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Aiemwongnukul, R, Wong, CY orcid.org/0000-0002-4933-1770, Huatuco, LH et al. (1 more author) (2017) *Response Capabilities to Natural Disasters: Case Studies of Thailand Flooding*. In: *Proceedings of EurOMA 2017*. EurOMA 2017, 01-05 Jul 2017, Edinburgh, Scotland. .

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Response Capabilities to Natural Disasters: Case Studies of Thailand Flooding

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Abstract

This paper explores and identifies the natural disaster response capabilities, and uncovers the underlying processes and mechanisms of which businesses respond to natural disasters. Evidence from two comparative extreme cases of factories dealing with the Thailand 2011 flood were examined, which resulted in a process framework that exhibits enabler response capabilities, organization response capabilities and underpinning response capabilities required to achieve a successful response. It highlights that the successful factory had better flexibility, speed and continuous updating enabler response capabilities as well as activated, adaptable and the ability to extend higher amounts of underpinning response capabilities.

Keywords: Supply chain risk, Resilience, Disaster management

Introduction

The increase in frequency and severity of natural disasters (ND) intensifies impacts on business performance and the world economy. Thus, there is a need for more supply chain resiliency, mitigation (Wright, 2013), and risk management capabilities. ND is considered as a ‘random phenomena’ (Sheffi & Rice, 2005) with “low-likelihood and high-impact risks” (Trkman, & McCormack, 2009; Oke & Gopalakrishnan, 2009). An extensive amount of studies have acknowledged the need for capabilities in accordance with three disaster phases: preparation, response and recovery (Ponomarov and Holcomb, 2009). So far, the literature has focused mainly on capabilities in two phases: recovery capabilities (Craighead et al., 2007) and preparation (Knemeyer et al., 2009). In real life, not all businesses manage to prepare for mitigation against ND; therefore, the severity of damages relies on the ability to respond. Therefore, there is a need for both academics and practitioners to understand what effective response capabilities are required for ND.

This paper examines and unfolds the abilities to respond to ND by investigating how businesses in Thailand responded to flooding. In the year 2011, many electronics manufacturers in Thailand, one of the largest sources of computer hard drives, were submerged; this caused extensive and long term impacts to companies around the world (Wright, 2013). The estimated damages were around \$46.5 billion which is accounted for more than 25% of world production (World Bank, 2011). By comparing two extreme

cases of factories affected by the Thailand 2011 flood, this paper answers two questions: (1) What constitutes response capabilities in a flooding situation? And, what are the procedure, underlying processes and mechanism to create response capabilities? The effective response capabilities are exhibited in a framework.

Literature and Conceptual Background

Supply chain resilience and risk management are two major strands of literature that identify capabilities for mitigating supply chain disruptions including those generated by natural disasters (ND). Supply chain resilience offers a system perspective that helps reduce the severity of supply chain disruptions (Hanifan, 2007), enable operational continuity (Ponomarov & Holcomb, 2009), and the “return to its original state or move to a new, more desirable state” (Christopher and Peck, 2004). The supply chain risk management literature emphasizes guidance for risk identification, risk assessment tools, and evaluation of risk and risk mitigation strategies (Manuj and Mentzer, 2008). The literature emphasizes mainly advance preparation or planning based on capabilities such as flexibility (Sheffi and Rice, 2005), redundancy (Sheffi and Rice, 2005; Jüttner and Maklan, 2011), collaboration (Christopher and Peck, 2004) and agility (Wieland and Wallenburg, 2012). Therefore, there is less known about which ways and when managers should apply resilience capabilities if ND occur.

With regards to ND, the supply chain literature can learn from the disaster management literature because it provides knowledge for understanding, controlling and management of disasters. The International Federation of Red Cross and Red Crescent Societies (IFRC, 2014) considers disaster management as “the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies”. The disaster management literature typically divides disasters into different phases and it is well acknowledged from scholars of various disciplines (e.g. crisis management, emergency management and humanitarian logistics management, etc.) to adapt this lens to enhance their abilities in dealing with the threats (Faulkner, 2001; Moe and Pathranarakul, 2006). This integration allows an understanding and design appropriate to the abilities that fit with the characteristics of threats in each phase. Before the disaster, the relevant stakeholder may try to mitigate by building dams, conducting plans, predicting, providing early warning, and preparing necessary resources. During the disaster, a company needs to deal with the emergency by rescuing, evacuating and protecting lives and properties while trying to continue operations and start making recoveries. After the disaster, the emphasis is on recovery, reconstruction and resolution. Therefore, these studies focus on the tasks of non-profit organizations, governments and communities which have not been much covered by the supply chain resilience and risk management literature.

