SUPPORTING CROSS BORDER EMERGENCY MANAGEMENT DECISION-MAKING

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Abstract

Volatile events such as public health disasters bring the prospect of rapid contagion and the threat of disastrous impacts for Europe. Vulnerabilities and cascading effects can result in significant injuries, illness and loss of life. Damage to health infrastructure, demand for medical attention, displacement and major outbreaks all place a strain on health services. Preparedness, response and recovery capabilities of health services will directly impact society's ability to 'bounce back' to become more resilient to such devastating shocks. This research in progress paper investigates the challenges facing multi-agency coordination, the characteristics of commercially available tools in addressing these issues and as a result current decision support in managing emergencies. The findings of the study provide a rich foundation for future research on the design of incident/emergency management decision support (DS) tools. This study then proposes the development of a tool-set which will enhance the protection of public health across borders and common grounds for interoperability by significantly advancing the existing knowledge base required for the development of next generation (user-centred) DS tools for better preparedness, rapid response and coordinated recovery in emergency situations.

Keywords: Decision Support tools, interoperability, multi factorial and multi-agency challenges, health services

1 Introduction

Large scale disasters be they natural, deliberate or accidental are inevitable. They do not respect borders, a large number of people will die and the long term consequences from economic to mental health can for years devastate the affected population. People, not tools, are the most important asset. Nothing can replace well trained, competent and motivated people. Healthcare practitioners and services respond to emergency situations but they are sometimes overwhelmed often requiring rapid decision-making (Alexander, 2002) Decisions in the allocation of strained resources, prioritising casualties, while simultaneously trying to contain the level of impact are challenging. Several times a year, the response requirements of emergency situations exceed the disaster management abilities of the local area, region, country or even several countries. Health emergency management (EM) in is a complex process. Response and recovery activities alone are not an effective means of managing emergencies, of any scale, if they are performed in the absence of preparedness and planning activities.

In fact the main challenge for health services, emergency managers and first responders is to prepare for, respond to and recover from emergency situations. Most commonly, disasters are measured in terms of direct consequences: deaths, injury and mental illnesses. However, the great majority of losses, between 70% and 80%, are secondary to indirect deaths that would not have occurred without the breakdown of social and health services and the information systems which inform them (Burkle and Greenough, 2008). Indirect deaths are rarely the subject of disaster planning or a part of the post crisis evaluation. Therefore given the importance of (public) health services in emergency situations, the consequences of them being unprepared and the vulnerable overlooked can be particularly dramatic in terms of casualties. Other challenges are a lack of coordination and information sharing in a multi-agency response, information overload and a lack of interoperability, all of which create operational inefficiencies and delays. Healthcare systems establish health care priorities, follow historical emergency trends and reassess priorities, detect and respond to an emergency, evaluate the effectiveness of the response, ensure the effective management of resources and evaluate quality of healthcare (Cappola, 2011). The objective of this study is to determine if current commercial tools address multi-agency coordination and collaboration issues in order to propose the development of a DS tool-set to deliver improved healthcare preparedness, response and recovery. The remainder of the paper is structured as follows. In section 2 we discuss the processes used to respond to emergencies, challenges faced within and across response agencies and the trends in DSS research. In section 3 we describe the research objective and method used. In section 4 we present our findings and conclude with a description of our proposed solution and next step.

2 Theoretical Foundation

2.1 Challenges in Multi-Agency Incident Coordination and Sharing

The visibility and importance of emergency procedures and decision-making are increasingly highlighted through rigorous studies of disasters. Decisions must be made regarding the prioritisation of planning activities and how to respond effectively as a coordinated health emergency planning and response system across many disciplines, border boundaries and various levels of government. According to Cappola (2011) comprehensive disaster management is based on four distinct processes: (1) mitigation: reducing the consequences of an emergency, (2) preparedness: equipping responders, decision-makers and the public with the tools and mechanisms to minimise losses, (3) response: actions to prevent further health suffering, and (4) recovery: returning to normal. The initial actions taken by health emergency agencies are reactive in order to rapidly respond to a disaster but become proactive as soon as an operational picture of the incident becomes available.

