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Decision-making and operations in disasters: challenges and opportunities

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1. INTRODUCTION

Around the world, the number of people affected by disasters has increased. Since 2000, nearly 81.7 million people have been affected by disasters globally, with over 1.3 million of reported casualties (CRED 2018). These numbers highlight the need to design and implement efficient and effective disaster management systems, especially considering the limited resources available to deal with them (e.g. Sienou and Karduck 2012; Nathan et al. 2017). Recent disasters, however, have shown several shortcomings in these systems' performance (Santos-Reyes et al. 2010). Among these are the deficient knowledge in emergency response, poor operational management, absence of leadership, lack of strategies, difficulties to allocate tasks, limited intergovernmental planning, and insufficient coordination (Grünewald et al. 2010; Nigg et al. 2006). To overcome these challenges, there are calls for empirical work to analyse the decision-making structures and public policy in disasters (Holguin-Veras et al. 2012; Hartet al. 1993).

Even after different articles have explored the implications of decision-making structures in disasters (e.g. Takeda and Helms 2006; Dhouha and Gonzalo 2013; Manyena 2006; Scolobig et al. 2015; Drabek 1985), command and control problems have been identified in several situations (Sienou and Karduck 2012; Van Wassenhove 2006; Whybark et al. 2010). These problems lead to the emergence of ad-hoc norms during disasters (Drabek and McEntire 2003), which affect and are affected by operational activities on the ground. Currently, the link and the discrepancies between the decision-making structure and the operational activities on the ground have not been sufficiently researched (Hart et al. 1993). This situation creates the need to look closer to the link between both levels. The purpose is to enhance the performance (i.e. the support provided to disaster victims) achieved by disaster management activities.

This article contributes to the understanding of the interaction of the components of disaster management responses systems and their effect on logistics performance. It has been long thought that the decision-making structure used in a disaster management system has automatic implications on logistics performance (Brouillette and Quarantelli 1971). It has been seen during disaster operations instead that performance is commonly affected by the operational decisions made on the ground (Holguín-Veras et al. 2012). Further investigations are necessary to analyse the relationship between the decision-making structure and operational activities on the ground to provide insights about their impact on logistics performance. This article is contending that it is the alignment of both components what has an effect on performance.

Disaster management at the organisational level has been studied from the perspective of Organisational Studies (OS) (Mileti and Sorensen 1987), whereas operational activities on the ground have been explored in the field of humanitarian logistics with the support of Operations Management (OM) (Gupta 1995; Taylor and Taylor 2009). Even though the link between OM and the organisational structure has been stated in the literature recently (MacCarthy et al. 2016), there is a disconnection between both literatures. As part of OS, problems with centralised and decentralised systems have been identified by focusing on the impact of the decision-making structures. Among these articles, however, there is little discussion about the importance of activities on the ground. On the other hand, different models and frameworks have been developed in OM with the aim to improve logistics performance (e.g. Chang et al. 2007; Tofighi et al. 2016; Ransikarbum and Mason 2016). Unfortunately, these articles neglect the value of the decision-making structure and how it affects the models developed. Both perspectives have valuable insights to support disaster operations and maximise logistics performance. Thus, a greater understanding of the elements hindering logistics performance may be gained by blending the perspective of OS and OM. This article represents a step toward such integration.

The central difficulty presented by the perspectives undertaken in the fields of OS and OM is the assumption of a precedence because of hierarchy (Miletiand Sorensen 1987) and urgency (Wijngaard et al. 2006), respectively. This article argues that looking at the decision-making structure or at the operational activities on the ground independently can create a disjointed disaster management system with a negative impact on performance. Instead, Ford and Schellenberg (1982) stated that an organisation can be assessed based on the extent in which the decision-making structure and the operational activities on the ground converge. Taking up this perspective, this article considers the manner in which the alignment between both levels can be used to reduce the shortcomings of each one of them. Hence, the purpose of this article is not to determine which perspective should take precedence, but to consider both perspectives and their relation to understand the conditions hindering logistics performance.

structure, the operational activities on the ground, and their link, are analysed to provide insights to improve disaster management systems. The purpose is to tackle the following research question: What is the effect on logistics performance of the alignment between the operational activities on the ground and the decision-making structure adopted in disaster management? From the practical perspective, this research analyses both levels and the fit between them based on empirical data to provide insights about the Mexican disaster management system. Real data was gathered to develop an analysis that could also provide valuable results for practitioners (Charles et al. 2016).

This article contributes to practice and research in a variety of ways. First, it increases understanding of the interaction of the components of disaster management response systems and their relationships (i.e. the decision-making structure and the operational activities on the ground). Second, the paper integrates the perspectives of OS and OM into a holistic approach to improve disaster management systems. Third, this article proposes a novel perspective to enhance the performance of disaster management systems considering the alignment between the hierarchical decision-making structure and the operational activities on the ground. Finally, this paper provides recommendations for best practices in humanitarian logistics which are applicable to Mexico and other countries using centralised decision-making. This has the potential to support researchers on OS and OM to develop more comprehensive solutions for disaster management.

The paper is organised as follows: Section 2 introduces relevant articles from the perspective of this research and the methodology used is presented in Section 3. Section 4 describes the Mexican framework for disaster management, whereas Section 5 introduces the analysis of the case. Section 6 provides a discussion of the results obtained while Section 7 enumerates some policy implications. Concluding remarks are presented in Section 8.

2. LITERATURE REVIEW

This paper is focused on the link between the decision-making structure and the operational activities on the ground, and its impact on performance of the alignment between them. To place the article in the literature, initially this section introduces the perspective of operational activities on the ground to describe the focus of articles in the area and the importance of logistics performance. Then, the literature on decision-making in disaster management organisations is presented to define the most common perspectives used before in the area (i.e. centralisation and decentralisation). Next, articles related to performance in disaster management are discussed. These section serve as context to frame the final section linking the three dimensions.

2.1. Operational activities on the ground

Humanitarian logistics are essential during disaster management to support affected communities promptly (Nathan et al. 2017). This area is closely related to disaster preparedness and response. Caunhye et al. (2012) identified evacuation, facility location, stock pre-positioning, relief distribution, capacity planning, inventory management, and casualty transportation as closely connected activities which have been commonly studied in literature of humanitarian logistics.

There are several articles developing models and frameworks to achieve successful operations on the field (See Caunhye et al. 2012), even incorporating "social cost" in the performance measures (See Holguín-Veras et al. 2013). Usually, operational activities on the ground are performed in line with policy and procedures (Hartet al. 1993), although many times urgency becomes a factor causing inconsistency (Wijngaard et al. 2006). The reason is because of the inconsistencies between plans and the operational environment (Nathan et al. 2017). Despite the importance of decision-making structures and hierarchy between units (Wijngaard et al. 2006), however, most of the articles in the field of humanitarian logistics are neglecting to incorporate these dimensions.