The extent to which a company can prepare for and respond to ND depends on the scale and time available for preparation. By understanding the characteristics of ND, such as frequency, magnitude, duration of impact, intensity, and speed of onset, it is possible to prepare appropriately budget and resources, and improving mitigation performance. For instance, “speed of onset” and “availability of perceptual cue” are important knowledge that provides adequate forewarning for detecting and reducing the impact of ND (Lindell, 1994) have not been integrated into supply chain literature yet. Response capabilities have been recognized as a major component of supply chain resiliency (Tukamuhabwa et al., 2015), during the response phase of a disruptive event. The diverse

literature has identified warning, collaboration, coordination, and communication are key to a successful response.

It is popular for supply chain scholars to adapt dynamic capabilities framework (sensing, seizing and reconfiguring) in their works for understanding capabilities in dealing with supply chain disruptions (Su et. al., 2014; Vanpoucke, 2014; Ambulkar et al., 2015). The concept offers the view that a company can “integrate, build, and reconfigure internal and external competence to address rapidly changing environment” (Teece et al., 1997, p. 516). This study acknowledges the importance of the dynamic capabilities. Although, the investigation is in the context of an emergency situation or “ad hoc problem solving” may not meet the requirement of the definition of dynamic capabilities (Winter, 2003), the concept of ‘zero-level’ and ‘higher order capabilities’ (Winter, 2003) offers an insight of multi-level of capabilities. Perhaps such a conceptualization could provide us a view on where response capabilities are developed.

Methodology

The research is based on a comparative case study (Eisenhardt, 1989; Ketokivi & Choi, 2014). Following a purposive sampling strategy, the research identified two polarised case exemplars based in Thailand, which had experienced flooding in 2011, i.e., Food company (FoodCo) recovered fast and Polyester Product Company (PolyCo) recovered slow. Table 1 shows the summary of the case study profiles. Semi-structured interviews were conducted with managers in operations, supply chain, risk management and related positions, six in the first and nine in the second company. The interviewees were asked to describe how/why they responded to the flood and what the important factors were. The interviews were conducted in two rounds in the year 2015 and 2016 by using face-to-face, telephone interview, site visits. Based on the first round, some initial ideas and concepts were identified. In the second round, follow-up interviews helped refine the concepts and gain in-depth understanding of the response capabilities.

Table 1: Summary of the company profiles in the year 2011

Profiles	PolyCo	FoodCo
Business sector	Polyester product	Ready to eat Food
Number of employees (at flooding site)	~ 450	~ 4000
Primary suppliers and customers	<u>Suppliers</u> : 20% import, 80% domestic (main raw materials were from affiliated companies) <u>Customers</u> : 55% export, 45% domestic	<u>Suppliers</u> : 90% domestic <u>Customers</u> : 10% exports (85% affiliated company that owns more than 4,000 convenience stores, 15% external)
Production locations in Thailand	3 locations	1 location
ND plans prior to the 2011 flooding	Yes, but limited (was first developed in 2010)	No plan
Number of interviewees	9 (administration, production, purchasing, power & Utilities, HRD, utilities, vice president of manufacturing, Director)	6 (Logistics, production, purchasing, safety, assistant general manager (export / risk management)
Operations discontinuity	~ 7 months	~ 1 1/4 month

Findings:

The theoretical framework in Fig.1 emerged from the empirical data. This paper defines response capabilities as “*the ability to respond to the emerging ND incident*”

aiming at alleviating its impact”. The coding identified three types of activities representing organization response capabilities and three enabler response capabilities clustered into response capabilities, and each of them are embedded by three underpinning capabilities. These responses and capabilities are illustrated in a form of continuous interaction and holistic build.

Organization response Capabilities

The company used organization response capabilities, which involved facilities protection, damage minimization and business and operational continuity to limit the amount of losses and impacts of ND. Organization response capabilities consisted of several strategies and activities to respond to ND in different emerging situations.

