Towards a solution to partner proliferation problem in disaster response networks

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Abstract
This research is drawn upon the existing literature by examining and comparing existing structures including supply chains, public projects and virtual organisations. It also investigates the existing decision techniques for partners’ selection and their probability for being utilised in temporary and highly uncertain environment.

Keywords: Partner configuration, disaster response network, decisions support tool

Introduction and background
Disasters are intense forms of collective stress induced by a disaster agent (Britton, 1986) where the community is incapable of coping with its negative effects (Wassenhove, 2005). Natural or man-made disasters can both be comprised of sudden-onset or slow-onset (Wassenhove, 2005). The sudden onset disasters such as earthquakes “occur with little or no warning and often cause excessive injuries far surpassing the national response capacities” (Norton et al., 2013, p.10). On the other hand the slow-onset disasters such as famine “do not emerge from a single incident, instead, they emerge gradually over time, often based on a confluence of different events” (OCHA, 2011, p.3). Figure 1 presents the data from relief web (Disasters|resliefweb, 2013) suggesting that the number of disasters since 1983 has been tripled.

Figure 1 – Growth in the number of sudden onset disasters since 1983

The natural sudden-onset disasters are the focus of the current paper because despite their increased frequency and severity during the past decade (Figure 1) the failure in relief operations (Benjamin et al, 2011; Kovac and Spense, 2009) in the large-scale disasters such as
Haiti earthquake (2010) and Indian Ocean tsunami (2004) has yet to be addressed. These failures signal the necessity to investigate solutions to minimise the negative effects of such disasters (Moe and Pathranarakul, 2006).

**Proliferation problem**

The proliferation of actors occurs when the extreme requirements of the disaster necessitates the mobilization of all resources and partners available (Tierney and Trainer, 2004). This phenomenon stretches the relief budget in both public and private sectors (such as NGOs) and pushes the inexperienced actors into the affected area (Telford et al., 2006; Careem et al., 2010). For example, Figure 2 depicts the entry pattern of humanitarian partners into the area affected by Hurricane Katrina.

![Figure 2 - Partner's entry pattern based on date of entrance into Katrina affected area](image)

*Source: Comfort (2007)*

This proliferation may lead to loss of lives, in addition to duplicated efforts, inappropriate aid and risk of reduced quality of response, resulting in damage to the reputation of humanitarian networks (Telford et al., 2006; Balcik et al., 2010). To that end methods for selection and configuration of effective partners need to be developed in response to the call from various scholars (Kovac and Spencer, 2009; Moore et al., 2003; Altay and Green, 2006) who placed emphasized the paucity of an optimal network structure to facilitate disaster relief.

**Re-structuring the disaster network**

Following the popularity in literature, the long-term structures (e.g. supply chains) for disaster management in literature (Maon et al., 2009; Ebig and Tandler, 2009; Tatham and Spens, 2011) the humanitarian industry such as International Federation of Red Cross and Red Crescent Societies and World Food Programme have started to adopt these structures (Wassenhove et al., 2005). However, temporary organisational structures (Simpson and Hancock, 2009) such as project-based networks (Moe and Pathranakul, 2006), ad hoc collaboration networks (Camarinha-Matos and Afsarmanesh, 2008; Nolte and Boegnick, 2012) are also adopted to address the short term outlook required for various phases of disaster operation (Noran, 2011). Although the Virtual Organisation (VO) has been introduced as the short-term structure for disaster response phase (Grabowski and Roberts, 2011; Noran, 2011; Javaid et al., 2013), the present study draws upon the literature (table 3) to justify the reasoning behind choosing VO as the response structure by developing a conceptual model (Figure 3) that explains formation of virtual organisations. A virtual
organisation is an extreme case of collaborative networks and comprise of temporary alliances of independent enterprises (Afsarmanesh and Camarinha-Matos, 2005) which collaborate in response to a single market opportunity (Martinez et al., 2001) and dissolves when the market declines (Brown and Zhang, 1999). A comparison between the characteristics of the VO and Disaster Response Network (DRN) exhibits the conformity of VO and DRN in 19 criteria identified through literature review and supports the suitability of VO structure for DRN.

<table>
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<th>Characteristics</th>
<th>Virtual organisation</th>
<th>Disaster Response Networks</th>
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<td>Unpredictable changes</td>
<td>Brown and Zhang (1999),</td>
<td>Notle and Boenigk (2012)</td>
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This conformity of VO and DRN structures in table 3 is exhibited in the necessity for effectiveness in time and cost, temporariness of the network, collective access to resources, independence and mutual importance of the partners, lack of hierarchy, uncertainty and complexity of the environment, being capable of dynamic and flexible actions, niche market demand and geographically dispersed partners. These characteristics are shared in both structures. Disaster life cycle (Drabek, 1986) including preparedness (planning and warning), response (evacuation and emergency), recovery (restoration and reconstruction), and mitigation (perceptions and adjustment) might coincide (Noran, 2011) with the various phases of VO life cycle (Thoben and Jagdev, 2001(a), (b); Sitek et al., 2010) including initiation, operation and dissolution. To that end a conceptual model is developed to examine the area of overlaps (Figure 3).
Figure 3 illustrates that the disaster strike as a sudden change in the environment creates a demand for disaster response. This starts the life cycle by configuration of a short-term collaboration (VO) from a pool of potential partners executing initiation, operation and dissolution of response phase. When the response phase is complete, and VO is dissolved, the network will be re-configured into a long-term collaboration operating the disaster recovery, mitigation and preparation. This structure continues until another disaster strikes and leads to the temporary collaborations of partners in VO.

