Defence Research and Development Canada
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Research Using In Vivo Simulation of Meta-Organizational Shared Decision Making (SDM)

Task 4: Modeling of Communication and Decision Functions within a Shared Decision-making (SDM) Framework

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Defence R&D Canada – Centre for Security Science
DRDC CSS CR 2011-33
December 2011

Canada

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Defence R&D Canada – Centre for Security Science

Contractor Report
DRDC CSS CR 2011-33
December 2011

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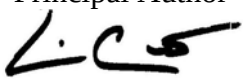

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Abstract

Background: This report presents *Task 4*: *Modeling of Communication and Decision Functions within a Shared Decision-making (SDM) Framework* of the work stream "Research Using in Vivo Simulation of Meta-Organizational Shared Decision Making (SDM)". This component of the Technology Innovation Fund (TIF) program on Meta-organizational Collaboration was designed to assist in understanding challenges faced by the Canadian Forces (CF). The objective of the stream is to conduct basic research into shared decision making through the analysis of case studies, exercises and live simulations, as well as to test the shared decision making framework *in vivo*.

Method: Activities under *Task 4* focused on the completion of sessions of the *in vivo* simulation of shared decision making in a complex scenario with experienced high level responders, as well as completing additional qualitative interviews with key decision makers involved with one or more extreme events. The data generated was analyzed with the aim to validate the *Model of Inter-organizational Problem-solving Approaches* developed under Task 1 and to develop potential considerations and guidelines with respect to communication, decision-making and problem-solving in multi-organizational environments during extreme events. The approach to validating the theoretical *Model* was to test various hypotheses using an experimental design that allowed for actual *in vivo* sessions during which senior decision-makers performed specific tasks in relation to a complex scenario. Qualitative methods consisted of in-person, semi-structured interviews with professionals from a variety of organizations and jurisdictions in senior decision-making roles related to emergency management.

Results: In general, the study findings support the main components of the *Model* as to the critical role of time, information, resources and authority. The simulation experiment confirmed that there are considerable challenges when engaging in collaborative tasks, yet it showed higher levels of participation, higher satisfaction with the results, and higher engagement. The finding that organizations could be "instructed" to solve tasks in either a collaborative or coordinated manner, offers insight on the important role that training can play in eliciting collaborative behaviours. Interviews confirmed the significant impacts that modifiers can have on the capacity and willingness of organizations to coordinate and collaborate in multi-organizational environments. Results indicated differences in the subgroups' understanding of complexity, accountability, relationship with the media and timing of role. Hence, the *Model* has to articulate the problem solving approaches as multi-dimensional with various interactions and behaviours occurring at different times and in different conditions; adding other dimensions such as trust ; including organization culture and identity as modifiers to selecting approach to problem solving) would be useful. The research raises a number of considerations about the need to initiate inter-organizational problem-solving over the complete event timeline, particularly during the preparedness and planning phases in order to create the network needed to facilitate collaboration during a crisis. Suggestions are offered for future research.

Résumé

Contexte : Ce rapport présente la Tâche 4 : *La modélisation des fonctions de communication et de prise de décision dans le cadre de la prise de décision partagée (PDP)* du volet de travail « *Recherche par la simulation in-vivo sur la prise de décision partagée des méta-organisations* ». Cette composante du programme du Fond pour l'innovation technologique (Technology Innovation Fund - TIF) sur la Collaboration méta-organisationnelle a été conçue afin d'aider à comprendre les défis que doivent affronter les Forces canadiennes (FC). Le but de ce volet est de faire une recherche fondamentale sur la prise de décision partagée au moyen d'études de cas, d'exercices et de simulations, ainsi que de tester le cadre de prise de décision partagée *in-vivo*.

Méthode : Les activités de la *Tâche 4* visaient à achever les sessions de simulation *in vivo* de prise de décision partagée avec des intervenants de haut niveau dans le cadre d'un scénario complexe, ainsi qu'à mener de entrevues qualitatives additionnelles auprès de décideurs principaux impliqués dans un ou plusieurs événements extrêmes. Les données produites ont été analysées dans le but de valider les *démarches du Modèle pour la résolution inter-organisationnelle des problèmes* développées lors de la Tâche 1 du projet ainsi que de cerner les facteurs éventuels et d'élaborer des lignes directrices en matière de communication, de prise de décision et de résolution des problèmes dans des environnements multi-organisationnels lors d'événements extrêmes. La démarche visant à valider le *Modèle* théorique consistait à tester diverses hypothèses à l'aide d'un concept expérimental qui permettait la tenue de sessions in-vivo au cours desquelles des décideurs principaux effectuaient des tâches précises en réponse à un scénario complexe. Les méthodes qualitatives consistaient en des entrevues personnelles semi-structurées auprès de professionnels de diverses organisations et compétences assumant les principaux rôles décisionnels en matière de gestion des urgences.

Résultats : Dans l'ensemble, les résultats de l'étude corroborent les principales composantes du *Model* quant au rôle crucial que joue le temps, l'information, les ressources et l'autorité. L'expérience de simulation a permis de confirmer que des tâches collaboratives présentent des défis considérables; par ailleurs cela a démontré des niveaux plus élevés de participation, de satisfaction face aux résultats, et d'engagement. Les défis liés à la participation dans un environnement multi-organisationnel augmentent au fur et à mesure que s'accroît la diversité des organisations. Le résultat voulant que les organisations puissent « recevoir l'ordre » de résoudre les problèmes liés aux tâches de manière collaborative ou coordonnée permet de mieux comprendre le rôle important que peut jouer la formation pour susciter des comportements de collaboration. Les entrevues ont permis de confirmer les conséquences importantes que les modificateurs peuvent avoir sur l'habileté et l'empressement des organisations à coordonner et à collaborer dans des environnements multi-organisationnels. Les résultats montrent des différences entre les groupes dans leur vision des notions de complexité, de responsabilité, de relation avec les médias et des aspects temporels de leur rôle. Conséquemment, le Modèle doit articuler les approches à la résolution de problèmes de façon multidimensionnelle, et tenir compte de divers comportements et interactions se produisant à des périodes différentes et dans des conditions différentes; ajouter d'autres attributs dont la confiance; considérer la culture et l'identité de l'organisation comme étant des modificateurs qui entrent en jeu dans le choix de la démarche de résolution des problèmes). La recherche fait ressortir plusieurs facteurs liés au besoin de procéder à la résolution inter-organisationnelle des problèmes pendant toute la durée de l'événement, et plus particulièrement pendant les phases de préparation et de planification afin de mettre en place

le réseau nécessaire pour faciliter la collaboration en période de crise. Des suggestions de recherches futures sont présentées.