Facilities protection. Facilities protection was used to limit the scope and magnitude of ND impacts on facilities, assets and operations. A common activity was to build temporary physical defences. Both companies used competent employees to obtain information on how to build flood-proof walls and they had good collaboration among staff. Prioritising of critical factors explains why FoodCo was successful while PolyCo failed in facilities protection. FoodCo only focused on the critical areas and equipment, while PolyCo staff decided to protect the whole area and took more time to make flood protection, while having a limited number of staff. The assistant general manager from FoodCo explained the prioritisation: *“We left this area to be flooded, we just protected the main area which were the production zone at that time...As we did not have any flood plan earlier, so we only protect the electrical system room... if we could not protect and it was flooded, it took at least 4 months.”*

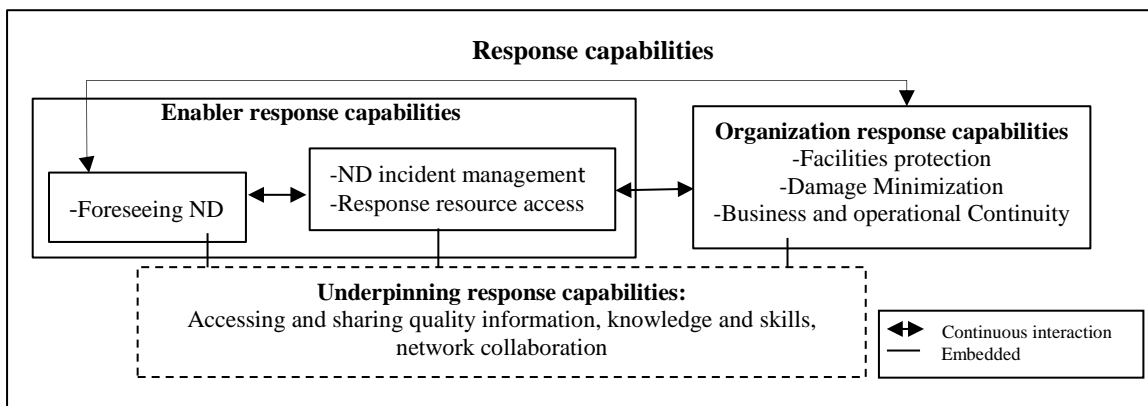


Fig. 1. Theoretical framework

Close monitoring was another strategy that was associated with flood protection. Not all FoodCo staff left the plants when the flood came in, they still continuously monitored the flood levels and the barriers, and then enforced or repaired them accordingly. The high frequency of monitoring allowed the staff to react promptly even when the water rose higher than expected. These activities could not be done without human resources, competency and collaboration. The FoodCo staff employed their technical knowledge to develop new ways of building flood defences. They exhibited great commitments by aiding in reacting to the incident, regardless of tasks they were assigned to.

Damage minimization. Damage minimization refers to the ability to reduce and eliminate further damages to assets, lives and operations in a timely manner. The analysis shows that the most common damage minimization practices involved assets relocation, plant shutdown, and evacuation of staff. The amount of disruptions and damages depend

on how the firms exercise the above activities. From the analysis, PolyCo had greater losses than FoodCo for several reasons. First, PolyCo did not relocate their assets and shut down the production systems properly because they did not foresee the situation and the instruction was not communicated properly. To illustrate, much of the equipment was lifted on to tables, but they were not high enough to escape from the flood. Furthermore, they focused on the wrong strategy, instead of working on damage minimization activities, they were working on flood protection. In contrast, prior to the arrival of the flood, the teams in FoodCo discussed and agreed to shut down the production operations. Even though the flood entered the site one day earlier than planned, due to the reduced production capacity before the flood arrived, damage to critical areas were reduced.

Overall, there was limited use of damage minimization by both companies. This was due to the inexperience in dealing with flooding prior to the incident, leading to a lot of tasks to be carried out afterwards. In addition, the choice of relocating or shutting down the factory was an important decision because these activities induced huge amounts of expenses, while reducing sum amount of incomes.