Reconfiguration of the existing network

The reconfiguration process in disaster literature has attracted attention from task allocation (Smirnov et al., 2007) and scheduling (Rolland et al., 2010) perspectives, but the overall partner selection literature in this ilk is underdeveloped. On the other hand, partner selection in short-term collaboration is vastly studied. The majority of the literature measure the resources (Avila et al., 2010, Wu and Su, 2005, Lavrac et al., 2007, Niu et al., 2012; Msanjila and Afsarmanesh, 2008; Yun, 2011; Schmidt, 2007) or capability required to perform a task (Chen et al., 2007; Romero et al., 2009; Wu and Su, 2005; Yao et al., 2006; Huang et al., 2011; Tiacci and Cardoni, 2012; Crispim de Sousa, 2009; Talluri and Baker, 1996; Wu and Su, 2005; Chen et al., 2007; Mun et al., 2011; Tao et al., 2012; Niu et al., 2012). However this paper argues that all the above approaches are basically measuring the competency of the partner for performing the task.

Afsarmanesh and Camarinha-Matos (2005) define competency as the capacity for existing resources plus the available capabilities/skills to perform some task or activity. Based on this definition, the competent company can be selected based on their resources and capabilities required for performing the task. Resources in present research are defined based on Javidan (1998) who categorises resources into three groups of physical (equipment, financial), human (skills, experience,) and organisational resources (reputation, culture,). Also alignment and trust can be defined as the derivation of the partners (Emden et al., 2006; Naesens et al., 2009) from the optimal capability (technical, knowledge, relations) to perform each task (Mun et al., 2009, 2011) and therefore could be categorised under competency.

In order to implement the partner selection process, the above criteria require a framework for decision-making. These decision support frameworks or tools can be a combination of hard and heuristic methods. Hard methods accommodate numbers and crisp values such as exact algorithms e.g. the Branch and Bound algorithm (Ip et al. 2004, Zeng et al. 2006, Avila et al., 2010; Fulga, 2007) or mathematical modelling and programming, e.g. goal programming (Famuyiwa et al. 2008) and integer programming (Wu and Su 2005; Zeng et al., 2005; Jarimo and Salo 2009). Heuristic methods accommodate the uncertain weights and preferences of decision makers. These method amongst others include Fuzzy decision-making and multi-attributive decision-making (MADM) algorithms, e.g. analytic network process (ANP) (Chen et al. 2008; Sarkis et al 2007), analytical hierarchy process or AHP (Zolghadri et al., 2011; Li et al., 2008), Data Envelopment Analysis or DEA (Talluri and Baker, 1996), fuzzy-AHP approach (Chen et al., 2008), Technique for Order Performance by Similarity to Ideal Solution or TOPSIS (Ye and Li 2009; Ye, 2010, Crispim and de Sousa, 2009), fuzzy preference programming (Wang and Chen 2007; Chen and Wang ,2009; Azadnia et al ,2012; Mikhailov, 2002; Mun, 2009) and meta-heuristic algorithms, e.g. genetic algorithms or GA (Ip et al., 2003), Ant Colony Optimisation (Fischer et al., 2004), particle swarm optimisation (Xiao and Liu, 2009; Bu et al., 2008; Zhao et al., 2008), Tabu Search
algorithm (Crispim and de Sousa, 2009, 2010) and Neural Network (Azadnia et al., 2012). Both methods are subject to their own weaknesses and need to be employed in combination. For example hard methods can only accommodate the crisp values and quantitative data, which are difficult to obtain in disaster situations. The soft values and uncertain data inherited in a disaster situation such as trust or alignment can be addressed by heuristic techniques, which may fail to accommodate quantitative data and cope with disaster complexity.

Developing the decision support tool

To summarize the above arguments, the present paper suggests developing a decision support tool for partner selection in order to configure the suitable partners for disaster response operation in a short-term collaborative structure and to address the partner proliferation problem. The following framework is introduced to develop a scenario based decision tool. Pre-planning and long-term outlook is also impossible because they require information about supply/demand (Comfort 2004, Tierney and Trainer, 2004, Wassenhove, 2005), which are not obtainable due to the uncertainty off disaster situation (Tomasini and Van Wassenhove, 2009). Also budgeting is impossible due to the unsteady flow of the financial resources obtained by fund-raising through occasional donors (Oloruntoba and Gray, 2006). In other words the planning and implementation are required to be executed simultaneously (Simpson and Hancock, 2009) and the pre-existing plans need to be substituted by scenario based planning (Jiang et al., 2012). To that end three phases are designed for partner configuration in a disaster response network, disaster profiling, partners clustering and final decision-making (Figure 5).