2.2. Decision-making in disaster management organisations

The organisational design is relevant because the fit within the internal components of the system, as well as the fit between the system and the environment have a significant effect on performance (Ruffini et al. 2000; Dalton et al. 1980; Ford and Schellenberg 1982). The process and structures involved in decision-making are key dimensions in the organisational structure (Al-Abbadi 2015). These play an important role in the efficiency of organisations because they affect the kind of problems faced in operations. For instance, in a decentralised system, resource constraints can create divisiveness among groups, something less likely to happen on

centralised systems. On the other hand, in decentralized systems, decision-making has to go through fewer layers of authority allowing more responsiveness, unlike centralised systems (Takeda and Helms 2006).

There has been a considerable discussion about the appropriateness of centralisation and decentralization in the business sector (Dalton et al. 1980). Encouraging the rationalisation of decision-making with inclusion of few individuals leads to centralisation, whereas promoting wider participation in decision-making leads to decentralisation (Marks 1978). The former has several layers of managers, whereas the latter has fewer layers and several decisions are made in parallel. Marks (1978) and Dalton et al. (1980) provided evidence that decentralization can be highly efficient and effective in the business environment, although Dalton et al. (1980) also argued that a decentralised system needs more time for coordination and the resolution of conflicts. Furthermore, they stated that many studies supporting decentralization were not using "hard" performance measures, constraining the value of the results.

During disaster management, the overarching goal of survival often leads governments to implement centralised decision-making to attempt to control and find optimal solutions (Child 1972; Quarantelli 1988). That is the reason most emergency management systems are modelled using this approach (Takeda and Helms 2006). In the literature, Takeda and Helms (2006) discuss the use of bureaucratic models for emergency response and identify centralised decision-making, external knowledge, complex conditions of the disaster and lack of flexibility as major issues for the bureaucratic model. Dhouha and Gonzalo (2013) study the impact of centralisation of decision-making during the reconstruction stage using a case from the 2003 flood in Tunisia. Their results showed that the top-down approach achieved a poor level of satisfaction.

Centralisation has been considered a bad model for disasters because of its inherent disadvantages (Quarantelli 1988). The large number of organisations that require access to the disaster management system (Child 1972; Boin and Lagadec 2000; Holguin-Veras et al. 2012), the need for flexibility in the implementation of policy and regulation (Oloruntoba 2005), and the need of non-programmable responses (Boin and Lagadec 2000) are reasons why humanitarian organisations are moving their supply chain towards decentralisation (Charles et al. 2016). Manyena (2006) focused on local authorities to explore the link between disaster management and disaster resilience. The author emphasises autonomy for decision-making, fiscal and administrative issues, and an appropriate organisational structure as relevant elements to build resilience. Chang Seng (2013) describes the disaster preparedness of a decentralized system in an Early Warning System in Indonesia. They identified national security and social conflict, challenges of implementing decentralization policies, funding and resources as the main barriers for institutional advancement in disaster risk reduction.

In view of the evidence against centralisation, Scolobig et al. (2015) argue that a people-centred approach could be more suitable for modern conditions given the limitations in capability of a single organisation, such as the government. Similarly, Kovacs and Spens (2011) mentioned the value of community-based approaches to integrate beneficiaries in activities. Nevertheless, these approaches have been more commonly adopted under improvised circumstances, such as during Hurricane Sandy. The reason is that decentralized models can be complex (Manyena 2006) and very challenging to implement in the context of some countries (Chang Seng 2013). Garschagen (2016) argue that decentralising disaster management in a centralised system, such as a government, faces several challenges for implementation because of the lack of investment in capacity building and procedural adjustment. Furthermore, decentralization may cause lack of standardization and fragmentation if it is not properly prepared and managed (Thomas E. Drabek 1985), a major concern for disaster operations.

Therefore, the major decision-making structures in the literature (Garschagen 2016) have shown several shortcomings at the level of the operational activities on the ground. The current discussion in the field, however, is still not integrating this dimension.

2.3. Performance in disaster management systems

Looking at organisational performance, Santos-Reyes et al. (2010) proposed a fault-tree model to assess the organisational activities of the government during disasters in Mexico. Later on, Roshan Bhakta et al. (2011) provided an analysis of the performance of fire services organisations in emergency conditions in New Zealand. The authors confirmed that stability, leadership, stakeholder communication and adaptability are main predictors of organisational success in those settings. Dube et al. (2016) studied countries affected by man-made disasters with a high State Fragility Index (http://fundforpeace.org/fsi/) to explore the motivation and impact of host governments in the performance of International Humanitarian Organisations (IHOs). The authors

nflicting strategic goals and enforcement capabilities.

There are extensive studies measuring performance in the supply chain (Beamon 1999; Helena 2007). The purpose of the operational activities on the ground is to satisfy the requirements of the victims (Thomas and Mizushima 2005). Considering the high stakes involved in disaster operations (Kovacs and Spens 2011), this paper defines logistics performance as the ability to successfully satisfy such needs. Beamon (1999) classified supply chain performance measures in three main types: resources, output and flexibility. Resources account for the input of a process, whereas output involves the organisation's and customers' goals, and flexibility refers to the capability to adapt to fluctuations (Beamon 1999). The successful achievement of these three measures is linked to the satisfaction of the needs of disaster victims. The reason logistics performance is studied in this article is the focus on the support to disaster victims. Operational activities on the ground are performed by a large number of actors such as: host (governments with responsibility over the affected areas) and associated governments, regional authorities, State governments, military units, NGOs, private and quasi-private organisations (Cozzolino 2012; Mileti and Sorensen 1987). Instead of looking to the performance of individual organisations (i.e. the supply side), this research is focused on the ability of the disaster management system to satisfy the requirements of the victims (i.e. the demand side). This support is linked to the three types of measures described by Beamon (1999).

Focusing on logistics performance, Thompson (2015) assessed the current state of disaster logistics in the Caribbean through eight in-depth unstructured interviews with logistics managers and heads of disaster agencies. They identified a lack of a coherent and integrated logistics strategy as a common problem. Nigg et al. (2006) provided an assessment of governmental activities focused on evacuation and providing shelters and temporary housing after Katrina in the United States. The authors identified several issues in terms of shelter management, lack of policies for successful evacuation across states, poor standardisation and disjointed local political cultures.

2.4. The decision-making structure and logistics performance

The research presented so far provides context about operational activities on the ground, decision-making structures and performance in disaster management. This section includes sources looking at the link between these dimensions.

In view of the variety of organisations involved in disaster management, research has considered different types of organisations. Some studies analyse Non-Governmental Organisations (NGOs) during disaster operations to improve their supply chain (Kumar et al. 2009), propose an integrated framework for post-disaster reconstruction (Lu and Xu 2015), determine the location of facilities and the amount to stock to preposition based on decentralisation policies from Red Cross (Charles et al. 2016), and analyse the role of the organisational structure of NGOs in their influence on policy development (Marquez 2016). Additionally, other authors have looked at the link between NGO's organisational principles and performance (Hilhorst and Schmiemann 2002) and thus provided insights about the challenges for logistics in these organisations (Kovacs and Spens 2009).