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Sommaire

Recherche sur le partage de décision des méta-organisations en utilisant la simulation *in vivo* – Tâche 4 : Modélisation des fonctions de communication et de prise de décision au sein d'une structure de prise de décision partagée

Louise Lemyre[1] et al.; DRDC CSS CR 2011-33; R & D pour la défense Canada – CSS; .

Contexte : Selon l'aperçu du projet du Fond pour l'innovation technologique (Technology Innovation Fund - TIF) (Chouinard, 2009), les Forces canadiennes (FC) interviennent de plus en plus fréquemment lors d'événements complexes ne présentant pas de solution facile. Les événements complexes produisent des effets en cascade qui dépassent les répercussions immédiates, et qui sont exacerbées par les vulnérabilités existantes ainsi que par les incertitudes intrinsèques aux menaces et aux urgences à grande échelle. À mesure que les effets de ces événements s'atténuent, les FC doivent rencontrer leurs partenaires conventionnels, non-conventionnels et internationaux pour collaborer et aider à résoudre des problèmes difficiles. Le projet TIF a été mise en œuvre dans le but général d'aider les FC et les organismes partenaires à mieux comprendre le comportement collaboratif inter-organisationnel, les conséquences des relations inter-organisationnelles sur la prise collective de décision et l'incidence des facteurs psychosociaux (Chouinard, 2009, p.2).

Le programme de recherche courant, *Recherche par la simulation in-vitro sur la prise de décision partagée des méta-organisations*, a été conçu dans le but d'appuyer le but du projet TIF en complétant cinq tâches spécifiques. Ce rapport présente les résultats de la *Tâche 4 : La modélisation des fonctions de communication et de prise de décision dans le cadre de la prise de décision partagée (PDP).*

Méthode : Les activités de la *Tâches 4* du projet visaient à achever avec des professionnels chevronnés les sessions de simulations *in* vivo de prise de décision partagée dans le cadre d'un scénario complexe, ainsi qu'à mener des entrevues qualitatives additionnelles auprès des décideurs principaux impliqués dans un ou plusieurs événements extrêmes. Les données produites ont été analysées dans le but de valider le *Modèle pour la résolution inter-organisationnelle des problèmes* développé lors de la Tâche 1 du projet ainsi que de cerner les facteurs éventuels et d'élaborer des lignes directrices en matière de communication, de prise de décision et de résolution de problème dans des environnements multi-organisationnels lors d'événements extrêmes.

La démarche visant à valider le *Modèle* théorique consistait à tester diverses hypothèses à l'aide d'un concept expérimental qui permettait la collecte de données empiriques (comportement, auto-évaluation et observations) dans le cadre de véritables sessions in-vivo au cours desquelles des décideurs principaux effectuaient des tâches précises en réponse à une scénario complexe. L'expérimentation et la simulation de résolution des problèmes et de prise organisationnelle de

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décision consistaient en une conception 2X2 ayant deux conditions liées à la démarche de résolution des problèmes reposant sur les types de tâches (Coordination contre Collaboration), et deux conditions liées à la composition de groupes conformément au type organisationnel (Homogène contre Mixe). Les méthodes qualitatives consistaient en des entrevues détaillées, personnelles et semi-structurées auprès de professionnels responsables des prises de décision relatives à la gestion des urgences au sein d'une diversité d'organismes municipaux, provinciaux et fédéraux. Les entrevues ont permis d'élucider divers aspects du processus de prise de décision et de résolution des problèmes dans un environnement multi-organisationnel au cours des diverses étapes d'un événement extrême. Les données obtenues ont été regroupées et classer par catégories selon des thèmes vastes à l'aide d'un logiciel analytique quantitatif afin d'étayer les résultats de la recherche et la validation du *Modèle.*

Résultats : Dans l'ensemble, les résultats de l'étude corroborent les hypothèses fondamentales et les principales composantes du *Modèle de résolution inter-organisationnelle des problèmes.* L'expérimentation a produit des données empiriques qui confirment que la participation à des tâches collaboratives présente des défis considérables en matière de communication et de ressources nécessaires. De plus, l'expérimentation a généré des données probantes que la collaboration induit plus de participation, plus de satisfaction face aux résultats, et plus d'engagement. Dans les environnements mixtes, il y a plus de différences d'opinion et moins d'entente quant aux décisions et plus de pression temporelle que dans les environnements organisationnels homogènes. Quand les participants s'identifient comme ayant un leadership individuel, ils rapportent moins de frustration et sont plus engagés dans la tâche. Fait intéressant, l'expérience a démontré que les organisations peuvent « recevoir l'ordre » de résoudre les problèmes liés aux tâches de manière collaborative ou coordonnée, ce qui peut être particulièrement utile lorsque les organisations ou les groupes planifient et développent des tâches et des scénarios à des fins de formation.

Les données qualitatives recueillies lors des entrevues auprès des décideurs principaux ont également confirmé certaines composantes du *Modèle.* Les entrevues ont confirmé les importantes conséquences que certains modificateurs dont le temps, l'information, les ressources, la puissance et l'autorité peuvent avoir sur l'habileté et l'empressement des organisations à coordonner, coopérer et collaborer dans des environnements multi-organisationnels lors d'évènements extrêmes. Toutes les personnes interrogées ont pu fournir des exemples démontrant que chacun de ces facteurs sont tantôt des obstacles, et tantôt un facilitateur des trois démarches de résolution des problèmes. Les autres résultats incluent l'émergence de modèles distincts selon le type d'organisation pour certaines des composantes clés et des modificateurs du modèle. Plusieurs différences ont été soulignées entre une organisation militaire, une organisation s'appuyant sur un système de commandement des interventions (SCI) et une organisation n'ayant pas un tel système en place quant à la façon dont la résolution des problèmes est perçue et mise en pratique lors d'évènements extrêmes.