Figure5- The conceptual model of scenario based partner configuration in disaster response

The aim is to build various disaster scenarios and pre-evaluate the potential partners for each disaster scenario based on their capability to deliver each task at each degree of severity.

1. Disaster profiling is designed to define the scenarios for a disaster based on its severity. Inspired by various studies (Rutherford and De Boer 1982; Ferro, 2005; Gad-El-Hak, 2007; Wickramaratne et al., 2010; Javaid et al., 2013), a disaster severity assessment (DSA) tool is developed. DSA categorises disasters in three different degrees of severity based on six criteria including the impact time, the number of fatalities, the number of casualties, financial damage per capita, disaster risk index,
and the Human Development Index. Because each scenario of disaster causes a different level of disruption, each scenario requires a different response. For example, if we have an ‘Extremely Severe’ hurricane scenario, in a less developed area such as Haiti, the estimated response will differ from a ‘Severe’ earthquake in a more developed area such as Japan.

2. Based on requirements of each scenario, the partners can be clustered into enterprise groups with the capability to perform each task (e.g. high level medical expertise, medium level communication facilities.). For this purpose, the decision environment might be first reduced (Ip et al., 2003) by pre-qualifying a ‘pool of partners’ (Hoffner et al., 2001; Fischer et al. 2004; Msanjila and Afsarmanesh, 2008; Ermilova and Afsarmanesh, 2007; Romero et al., 2009; Jarimo and Salo, 2009; Zolghadri et al., 2011; Paszkiewicz and Picard, 2011; Rosas et al., 2011; Abreu et al., 2009) and then the clustering (Crispim and De Sousa, 2009; Azadnia et al., 2012) could be executed.

3. Finally a set of partners, which are qualified to perform each task, could be selected with the aid of decision techniques such as scheduling and task allocation (Rolland et al., 2010; Chen et al., 2007) or heuristic algorithms such as Tabu search algorithms (KO et al., 2001; Crispim and de Sousa, 2009). This could be executed by matching a set of partners’ capability to the requirements of a task (Talluri and Baker, 1996; Wu and Su, 2005; Chen et al., 2007; Mun et al., 2011; Tao et al., 2012) or objectives (Tiacci and Cardoni, 2012; Crispim de Sousa, 2009) by employing an industry wide search (Chen et al., 2007; Romero et al., 2009), taking into account the precedence of the tasks where the suitability of candidate A for task B qualifies the candidate C for task D (Wu and Su, 2005; Yao et al., 2006; Huang et al., 2011) or optimizing the total result of the sub-projects allocated to various partners (Niu et al., 2012).

The design of this framework is a part of an extensive on-going research by the authors and is expected to be fully developed and implemented in the near future. However, a number of considerations need to be added to the model. For example due to the unpredictable situation in disaster response operations various failure/success probabilities (Ip et al., 2003; Fuqing et al., 2005, Yao et al., 2006, Jarimo and Salo, 2009, Kumar and Harding, 2011, Mun et al., 2009, Tiacci and Cardoni, 2009) and risk factors (Jarimo and Salo, 2009, Kumar and Harding, 2011, Li et al., 2008, Ye and Li, 2009, Ye, 2010, Huang et al., 2010, Li et al., 2008, 2009) need to be taken into account. Also the historical data for partner appraisal in disaster situation may ignore an important part of operation including ad-hoc partners and volunteers who are responsible for the majority of life-saving and initial emergency activities in the response phase (Telford et al., 2006, Simpson and Hancock, 2009). Also non-traditional financial factors such as human lives and the time values associated to the rescue need to be considered with more weight due to their importance in disaster situation (Oloruntoba and Gray, 2006, Pettit and Beresford, 2009).

Conclusion

The study embarks upon the definition of natural sudden onset disaster as the most reoccurring disaster in the past decades. It focuses on one of the neglected problems in the disaster situation - the proliferation of partners. Comparing various forms of collaboration during the life cycle of disaster, the study suggests the concept of Virtual Organisation as the key structure for the response phase. A review of the literature concerning the partner selection in short-term collaborations exhibits that the characteristics of a disaster situation necessitate a scenario based decision support tool for partner configuration. Hence, the research proposes a scenario-based decision support model for partner selection and configuration. This decision support model consists of three phases: disaster profiling, partner
clustering and decision making. The process will identify a set of suitable partners for each task in each scenario. This model will contribute to the faster and more efficient partner selection and configuration in the disaster response phase and it will reduce the problem of proliferation. The development, simulation and implementation of this decision support model of partner selection will be the subject of further studies.

References


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