Disaster Relief Operations: Past, Present and Future

Rameshwar Dubey[1] • Angappa Gunasekaran[2] • Thanon Papadopoulos[3]

Montpellier Business School
Montpellier Research in Management
2300 Avenue des Moulins
34185 Montpellier France
E-mail: r.dubey@montpellier-bs.com

Angappa Gunasekaran
School of Business and Public Administration
California State University, Bakersfield
9001 Stockdale Highway
Bakersfield, CA 93311-1022
USA
E-mail: agunasekaran@csub.edu

Thanos Papadopoulos
Kent Business School
University of Kent
Sail and Colour Loft, The Historic Dockyard
Chatham, Kent ME4 4TE
United Kingdom
E-mail: A.Papadopoulos@kent.ac.uk

Abstract

The aim of the preface is to introduce the scope of this special issue (SI). We explain our editorial approach and summarise our findings based on articles included in this SI. Finally, we outline future research questions which stemmed out of the discussions of this SI.

Keywords: disaster relief operations, humanitarian operations, humanitarian supply chain management

1. Introduction

The impact of disasters on people lives and properties across the world has attracted significant attention from governments, policy makers, non-governmental organizations and scholars (Altay et al. 2018; Dubey et al. 2019. Altay and Green (2006, p. 475) argue that, "Disasters are large intractable problems that test the ability of communities and nations to effectively protect their populations and infrastructure, to reduce both human and property loss, and to rapidly recover." Our review of available databases such as EM-DAT, maintained by the Center for Research on the Epidemiology of Disasters (CRED), suggest that in the year 2018 alone, there were 281 climate-related and geophysical events recorded in the EM-DAT with 10,733 deaths, and over 60

million people affected across the world. Galindo and Batta (2013) further explain disaster relief operations as the set of activities performed before, during and after a disaster to reduce its impact on human lives and properties (c.f. Altay and Green, 2006). However, many of these activities often require operations research (OR)/ management science (MS) skills (Altay and Green, 2006; Galindo and Batta, 2013). For instance, location of shelters in preparation for evacuations may be addressed as a special case of location analysis; evacuation itself can be better analysed through the applications of gravity location model or transportation techniques. Moreover, in the era of large data, the location intelligence (i.e., big data analytics capability powered by artificial intelligence) may reveal better opportunities. Despite the increasing applications of OR/MS techniques, it is often observed that most of the times the disaster relief team fail to understand the survivors' needs and even when the disaster relief team reaches the affected areas in time, the relief to the survivor is still far from reality (Altay, 2008; Chakravarty, 2014; Gunasekaran et al. 2018). Hence, in such cases statistics and probabilistic approach may further help address uncertainties associated with such large events in disaster locations and demands; and in general various OR/MS techniques can be applied to the different stages of disaster relief operations involving multiple diverse actors. In the past we have seen some significant efforts from OR/MS scholars in shaping the disaster relief operations field via application of OR/MS techniques (see, Altay and Green, 2006; Galindo and Batta, 2013; Besiou et al. 2018). We have noted some significant rise in articles focusing on disaster relief operations/humanitarian operations with rich applications of mathematical techniques or statistical methods to address some of the pressing issues like coordination among humanitarian actors, vehicle routing problems, demand forecasting or optimization of resources at various stages that includes*: mitigation, preparedness, response and recovery.* However, the application of OR/MS techniques in disaster relief operations has often attracted criticisms from scholars (see, Galindo and Batta, 2013). This may be attributed to the lack of adequate understanding of disaster relief operations management field (Kovacs and Spens, 2011; Holguin-Veras et al. 2012). We have noted this as a clear gap in the existing literature. Hence, to address this gap we have organized a SI for *Annals of Operations Research* (AOR). We have attempted to address the following research questions via this SI:

(1) What is the current state of art in disaster relief operations management?

(2) How various OR/MS techniques were used to address various issues in various stages of disaster relief operations management?

(3) What are the gaps noted in the applications of OR/MS techniques in various stages of disaster relief operations?