In many countries, the military provides primary assistance in cases of disaster because of its structure and the resources it has available (Cozzolino 2012; Heaslip and Barber 2014). Heaslip and Barber (2014) focus on the organisational challenges of the military for disaster operations and how the interaction between coordination, logistics and human resources can improve performance in disaster operations.

Despite the importance of the NGOs and the military, the role of the host government as initiators of disaster response is prominent. These governments have the jurisdiction and authority to allow operations to be carried out (Cozzolino 2012), and they become responsible for disaster operations abiding by a set of national and international regulations (Dube et al. 2016). Therefore, the decision-making structure of the host government affects the overall performance of disaster operations (Brouillette and Quarantelli 1971) and its activities on the ground are the reference point for the disaster management system. From that perspective, Westley et al. (2008) performed an analysis of bureaucracy based on FEMA following Katrina in the United States. The authors pointed out failures associated to the provision of relief and care to the people affected because of the highly centralised institutional system which hindered participation of more people in the decision process.

Chandes and Paché (2010) proposed the use of adaptive collective strategies to improve humanitarian logistics. They used a case in Peru to show the potential benefits of collective action. Using participant observation, they analysed the governmental response and found the importance of a central directive unit, with the purpose of coordinating the multiple civil defence committees. They suggested the inclusion of adapted performance indicators, mass customization, and collective action to improve humanitarian operations. Richter et al. (2013) proposed a decentralized evacuation application on mobile devices for situations in which a centralised systems has failed or is non-existent. Using agent-based simulation to test the peer-to-peer information communication, the authors showed how a decentralised approach can provide advantages to improve evacuation management.

In the literature presented we find that there is evidence of the assessment of different systems based on an organisational view or a logistics perspective, but the fit between them has been neglected before. The aim of this article is to fill that gap by taking a holistic approach to analyse the impact of misalignment between those levels on performance during emergencies.

3. METHODOLOGY

3.1. Overall design

In order to analyse the impact of the alignment between the decision-making structure and operational activities on the ground, this study includes a case based on the activities of the Mexican disaster management system during the worst disaster experienced in thirty years. Given the exploratory nature of the research question (What is the effect on logistics performance of the alignment between the operational activities on the ground and the decision-making structure adopted in disaster management?), a case study approach using empirical data was undertaken to analyse the situation in its natural context (Voss et al. 2002).

Case studies can be used for theory generation, theory testing or theory elaboration (Ketokivi and Choi 2014) because it is a strategy that allows to understand the dynamics existent within a defined situation (Eisenhardt 1989). This paper is defined as theory elaboration, which is placed in between theory testing and theory generation (Ketokivi and Choi 2014). Fisher and Aguinis (2017) defined theory elaboration as "…the process of conceptualizing and executing empirical research using pre-existing conceptual ideas or a preliminary model as a basis for developing new theoretical insights by contrasting, specifying, or structuring theoretical constructs and relations to account for and explain empirical observations" (Fisher and Aguinis 2017).

A theory can be elaborated through the in-depth analysis of the relationships among different elements considering the general context and previous findings simultaneously (Ketokivi and Choi 2014). Using constructs and relationships from OS and OM, this research empirically analyses the effect on logistics performance of the relation between the decision-making structure and the operational activities on the ground. The purpose is to elaborate on current knowledge and increase the understanding about the relationship between the decision-making structure and the operational activities on the ground using empirical data, which can lead to the development of more integrated solutions.

3.2. Research planning

For the development of this research the methodology outlined by Eisenhardt (1989) was followed. Initially, literature from different areas was analysed and used to define the research question. Next, the case was selected considering the vulnerability of developing countries (Davarzani et al. 2015) and the research question defined. Then, archival data and interview were selected as data collection methods and data collection was undertaken. After the information was collected, a within-a-case analysis was performed to investigate the relationships between components and their effect in logistics performance. Next, the results were compared and contrasted with the extant literature and closure was reached (Eisenhardt 1989).

3.3. Case selection

The case study method is one of the most common approaches undertaken in Operations Management studies (Taylor and Taylor 2009) because it can be used to explain complex real-world phenomena (Peter-Christian and Dmitrij 2015). It has been used in this research because it can provide relevant insights about the situation (Helena 2007). Yin (1994) states that case studies should be used when "a why or how question is being asked about a contemporary set of events over which the investigator has little or no control". Case studies can help to understand more deeply the processes and context, and to provide meaningful insights in an underexplored field.

ructures and public policy in disasters (Holguin-Veras et al. 2012), a case study can be used to capture the conditions generated by the disaster and evaluate the performance of the disaster management system. Davarzani et al. 2015 suggest that it is important to understand the impact and performance of the decision-making structure in settings with political and economic uncertainty, such as the conditions experienced in developing countries. Accordingly, a case study in Mexico was selected because it fulfils these characteristics. The case was based on the 2007 flooding in Villahermosa.

Mexico is located in a very active seismic area and in the path of hurricanes and tropical storms coming from the Atlantic and the Pacific (Saldana-Zorrilla 2015). From 1950 to 2015, the country has been the most disaster prone nation in the Americas after the United States (CRED 2016). Mexico's case is also interesting because it has the second largest economy in Latin America, while at the same time, nearly half the population lives in poverty conditions (INEGI 2012). Despite having a disaster policy in place, recent experiences have demonstrated that the support provided to disaster victims using a top-down centralised decision-making structure is not achieving the expected results (Santos-Reyes et al. 2010).

Developing countries, such as Mexico, commonly use a 'military' approach for decision-making because it provides a known and manageable structure. Activities can be delegated depending on technical skills and expertise using a centralised model of management involving a single 'leading' organisation (Scolobig et al. 2015). However, it has been pointed out how this approach is focussed more on the process than in the outcome (Takeda and Helms 2006).

The organisational and decision-making structure of the Mexican disaster management system was acquired through a review of Mexican regulations, white papers, and research articles. The operational procedures employed by the Mexican organisations involved in humanitarian logistics in the field included rules and regulations from organisations involved in disaster relief operations, as well as guidelines provided by Plan Marina and Plan DN-III (Disaster management plans for the most serious disasters) from the navy and the military, respectively. Additionally, the emergency relief request process for the Natural Disaster Fund (FONDEN) was analysed along with the process to request medicines in case of emergency.

3.4. Data collection methods

Data collection was performed through a combination of interviews and gathering of archival data. Information about medical services and procedures was obtained from an interview with CENAPRECE [National Centre of Preventive Plans and Disease Control (CENAPRECE), personal communication, September 2, 2014], whereas an interview with a representative from the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) was carried out to understand the procedures undertaken by them and other organisations for disaster situations in Mexico [Office for Coordination of Humanitarian Affairs (OCHA), personal communication, August 28, 2014]. Additionally, an exploratory interview was undertaken with members of the disaster management unit from the Mexican National Defence Secretariat (SEDENA) [SEDENA, personal communication, March 11, 2010]. The interview involved a set of written questions answered by the officials prior to the interview, and open-ended questions about general procedures and practices.

