# Collaborative disaster management: An interdisciplinary approach

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A B S T R A C T

Large scale natural and man-made catastrophic events, triggered or augmented by regional conflicts, climate change and new disease strains appear to be steadily increasing in intensity and frequency. Proper preparation, response and recovery are required in order to cope with and survive large-scale disasters; unfortunately however, the institutions responsible for delivering emergency response services form a heterogeneous set that often under-performs due to lack of proper interoperation and collaboration. New innovative, holistic and integrated models, representing all essential aspects of the disaster events and response team participants are necessary to successfully meet these new challenges. Based on previous research and applications, this paper argues that the necessary artefacts can be built using an interdisciplinary, industry-based paradigm enabled by advances in the Interoperability, Collaborative Networks and Enterprise Architecture disciplines. This combined approach aims to provide a sound platform for efficient disaster response delivered by agile and synergic task force teams.

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## 1. Introduction

The rate and force of natural and man-made disasters, whether triggered or augmented by new strains of drug-resistant diseases, regional conflicts and climate change, appears to be on the rise. In this context, it is nowadays essential to promptly and effectively prevent, prepare for, respond to and recover from catastrophic events. Governments worldwide react to this challenge by creating specific policies, departments and organisations. The resulting 'Disaster management' organisations (DMOs) operate in a complex environment featuring diverse history, tradition, geographic location and culture, level and type of governance etc.; the resulting organisational diversity of the DMOs requires significant effort to achieve proper and effective collaboration [1]. As coping with large scale catastrophic events typically demands resources and capabilities beyond those of any individual organisation, the effective cooperation of DMOs at all necessary levels and addressing all relevant aspects is essential [2–5]. Failing to achieve effective collaboration in disaster management typically has dire consequences, including loss of property and human life.

The paper adopts an interdisciplinary approach to disaster management collaboration drawing upon knowledge accumulated by state-of-the-art research in Interoperability, Collaborative Networks and Enterprise Architecture (see Fig. 1). It is expected that that this approach will promote an integrated holistic, life cycle-based analysis and architectural design approach covering all aspects deemed relevant for the disaster management universe of discourse.

## 2. Current issues in collaborative disaster management

The operation of emergency services is typically legislated at state, national and international levels (e.g. [6–9]). However, merely instructing organisations to cooperate using high-level generic directives does not bring about true collaboration; the consequences are increased response times, confusion about the situation on the ground and sometimes even dispute as to who, where and when is in charge. Wilson et al. [10] reinforce this point by stating that collaboration does not automatically occur but rather must be "constructed, learned [...]" and importantly, "[...] once established, protected" (ibid.). Like most human-related processes, collaboration cannot be successfully forced on the participants or achieved in a short period.

Coordination in crisis situations is also difficult due to incompatibilities in infrastructure and difficulty in filtering and validating the typical flood of information generated during disaster events. For example, inconsistency in alert notice types and formats may delay intervention and hinder warnings by fuelling a 'cry wolf' situation where the population is saturated

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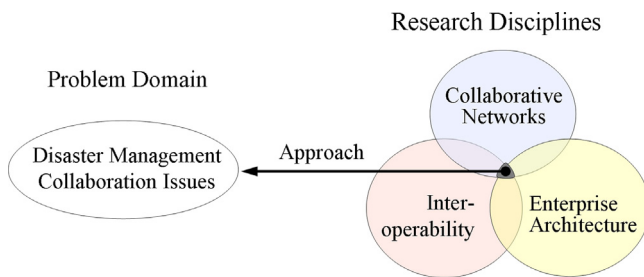E-mail address: O.Noran@griffith.edu.au

Fig. 1. A multidisciplinary approach to advance collaborative disaster management.

with ambiguous and/or irrelevant messages [11,12]. This may lead to sub-optimal prevention and response by intended recipients and potential property and life loss. Unfortunately, efforts to standardise warning message protocols are still rather localised, with low take-up rates [13,14].

Various documents, inquiries, reviews and reports ([9,11,12,15–17,18], etc.), suggest that the root causes of current shortcomings could in fact be the inadequate information flow and quality between the participants [19,20], owing mostly to incompatibilities originating in heterogeneity, lack of trust, organisational confusion and even competition fallacies. Thus, true collaboration is intricate and multifaceted, involving information, processes, resources and organisational cultures of the participants [3,4], as well as their information systems that reflect and manage most of these aspects [21].