To address our research questions we have invited articles via various platforms to build a collection of high-quality research that further our understanding towards complex disaster relief operations involving multiple actors characterized by different nationalities, cultures and values. Moreover, with this SI we wanted to invite articles in context to applications of OR/MS techniques in various stages of disaster relief operations. Hence, the invitation was not limited to a specific method or methods. We encouraged scholars to submit qualitative based research, survey based studies, mathematical modelling, and simulation based studies. These methods offered solid contribution to theory and practice. Potential topics for this SI included:

- Disaster relief operations
- Agility in disaster relief chains
- Adaptability in disaster relief chains/humanitarian supply chains
- Alignment in disaster relief chains/humanitarian supply chains
- Coordination and collaboration in disaster relief network/humanitarian supply chains
- Resilience in humanitarian supply chains
- Role of emerging technologies in disaster relief operations
- Innovations in humanitarian supply chains
- Swift-trust
- Military–civil interface in humanitarian operations
- Capacity building
- Behavioural humanitarian operations
- Relationship management in context to humanitarian operations
- Performance measures and metrics in humanitarian supply chains
- Logistics in humanitarian operations
- Total quality management in humanitarian supply chain and logistics
- Costing in humanitarian logistics and supply chains

After discouraging many inappropriate submissions, we ended up with 94 online submissions within the scope of our special issue. We invited two or more subject matter experts to review the 94 submissions. Based on their reports, we either rejected some of the papers or invited the authors to undertake extensive revisions. Finally, after multiple rounds of review and revision we accepted 59 articles for our SI classified into two parts.

2. Classification of Accepted Papers

In this section we have organized our accepted papers based on two complementary approaches: *qualitative* and *quantitative* (Kilmann and Mitroff, 1976). We further propose the classification scheme (see Figure 1), the two sub-categories (i.e., *review and conceptual or case based studies*) under

qualitative category and three sub-categories (i.e., *articles based on MCDM techniques, optimization and econometric modelling*) under quantitative category.

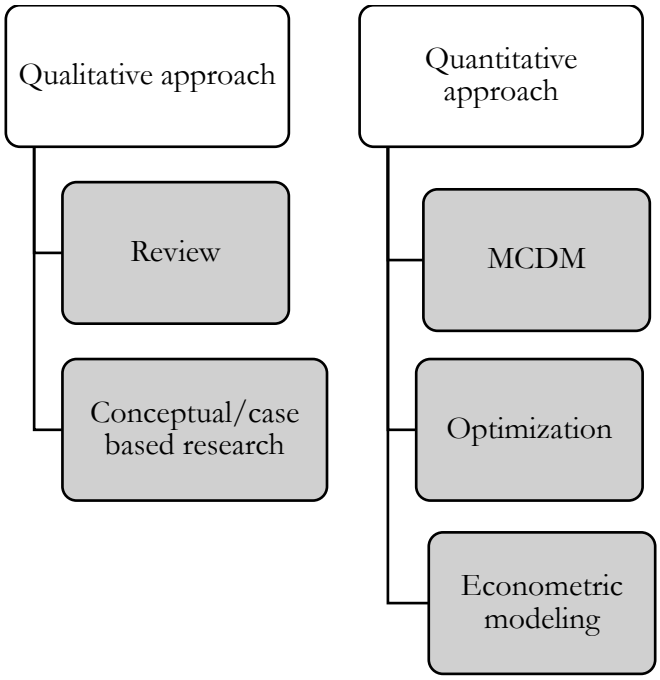

Figure 1: Classification scheme of articles

We have further distributed 59 accepted articles based on the contributors as (Figure 2):