Les résultats de l'étude ont également aidé à faire la lumière sur les modifications éventuelles à apporter au *Modèle* proposé et sur les facteurs à prendre en considération lorsque le travail est effectué dans un environnement multi-organisationnel lors d'évènements extrêmes. À l'origine, les démarches de résolution des problèmes ont été illustrées dans le *Modèle* comme appartenant à trois catégories distinctes (soit, la coordination, la coopération, la collaboration). Les résultats montrent des différences dans les notions de complexité, de responsabilité, de relation avec les médias et des aspects temporels. Il est probablement plus exact et utile de concevoir les démarches de résolution des problèmes comme étant multidimensionnelles et comportant diverses

interactions et divers comportements se produisant à divers moments et dans différentes conditions. Outre l'élément de « partage », d'autres éléments peuvent être ajoutés, dont la conditionnalité et la confiance (p. ex., la mise en commun des ressources uniquement entre organisations semblables), la formalité (p. ex., les protocoles d'entente pour la mise en commun des renseignements) et l'échange directionnel (p. ex., la circulation des renseignements à sens unique seulement). Une autre modification à apporter au modèle initial est l'ajout de la culture, de l'identité et de la structure de l'organisation en tant que modificateurs importants pour déterminer la démarche de résolution des problèmes la plus appropriée et la plus probable. Une troisième modification au *Modèle* porte sur la compréhension de la dynamique du partage des renseignements, des ressources, du pouvoir et de l'autorité. Ces concepts sont probablement plus complexes et plus étroitement liés que ne le montrait le modèle à l'origine et nécessitent qu'on s'y attarde davantage.

Les résultats de l'étude joints aux observations recueillies lors de l'analyse documentaire et des études de cas menées au cours des tâches précédentes ont également mise en lumière plusieurs autres facteurs à prendre en considération lorsque le travail s'effectue dans des environnements multi-organisationnels lors d'évènements extrêmes. La résolution inter-organisationnelle des problèmes se produit non seulement aux phases de l'éclatement et de sauvetage mais tout au long du déroulement de l'évènement extrême et il faut donc s'exercer à prendre des décisions coordonnées, conjointes et partagées dès les phases de la préparation et de la planification afin de créer le réseau nécessaire pour faciliter la collaboration en période de crise. D'autres facteurs à prendre en considérations sont présentés en fonction du niveau de complexité de la situation (simple, compliquée, complexe) et de la démarche de résolution des problèmes (coordination, coopération, collaboration). Un thème susceptible de se répéter est que la collaboration, à l'instar des autres démarches de résolution des problèmes, ne se produit pas de manière spontanée mais est le fruit de la pratique et de la planification.

Prochaines étapes : Les résultats de l'étude servent de guide pour les recherches futures liées à la résolution des problèmes dans des environnements multi-organisationnels lors d'évènements extrêmes. Les sujets de recherche éventuels dégagés incluent le développement plus poussé et une définition plus précise des démarches de résolution des problèmes; l'évaluation des communications et des modèles de recherche d'information dans le but de prévoir la façon dont ces modèles changent ou demeurent constants en fonction du temps, des différentes étapes, du type de tâche et de l'environnement organisationnel; la détermination des « points de décision »; le rôle de la culture de l'organisation dans la résolution organisationnelle des problèmes.

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Acknowledgements

As principal investigator, Dr. Louise Lemyre wishes to acknowledge the funding made available by Defence Research and Development Canada (DRDC) for this important research initiative. The GAP-Santé research team would also like to acknowledge the contributions of concepts and guidance provided by Dr. Daniel Krewski and Professor Gilles Paquet. We also want to thank all of our various partners and collaborators, especially those of DRDC, Canadian Forces and emergency response of all sectors who have shared their experiences and through which we have gained a better understanding of the challenges.

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Preface

This document represents the final version of *Task 4: Modeling of Communication and Decision Functions within a Shared Decision-making (SDM) Framework*, and is submitted using the DRDC supplied template for Contractor reports. The work has been completed for Defence Research and Development Canada (DRDC) as part of the contract deliverable defined in the project entitled *Research Using In-Vivo Simulation of Meta-Organizational Shared Decision-making (SDM)*, Contract No.: W7714-083659/001/SV. As per contract requirements, the document is provided in both electronic format and printed copy (5).

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Document distribution and confidentiality protocols as specified in the contract noted above will apply to this document. Please contact Dr. Louise Lemyre, Principal Investigator, University of Ottawa, at louise.lemyre@uOttawa.ca should a change in protocols be requested. Please quote with due reference to Lemyre et al. 2011, Report on Research Using in Vivo Simulation of Meta-Organizational Shared Decision-making (SDM) – Task 4: Modeling of Communication and Decision Functions within a Shared Decision-making (SDM) Framework.

1 Introduction

1.1 Purpose, strategy and structure of report

According to the overview of the Technology Innovation Fund (TIF) project (Chouinard, 2009), the Canadian Forces (CF) have become increasingly involved with complex events that defy easy solutions. Complex events result in ripple effects that extend beyond immediate impacts, and are exacerbated by existing vulnerabilities and by the uncertainties inherent in large scale threats and emergencies. As the effects of these events are mitigated, the CF must engage with traditional, non-traditional, and international partners to collaborate on and contribute to solutions to challenging problems. The TIF project was implemented with the overall goal of: *assisting the CF and partnering agencies through an understanding of interagency collaborative behaviour, the effects of inter-agency relationships on collective decision making and the influences of psycho-social factors*. (Chouinard, 2009, p.2)

The current research program, *Research Using In Vivo Simulation of Meta-organizational Shared Decision Making*, was designed to support the TIF goal via completion of five specific tasks. The overall strategy for the research project is outlined in Figure 1. Task 1 focused on project conceptualization, a review of the relevant literatures, and a series of Canadian and international case studies, culminating in the development of the *Model for Inter-organizational Problem-solving* which served as the shared decision-making framework. This provided the theoretical basis for the remaining tasks. Task 2 involved the development of a research plan for an *in vivo* simulation experiment and qualitative interviews, both of which were then implemented under Task 3, the actual data collection endeavour. Task 4, the topic of the present report, focused on analysing the findings from the various data sources and methods implemented in previous tasks to develop potential considerations and guidelines with respect to communication, decision-making and problem-solving in multi-organizational environments during extreme events. Task 5, the final task of the research project, will involve the development of a user-friendly database that will help direct individuals to key sources and references for each of the main concepts and constructs used throughout the research process.