It is also essential to point out that the collaboration capability of the participants involved in a disaster management effort also fluctuates in relation to their current life cycle phase/s. For example, the collaborative potential and agility of an organisation may decrease during its re-engineering, which may involve concurrent operation, analysis and design life cycle phases. Currently, this important aspect appears to be largely overlooked with most of the modelling performed in a snapshot-like manner.

An important part of disaster management is represented by health-related incidents. Healthcare has made significant advances in the last century, such as the development and wide use of vaccines, eradication of serious diseases and large reductions in communicable disease epidemics and chronic illnesses [22,23]. Unfortunately however, nowadays we are still confronted with global health hazards owing to causes such as new strains of diseases [24] and climate change [25]. Typical psychological effects triggered by disaster events such as uncertainty, anguish, confusion, panic etc. are amplified in pandemic-type situations and thus claim appropriate and specific collaboration *preparedness* of the participant organisations [5,26], achieved in advance, based on frameworks with a strong ethics component [27,28].

Owing to the urgency involved and often in the context of slow response of some task force members, the higher ranking organisation/s may be tempted to override, exclude or replace some participants, adopting a 'central command'-type approach in preference to a cooperative one [29]. This is not desirable, as successful disaster management (including healthcare crises) relies on a wide range of community economic, social-psychological, and political resources. This cooperation brings communities together, gives them a sense of usefulness [29] and thus alleviates negative psychological effects of disaster events. The disaster management federalisation approach offered as an alternative to central command has also achieved sub-optimal results in the past as reflected in criticism expressed in the relevant literature [15,18,30]. The adoption of military-type network-enabled capabilities in disaster management [31] has also been found to have limited applicability due to potential over-reliance on failure-prone civilian communication infrastructure.

Piece-meal solutions to various collaborative disaster management barriers are emerging. Thus, Baker et al. [32] argue that the typically divergent perceptions and expectations of the task force parties involved [33], often augmented by strong hierarchy and marked difference in status between partners [34], can be dealt with by the higher ranking participants promoting collaboration and trust through a participatory and inclusive approach.

Literature further argues that collaborative disaster management can be enhanced by modelling and participatory design [35] aimed at integrating scientific but also administrative and political aspects into a whole-system approach [36,5,37]. The essential life cycle aspect is somewhat addressed [6,38] however not seen as a context to all other viewpoints and participants.

Thus, poor aspect coverage (including life cycle), lack of commonly understood integrated models and a missing mature cooperation paradigm appear to be the major obstacles in achieving suitable collaborative preparedness. Overcoming these barriers requires access to a multitude of interdisciplinary information and knowledge not always obvious or easily accessible to planners and disaster managers. This paper attempts to propose a way forward in this regard.

## 3. Disaster management interoperability: approach and aspects

Successful disaster management cooperation involves the will *and capability* of the participating organisations to work together in an optimal way. The concept of 'interoperability' (sometimes accompanied by 'maturity') is often used as a measure of cooperation capability [39,40]. Note that interoperability is understood here as enabling the use and exchange of information but *also* as ability to perform a function on behalf of another entity [41]. The analysis of interoperability in the disaster management domain must include some important aspects:

- what is the required interoperability extent?
- what components/aspects need to interoperate?
- how can it be ensured that all necessary aspects are covered?
- how can it be ensured that the interoperability achieved is *sustainable* in time?

Each disaster event is quite unique; thus, there is no 'one size fits all crisis situations' DMO interoperability level. At a minimum, the participating organisations' systems should be *compatible*, so at least they do not hinder each other's operations (see Fig. 2).
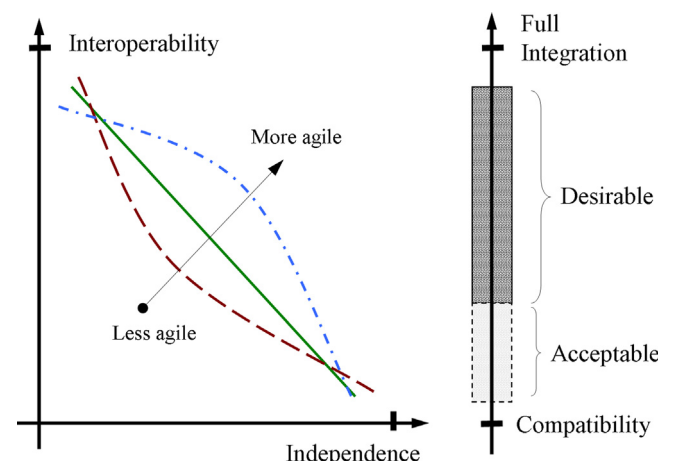


Fig. 2. Acceptable vs. desirable interoperability levels in disaster management.