Secondary information about the circumstances of the disaster was obtained through a series of freedom of information (FOI) requests directed to relevant Local, State and National government agencies. Participants other than the government were incorporated using reports and press releases from these other organisations. This included the relief aid sent by other governments and international organisations.

The data collected provides insights about the implications of the current system in performance. The database collected included the organisational decision-making structure and the logistics activities performed on the ground in the country. Having both sides is essential to explore the impact of the alignment between them on performance. Therefore, both sides can be analysed to draw conclusions from a holistic perspective, with the purpose of identifying the real challenges affecting performance beyond the common constructs associated with the operational or the organisational view.

3.5. Data analysis

Data analysis is the least standardised part of the application of the case study method (Eisenhardt 1989). The data from the interviews and FOI requests was initially used to draw a picture of the logistics activities performed by authorities during the disaster. Based on that, an analysis of supply and demand was carried out.

The information about the resources deployed by the organisations was contrasted to the demand of disaster victims based on the operational parameters (i.e. personnel required per activity, service capacity of the products, shelter requirements) provided by the organisations, policy and guidelines publicly available. This sectionoftheanalysiswas clusteredbasedonthelogisticsactivitytoidentifypatternspresentinthecase.

Based on the performance of the logistics activities, the results were analysed from the lens of the decision- making structure used in Mexico using the three type of metrics described by Beamon (1999). From that point onwards, the analysis included the comparison and contrast of the results with extant literature (Eisenhardt 1989) to evaluate the accuracy of considering an OS or OM perspective alone. Then, the alignment between the decision-making structure and the operational activities on the ground is investigated, and its effect on logistics performance was analysed.

4. DISASTER MANAGEMENT IN MEXICO

4.1. National Civil Protection System

Decision-making in disaster situations in Mexico uses a centralised, top-down structure to avoid uncertainty in the control and management of operations (Parnell 2015), with the National System for Civil Protection (SINAPROC) as the coordinating body in charge of develop and oversee plans from different participants for disaster management.

Humanitarian logistics in Mexico basically involves three main activities: the provision of food, shelter and medical attention (Ordaz and Zeballos 2007). These activities are carried out with support from SINAPROC based on the guidelines established as part of the policy.

4.2. Disaster management structure

Disaster management in the country includes four main branches: executive coordination, technical coordination, technical support and co-responsibility. SINAPROC works as the coordinator of the different branches to manage emergency situations. Each branch has a different purpose;

- Executive coordination. The Ministry of Interior is the entity responsible for working with organisations of the three government levels (viz. National, State and Municipal).
- Technical coordination. Organisations with the capability and expertise to provide technical counsel for the planning, operation and assessment of activities related to disaster management in any emergency.
- Technical support. Organisations with capabilities to provide aid and advice for a specific disaster.
- Co-responsibility. Organisations charged with the responsibilities to provide supplementary support along with human and material resources to the emergency activities on top of their normal duties.

4.3. Guidelines for disaster response

After a disaster strikes a community, the first agency on location should provide aid to the victims, and then municipal authorities have to take over to continue the relief activities. If local authorities can cope with the disaster they oversee the whole operation, otherwise they have to notify state authorities to ask for support. That procedure is repeated for the case of state and federal authorities, until the full resources of SINAPROC are deployed (Ordaz and Zeballos 2007). This approach is consistent with other governmental systems, in which as the disaster develops response structures at local, regional and national level need to be requested to deal with the situation. (Roshan Bhakta et al. 2014).

For initial supplies after an event, authorities in Mexico use stock prepositioning because this strategy can prevent response delays. Mexican authorities use a prepositioning policy for food pantries, whereas for medicines, some kits are stocked at local units, but most of the medicines are available on request after the disaster strikes (SEGOB 2012). Information about the method to determine the level of stock, however, is not clearly defined.

For the ongoing supply of relief, authorities can request relief items based on needs assessment. The level of demand is established by regional authorities to request support and supplies from FONDEN. Consumable goods are arranged in kits to provide support for four people for four days. The rest of the items are provided based on the composition of the population. The products listed in the "Agreement for the operation of the fund for natural disasters" can be charged to FONDEN (SEGOB 2012), using them as standard units for distribution.

reventive Planning and Disease Control, namely CENAPRECE (SEGOB 2012). A council is in charge of evaluating the requests based on the information available about the emergency. In case the request is approved, the items are gathered/procured and sent to the area [National Centre of Preventive Plans and Disease Control (CENAPRECE), personal communication, September 2, 2014].

The relief is sent to communities and facilities supported by authorities. Civil protection authorities must select places in which acceptable living conditions can be provided to disaster victims to serve as shelters prior to any emergency [SEDENA, personal communication, March 11, 2010]. Risk atlases should be developed to graphically show the levels of danger in different regions. Using these atlases, a list of suitable shelters is provided to people before the disaster strikes to ease evacuation procedures and allow them to move to these facilities in cases of emergency (Saldana-Zorrilla 2015).

5. DISASTER MANAGEMENT IN THE FLOOD OF VILLAHERMOSA IN 2007

5.1. Villahermosa, Mexico

Villahermosa is the county seat of the Municipality of Centro (CENTRO) and the capital of the State of Tabasco. The links of Villahermosa to natural gas production and ports for oil exports make the area economically important for the country. Nonetheless, around 49.6% of the population are living in poverty (INEGI 2012).

Villahermosa is surrounded by the rivers Grijalva and Carrizales, it borders with the water body "Laguna de los Espejos" and it is close to the "Las Peñitas" dam system, which makes the city an area very prone to flooding. In the absence of a successful relocation policy for the community, disaster management in the area is a priority for the State government.

5.2. Conditions of the flood of 2007 in Villahermosa

A severe cold front caused strong rainfall in several parts of the country, especially in Villahermosa. This situation, combined with the opening of the floodgates of the "Peñitas" dam, created a catastrophic event with nearly 80% of Tabasco covered by water (approximately 19,800 Km^2), with water heights of four meters and more than one million people affected (Santos-Reyes et al. 2010). Around 90% of the area of Villahermosa was covered by water.

5.3. Data collected about the flood in Villahermosa

Most of the data collection was done through FOI requests submitted to national and state authorities using the list of organisations involved in logistics activities during disasters. The list was available from the guidelines for disaster management in the country. A total of 134 requests were directed to eight regional authorities and 128 requests were filed to nine National authorities. Among the seventeen agencies approached, thirteen agencies declared to have participated and were included in the analysis. At regional level the municipality of Centro, family services (DIF), State Health Ministry of Tabasco (STABASCO), Public Security Secretariat (SSP), Social Security Institute of the State of Tabasco (ISSET), Civil Protection (PC) and the Transport and Communications Secretariat (SCT). At National level, information was collected from DICONSA, Social Security Mexican Institute (IMSS), Health Ministry (SMEXICO), SEDENA, Ministry of Interior (SEGOB) and the Navy (SEMAR). Given that large-scale situations require to support local capacity with other sources, relief aid sent by other governments recorded by Mexican authorities was also included.