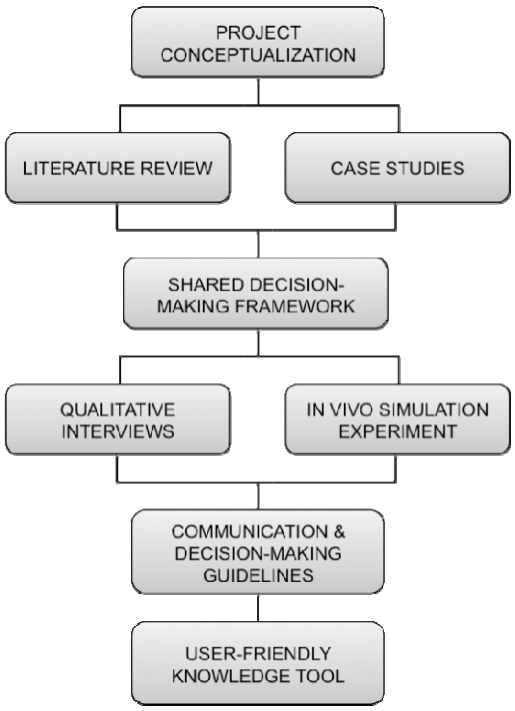

Figure 1: Overview of research strategy

This report presents the results of *Task 4: Modeling of Communication and Decision Functions within a Shared Decision-making (SDM) Framework.* As an introduction, this report presents a brief outline of the main components of the *Model for Inter-organizational Problem-solving*. This is followed by a description of the research methods implemented during the various tasks, and an overview of results. The final section consists of key considerations derived from the results according to: potential modifications required to improve the *Model*; effective participation in multi-organization problem-solving; and, future research required to further advance this study's findings.

1.2 Overview of Model for Inter-organizational Problem Solving

The *Model for Inter-organizational Problem-solving* (see Figure 2), was developed to assist in the understanding of decision-making and problem-solving approaches used in multi-stakeholder partnerships during complex emergency events.[2] The *Model* consists of two main components: 1) *Situation*, which is characterized in terms of complexity (simple, complicated and complex); and 2) *Approach to problem-solving*, which is characterized by inter-organizational approach (coordination, cooperation and collaboration). Though this figure is linear in its depiction of problem-solving, it is important to note that the relationship between situation and problem-solving approach is conceptualized as both dynamic and continuous. Situation complexity fluctuates, rising and falling according to a number of factors and elements, including impact, uncertainty and vulnerability. Problem-solving approach is also modified by *time*, as the optimum

[2] For a more detailed presentation of the model, please refer to Annex A. Readers wanting to further understand the supporting background for the model are referred to *Task 1: Synthesis of Case Studies to form a SDM framework.*

approach needed varies according to not only the different stages of the event (e.g., planning, recovery) but also to the different stages of problem-solving (e.g., problem definition, solution implementation). The other main modifier identified in the *Model* is *assets* such as information, resources and power.

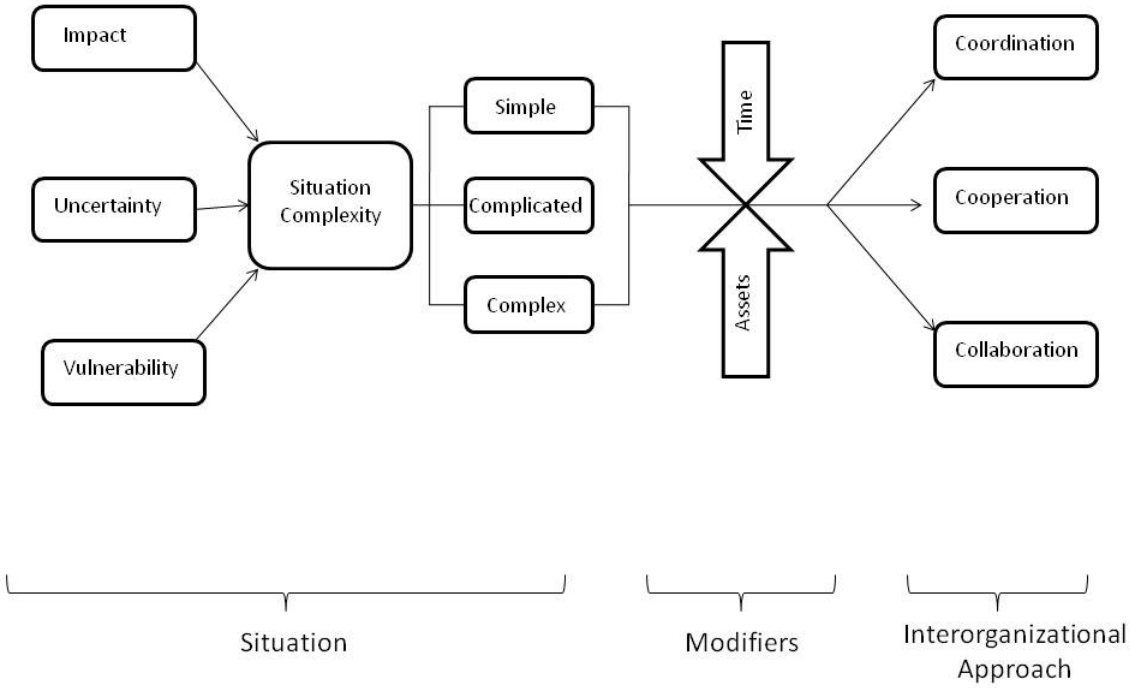

Figure 2: Model of inter-organizational problem-solving approaches as a function of situation complexity, assets of organizations and time phase.

