network in 110 plans, where 1 indicates the existence of interactions and 0 means none. Next, the matrix is calculated using two formulas to generate the two structural attributes of the network, namely, accessibility (Stephenson & Zelen, 1989) and connectedness (Borgatti, 1997; Borgatti & Halgin, 2011). Data gathered using the Likert scale and social network matrix were combined, and a multiple linear regression model was conducted to test the proposed hypotheses. Fig. 4 illustrates the data processing procedure.

The mixed method retains the advantage of the traditional approach of subjective data gathering, which comprises a survey and a questionnaire. This method mines data from the context of contingency plans to ensure the objectiveness of network relations. For measurements that are hard to quantify with objective data, we used the Delphi method to evaluate the corresponding content in the contingency plan and eliminate the bias caused by subjective data gathering. Given that the evaluation procedures are conducted by the researcher and other experts, the possible reliability problem of traditional questionnaire surveys decreases.

3.2. Questionnaire design

On the basis of these assumptions, this study borrows mature scales that have already been used and empirically examined to construct the questionnaire. The questionnaire contains five parts, namely, basic information of the contingency plan, emergency collaboration capability, business network, absorptive capacity of the leading department, and an appendix. Table 1 provides the original scales of the questions.

To ensure the content validity of the questionnaire, we adjusted the existing mature scales to emergency scenarios. After the initial version of the questionnaire, we revised certain questions and language under the suggestion of six experts, which include civil servants, social survey experts, and emergency management scholars. We used specific terminologies in emergency management to avoid ambiguity. The subjects include 110 contingency plans from F District in Shanghai. First, three scholars specialized in emergency management carefully studied each contingency plan, and a four-round Delphi method was conducted to score each item for the explanatory variables "Absorptive Capacity (AC)," "Workflow Integration (WI)," "Accessibility (ACC)," and "Interconnectedness (INTC)" and control variables "Plan Management (PM)" and "Years in use (YR)." The values of PM, YR, INTC, and ACC are attributes that were judged and assigned by reviewing the plan. The values of AC and WI are measured using a five-level Likert scale, where officials scored each item of the two variables. Furthermore, using a three-round Delphi method, we handed over the contingency plans to three government officials and repeated the scoring process for the

Table 1
Scales of the variables.