Concerning operations after the disaster occurred, other organisations were contacted to enquire for reports about their involvement in relief activities. Online reports and press releases were gathered as well. Information about organisations such as the Presbyterian Mission Agency, Action by Churches Together International, Aktion Deutschland Hilft, Samaritan's purse, Malteser, World Vision, and Search and Rescue Assistance in Disasters was obtained, as well as information about the Mexican Red Cross.

The overview of the data collected can be seen in Table 1. The table includes information about the source institution and the official document reference (if applicable). Information collected included emergency facilities used, demand served, relief items pre-positioned, personnel employed, vehicles involved, the variation of demand per period, international aid, and supply capacity from the organisations involved.

Table 1. Data collected about the case of Villahermosa

Type of data	Source	FOI
Shelters used	PC, ISSET	700106513, 06401914
Facility cleaning cost	DIF	1236000003414
Distribution centres used	SEDENA, DICONSA	700003414, 2015000000714
Procurement per product	DICONSA	R2015000008113
Required personnel per activity	SEDENA, PC, IMSS, DICONSA	700003214, 00001514, 00430914, 00432114, 64101320214, 700004914, 2015000010414
Number of personnel per activity per organisation	DICONSA, DIF, IMSS, ISSET, PC, SMEXICO, STABASCO, SCT, SEDENA, SEGOB, SEMAR, SSP	2015000001314, 2015000003814, 2015000004014, 06399914, 0064100438914, 06644914, 06402614, 06402714, 0001200006714, 06400314, 06243714, 0000700031014, 0000700144314, 0000700106513, 0000400264914, Press release 148/2007, 05924314
Total personnel per agency	DICONSA, DIF, IMSS, ISSET, PC, SMEXICO, STABASCO, SCT, SEDENA, SEGOB, SEMAR, SSP	2015000001314, 2015000003814, 2015000004014, 06399914, 0064100438914, 06644914, 06402614, 06402714, 0001200006714, 06400314, 06243714, 0000700031014, 0000700144314, 0000700106513, 0000400264914, Press release 148/2007, 05924314
Vehicles used	CENTRO, DICONSA, DIF, IMSS, PC, SMEXICO, STABASCO, SEDENA, SEGOB, SEMAR, SSP SEDENA	05923014, 05923214, 2015000001014, 2015000003714, 2015000003914, 06400114, 0064100439014, 0064100439414, 06402814, 0001200006814, 05923814, 05924014, 0000700002614, 0000700031114, 0000700031314, 0000700106513, 0000400264914, Press release 148/2007, 05924414
Medicines delivered	SEGOB	0000400160314
Flood mask	CENAPRED	0413000000214
Technical reports of the situation	SEMAR, CENAPRED	0064100439014, 0413000000514
International aid	SRE	0000500088214
Elevation models of the region	United States Geological Survey (www.usgs.gov) and the website of the National Institute of Geography and Statistics (INEGI) in Mexico (http://www.inegi.org.mx/)	
~~Road network~~ Neighbourhoods denominated Basic Geo-Statistical Area (AGEBs)	~~Software developed by INEGI, namely SCINCE 2010 (http://www.inegi.org.mx/)~~ Software developed by INEGI, namely SCINCE 2010 (http://www.inegi.org.mx/)	

Demographical data Software developed by INEGI, namely SCINCE 2010 (http://www.inegi.org.mx/) Resources from NGOs Online reports from the Mexican Red Cross, Presbyterian Mission Agency, Action by Churches Together International, Aktion Deutschland Hilft, Samaritan's purse, Malteser, World Vision, Search and Rescue Assistance in Disasters, Medical Teams International, Adventist Development and Relief Agency, Americares and the World Food Programme.

5.4. Logistics activities in Villahermosa

Based on the activities considered by Caunhye et al. (2012), the information gathered was used to analyse the operations during the flood in Villahermosa. Unfortunately, there was no information available about casualty transportation, capacity planning, or inventory management, thus the analysis is focused on evacuation, facility location, stock pre-positioning, and relief distribution.

EvacuationandFacilitylocation

Information from Civil Protection, the Social Security Institute of the State of Tabasco and the Mexican National Defence Secretariat showed that around 99,000 people were sheltered during the emergency. The number of evacuees was even higher considering the number of people fleeing the area to stay in other

ortation vehicles, 17 boats and 4 helicopters during the emergency, which considering the capacity of each vehicle and the time horizon of one day, ought to be enough for the evacuation activities.

Before the flood of 2007, the public catalogue of facilities of Villahermosa contained 107 shelters with a total capacity of 26,380 people. The catalogue considered the use of some police stations to provide support for 4-10 people. Those facilities can be arguably appropriate to serve as shelter for disaster victims. Beyond that, the limited capacity of these facilities creates the need to serve several facilities under disaster conditions, which represents a challenge for relief distribution.

Contradicting the evidence that shelters usually are underused (Nigg et al. 2006), there was insufficient capacity in the shelters listed by authorities to accommodate the evacuees. There was a need to improvise, even to the point of using private homes as shelters. The result was the use of around 676 shelters in the area. Shelters declared to have been used by authorities during the emergency were identified and georeferenced in TransCAD® using a layer of the road network available from INEGI.

The results of the analysis agree with reports of facilities flooded and the demand exceeding the capacity provided by the authorities (Santos-Reyes et al. 2010). It is believed than more than one million people affected by the disaster could not find shelters (Santos-Reyes et al. 2010).

Conversely, human resources were exceeding the needs of the situation. From the co-responsibility branch of the disaster management hierarchy in Mexico, there were 13,124 members of staff from 7 organisations for support on shelters, and 3,150 teams (including one doctor, a nurse, a dentist and two helpers) from five organisations for healthcare in shelters as well. The military provided guidelines of six members of shelter staff to serve 90 people for activities such as cooking, security, organising leisure activities, among others, meanwhile it was required to have one healthcare team for every 90 people sheltered. Following those guidelines, it seemed authorities had roughly enough personnel to serve around 196,860 people in terms of shelter care and 283,500 people in terms of healthcare. Considering the estimated demand of 99,000 people, authorities had nearly two and three times the employees required for shelter care and healthcare, respectively. The number of staff in the area was more than that required to serve the highest number of people estimated by National authorities at any point (150,000 people).

Stockprepositioning

DICONSA, organisation in charge of procurement and social programmes, reported a stock of 2,500 prepositioned food pantries available for distribution in the area. In terms of medicines, there was a local supply of medicines from the health authorities (National and State). Distribution of the initial stock was planned to take place right after the disaster giving time to undertake needs assessment. With knowledge about demand, State authorities could request food and medicines from FONDEN and CENAPRECE, respectively.

It is evident that the magnitude of the event exceeded the capacity held by authorities. There were enough items to satisfy a little over 10% of the population in terms of food, and enough medicine to cover less than 3% of the population in the first days of the emergency. Because of the magnitude of the event, this is understandable. However, considering the objective of stock prepositioning about reduction of lead time, the process to determine the number and location of stock to preposition is essential. Currently, there is no information about a clear policy to determine the number of stock to preposition other than available budget. For instance, after the flood of Acapulco in 2013, authorities changed from the 2,500 food pantries held before the emergency to 10,000 food pantries for prepositioning (DICONSA 2014), which was around the number of people sheltered in the State during the flood. The stock was subsequently reduced to 5,000 three years after the flood.