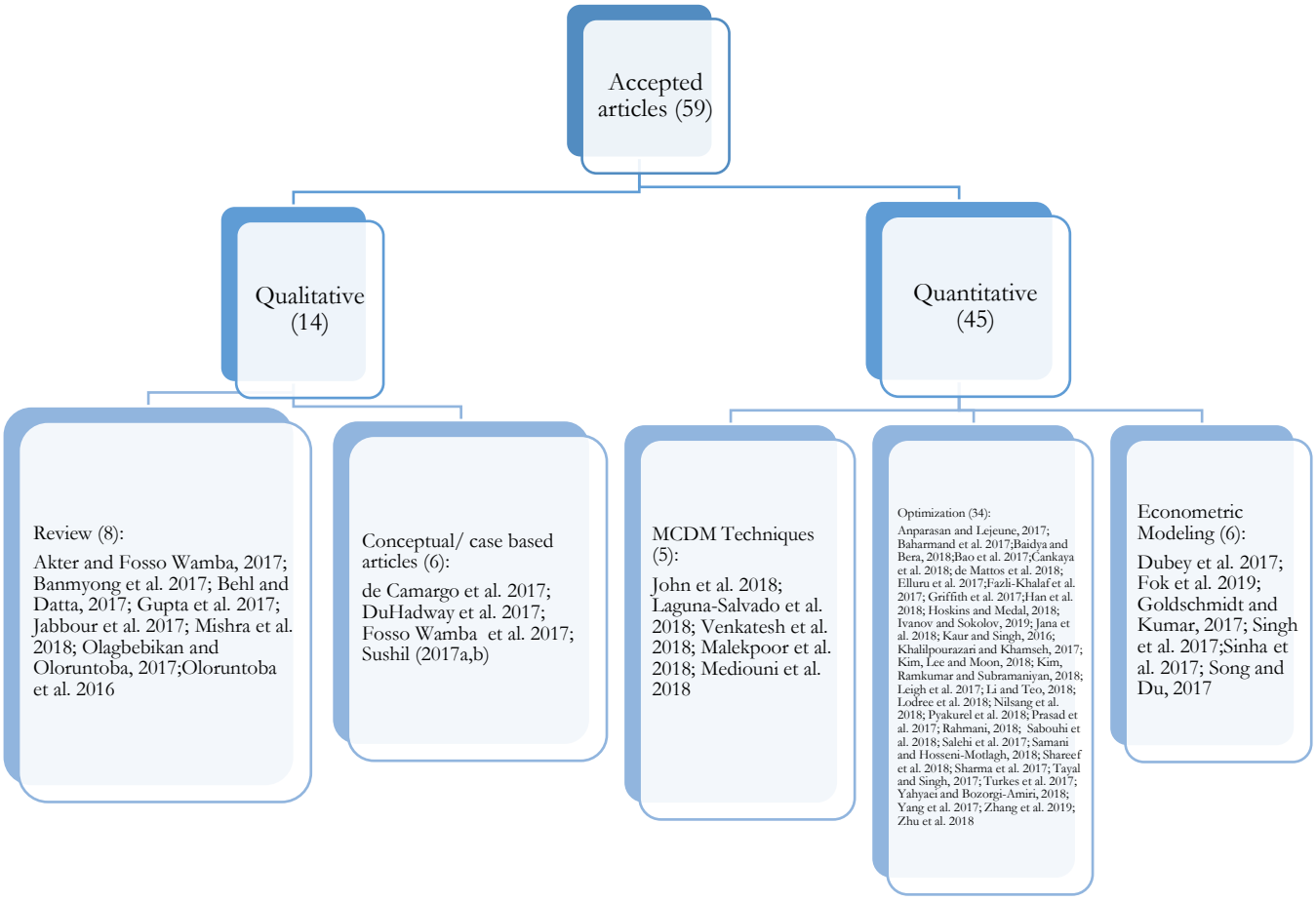

Figure 2: Distribution of accepted articles based on classification scheme

3. Future Research Directions

Based on the 59 articles, we have observed that the contributing authors to our SI have used qualitative and quantitative approaches. We have accepted 8 articles based on critical review of existing literature and 6 articles focusing on theory building (Figure 1 and Figure 2). Hence, these 14 accepted articles in this SI provide comprehensive understanding of the state of the art of disaster relief operations management field. Hence, we can argue that these 8 articles may provide numerous directions to the humanitarian or disaster relief operations management scholars or policy makers to formulate their research hypotheses.

Secondly, we have 45 articles based on quantitative methods. We have further categorized these 45 articles into three sub-categories: MCDM techniques (5), optimization (34) and econometric modelling (6). Hence, these articles provide in depth understanding of the situation or

circumstance under which MCDM tools, optimization techniques and econometric modelling can be applied to address complex situations at any stage in the disaster relief operations.

Further, this SI also offers interesting insights for building resilient disaster relief chains, developing inventory strategies for disaster relief materials and how emerging technologies like IoT and big data analytics capability can improve coordination among various partners engaged in disaster relief operations. These contributions have led to further theoretical debates surrounding disaster relief operations using OR/MS techniques. Yet, some research questions remain unaddressed:

RQ1: How can big data analytics capability powered by artificial intelligence help to improve the visibility in disaster relief chains?

RQ2: How can intelligent optimization techniques be used to solve complex vehicle routing or location analysis problems?

RQ3: How can game theoretic model help to explain the civil and military cooperation under limited information environment?

RQ4: How can soft OR techniques improve coordination among various humanitarian actors engaged in disaster relief operations?

We believe these research questions may further help to bridge the gap between disaster relief operations management and OR/MS field.

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