| Variable	Concept	Measurement
Plan management (PM)	Does the leading department of this contingency plan belong to the local government system or the vertical system?	Binary variable, 0 = local government system, 1 = vertical government system
Years in use (YR)	Time duration since the first time this current version of contingency plan came into effect	Year of active time
Accessibility (ACC) Stephenson & Zelen (1989); Chen & kruskopf, 2013	Capacity of a department to gain access to necessary information and knowledge through other members in the network, including members with indirect relations	Social network matrix calculation formula (Stephenson & Zelen, 1989)
Interconnectedness (INTC) Borgatti (1997)	Shared connections among the core department and its direct partners	Social network matrix calculation formula (Borgatti, 1997)
Flexibility (FL) Verdú-Jover, Lloréns-Montes, and García-Morales (2006) and Karimi et al. (2004)	Ability of the plan to adjust to the complex emergency environment and take proper reactions against it	• The plan can quickly shift strategies. • The plan is inflexible and cannot meet the requirement of changing emergency demands. • The plan enhances the capacity of the leading department to adapt and respond to changing emergency demands. • The plan enables the leading department to adapt and adjust well to the times when working performance is bad.
Efficiency (EF) Gunasekaran et al. (2004)	Capability of the emergency collaboration to respond in time and provide reliable emergency response services	• How does the plan perform in improving the quality of emergency services? • How does the plan perform in improving the timeliness of emergency services? • How does the plan perform in enriching information? • How does the plan perform in improving reliability?
Workflow Integration (WI) Narasimhan and Kim (2002) and Flynn, Huo, and Zhao (2010)	Extent to which the leading department carries out strategic collaboration, information sharing, and business integration with other departments in the plan	• To what extent does the leading department use information technology to accomplish information sharing with other departments? • To what extent does the leading department collaborate with other departments on a strategic level? • To what extent do other departments participate in making contingency plans?
Absorptive Capacity (AC) Jansen, van den Bosch, and Volberda (2005)	Ability of the organization to recognize, assimilate, exploit, and develop new information on the basis of its original knowledge	• The changing emergency circumstances are usually considered in preparation for new emergency response actions. • Staff record and save newly obtained information to react in the case of future emergencies. • The plan will realize the utility of external information and knowledge. • The contingency plan clearly states the role and responsibility of every department involved in corresponding emergency situations. • The leading department of this contingency plan constantly aims to optimize the utility of information. • The leading department of this contingency plan cannot respond well to new situations.
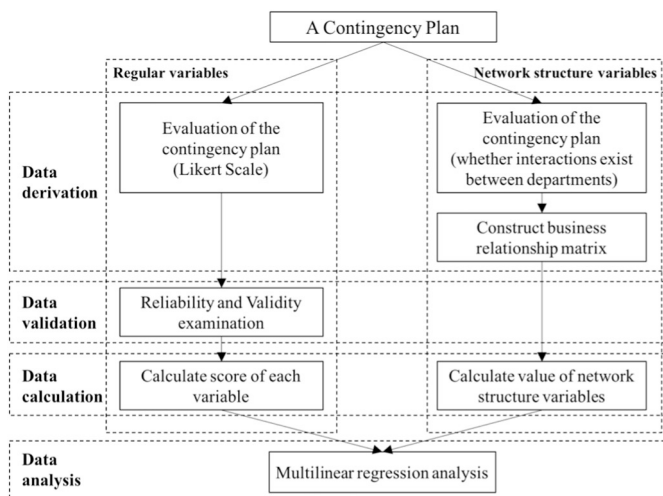
Fig. 4. Data processing procedure.

dependent variables "Efficiency (EF)" and "Flexibility (FL)" in each plan. Officials are in charge of emergency duty of the district and evaluate the quality of submitted plans yearly. Therefore, EF and FL are

the expected values of each plan that the local government desires and examines and are measured using a five-level Likert scale, where officials had to reach an agreement for each item of the two dependent variables. Their anonymous responses are aggregated and shared with three experts after each round. The experts are allowed to adjust their answers in subsequent rounds on the basis of their interpretation of "expert response" that has been provided. The final value is reached on a five-level Likert value of a single contingency case after a maximum of three rounds. Next, we finalized the score of each question in each questionnaire and matched the control variables, independent, and dependent variables. Eventually, we obtained one scored questionnaire, including one department relation matrix for each contingency plan.

4. Empirical analyses

4.1. Sample description

The contingency plans analyzed in this study comprise town-level general contingency plans and hazard-based specific contingency plans (i.e., flooding, typhoon, landslides, severe weather, pandemic, and bird flu). Table 2 presents the basic descriptions. In the 110 plans, eight are town-level general contingency plans, and others are incident- or department-based specific contingency plans, most of which are locally governed. Only three are vertically governed. The mean year of

Table 2

Descriptive statistics of the contingency plans.

Variable	Mean (St. Dev.)	Attribute	Count	Percentage
Contingency plan category	–	General	8	7.27%
	–	Specific	102	92.73%
Plan management	–	Locally governed	107	97.27%
	–	Vertically governed	3	2.72%
Year of existence	2.87 (2.393)	–	–	–

Table 3

Factor loadings and reliabilities of variables.

Variable	Factor loading	Cronbach's Alpha (AVE)
ACC	–	–
FL	0.823***	0.767 (0.589)
	0.736***	
	0.759***	
	0.748***	
EF	0.749***	0.763 (0.584)
	0.780***	
	0.766***	
	0.761***	
WI	0.763***	0.712 (0.632)
	0.895***	
	0.717***	
AC	0.858***	0.902 (0.672)
	0.875***	
	0.847***	
	0.772***	
	0.815***	
	0.744***	

$p < 0.001$

existence is 2.87, which indicates that the local government has not updated the contingency plans in three years.