Time is a significant dimension that influences how well the firms exercise the protection and damage minimization activities appropriately. PolyCo could have achieved damage minimization timely if they had sufficient time for shutting down the plants and relocating the assets properly. PolyCo shifted from a protection strategy to damage minimization when the flood was entering the plant, so they did not have time to manage things well. The staff did not manage to move any finished goods or even contact their supply network for help. The goods were left to soak in the water. The production manager illustrated the problem: *“We had no time to ship material because it came so fast water and without much advance information. You will see now what our product is like big bulky, bag has 1 tons, 1.2 tons of materials.... To ship that, you need a lot of times and breaker and a lot of resources that we people could not manage in time.”*

However, after the evacuation, some PolyCo staff came back to the factory to take out some of the important items such as computer servers and documentation. These activities helped them to recover the plant faster later on in the recovery phase.

Business & Operational Continuity (BOC). BOC was used when the companies wanted to maintain operations, and deliver service and products to fulfil existing customer orders. It involved activating an emergency strategy, adjusting and realigning the supply chain flow and activities among supply network using an irregular system under constrained conditions. The activities were diverse between these two cases. FoodCo had a strong focus on continuing their operations and business; productions and logistics were restructured to be flexible and could operate under emergency condition. They applied more flexible logistics routes, alternative vehicles, introduced new loading systems and new supplier contracts. These activities were operated under the conditions of flood risk areas, traffic restriction and limited number of vehicles. Therefore, the staff could not plan far ahead and it needed real-time updates according to the situation. They also prioritized the production capability based on the available raw materials and customers.

After detecting the warning sign, such as weather forecasting from media and filedwork monitoring, FoodCo stocked up resources for avoiding supply disruptions. This helped them continue doing their business far better than the other companies in the surrounding areas, until they decided to stop the operations. The purchasing manager of FoodCo explained their response strategies: *“Actually, when the flood arrived our factory, many suppliers already stopped the productions, but our factory was operating.*

We could run our production longer than them because we had available materials to support and we worked in advance.”

PolyCo exercised BOC activities after they were flooded for maintaining supply to the customers. They activated a multiple production location strategy which was implemented as a part of their corporate risk diversification strategy. Their products were delivered by affiliated plants both domestically and overseas instead of flooded plants.

Overall, there was one common activity among FoodCo and PolyCo, i.e., to relocate to new offices in other areas. This approach helped the companies to continue to operate, plan, share information and communicate with relevant stakeholders. Interestingly, organization response capabilities also enhanced the response capabilities, and vice versa. As such, after PolyCo was attacked by the flood and relocated to another area by the help of its affiliated company, the new office was temporarily used for meeting, continuing temporary transactions (e.g. planning, contact suppliers), and planning. Meanwhile some of FoodCo staff e.g. purchasing and logistics relocated to work near the site because it was more convenient to access resources and continue their operations.

Enabler response capabilities

The analysis suggests enabler response capabilities involved foreseeing ND, ND incident management and response resources access. These three capabilities were used in the first place and helped facilitate each organization response capability. At the same time, they are highlighted to have bi-directional relationship between organization response capabilities, ND incident management and response resource access. Therefore, these three activities interacted each other. Foreseeing appeared to be the first point that was required to support the other capabilities.

Foreseeing ND. The companies used foreseeing ND to understand ND and help decide appropriate further actions. These capabilities involved monitoring and detecting ND threats, and obtaining, forecasting, updating and interpreting ND and supply chain information. Incomplete and unavailable information is a common problem in disaster situations. The lack of foreseeing ND is one of crucial factor that differentiate FoodCo from PolyCo in terms of the exercise of appropriate organization response capabilities. The failure of PolyCo was partly due to missing information and low speed in obtaining correct information. The PolyCo purchasing manager admitted that they activated the wrong strategy at an inappropriate time because they misjudged the situation which resulted in high severity of disruptions, “*We might have the wrong plans. We had never thought the flood would be such this height. The plant was flooded almost 2 meters.*”

Because of the uncertain situation, missing information was a barrier to an accurate interpretation of the warning signs, it was necessary to find evidence from the reliable sources, and access quality and comprehensive information in a timely manner. FoodCo was proactive in obtaining and updating flood information in real-time on their own and from their networks and the use of collaboration.

ND incident management. ND incident (emergency) management is the ability to operate, control and monitor emergency tasks to respond to an emerging and uncertain ND. It consisted of combinations of activities such as teams setting up, planning, meetings and decision making. Its application is concerned with the effectiveness of emergency process management. Overall, both FoodCo and PolyCo addressed the incident in a similar way, such as forming the teams from cross-sectional departments and using it as a command centre. Required information would be obtained for analysing and making decisions for having appropriate response activities. Decision-making concerning plans,

strategies and activities were decided from here and the tasks and responsibilities were assigned to the appropriate staff.