Situation complexity is conceptualized as having three main contributing factors: 1) *Impact* – which includes potential, actual and perceived impacts with sub-elements such as scope, severity and timing of impacts, media involvement, and political processes; 2) *Uncertainty* – which includes sub-elements such as novelty of situation, anticipation and planning, lack of data/information, new organizations/partners, rapidly changing context, and flexibility of interpretive frameworks; and 3) *Vulnerability and resiliency* – which includes sub-elements such as economic development, social capital, community competence, information and communication.

Inter-organizational problem-solving approach is conceptualized according to the extent to which assets such as information, resources, and power are shared. The *Model* assumes that there is no singular "best" approach to inter-organizational problem-solving. Instead, it is more likely that these approaches will be used concurrently or consecutively depending upon the stage of problem-solving and the level of situational complexity. Three problem-solving approaches are used in this *Model*: 1) *Coordination* – a process of sharing information for the purposes of efficiency and effectiveness in achieving complementary goals with an emphasis on preventing overlapping of resources and services, with most activities and decision-making occurring within organizational silos in parallel with other organizations; 2) *Cooperation* –a process of sharing information and resources, recruiting other organizations to fill resource and information gaps, all the while maintaining separate identities engaged in joint decision-making to achieve joint goals; and 3) *Collaboration* –a process whereby organizations maintain their own identities while

sharing information, resources and power/authority in order to see different aspects of the problem, identify common goals, and explore solutions within their differences placing an emphasis on a shared definition of the problem which may require the organizations to accommodate different visions of the problem using flexible interpretive frameworks.

2 Methods

2.1 Methods overview

The study focused on the development and partial validation of the *Model* of inter-organizational problem-solving approaches as a function of situation complexity, assets of organizations and time phases. At this point, the "model" is itself a theoretical construction based on literature reviews and case studies. Our approach to validating this theoretical *Model* was to test various hypotheses using an experimental design that allowed for the collection of empirical data (behaviour, self-report and observations) from actual *in vivo* sessions during which senior decision-makers performed specific tasks in relation to a complex scenario of an extreme event. This was supplemented through qualitative in-depth interviews with senior decision-makers. Our approach assumes that a strong theoretical model combined with a solid evidence base should contribute to the data and information required to improve the approaches to computer modeling currently underway in this area (e.g., agent-based modeling).

The study included both experimental quantitative methods, and qualitative interview methods. The Problem solving and Organizational Decision making Simulation (PODS) experiment consisted of in vivo sessions conducted with professionals in senior emergency management decision-making roles working in small groups (*pods*) connected via video teleconferencing equipment to perform two tasks related to responding to an emergency scenario. The experiment was a 2X2 design with two conditions related to problem-solving approach based on the types of tasks (coordination vs. collaboration), and two conditions related to the composition of pods according to organizational type (homogenous vs. mixed). Qualitative methods consisted of detailed, in-person, semi-structured interviews with professionals in senior decision-making roles related to emergency management within a variety of municipal, provincial, and federal organizations. Interviews explored different aspects of decision-making and problem solving within a multi-organizational context during various stages of an extreme event.

2.2 PODS Experiment

Participants

The sample consisted of professionals in senior decision-making roles from organizations involved in emergency management and response. The participants represented various organizations within three broad categories: 1) the military; 2) organizations that use the incident command system (ICS) in managing and responding to emergencies; and 3) organizations that do not typically use ICS in emergencies. Besides a number of pilot trials, a total of 27 professionals volunteered to participate in one of the experimental sessions.

Materials

Multimedia. As described extensively in Task 3, multimedia was used to convey information to participants in order to simulate a complex emergency event. Participants were given maps as well as packages of text outlining the city, the scenario, and steps to complete the task at hand. Participants were set up in their rooms with a computer station to share, where all participants were being audio and video recorded by video camera, tape recorder, and webcam. Webcams were fed into the NEFSIS video conferencing software, so that participants could view one

another when communicating. Multiple videos as well as PowerPoint slides were used to guide participants through a simulated complex emergency event and tasks. Videos also served the purpose of delivering important information to the participants (e.g., news reports).

Questionnaires. Participants were asked to complete six questionnaires at different stages during the session: 1) *Background Questionnaire* - collected information about participant demographics such as current job title, roles and responsibilities, months of experience in emergency management, age, gender, education, and language; 2) *Individual participation* –measured individual opinions and perspectives on their own during a task; 3) *Within pod participation* – measured an individual's opinions and perspectives on the other participants behaviour and intentions in his/her own pod during a task; 4) *Between pod participation* – measured an individual's opinions and perspectives on other participants' behaviour and intentions not from his/her own pod; 5) *Scenario Recall Questionnaire* - measured consistency of interpretation and recall of key aspects of scenario to determine whether participants' interpretation of the scenario matched the information delivered during the session; and 6) *Network Questionnaire* – measured the extent to which individual participants knew one another and/or had worked with each other prior to the study.

Procedure

Once ethics approval for the study was obtained from the University of Ottawa's Research Ethics Board, participant recruitment was initiated. Recruitment of participants was non-random and via the study team's professional networks. Potential participants were approached by email invitation from the study team to determine if they were interested in participating and/or to relay the invitation to other colleagues who may be interested in the study. Interested participants were contacted and provided additional information about the study, and scheduled into one of four experimental sessions. Participants received a brief email reminder of the scheduled session approximately one week prior to the session date.

The procedure implemented during each experimental session consisted of obtaining informed consent, an overall briefing session, participation in pods to complete two tasks related to a specific emergency scenario, and a debriefing session about the study. When participants arrived at the session, they were initially asked to review information about the study and sign a consent form indicating their voluntary agreement to participate in the session. The study information and consent form outlined the study purpose, protection of confidentiality, potential risks and benefits from participation, and contact information for the primary investigator. Participants were asked to sign two copies and retain one for their own records.

The briefing session was conducted by a senior researcher according to a set script and provided an overview of the session with respect to how participants would be divided into pods, and a broad description of the timing and tasks to be undertaken. The briefing session reiterated the fact that participation was completely voluntary and that the study would require approximately three to three and a half hours of their time.