4.1.1. Reliability and validity examination

In terms of reliability, the data are generally reliable at a Cronbach's alpha value that is > 0.7 (Nunnally, 1994). According to the test results in Table 3, the Cronbach's alpha coefficients of all factors are > 0.70, which indicates the reliability of our dataset. In terms of validity, the data have good convergent validity at a factor loading of > 0.70 (Thompson, Higgins, & Howell, 1994). When the average variance extracted (AVE) of a variable exceeds 0.50, the statement is valid (Chin, 1998). After the test, we found that all AVEs of factors exceed 0.5 and the loadings surpass 0.70. Therefore, the data have good convergent validity.

In the discriminant validity test, if the square root of AVE of one factor is greater than the correlation coefficients between that factor and others, then the factor is discriminant (Fornell & Larcker, 1981). In Table 4, the numbers in boldface are the square root of AVEs and the rest are the mean of each variable and the correlation coefficient between the variables. The data have good discriminant validity among variables as the square roots of AVEs are greater than the correlation coefficient in corresponding columns. The remaining two variables, namely, information accessibility and interconnectedness, are objective

Table 4

Correlation coefficient matrix.

	Mean (St. Dev.)	AC	EF	FL	WI	ACC	INTC
AC	3.056 (0.514)	**0.820**					
EF	2.900 (0.374)	0.811	**0.764**				
FL	2.827 (0.369)	0.676	0.695	**0.767**			
WI	2.727 (0.449)	0.673	0.676	0.624	**0.795**		
ACC	2.426 (0.751)	0.547	0.505	0.411	0.434	–	
INTC	1.673 (1.236)	0.537	0.453	0.409	0.504	0.894	–

Table 5

VIF.

Factor	VIF
ACC	6.356
INTC	7.774
WI	1.58
PM	1.087
YR	1.055

network variables. Thus, the discriminant validity test does not cover them. These variables represent the capacity of the leading department to acquire information from the network, and workflow integration reflects the holistic collaboration of the entire workflow.

To validate the pre-assumptions of the linear regression analysis, we conducted a multi-collinearity test with the results shown in Table 5. The variance inflation factor (VIF) represents collinearity between variables. Small values mean less collinearity (with a minimum value of one). If the VIF is greater or equal to 10, then this value indicates that severe multi-collinearity occurs between variables. The results show collinearity between accessibility and interconnectedness but within the acceptable range (VIFs are smaller than 10).

4.1.2. Common method bias (CMB) test

This study is based on two groups of respondents who score dependent and independent variables, but the scoring system shares the same contingency plan. CMB is a systematic bias that comes from the shared variance among measured variables. It arises when they are assessed using a common method, such as the same data source or respondent, measuring environment, and project content (Siemsen, Roth, & Oliveira, 2010; Zhou & Long, 2004).

The most commonly used method to inspect bias is Hermon's single-factor test. The first extracted factor is the single method factor, which explains 45.91% (< 50%) of the variance in the sample data. Afterward, a confirmative factor analysis was conducted on Hermon's single-factor model. The results indicate that the suitability measurement ($X^2/df = 3.563$, RMSEA = 0.153, NNFI = 0.617, CFI = 0.687) of the model with only the single method factor and dependent variable is significantly different from that of the original model ($X^2/df = 1.583$, RMSEA = 0.073, NNFI = 0.837, CFI = 0.932). To verify the results, we added the single method factor into the original model and examined the goodness of fit (Flynn et al., 2010; Paulraj, Lado, & Chen, 2008), which is high ($\Delta X^2/df = -0.309$, ΔRMSEA = -0.023, ΔNNFI = 0.048, ΔCFI = 0.004). The conclusion is that common method variance did not significantly influence our results.

4.2. Hypothesis testing

After the reliability and validity tests, we conducted a regression analysis and assumption tests through SPSS 19.0 with results shown in Table 6.