However coordination and sharing of information is a worldwide challenge associated with multi-agency EM (Van de Walle and Turoff, 2007). The obstacles and challenges fall into one of three levels: (1) inter-organisational level; (2) intra-organisational level; and (3) individual level. Challenges and obstacles at the inter-organisational level consist of lack of working history between the agencies, lack of trust, constraints on resources to facilitate sharing and coordination, lack of investment in training, essential technology upgrades, lack of a shared/common vocabulary across the agencies (Manoj and Baker, 2007). In the event of a joint response, agencies effectively operate as independent units when not responding to an emergency (Bharosa et al., 2010) so there is an in-built complexity when collaborating as independent units and not as teams when responding to a disaster. At the intra-organisational level, challenges include issues around cultures and structures (Mendonca et al., 2007). When a mix of responder agencies work together, it is usually in an improvised and ad-hoc manner; the work is often stifled by responder reluctance to deviate from their familiar internal structures (Carver and Turoff, 2007). The issue of interoperability facilitates increasing organisational agility through embracing improvisation, and mixing and matching technologies.

Information overload, although most frequently tied to an individuals’ degree of cognitive overload, can also occur at the intra-organisational level (Manoj & Baker, 2007) as the sheer volume of information made available is just too much and leads to an organisations’ inability to search/find and use the information needed. Systems selected for information sharing and coordination across agencies is due primarily to the expected agency value from use (Lee et al., 2011). A lack of understanding of organisational information requirements and end user interface design may potentially reduce the expected group value of the system and prevent effective use. As a result a significant effort must be made to ensure that increased inter-agency integration does not lead to voluminous amounts of irrelevant information and overload the organisations (French and Turoff, 2007). Developing interoperability solutions which facilitate agency response improvements by: embracing creativity, integrating technologies, and increasing overall agility and flexibility as an approach to overcome challenges in multi-agency coordination and information sharing.

2.2 Trends in Decision Support Systems (DSS)

Decision-making functions such as: coordination, organisation, command, and planning are knowledge-based activities that require not only one but a series of interconnected decisions. Project management and exception reporting software, collaboration/coordination systems allow decision-makers to focus on the more challenging knowledge acquisition, sharing, analysis, creation, retention and the decision-making functions. There is a continued shift from building systems to configuring solutions delivered out of the box or a mash-up of services and streams of data pulled together to address a pressing need for, individual, inter-agency and intra-agency levels. Hosack et al., (2012) predicts that the research streams of knowledge management-DSS (KMDSS) and data warehousing will merge, and the focus will incorporate better ways to allow end users to interact with available information, wherever and whenever it is available. As the complexities of decision-making increase and the availability of information increases, there will be a need for larger and more analytically based data infrastructures to be aligned with knowledge and DS tools. The merging of trends (patterns) is occurring and is supported by the use of tools by firms such as Google (ranked, best fit algorithms). Our contention is that merging patterns in threat analysis and in health can be supported by the use of tools to leverage or model data to help end users make informed, knowledgeable decisions.

Social media to inform decision-making is "cutting edge", and will likely dominate research for the next decade. Notably, social networking applications are beginning to be seen in critical decision-making (Scott, 2011) or decision making in healthcare (Griffin and de Leaster, 2009). Feeds from Twitter and Facebook can be integrated to provide up-to-the-minute information to emergency response teams. www.weather.com feeds can be captured to determine weather patterns across countries. These systems use a combination of the algorithms and structured data that traditionally make up a DSS but add geographical information systems (GIS) and social media to the models which further enhance decision-making. Future DSS research opportunities include better understanding the complexities of decision-making in a rapidly changing environment, how to best balance the speed and breadth of available information against the cognitive limitations of the human mind. DSS research will evolve less along technological lines, but more along the lines of how it can best be positioned in the support of KM and DS that allow end users to interact with information from anywhere and across multiple (agencies) groups.