Prior to beginning the session, participants were divided into three separate pods (groups), with two to four people per pod. For the two sessions that had homogenous pods as a condition, pods were assembled so that participants from organizations with similar decision-making structures were in the same pod (e.g., military pod, ICS pod, non-ICS pod). For the two mixed sessions, participants were purposely placed in pods that had different types of organizations participating within the same pod.

Once the pod assignments were completed, participants in each pod left the briefing room and were relocated in their own separate pod room. Each pod room was equipped with a computer station, video conferencing equipment, flip charts, and various session materials in individual binders. Each binder contained envelopes with information about a complex dirty bomb incident in a town named "Gapville", instructions regarding two tasks, and questionnaires.

An overall session "controller" of the video conferencing software guided the pods through the various tasks required by the experiment. The controller simultaneously presented to the three pods videos which introduced participants to the city of "Gapville" and gave them information about the emergency situation. Various slides and scripted voice-overs prompted participants to open certain envelopes according to a set timing and sequence throughout the experiment session.

Once the introduction to the scenario was completed, the session was divided into two main components, each corresponding to a specific task that had been designed to elicit either coordination or collaboration among the pods. The tasks focused on either coordinating or collaborating with respect to public communications (Task 1) and responder health and safety (Task 2). Collaborating tasks focused on consensus in decision making, and coordinating tasks focused on the participants making their own decision after taking into account the actions and decisions of others. For each task, there was minimal communication between pods (CB radio; chat/texting function) for the initial 10 minutes. The video conferencing function was then opened for the final 20 minutes for each task. After each task, participants took approximately 15 minutes to complete questionnaires designed to collect their perceptions and opinions on the task.

At conclusion of the session, all participants returned to the briefing room where a senior researcher debriefed participants on the theoretical background to the study as well as the experimental design. All participants received a complimentary breakfast and lunch for their participation.

Analyses

Data from questionnaires were coded and captured in SPSS. Preliminary analyses involved examining distributions and descriptive statistics (e.g., mean, median, standard deviation) for the data resulting from various measures of task process and outcomes. Exploratory univariate analyses such as t-tests and ANOVAs were then conducted comparing problem solving approaches (coordination vs. collaboration) and multi-organizational environment (homogenous vs. mixed pods) to identify key trends within the data.

Dependent variables consist of individual measures as well as combined measures. Individual measures are separate items that participants rated on a 5 point likert scale (e.g. "*I participated actively in the decision making process"*), and combined measures are a combination of these separate items. Combined measures consist of: combined within pod engagement, combined between pod engagement, combined within pod frustration, and combined between pod frustration.

Combined within pod engagement (task 1 – alpha=.85, task 2 – alpha=.85) is an average of participants' scores on the following items:

- I felt a sense of belonging within my pod
- The people in my pod actively participated in the problem solving process
- The people in my pod communicated effectively with one another
- The people in my pod were engaged in the decision making process

- The people in my pod were motivated to complete the task
- The people in my pod were able to stay focused on the task
- I recorded information on behalf of my own pod

Combined between pod engagement (task 1 – alpha=.75, task 2 – alpha=.71) is an average of participants' scores on the following items:

- I felt a sense of belonging with the other pods
- People from the other pod actively participated with people from my pod in the problem solving process
- The pods communicated effectively with one another
- People from the other pods were engaged in the decision making process
- The people from the other pods were motivated to complete the task
- The pods were able to stay focused on the task
- Decisions made between my pod and the other pods were consensus-based
- I recorded information on behalf of all pods

Combined within pod frustration (task 1 – alpha=.42, task 2 – alpha=.64) is an average of participants' scores on the following items:

- I am frustrated working with the people in my pod group
- I was frustrated by differences of opinion within my pod during the task

Combined between pod frustration (task 1 – alpha=.38, task 2 – alpha=.74) is an average of participants' scores on the following items:

- I am frustrated working with the people in the other pods
- I was frustrated by differences of opinion between the other pods during the task

2.3 In-depth Qualitative Interviews with Decision-Makers

Participants

Interview participants included a variety of professionals all of whom held senior decision-making positions within their organizations during the planning, response and/or management stages of extreme events, and consistently worked within a multi-organizational context. The inclusion criteria for participants were that they were or had been professionals who held senior decision-making positions with respect to extreme events within the past 10 years. Other characteristics considered included the level of experience managing events with long durations, and having the authority to make decisions regarding allocation of resources on behalf of their organizations with respect to major events. Also considered during the recruitment was obtaining participants from organizations with different command structures (e.g., military, ICS, non-ICS), and experience with different types of events. Given the inherent challenges involved in the recruitment of senior professionals, the study team worked through existing networks to identify and approach potential participants. In total, 14 professionals participated in interviews.

Materials

All interviews were conducted using a semi-structured interview guide consisting of open-ended questions. Questions were developed to elicit information, perspectives and opinions of the

interviewee with respect to planning for, responding to, and managing a specific extreme event that had occurred within a multi-organizational context. All interviews were audio-taped and later transcribed.

Procedure

Once ethics approval for the study had been received from the University of Ottawa Research Ethics Board, participants were recruited for the interviews.

Once interviews were scheduled, interviewees were provided with information about the study and a consent form. Prior to the interview starting, informed consent was obtained from the participant. All interviews were conducted by a senior researcher using the semi-structured interview guide developed specifically for the study. Interviews took place in participants' offices, and all interviews were audio-recorded. Interviews ranged in length from approximately 20 to 90 minutes.

Analysis

Audio recordings of interviews were transcribed verbatim. Transcriptions were then analysed using qualitative analytic software (NVivo v2.0 and v9.0) to develop a phenomenological analysis from each interview to explore the themes and meanings described by the participants. Data were categorized into various topics elicited from the content of the interviews. Then each category was clustered into broader themes. These themes were then used to validate qualitatively the inter-organizational problem solving model and to identify themes that could potentially inform additional aspects of the *Model*.