4.2.1. Effect of managerial attributes and year of existence of plans on collaborative efficiency and flexibility

To pinpoint the main effect above and beyond the effect of known contributing factors, we included two control variables, namely,

Table 6
Multilinear regression model.

Variable		Efficiency			Flexibility		
		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
		Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)
Independent variables	Information accessibility		0.176* (−0.085)	−0.451*** (0.105)		−0.02 (−0.095)	−0.442** (0.139)
	Information interconnectedness		−0.031 (−0.057)	−0.049 (0.046)		−0.071 (−0.064)	−0.058 (0.060)
	Workflow integration		0.489*** (−0.071)	0.280*** (0.063)		0.393*** (−0.079)	0.253** (0.082)
Interaction effects	Accessibility × Absorptive capacity			0.175*** (0.022)			0.117*** (0.03)
Control variables	Plan management	−0.292 (0.221)	0.011 (−0.162)	0.067 (0.13)	−0.419 (0.218)	−0.127 (−0.18)	−0.090 (0.169)
	Year of existence	0.0225 (0.015)	0.024* (−0.011)	0.026** (0.009)	0.004 (0.015)	0.007 (−0.012)	0.009 (0.011)
Constant		2.843*** (0.056)	1.123*** (−0.243)	1.906*** (0.218)	2.826 (0.055)	1.667*** (−0.271)	2.194*** (0.285)
R²		0.0306	0.5226	0.6990	0.0335	0.3916	0.4732
ΔR²		0.0125	0.4996	0.6815	0.0154	0.3623	0.4425

* $p < .05$.
** $p < .01$.
*** $p < .001$.

contingency plan management and year of existence. The results presented in Table 6 show that the managerial attribute has no significant influence on either collaborative efficiency or flexibility.

The year of existence of the plan significantly influences collaborative efficiency as age indicates the familiarity and comprehension of the plan. Trainings and drills following the plan help the involved departments improve their business capability, which results in the improvement of efficiency in the collaboration plan. Flexibility, however, does not seem to be significantly influenced by the year of existence, which indicates that flexibility does not largely depend on the age of a contingency plan.

4.2.2. Effect of information accessibility and interconnectedness on collaborative emergency capability

As shown in Table 6, the regression model indicates that information accessibility has a significant and positive impact on collaborative efficiency (H1a), whereas information accessibility has no significant impact on flexibility (H1b). When the leading department is powerful in collecting information from the collaboration network, the avoidance of low efficiency due to asymmetric information is easy, which improves collaborative efficiency. Information accessibility has a negative correlation with flexibility, which is the opposite of our assumption. After the analysis, we found that high accessibility indicates the complicated relationship between departments. The network may have multiple centers, which prevents the leading department from making rapid changes in strategies, namely, flexibility. This finding corresponds to that of Bock, Opsahl, George, and Gann (2012). For example, the fire department from Tiao and emergency response center from Kuai built two information systems for emergency management. The emergency response center makes every effort to coordinate other departments in the Kuai system to gain more required information for the fire department, which greatly enhances the ability of collaborative efficiency of the fire department in leading the emergency response process. However, the fire department and emergency response center are two main nodes in the network (Fig. 2(1)). If the leading department makes fast changes to meet the needs of emergency evolution, then the coordination of the two main nodes will be slow for reacting because they are two different systems rather than a uniform system led by the fire department.

Model 2 in Table 6 shows the significant positive impact of workflow integration on collaborative efficiency (H3a). As strategic collaborations occur among government departments, managers and staff from different departments become familiar, and as their ties strengthen officially and unofficially, the communication barriers decrease during emergencies. Therefore, collaborative efficiency is improved. Similarly, if the leading department can mobilize more resources during emergencies, then they can regularly have more collaboration with other departments. The trust and familiarity cultivated through this process will enhance the executive power of the interdepartmental system and thus provide flexibility (H3b) when strategies change. Based on the aforementioned analysis, workflow integration is the macro basis of improving collaborative emergency capability. When departments work closely together, the leading department can improve the exploitation of information at the micro-level to create positive impacts on the efficiency of the entire collaboration network. For example, if the fire department carries out strategic collaboration, information sharing, and business integration with other related departments, such as hospitals, police stations, and transit authority, and cultivates trust with other agencies, then collaborative emergency capability can be improved.