3 Methodology

The objective of our study is to determine if current commercial tools address these challenges and end user requirements. The authors analysed incident management tools in order to improve on the design, information management, interoperability, response effectiveness and usage of the proposed DSS. To address this an incident management tools investigation was conducted on commercially available European tools to compare the requirements identified in literature against the functionality of the tools outlined in Table 1 from vendor documentation and tool analysis. Section 4 provides a detailed analyse of commercially available tools and the proposed health emergency management (HEM) DSS solution.

4 Findings: Commercially Available Incident Management Tools

Table 1 provides an overview of some of the most commonly used tools and their key functionalities. These commercially available tools were compared, for preparedness and for response to an emergency, against the requirements and the functionality identified in literature. The findings are as follows: interoperability prerequisites such as taxonomy (Req.1) are not supported by any of the reviewed systems. A comprehensive interoperability standard will need to be developed as part of the HEM solution to improve the performance of EM. A shared collective understanding, through inherently reducing uncertainty and ambiguity across agencies, will serve to diminish the number of incident management failures identified as a result of information sharing, management and coordination inefficiencies. Although threat analysis (Req.2) and preparation processes (Req.3) were found to be moderately supported by current tools, there is little evidence that the preparation processes are validated (Req.4). Through catering to all three (Req.2, 3, 4), the HEM DSS will ensure there is a comprehensive and effective preparedness process in operation which will create greater response efficiencies.

The intelligence of analysis and gathering tools (Req 5) for biological events, which can be broken down into alerting and predicting the evolution of an event, is currently not generally supported. Incorporating such a functionality will enable the HEM to build on existing alert knowledge and provide DS for the detection and evolutionary modeling/projection of biological events as well as the creation and sharing of relevant situation information for stakeholders. Resource management modelling (Req.6) is strongly supported by current vendor systems. HEM will incorporate logistics models to assess needed resources and their positioning and stocking. Data will be mined from multiple sources such as from end users, ordinance survey maps, global positioning system (GPS), open source spatial data and healthcare systems in order to provide a comprehensive picture of the (emergency) landscape. Surge capacity tools (Req.7) are not supported by the current systems to a great extent. HEM will incorporate such tools to help decision-makers to map the impact of a surge. It is through leveraging cross agency coordination and communication tools (Req. 8) that HEM will ensure that surge capacity (Req. 7) and resourcing (Req. 6) concerns will be communicated effectively to relevant stakeholders. Additionally, most systems support communication and coordination tools in general, very few appear to leverage social media. HEM will leverage research and practitioner findings (Yates and Paquette, 2011) on how best to employ social media to support coordination and risk communication in managing accurate information and in its utilisation in building a situation picture from witnesses. Training (Req.10) is supported by the majority of the reviewed tools. However most fail to track end user training, and therefore will miss opportunities to refresh and retrain responder knowledge. HEM will combat this by integrating training methodologies, and the ability to track training. Another important requirement of emergency tools is post evaluations (Req.11). This requires the generation of lessons-learned to facilitate future improved decision-making. Eight of the fifteen tools analysed address this, but only four cater for gap analysis reporting to incorporate post-crisis lessons learned into the training. Through the integration of these three post-crisis components (Req.11) HEM will ensure a continuous cycle of learning and improvements (such as reduced response times).