However, there were some minor differences among the two companies. FoodCo assigned an appropriate and skillful staff member to be the team leader for the situation. They also used emergency meetings to generate new ideas and solve the problems. The staff would report and update their progress of their responsible tasks on the 'organization response capabilities' tasks at the meeting for further decisions. These minor differences helped them gain most benefits from having incident management.

Emergency plans had been long introduced in FoodCo and PolyCo, they focused on fire and other incidences rather than flooding. As it was FoodCo's first exposure to extreme flooding, the team initiated flood plans and procedures from contacting their networks. The teams exhibited high attentiveness to the uncertain situations by continuously reviewing and updating their plans. As a result, the teams could react quickly to the changing situation, in comparison to PolyCo who were complacent in their flooding plans preparation, they did not actively update information in real time. The use of the plans in a reactive manner led PolyCo failing to cope with the rapid changes.

Response resource access. Accessing response resources means searching, selecting and obtaining raw materials and equipment for organization responses capabilities. In a chaos, the market did not function normally, the companies operated under conditions of supply constraints (Christopher and Peck, 2004) due to limited resources, traffic disruptions and suppliers' disruptions. Overcoming these barriers was challenging for both companies. Both cases illustrated that speed and network collaboration were two important factors that were associated with the amount of resources obtained. Prior to the most intense period of flooding, they did not find any difficulty in acquiring the resources within surrounding areas and this high level of preparation allowed them to build the flood walls for a certain period. Until the flood came higher, both companies realized the expected and the prepared resources were not enough; so, both companies searched the equipment in remote areas as well as requested their networks for assistance. For example, PolyCo accessed protective equipment such as big pumps, for making flood barriers by contacting local governments. FoodCo acquired additional flood equipment from their raw material suppliers. Furthermore, when facing supplies shortage the staff were also able to adapt the existing resources for new uses. This innovation helped save time and allowed for a quick reaction.

With appropriate enabler response capabilities, FoodCo managed to protect their assets and tapped into damage minimization, business and operational continuity activities. Several strategies were executed successfully e.g. inventory management, alternative suppliers, supplier risk assessment. The purchasing teams had to restructure and modify inbound delivery systems and purchasing systems to emergency modes. FoodCo contacted their suppliers and kept raw materials in advance, and these high preparations enabled their capabilities to continue business and operations until deciding to shut down the factory.

Underpinning response capabilities

There are three common capabilities which are actively engaged in enabler response capabilities and organization response capabilities: abilities to access and share information, knowledge and skills, and network collaboration. The accessing and sharing the quality of information, knowledge and skills, and network collaboration came from existing resources that were built and embedded in routine activities for any other

purposes, and then the companies activated, adapted, and extended for responding to the disruption on an ad hoc basis. FoodCo and PolyCo attempted to access ND and SC information for the capabilities building and sharing to their network, such as the need to access information of protection equipment. Therefore, enabler response capabilities and organization response capabilities were built on these three capabilities, which enhanced each other and are integrated with the other capabilities. Somehow, different response capabilities required different underpinning response capabilities and at different levels. FoodCo and PolyCo had limited preparation to respond to flooding in advance, so the activation of underpinning response capabilities depended on the amount of the prior resources that previously existed.

However, not everyone was able to activate, adapt and extend the existing capabilities for uses in flooding. Therefore, activation of such capabilities was noted of leading to failure or successful response. As such in the case of PolyCo they had good networks with other logistics and affiliated companies, but they lacked the ability to activate their prior resources and because of this their logistics companies failed to relocate their assets and resulting in high numbers of damages. In contrast, FoodCo was successful in the flood response, even though they did not have any plan previously. This was because they could quickly extend their existing resources and knowledge to the enable flood response by mobilizing the resources of their networks affiliated company, obtaining and sharing the quality of information.

Discussions and conclusions

This paper contributes to operations and supply chain literature in several manners. The study highlights the limitations of current understanding and extends the concept of response capabilities based on a focus on flooding. It highlights not only what they are, but also how, why and when response capabilities are effectively developed and work. The two comparative retrospective case studies of flooding disruptions in Thailand 2011 reveal multi-level capabilities from a process perspective.