Information connectedness has no impact on collaborative efficiency (H2a) and flexibility (H2b). However, it creates a redundant connectedness among departments based on the theory of embeddedness. Many connections among agencies generate complex relationships, which lead to a multi-center network. Coordinative efficiency and flexibility of the leading department with other agencies will be
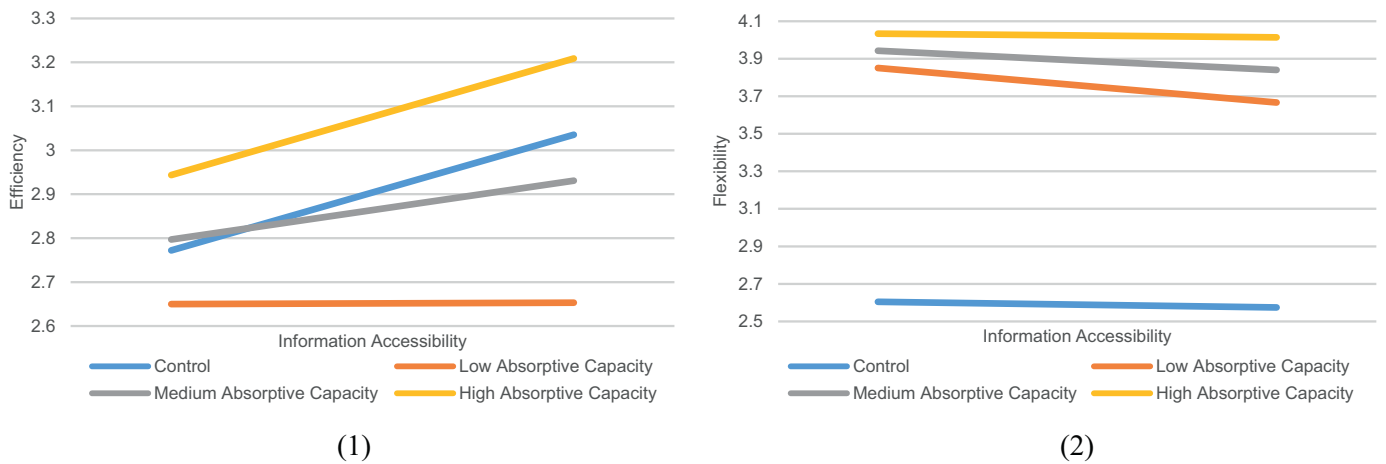
(1)

(2)

Fig. 5. Impact of interaction effect between information accessibility and absorptive capacity on collaborative emergency capability.

decreased by the complex network. If a leading department collaborates directly with other agencies without unnecessary connections, then efficient and flexible collaborative networks can also be built.

4.2.3. Moderating effect

Model 3 in Table 6 summarizes that the moderating effect of information absorptive capacity is significant, which enhances the positive impact of information accessibility on collaborative efficiency. As shown in Model 6, the interaction effect of absorptive capacity and information accessibility is significant. Thus, flexibility is significantly influenced by the interaction between information accessibility and absorptive capacity. However, we cannot claim that absorptive capacity significantly moderates the relationship between information accessibility and flexibility because the main effect of accessibility is non-significant in Model 5.

To further explain the moderation effect of information capacity, we plot the relationship between information accessibility and efficiency and flexibility under different levels of absorptive capacity. Fig. 5 shows the impact of the interaction effect of absorptive capacity and information accessibility on collaborative emergency capability. The lines in Fig. 5 are drawn by taking the mean, mean plus/minus a standard deviation of information accessibility and corresponding values of collaborative capacity.