3 Results

This technical report contains the most recent analyses of data collected from the PODS experiment and the qualitative interviews conducted with senior decision-makers during extreme events. Data collection for these methods concluded very recently, so the analyses have been focused on determining findings for a few key areas. In addition to the result presented below, other results from the project including the extensive literature reviews and case studies have been analysed and presented in an ongoing manner throughout the project in a series of technical reports. As well, project results have been presented in a number of venues such as the 16th *International Command and Control Research and Technology Symposium*[3], *Conference for Models and Modeling Methodologies in Science and Engineering*, and the International Symposium on Models and Modeling Methodologies in Science and Engineering (MMMse 2011, US). Upcoming presentations of results include the *Annual Meeting of the Society for Risk Analysis.* Copies of papers and abstracts outlining these additional results can be found in Annex B of this technical report.

3.1 PODS Experiment

3.1.1 Participant Profile

Beside the successive pilot trials with students and emergency trainees, the final experiment participant sample consisted of 27 senior professionals, including 20 men and 7 women. Of these 27 participants, there were relatively equal proportions of each coming from the three different types of organizations. Nine (9) participants reported having military backgrounds, 10 participants reported being affiliated with ICS-based organizations (e.g., police, firefighter), and 8 participants reported affiliation with non-ICS based organizations (e.g., public health, social services). Participants' age ranged from 38 to 66 years (M = 49.7, SD = 6.0). The vast majority of participants had university degrees with 12 having undergraduate degrees, 3 having undergraduate degrees and college diplomas, and 8 with graduate degrees. Two of the remaining 4 participants reported having college diplomas, while one participant reported having no education in either college or university, and one participant chose not to report their educational background. Twelve of the 27 participants reported being bilingual, working in both English and French. Participants' experience in their current position ranged considerably from 2 months to 12 years (216 months) (M = 71.7, SD = 68.0). Participants' affiliation with their current organization also ranged considerably from 6 months to 33 years (396 months) (M = 178.3, SD = 144.8).

3.1.2 Problem Solving Approach: Coordination vs. Collaboration

From the questionnaire data collected from participants after each of the two tasks (Task 1: public communications task, Task 2: responder health and safety task), some clear differences were found in process measures such as participation, satisfaction, and communication, based on whether the participants had worked on coordination tasks or collaboration tasks. Results are reported. Results are summarized in Table 1 at the end of this section.

[3] The paper based on this project's results received the Best Paper Award for the Approaches and Organizations track at this conference and was nominated for Best Paper overall.

Participation in problem solving and decision making. An independent-samples t-test was conducted to compare perceptions of participation within pods in collaboration and coordination tasks (*"the people in my pod actively participated in the problem solving process"*). Participants in the collaboration tasks rated their pod's participation in problem solving significantly higher (Task 1 - M=3.6, SD=.52, Task 2 - M=3.5, SD=.52) when compared with those in coordination tasks (Task 1 - M=3.0, SD=.76, Task 2 - M=3.1, SD=.30); Task 1 - t(25)=-2.28, p=.031, Task 2 - t(25)=-2.82, p=.009. Similarly, participants undertaking collaboration tasks were more likely to perceive that they as individuals had participated actively in the decision-making process (*"I participated actively in the decision making process"*) (Task 2 - M=3.5, SD=.52) when compared with those who had participated in coordination tasks (Task 2 - M=3.1, SD=.35); t(25)=-2.18, p=.039.

Satisfaction with problem solving. Self-reported individual satisfaction levels with opportunities to provide input to the problem solving were higher (*"I am satisfied with the opportunities I had to provide input"*) among those who participated in collaboration tasks (Task 2 - M=3.5, SD=.52) when compared with those who had participated in coordination tasks (Task 2 - M=3.1, SD=.26); t(25)=-2.82, p=.009.

Frustration with problem solving. Participants in the coordination sessions reported higher levels of frustration working with the people in the other pods (*"I am frustrated working with the people in the other pods"*) (Task 2 – M=0.6, SD=.51) when compared with those participating in the collaboration sessions (Task 2 – M=0.2, SD=.39); t(25)=-2.44, p=.022. Overall, participants in coordination tasks also scored higher on inter- pod frustration on a combined, multi-item measure of frustration (Task 2 - M=0.6, SD=.44) when compared with those participating in collaboration sessions (Task 2 – M=0.3, SD=.40); t(25)=2.09, p=.047.

Communication during problem solving. An independent-samples t-test was conducted to compare perceptions of communication effectiveness across pods in collaboration and coordination tasks (*"The people in my pod communicated effectively with one another"*). Those participating in collaboration tasks were more likely to indicate higher levels of communication effectiveness (Task 2 - M=3.4, SD=.52) when compared with participants in coordinating tasks (Task 2 - M=3.1, SD=.26); t(25)=-2.30, p=.030. Participants in collaboration tasks were also more likely to indicate that there was greater discussion facilitated during the task (Task 2 - M=3.0, SD=.60) when compared with those undertaking coordination tasks (Task 2 - M=2.5, SD=.64); t(25)=-2.21, p=.037 ("*I facilitated discussion between pods*").

Leadership. The perception of a clear leader within a pod was higher (*"A clear leader emerged within my pod"*) among those who participated in the coordination task (Task 1 – M=2.6, SD=.83) when compared with those who had participated in the collaboration tasks (Task 1 – M=1.8, SD=.58); Task 1 - t(25)=-2.72, p=.012.