This paper unveils responses to ND relies on enabler response capabilities, organization response capabilities and their underpinning response capabilities. Since we applied a process perspective, some of these capabilities are new to the operations and supply chain literature. The abilities to minimize damage and protect facilities do not only ensure safety and alleviate the impacts, but also promote recovery in the later phase. The ability to manage a ND incident on an ad-hoc basis, the ability to foresee ND and response resources access are backbones of responses for protecting from ND threats, minimizing damages and continuing operations and business. To be efficient in responding to ND capabilities, businesses should pay attention to such enabler response capabilities as well as activating resources in an emergency context, often under-prepared, because they have the underpinning response capabilities to access and share quality information, knowledge, skills and network collaboration.

Although the supply chain resilience literature has identified capabilities such as resilience, agility, flexibility, redundancy and collaboration, this paper provides empirical evidence for the development of theoretical explanations for the processes in which a company achieves such capabilities and responds to ND. This study shows that effective enabler response capabilities and organization response capabilities are achieved by three important qualities: flexibility, speed and continuous update. The study agrees with the literature that without flexibility and agility (similar to speed in this study), companies are hardly sense, respond (Sheffi and Rice, 2005), or adapt in any situations of disruption

(Carvalho et al., 2012). Nevertheless, this study adds that continuous update is a crucial quality of such capabilities to be along with unpredictable and volatile situation.

The study also challenges the current belief in supply chain resilience literature, on the ways ND response strategy is developed. The study suggests that some resources could be acquired temporarily for ad-hoc use during the ND, if companies have good ND foreseeing abilities and the knowledge about how such resources might be accessed. For example, the literature claims the need for a redundancy strategy such that it is necessary to own or occupy such resources (e.g. alternative warehouses and inventories) in advance. Instead, this study shows that it is possible to just tap into redundant resources when needed, by activating a relationship or knowledge, because severe ND is infrequent. Keep more inventories for buffering against ND threats will increase cost in long run.

This study unpacks the mechanisms in which enabler response capabilities and organization response capabilities operate, it found that during an emergency, companies could deal with ND without advance preparation because the three underpinning response capabilities: accessing and sharing the quality information, knowledge & skills and network collaboration utilized for responding to ND. These three capabilities extend current views of operations and supply chain resilience literature (Tukamuhabwa et al., 2015) to emergency situations. Even though these underpinning response capabilities are known to the literature, this paper adds new insights into when and how they are utilized during the response. The results show that FoodCo which had no ND plan, had higher response capabilities than PolyCo which had a ND plan because they activated, adapted and extended knowledge & skills and network collaboration as well as being able to access and share quality information. Therefore, FoodCo could activate the underpinning capabilities at a higher level to support protecting capabilities. In the terminology of capabilities of Winter (2003), these underlying capabilities are higher level capabilities that can be activated, adapted and extended for empowering response capabilities and responses to ND. This is perhaps the first study that divides ND response capabilities into multiple levels, such that it is now possible to explain what underpinning response capabilities are required to enable the capabilities to respond.

The response capabilities and their underpinning response capabilities can be used to explain a process framework for understanding how a company decides and executes appropriate responses to ND. This framework has significant implications not only to academics, but also practitioners. With the framework, companies can identify, develop and adapt relevant capabilities and processes for real-life implementation, including what conditions the companies would be able to respond to ND without having prior ND preparation or experience. This finding differs from the mainstream literature in crisis management, business continuity, disaster management, risk management that suggest businesses need to prepare and invest resources for disruptive low-probability events such as ND that lead to an unknown level of damages.

It is worth noting, that the response and underpinning response capabilities are not related to each other in a linear manner, but they emerge holistically from the individual activities. The response capabilities were developed ad-hoc from the integration of the existing capabilities while new ones were being developed. Although, some businesses can respond to ND without having organization preparation, it can be very risky as well. To be competent in future ND response, businesses are encouraged to develop such underpinning response capabilities in advance for utilizing and having appropriate respond to future unpredictable emerging ND situations.

Lastly, since this study aims to add and enrich our understanding in a rich context rather than generalization, one limitation is that it is based on a purposive sample from two firms collected from the Thailand 2011 flooding. To advance our knowledge, more case studies in other types of ND are needed.

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