The plan works efficiently for the emergency collaborative network that enables the leading department to acquire improved information accessibility. Moreover, Fig. 5(1) shows that the positive correlation between accessibility and efficiency strengthens as absorptive capacity increases. This finding indicates that as the leading department enhances its absorptive capacity, the collaborative efficiency of the plan improves as a whole. Interestingly, compared with the control group, efficiency decreases as we add in the moderation of absorptive capacity, and only when absorptive capacity is at a high level (mean plus a standard deviation) can efficiency surpass the control group. Therefore, we infer that the moderating variable further describes the reality

where low levels of absorptive capacity are unable to facilitate the leading department in exploiting large amounts of information to improve collaborative capacity. In actual emergency management, many factors hinder the absorptive capacity of the leading department. Such barriers include the fact that data resources are physically scattered among various departments in the Tiao and Kuai systems. Therefore, the leading departments face difficulty in absorbing valuable information from the data, and distortion occurs during data transfer. Fig. 5(2) shows that information accessibility has a negative correlation with flexibility. However, as absorptive capacity increases, the negative relationship between accessibility and flexibility weakens. This finding implies that when the leading department enhances its absorptive capacity, filtering information helps to create emergency decisions and improve flexibility during collaborative emergency actions.

We take fire emergency as example. The leading department obtains more information from other agencies to improve collaborative efficiency only when the fire department understands and utilizes other agencies' information well. The leading department with more information does not lead to collaborative flexibility due to difficulties in collaborating with the Tiao and Kuai systems. However, flexibility slightly increases when the leading department absorbs, understands, and transfers more information from other agencies, which is promising. That is, the more they practice together, the more the leading department acquires information.

Table 7 provides the results of each hypothesis testing.

4.3. Robustness test

To test the robustness of the result, we conducted a substitution transformation for the significant moderating variable, namely, absorptive capacity. Given that absorptive capacity is a latent variable, we calculated its score using the weighted sum of six observed variables (six questions in the questionnaire). Therefore, we substituted six observed variables for absorptive capacity, then repeated the original

Table 7
Results of the model.

Hypothesizes		Supported
H1	a: Information accessibility is associated with a positive impact on collaborative efficiency.	Yes
	b: Information accessibility is associated with a positive impact on collaborative flexibility.	No
H2	a: Information connectedness is associated with a positive impact on emergency collaborative efficiency.	No
	b: Information connectedness is associated with a positive impact on emergency collaborative flexibility.	No
H3	a: Workflow integration is associated with a positive impact on collaborative efficiency.	Yes
	b: Workflow integration is associated with a positive impact on collaborative flexibility.	Yes
H4	a: Absorptive capacity enhances the relationship between information accessibility and collaborative efficiency.	Yes
	b: Absorptive capacity enhances the relationship between information accessibility and collaborative flexibility.	No

regression model, and checked the significance of the interaction effect. The results show that, for collaborative efficiency and flexibility, the interaction effects of the six observed variables and information accessibility are significant. Thus, we conclude that the research results are robust and reliable.

4.4. Managerial implication

The government emergency management presents a cross-agency collaborative structure as emergency incidents become complicated. Workflow integration indeed improves the efficiency and flexibility of emergency collaboration, and the leading department plays a crucial role in the process as its information accessibility and absorptive capacity significantly enhance the collaborative capacity of the entire network. However, as Table 2 shows, governments remain ill-prepared for emergency collaboration in several ways. Emergency collaboration is based on the integration of workflow, which is relatively weak, as indicated by a low mean score of 2.73 among the government departments. Moreover, the absorptive capacity of the government is far from high, with a mean score of 3.06. Thus, policy makers should invest resources into the enhancement of workflow integration and absorptive capacity. The lack of workflow integration can negatively affect the timely exchange of crucial information about an unfolding crisis and hamper effective responses. For example, in Beijing city government's response to the severe acute respiratory syndrome crisis in 2002, the absence of workflow integration between military and civilian health authorities significantly delayed the government's response and contributed to a wide outbreak. Collective learning by the network of involved agencies during crises can be promoted by the facilitated sharing of failure and best practices among agencies' personnel, information systems, and virtual experiences (Moynihan, 2009a, 2009b). A revised standard operating procedure can be very useful for institutionalizing organizational and network learning.