Incident Mgt Vendors	Vector Command	Mapyx Ltd.	SAR Technology Inc.	ESRI	Firehouse Software	Adashi	WebEOC	NEMSIS	NC4	D4H	Intergraph	Fortek	Atlas Ops/AIMS	IMASS STEPS	National Extranet	DSS
Multi-agency Requirements																
1. Interoperability Across Agency (Taxonomy)																✓
2. Threat Analysis	✓			✓	✓	✓			✓	✓	✓	✓				✓
3. Preparation Processes	✓			✓	✓	✓		✓		✓	✓	✓		✓		✓
4. Validation of Preparation Processes					✓											✓
5. Intelligence of Analysis & Gathering Tools	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
-- 5.1 Alerts Unusual Event											✓					✓
-- 5.2 Predicitions of Evolution						✓				✓	✓					✓
6. Resource Mangement Modelling	✓	✓			✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
7. Identification of Surge Capacity Tools						✓	✓									✓
8. Cross Agency Coordination/ Communication Tools	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
-- 8.1 General	✓			✓	✓	✓	✓		✓		✓		✓	✓	✓	✓
-- 8.2 Social Media				✓			✓									✓
9. Analysis Evaluation of Planned Measures	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
-- 9.1 Social Acceptance (Human Factors Analysis)																✓
-- 9.2 Legal and Ethical (Data Protection/Cross)																✓
10. Training	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
-- 10.1 Training Methodologies	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓			✓	✓
-- 10.2 Refresher Training (Tracking)					✓				✓	✓						✓
11. Post Crisis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
-- 11.1 Evaluation of Crisis (Lessons Learned)	✓	✓					✓	✓	✓	✓	✓			✓		✓
-- 11.2 Documentation of Training					✓		✓	✓		✓						✓
-- 11.3 Implementation of Changes							✓	✓			✓					✓
Common Features																
Import/Export Data	✓		✓	✓	✓		✓				✓		✓	✓		✓
Modular Based	✓	✓			✓		✓			✓	✓	✓				✓
Reporting Capability		✓	✓	✓	✓		✓	✓	✓	✓		✓				✓
Mobile Based	✓	✓		✓	✓					✓	✓	✓		✓		✓
Cloud Capability				✓			✓			✓				✓		✓
Mapping using Multiple Information Sources	✓	✓		✓			✓		✓	✓		✓	✓	✓		✓
Map Overlays - Sketches & Notes	✓	✓			✓	✓					✓	✓	✓	✓		✓

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Table 1. Commercial Tools for Preparedness and Response to Emergency Situations

Vendor solutions, do not fully address first responder challenges such as: response under time pressure, lack of data, human factors (cognition, emotions, interpersonal relationships), the activation of social service for recovery (public mental health), trust-building across groups, definitions or conflicts in incidents and debriefs. The tools analysed in Table 1 incorporate very basic DS. The most common failure of these tools is information overload and inflexibility. Information overload, although most frequently tied to an individuals' degree of cognitive overload, can also occur at the intra-organisational level as the sheer volume of information made available is just too much and leads to an organisations' inability to search/find and use the information when needed. Tools selected for information sharing and coordination across agencies is due primarily to the expected value the agency expects. A lack of understanding of organisational information requirements and end user interface design can reduce the expected group value of the system and prevent effective use. As a result a significant effort must be made to ensure that increased inter-agency integration does not lead to voluminous amounts of irrelevant information and overload the organisations. HEM DSS will go beyond a mere technical only solution to ensure the effective ownership, sharing and coordination. It will be designed so as to ensure flexibility, minimise information overload and cognitive absorption to ensure system and information quality, two aspects concerned with emergency response DSS success.

4.1 Next Step: Proposed Emergency Management DSS

The key elements of the HEM DSS, as described in section 4.0, are graphically depicted in Figure 1. The solution will bring major benefits to emergency healthcare management, from learning and preparing for emergency incidents and analysing threats, to post evaluation, reporting and logistics management. It will provide a unique mechanism to assist stakeholders and end users to work together for co-ordinated, effective, evidence based decisions at all stages of EM including before an incident takes place, during the incident, immediately following an incident, and later post incident stages involving evaluation and the communication of information to the public.