In the case, the number of food and medicine prepositioned seemed arbitrary. The number of items was similar to the number kept in other regions of the country, without regard to vulnerability and the demographic composition. Therefore, the prepositioning policy did not provide the expected result of enhancing performance. Moreover, the analysis emphasises the need to determine the number of items to preposition based on an analysis of previous events, the demographic conditions and prospective scenarios.

Reliefdistribution

Mexican authorities deployed large quantities of items to Tabasco using the FONDEN, being the Centro Municipality the main focus of the aid. Water and food were the focus of authorities, although sand bags along with blankets and mattresses were also supplied in large numbers.

A list of items shipped by authorities obtained from SINAPROC and cross-referenced with information from the MinistryofInterior provided information about demand estimates of National and State authorities, along with the number of items shipped to the Centro Municipality. There were discrepancies between National and State authorities regarding the estimated number of people affected ranging from 22,500 to 367,500 people. Inaccurate estimations show potential for underestimation, but a common problem in reality is overestimation led by a 'false' sense of urgency (Kovacs and Spens 2011). There are some stages in which the estimations of State authorities were more than three times the estimation of National authorities, with a sudden decrease days later. These discrepancies reveal poor information management. Even if only half of the food sent by authorities reached the area, it would be more than twice the food required for people sheltered. Including the relief sent from other organisations, the amount of food provided was considerably more than what was needed. Additionally, lack of information updates was identified, which led to oversupply of some resources (i.e. food) and undersupply of others (i.e. diapers and towels).

Despite all the efforts from the participants, relief distribution became a significant issue as demonstrated by reports of shortages of food (Santos-Reyes et al. 2010), medicines and supplementary items. According to the information, the problem was the shortage of items at the first stage and delays to deliver the relief, which confirms the failure of the stock pre-positioning policy. This partly occurred because of uneven coverage due to political interference (Dudley 2007), impeding the provision of relief to high priority communities.

5.5. Effect of the fit between the decision-making structure and operational activities on the ground in logistics performance

The impact of the fit between the decision-making structure and operational activities on the ground in performance is based on three types of measures: resources, output and flexibility (See Beamon 1999).

Resources

Resources in disaster management include vehicles, relief aid, human resources and facilities, among others. This research shows a significant disagreement between the centralised system and operations in terms of resources. Looking at human resources, the Mexican system works through the activation of different layers, depending on the magnitude of the situation. The purpose is to allow the decision-maker to authorise enough resources to manage the emergency, thereby using resources efficiently. However, the activation of one layer (i.e. local, regional and/or national) means in fact the activation of many organisations, which at the operational level are deployed with the purpose to reach as many people as possible. This was shown in the case, where the healthcare and shelter care needed could have been achieved with fewer organisations. Therefore, the policy to minimise the use of resources at the top of the structure is clearly contradicted at the bottom of the system, allowed by the limited visibility of the decision-maker. The overcrowding of people can be evident for field agents, but it is hardly noticed on the top layers of the hierarchy. The result is convergence of people, which hinders operations by complicating coordination and allowing overlapping activities (Oloruntoba 2005).

Regarding stock prepositioning, the amount of prepositioned stock is set depending on budget, instead of determining the number of items based on other criteria such as vulnerability, previous disasters and the demographic composition of the country. Nevertheless, for the case study this was reflected in a very limited capacity of immediate supply compared to demand, which delayed response and complicated the scenario at the initial stages of the disaster. Hence, this policy was unable to provide insurance of immediate response, which further complicates the successful use of centralised decision-making because of the possibility of slow response (Takeda and Helms 2006).

Facility location is left for co-responsibility branches. However, the central decision-maker needs to oversee this activity better. Shelter location is performed independently from distribution centre location. The former is carried out by civil protection authorities using public facilities, whereas the latter is undertaken by DICONSA based on pre-owned regional facilities. Therefore, decisions are fragmented, which is a contradiction to the centralised system. Focusing on shelters, there are three major issues identified. The first is the absence of risk maps, the second is the use of unsuitable facilities because of the lack of well-defined criteria, and the third is the absence of scenario planning to manage demand. These problems are a result of the disagreement between the decision-making structure and the operational activities on the ground, which had an impact on poor facility location and management.

Output

In disaster management, the perspective of the beneficiaries is essential. A significant aspect affecting the perception of the disaster victims is relief distribution. Distribution becomes a problem in a centralised system because distribution plans ought to be drafted after assessing the state of the infrastructure (Holguin-Veras et al. 2012). In view of the multi-layered structure behind a centralised system, drafting the plans and approving them can be very time consuming and therefore unsuitable for disaster operations. There are two strategies embedded in the Mexican system to alleviate this problem; the development of maps of the disaster to draft distribution plans in advanced, and stock prepositioned for immediate deployment to allow for planning time. However, plans based on untested assumptions about the operational environment can affect the success of operations (Nathanetal.2017). That strategy assumes that operational authorities have risk maps and enough prepositioned stock, the latter being arbitrarily determined as discussed previously.

Regarding risk maps, nowadays the National atlas (the repository of risk maps) is still seriously incomplete and local atlases are even in poorer conditions (Alexander 2015). The reasons for this are the lack of archive material, financial resources and human personnel (CONAGUA 2011). Consequently, disaster planning is not based on the analysis of hazard scenarios nor geographical factors (Alexander 2015), incurring a high risk of choosing unsuitable facilities. Therefore, distribution plans at the operational level are indeed drafted after the disaster. The case of Villahermosa provided an example of this problem. The lack of a well-prepared risk atlas prevented authorities from developing distribution plans, which complicated the selection of suitable routes and effective shelter location. The result was the need of improvisation at the operational level and delays in the provision of relief items.

Flexibility

The capacity to react to variations in demand and adapt to different conditions is closely related to information management. Several issues for information management have been identified in centralised systems such as one-way communication (Scolobig et al. 2015), complicated the access to the system (Boin and Lagadec 2000) and the inability to consider external information (Takeda and Helms 2006). In the case presented, information sharing was a challenge that led to poor needs assessment and made centralised decision-making highly inefficient. The centralised approach relies on accurate information filtered through the layers of the hierarchy, but reality showed contradictions in demand estimates between National and State authorities. Independent data gathering and analysis can be useful to get robust results, but poor information sharing makes the effort fruitless.

A centralised system should use few comprehensive information systems (Marks 1978). Conversely, each agency handled its own information without sharing it, which can derive in unreliable data and duplication of efforts. It can be argued then that information management during disasters in Mexico is mostly decentralised, because different data was collected from various agencies and handled independently. This contradiction led to a centralised system with conflicting and incomplete information for decision-making, and operational activities on the ground with decisions based on inaccurate conditions. The result was an inflexible disaster management system with fragmented information.