Embeddedness also relates to information accessibility, which is essentially determined by the structure and complexity of the collaborative network and position of the leading department. Local government should consider building a network around such leading departments and ensure that the information and resources are aggregated and aim for an improved efficiency of the collaborative system. Taking special emergency incidents as scenarios, the Tiao and Kuai systems should be simplified to meet the need for information acquisition of the leading department. As Phillips, Lawrence, and Hardy (2000) pointed out, powerful participants in collaboration relations are able to advocate their interpretations of issues more forcefully than others and privilege their position and capabilities. However, in terms of flexibility, the leading department in a complicated network will encounter difficulty in mobilizing resources or executing changes expeditiously as redundant relations can reduce flexibility. Thus, avoiding micromanagement and setting extremely specific goals in a fast-moving crisis situation are wise decisions for policy makers. Goal setting has been found to be associated with predictable side effects in business research, which includes hampering of learning and collaboration by encouraging negative competition (Ordonez et al., 2009). Without detailed goal setting, collaboration pertains to increased autonomy and flexibility in responding to complex urban crises, such as mass infectious disease outbreaks, hurricanes, and serious air pollution.

Moreover, the positive impact of information accessibility on efficiency is enhanced by absorptive capacity, which simultaneously enhances the exploitation of emergency information and improves flexibility. Therefore, government managers should concentrate on gathering and collecting information from other departments to the leading departments. In addition, absorptive capacity is crucial for leading departments in a network because emergency information in general flows toward the core of the network. Zahra and George (2002) divided absorptive capacity into two categories, namely, potential and realized capacity, and further classified the four factors of absorptive

capacity, namely, "obtain and internalize" and "transfer and exploit," under the previous two categories. These detailed concepts can guide government managers to improve the absorptive ability of the leading department. In practice, proper training and drills can help establish positive absorptive capacity because these procedures help the concerned departments to practice and familiarize themselves with the process of gathering, classifying, and analyzing emergency information.

5. Conclusion and discussion

Our study verifies the positive impact of workflow integration on collaborative capacity. The empirical test based on contingency plans generates important insights for emergency management research. In addition, this study provides a unique network perspective in emergency management, through which we explore how emergency departments manage, through network embeddedness and organizational learning (via absorptive capacity) to improve performance with information flow from other departments in the entire plan.

Furthermore, this study contributes to the theory of embeddedness in public sectors by linking it with absorptive capacity and network flexibility. Prior network research overemphasized the determinant role of embeddedness. Our research shows that important organizational attributes, such as absorptive capacity of central actors in a network, can mediate the effects of embeddedness on network performance. Moreover, this study measures network structure from contingency plan texts, which avoids the typical network survey research problems in recall bias and response rate.

However, this study has several limitations. First, we measured network flexibility and efficiency via perceptual measures of the emergency management plan. Although the plan is important, flexibility and efficiency of the plan's implementation in real emergencies require future study. Second, the current study lacks external validity due to data sampling. External validity comprises situational validity and sampling validity. Regarding situational validity, this study can pass with a good score because it includes all contingency plans for various scenarios. For sampling validity, further inspection should be conducted because we only gathered contingency plans from F district, which is one of the 16 districts in Shanghai. Given that each district may have different measures in emergency management, the result of this study may be challenged when scaling up to a wide range. Furthermore, this study disregarded the personal embeddedness of department managers, which can include professional friendship ties internal and external to the government. Lastly, we only measured the absorptive capacity of the lead government department and overlooked the absorptive capacity of other departments or nongovernmental organizations. In addition, the level of absorptive capacity can change, for example, by shifting from high to low or low to high over time. The influence of this change on the network dynamics and outcome is worthy of further research.

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