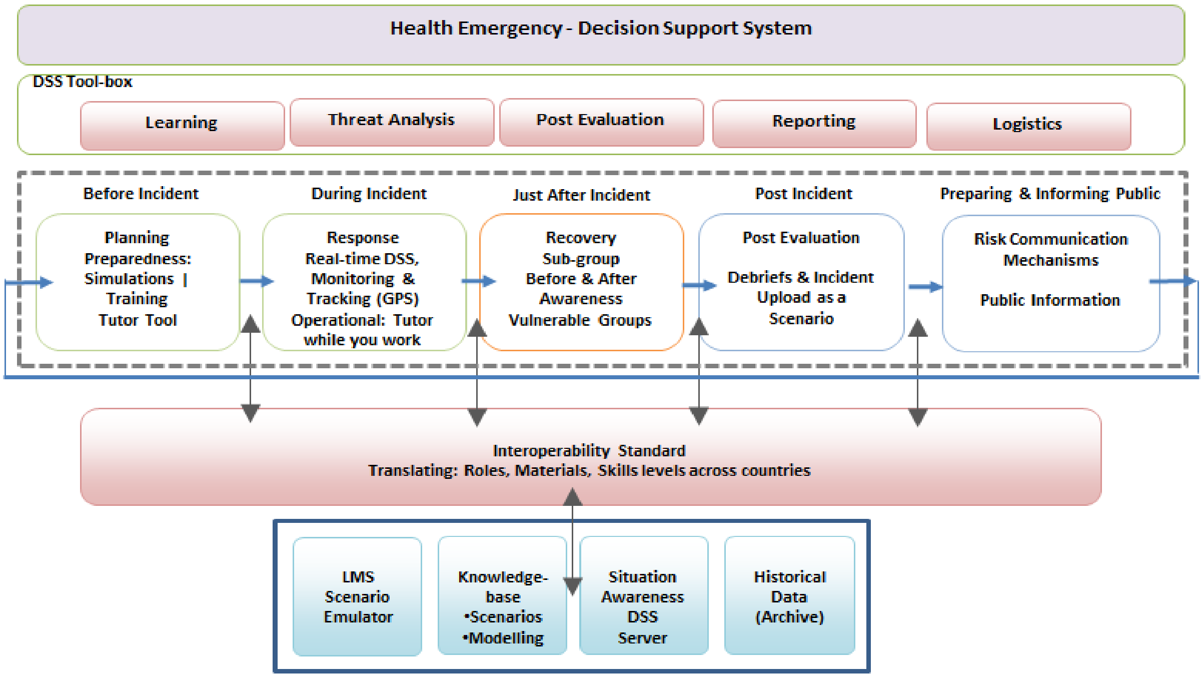

Figure 1. Proposed Emergency Decision Support System

HEM DSS through incorporating situation awareness information, accountability information, and visibility information will improve coordination and sharing. This is consistent with DSS experts such as Dabbish & Kraut (2008) who outline the benefits of using awareness information to motivate individuals to act in a certain way (e.g. situation awareness). The negative consequences associated with the rigidities and structure which often reduces effective response will be addressed through the incorporation of an interoperability standard which proposes increasing organisational agility and flexibility by embracing improvisation and the mixing and matching of DSS tools: learning (Neville et al., 2012), logistics, post evaluation, threat analysis, intelligence gathering and reporting.

HEM will enhance the operational, tactical and strategic preparedness to respond to natural and or deliberate incidents. Key characteristics/ functionality of the solution are real-time situational awareness, inter-agency information management, large-scale incident command processes and network analysis (communication and coordination assessed), integrated view of security/threat landscape , resource management, incident management strategies, incident action and operational support plan development, training simulation tools and all hazards, computer-simulation exercise creation and planning. Practitioner knowledge will be developed, individually and as a group and tested through the aid of a simulator applied (case examples and what-if analysis). HEM scenarios / simulations will be reusable and its tools will support model integration, model simulation, and model result analysis. Our research in progress is building the health EM DSS depicted in figure 1. This will be developed by forming a group of expertise in health, security, EM, interoperability, DSS, simulated learning, KM and disaster recovery as well as responders for the tools requirements definition and the scenario simulation and end user support organisations. Development will begin in 2013.

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