Also related to flexibility, the case showed infrequent needs assessment update. Because of the work involved in collecting and analysing information for each agency, the time between one assessment and the next could be extended to weeks or even a month. In view of the dynamic conditions of disaster management, that situation prevented the disaster management system to adapt and react to variations effectively.

Overall, this research has identified misalignment between the decision-making structure and operational activities on the ground in terms of information collection and sharing, facility location procedures, the prepositioning policy and distribution planning. The result has been the conflicting use of resources, deficient satisfaction of disaster victims and an inflexible disaster management system affecting logistics performance.

6. DISCUSSION

The analysis shows poor logistics performance as a result of significant disagreements between centralisation and operations. The first area to consider is to strengthen preparedness and response to support centralisation. The slow response associated with this approach (Takeda and Helms 2006) can be alleviated by placing resources and attention in disaster preparedness. The operational activities on the ground are often more

concerned with disaster response, but appropriate planning can reduce ambiguity (Wijngaard et al. 2006) and response times. Planning, however, has to include input from different stakeholders at different levels to make the plans useful, achievable and sustainable. This integration relates directly to distribution, facility location and stock prepositioning.

The alignment of goals is another important aspect to bear in mind. In a centralised system, it is expected that the goals from top layers guide the entire system, but in a collaborative environment such as disaster management the goals of different stakeholders, governmental and non-governmental, can affect the result. Logistics performance in the case of Villahermosa was affected by conflicting goals at different levels, even when the overarching goal was to prevent death and suffering. Instead of having the operational activities on the ground working within the boundaries established by the top layers of hierarchy, the objectives and guidelines need to be properly agreed across participants to have consistent operations.

Information management is an essential area to achieve high logistics performance. The case showed the impact of having a centralised structure without collaborative and reliable information systems. The duplication of efforts and the unreliability of information severely affects decision-making and complicates operational activities on the ground. Therefore, a collaborative and interactive system needs to be developed to support the decision-making structure at the top and to allow communication and the development of robust information to support operational activities on the ground. Mechanisms to aggregate and cross-reference information can help reduce the number of overlaps between different participants and provide a better quality of information to top layers of the disaster management system.

According to the interview with the representative from OCHA, the clarity about the decision-maker in the current system allows them to quickly approach them to offer support. This is an important revelation because even though Mexican authorities are commonly reluctant to ask for external support, when needed, international organisations can promptly provide support for the government, recognising the legitimacy of the authority. This aligns with the view that having a clear strategic centre and collective vision can be beneficial for operations (Chandes and Paché 2010). This view is contradicted, however, by smaller organisations which struggled to get in touch with the government and relevant decision-makers (Hernández 2009). This is expected because in this kind of system there is the possibility of an input overload (Hart et al. 1993). Adding more actors to the system can complicate control even further, which led authorities to ignore less recognised organisations. This is a problem because self-initiated participants are a reality in emergencies, and movements such as occupy Sandy have shown the potential of people-centred initiatives. Therefore, following the findings of Khan and Rahman (2007), a participation and collaboration mechanism that joins community members and different stakeholders can be valuable to improve disaster management in the country considering the centralised decision-making structure. Although working partnerships can emerge from disaster response activities, there is a need to develop agreements and policies in advance for the joint participation between different organisations and the Mexican government. Such agreements can ease coordination, clarify functions and improve overall operations by empowering different organisations and the wider society to work with the government instead of passively following them.

Needs assessment is one of the most important activities in the first hours after disaster (Charles et al. 2016), but the case showed poor management of this activity. Inaccurate needs assessment caused problems such as shortages of relief and uneven distribution. The flow of low-priority products can hinder operations (Holguin-Veras et al. 2012), because of the space and resources required. Needs assessment and procurement policies for disaster management should follow reliable and well-planned guidelines for a centralised system to work. These policies should ensure the flow of resources could satisfy different requirements in a timely manner and account for the operational capabilities. Currently that is an area for improvement for the case for Mexico.

Standardisation is one of the key aspects to align centralisation and operational activities on the ground. The case revealed that standardisation of relief items was a significant success for distribution after the initial phase, because it allowed to use more optimally the transportation resources and to make the distribution process more efficient. This idea has to be extrapolated to procedures and guidelines to improve logistics performance. The needs assessment process showed that procedures are not standardised, allowing each organisation to operate under their own terms. This approach created discrepancies among organisations which affected the level of service. For centralised decisions to achieve the expected results, the system has to create the right conditions through proper guidance and support to the operational activities on the ground, which has to be informed by the perspective of different stakeholders.

The presence of a set of regulations and an organisation overseeing the resources can support the stream of literature developing optimisation models (Caunhye et al. 2012), because models commonly aggregate resources to provide an optimal response, which is in principle better than the sum of optimised responses from each actor. Nevertheless, models have to be robust enough to account of the uncertain conditions of disaster management and the set of unforeseen challenges encountered, combining reliability and responsiveness.

Beyond the measures discussed, there are more alternatives in the literature that can be useful. Investment on disaster management capabilities, as mentioned by Kunz et al. (2014), to improve the flow of resources within the country and from outside, and agility and leanness in humanitarian operations could be approaches to improve responsiveness that can be supported by a centralised system (Cozzolino 2012). On the other hand, flattening the decision-making structure in disaster management would also allow for a speedy response.

Overall, this analysis emphasises the importance of looking at the alignment between the decision-making structure and operational activities on the ground. Instead of approaching the disaster management system from the perspective of the decision-making structure or the operational activities on the ground, the alignment between them has to be considered to enhance performance. This analysis suggests that appropriate alignment between both dimensions can alleviate some of the shortcomings centralisation and improve the performance of the disaster management system. According to this analysis, several of the issues commonly associated to centralisation are due to the misalignment between the decision-making structure and operations. This is a relevant finding because it moves from the current argument about the appropriate decision-making structure for disaster management to the identification of components to implement an efficient and effective disaster management system. It shows that the key for high performance is embedded in the integrated design of the system and the alignment between its components, which can prove a more feasible approach that moving from one decision-making structure to another, especially considering the evidence of problems associated with both approaches.

7. POLICY IMPLICATIONS

The analysis presented provided a set of implications that are relevant for practice. The implementation of a decision-making structure has to be supported by sensible assumptions at the operational level. This can prevent significant variations between policy and logistics activities.

The use of a centralised decision-making structure in Mexico faces challenges related to responsiveness, information management and poor collaboration. The current response processes are designed to use resources efficiently, but these require gathering, compiling and presenting information to decision-makers on higher layers of the system, thereby increasing response time. That information is not always shared across participants to find a collaborative solution, complicating joint operations. Additionally, distribution is performed by local branches of the government, which can use disaster relief with political purposes. It is important to create an inclusive disaster management system to facilitate operations, prevent delays, allow the participation of unbiased actors, and adapt to the dynamic environment posed by disasters. This requires a revision of disaster management policies and the structure of the disaster management system.

The activation of agencies based on layers of government has to be thoroughly revised. Sending every organisation available to the field is not the solution unless the right resources are at their disposal. In view of the logistics activities performed during disasters, the activation could be linked to the deployment of organisations based on the area of expertise and the needs assessment to prevent congestion and idle participants. Therefore, policy has to be developed to ensure resources are being properly managed and that guidelines are in place to improve operations.

Quality assurance processes for facility location, stock prepositioning and needs assessment have to be properly designed and implemented. This research identified several challenges related to the lack of control and proper management of those activities. Moreover, these quality assurance processes have to be shared across participant organisations to identify shortcomings (such as the lack of risk atlases or the absence of facility selection guidelines) and achieve high performance operations. In that sense, policy about disaster management has to provide guidance for clear boundaries and responsibilities of different participants, with the inclusion of potential self-initiated actors.

8. CONCLUSIONS

This paper provided an analysis of the impact of the alignment between centralisation and operations in the activities performed in the flood of Villahermosa in 2007. Data gathered from governmental and non-governmental organisations was used to look into the logistics operations carried out during the emergency and assess the performance of the disaster management system.

The centralised decision-making structure implemented in Mexico faces challenges of communication and responsiveness, as shown by several challenges arising from the case. The information showed discrepancies in the estimation of victims between State and National authorities, infrequent information updates, and delays on the initial stages of distribution. However, it was found that these problems are not only inherent of the decision-making structure, but also a result of the misalignment between centralisation and the operational activities on the ground. This article argues that aligning both dimensions can reduce some of the challenges and enhance logistics performance in a disaster management system. Considering the nature of centralisation, the implementation of investments in disaster capabilities, agility and leanness can help align the decision-making structure and the operational activities on the ground to improve the logistics performance of the system.

Because coordination and collaboration are of paramount importance in disaster management (B. Balcik et al. 2010), these should be strengthened by information sharing and clear agreements about guidelines for operation, to avoid duplication of efforts and uneven coverage. In the case of Villahermosa, the information gathered showed that poor collaboration led to the supply of more than twice the food required. Additionally, uneven coverage took place because of political reasons and the improvised facilities used by authorities. It is important to adapt the centralised structure to allow dialogue across levels and organisations to provide a more responsive system under uncertain conditions at the operational level. This requires to consider several layers of managers in a centralised system (Christensen and Knudsen 2010) and the potential of introducing better information systems and well-designed operational procedures on the ground to ease collaboration.

Generalisation is one of the challenges of the use of case studies. However, several of insights obtained from the case can be extrapolated to other centralised decision-making systems. The analysis was based on logistics activities commonly performed by host governments in disasters as stated by Caunhye et al. (2012), which makes this approach suitable to other similar systems. For instance, the argument about policy and plans based on untested assumptions shows a gap in the disaster management structure that can be found on several developing countries. Therefore, the analysis of the fit between the decision-making structure and operational activities on the ground can deliver interesting results in similar settings. However, there are limitations in terms of the type of disaster management structure, the level of development of the country, the financing structure and the governmental stability that can restrict the generalisation of some practical implications identified.

The analysis of procedures and policy is based on documentation and interviews whereas the logistics performance was assessed using secondary information. Therefore, information from the interviews can be affected by bias or experience, and inaccurate records of the activities during the emergency could affect the data. We tried to avoid those problems by cross-referencing the information and checking accounts from other sources such as newspapers and academic articles, but we reckon information can be a limitation of this research. Furthermore, information about transportation during evacuation and casualty transportation was not available from authorities, complicating the analysis. Finally, the analysis performed is focused on logistics performance based on the activities identified by Caunhye et al. (2012), without considering their link to other emergency activities.

This analysis showed the importance of looking at the alignment of the decision-making structure and the operational activities on the ground to achieve successful operations during disasters. This area can be further benefited by future research using primary information for the assessment of logistics performance, cross-case analysis to identify variations among countries, papers looking at the development of an assessment of logistics performance on a decentralised disaster management system to draw comparisons, and articles discussing the interaction of information management, collaboration agreements and decision-making structures to achieve high performance humanitarian operations.

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Table 1. Data collected about the case of Villahermosa

Type of data	Source	FOI
Shelters used	PC, ISSET	700106513, 06401914
Facility cleaning cost	DIF	1236000003414
Distribution centres used	SEDENA, DICONSA	700003414, 2015000000714
Procurement per product	DICONSA	R2015000008113
Required personnel per activity	SEDENA, PC, IMSS, DICONSA	700003214, 00001514, 00430914, 00432114, 64101320214, 700004914, 2015000010414
Number of personnel per activity per organisation	DICONSA, DIF, IMSS, ISSET, PC, SMEXICO, STABASCO, SCT, SEDENA, SEGOB, SEMAR, SSP	2015000001314, 2015000003814, 2015000004014, 06399914, 0064100438914, 06644914, 06402614, 06402714, 0001200006714, 06400314, 06243714, 0000700031014, 0000700144314, 0000700106513, 0000400264914, Press release 148/2007, 05924314
Total personnel per agency	DICONSA, DIF, IMSS, ISSET, PC, SMEXICO, STABASCO, SCT, SEDENA, SEGOB, SEMAR, SSP	2015000001314, 2015000003814, 2015000004014, 06399914, 0064100438914, 06644914, 06402614, 06402714, 0001200006714, 06400314, 06243714, 0000700031014, 0000700144314, 0000700106513, 0000400264914, Press release 148/2007, 05924314
Vehicles used	CENTRO, DICONSA, DIF, IMSS, PC, SMEXICO, STABASCO, SEDENA, SEGOB, SEMAR, SSP	05923014, 05923214, 2015000001014, 2015000003714, 2015000003914, 06400114, 0064100439014, 0064100439414, 06402814, 0001200006814, 05923814, 05924014, 0000700002614, 0000700031114, 0000700031314, 0000700106513, 0000400264914, Press release 148/2007, 05924414
Medicines delivered	SEDENA	0000400160314
Flood mask	SEGOB	0413000000214
Technical reports of the situation	CENAPRED	0064100439014, 0413000000514
International aid	SEMAR, CENAPRED	0000500088214
Elevation models of the region	SRE	United States Geological Survey (www.usgs.gov) and the website of the National Institute of Geography and Statistics (INEGI) in Mexico (http://www.inegi.org.mx/)
Road network	Software developed by INEGI, namely SCINCE 2010 (http://www.inegi.org.mx/)	
Neighbourhoods denominated Basic Geo-Statistical Area (AGEBs)	Software developed by INEGI, namely SCINCE 2010 (http://www.inegi.org.mx/)	
Demographical data	Software developed by INEGI, namely SCINCE 2010 (http://www.inegi.org.mx/)	
Resources from NGOs	Online reports from the Mexican Red Cross, Presbyterian Mission Agency, Action by	

Churches Together International, Aktion Deutschland Hilft, Samaritan's purse, Malteser, World Vision, Search and Rescue Assistance in Disasters, Medical Teams International, Adventist Development and Relief Agency, Americares and the World Food Programme.