Decision outcome. As a confirmation of the task, there was a stronger indication among those who participated in a collaborating task that the decisions were consensus based (Task 2 - M=3.5, SD=.52) when compared with those undertaking a coordinated task (Task 2 - M=3.0, SD=.38); t(25)=-2.89, p=.008 (*"Decisions made between my pod and the other pods were consensus-based"*)

Table 1: Independent samples t-tests of coordinative and collaborative pods

Measure	Task	Problem solving approach		Mean difference	t	df
		Coordination Mean (SD)	Collaboration Mean (SD)			
The people in my pod actively participated in the problem solving process	1	3.0 (.76)	3.6 (.52)	0.6	-2.28*	25
The people in my pod actively participated in the problem solving process	2	3.1 (.30)	3.5 (.52)	0.4	-2.82*	25
I participated actively in the decision making process	2	3.1 (.35)	3.5 (.52)	0.4	-2.18*	25
I am satisfied with the opportunities I had to provide input	2	3.1 (.26)	3.5 (.52)	0.4	-2.82*	25
I am frustrated working with the people in the other pods	2	0.6(.51)	0.2(.39)	0.4	2.44*	25
Combined between pod frustration	2	0.6(.44)	0.3(.40)	0.3	2.09*	25
The people in my pod communicated effectively with one another	2	3.1 (.26)	3.4 (.52)	0.3	-2.30*	25
I facilitated discussion between pods	2	2.5 (.64)	3.0 (.60)	0.5	-2.21*	25
A clear leader emerged within my pod	1	2.6(.83)	1.8(.58)	0.8	2.72*	25
Decisions made between my pod and the other pods were consensus-based	2	3.0 (.38)	3.5 (.52)	0.5	-2.89*	25

Note. * = $p < .05$

3.1.3 Organizational Environment: Homogenous vs. Mixed Pods

The experimental conditions of assigning participants to pods with organizations with similar decision-making structures (homogeneous pods) or to pods with dissimilar organizations (mixed pods) provided the opportunity to determine what impact organizational environment has within the management and response of an extreme event. Data varied in the areas of satisfaction with problem solving, communication during problem solving, and decision outcomes. Results are summarized in Table 2 at the end of this section.

Satisfaction with problem solving. Participants in homogenous pods reported higher levels of satisfaction with the time allocated to problem solve during the tasks (*"There was enough time allotted to solve the problems during the task"*) (Task 1 - M=3.3, SD=.47) when compared with those participating in mixed pods (Task 1 - M=2.8, SD=.42); t(25)=2.74, p=.011. Overall, participants in mixed pods were more likely to agree the task was difficult (*"The task was difficult to complete"*) (Task 1 - M=1.7, SD=1.1) when compared with those in homogenous pods (Task 1 - M=.88, SD=.47); t(25)=-2.76, p=.011.

Frustration during problem solving. Participants in mixed pods reported higher levels of frustration with differences of opinion between other pods during the task (*"I was frustrated by differences of opinion between the other pods during the task"*) (Task 1 - M=0.6, SD=.70) when compared with those participating in homogenous pods (Task 1 - M=0.5, SD=1.4); t(25)=-3.4, p=.002. Overall, participants in mixed pods also scored higher on between pod frustration using a

between pod combined measure of frustration (Task 1 - M=1.2, SD=.86) when compared with those participating in homogenous pods (Task 1 – M=.56, SD=.50); t(25)=-2.48, p=.020.

Communication during problem solving. An independent-samples t-test was conducted to compare perceptions of whether there were differences of opinions across pods in mixed and homogenous pods (*"The people within my pod had frequent differences of opinion"*). Those participating in mixed pods were more likely to indicate higher levels of differences in opinions (Task 1 - M=1.4, SD=.84) when compared with participants in homogenous pods (Task 1 - M=0.7, SD=.59); Task 1 - t(25)=-2.52, p=.018. Participants self-reported perception of other pods generating various alternative ideas (*"People from the other pods generated various alternative ideas"*) was higher in homogenous pods(Task 1 – M=3.3, SD=.69, Task 2 – M=3.2, SD=.53) when compared with those who had participated in mixed pods (Task 1 – M=2.6, SD=.52, Task 2 – M=2.7, SD=.48); Task 1 - t(25)=2.76, p=.011, Task 2 – t(25)=2.33, p=.028. Overall, participants self-reported perception of between pod effective communication *("The pods communicated effectively with one another"*) was higher in homogenous pods (Task 1 – M=3.1, SD=.43) when compared with those who had participated in mixed pods (Task 1 – M=2.6, SD=.70); t(25)=-2.13, p=.044.

Motivation. Participants in homogenous pods reported higher levels of perceived motivation in the other pods during the task ("*the people from the other pods were motivated to complete the task"*) (Task 1 – M=3.4, SD=.51) when comparing with those participating in mixed pods (Task 1 – M=2.9, SD=.32); t(25)=-2.87, p=.008.

Focus. Participants in homogenous pods reported higher levels of perceived between pod focus ("*The pods were able to stay focused on the task"*) (Task 1 – M=3.35, SD=.61) when comparing with those participating in mixed pods (Task 1 – M=2,9, SD=.32); t(25)=-2.18, p=.039.

Engagement. Participants in homogenous pods reported higher levels of perceived engagement in the other pods during the task("*People from the other pods were engaged in the decision making process"*)(Task 1 – M=3.3, SD=.47, Task 2 – M=3.3, SD=.47) when comparing with those participating in mixed pods (Task 1 – M=2.8, SD=.42, Task 2- M=2.9, SD=.32);); Task 1 - t(25)=-2.74, p=.011, Task 2 - t(25)=-2.35, p=.027. Overall, participants in homogenous pods also scored higher on between pod engagement using a between pod combined measure of engagement (Task 1 - M=3.0, SD=.36) when compared with those participating in homogenous pods (Task 1 – M=2.7, SD=.32); t(25)=-2.17, p=.040.

Within pod trust. Participants in homogenous pods reported higher levels of trust for the people within their pod ("*I trust the people in my pod*") (Task 2 – M=3.5, SD=.51) when compared with those participating in mixed pods (Task 2 – M=3.1, SD=.32); Task 2 - t(25)=-2.38, p=.025.

Decision outcome. With respect to agreement on the final decisions and outcomes resulting from tasks (*"I agree with the decisions and outcomes from the task"*) there was a stronger levels of agreement among those who participated in homogenous pods (Task 1 - M=3.5, SD=.51, Task 2 – M=3.4, SD=.62) when compared with those working in mixed pods (Task 1 - M=2.7, SD=.95, Task 2 – M=3.0, SD-.00); Task 1- t(25)=2.75, p=.011, Task 2 – t(25)2.09, p=.047.

Table 2: Independent samples t-tests of homogenous and mixed pods

Measure	Task	Pod type		Mean difference	t	df
		Homogenous Mean (SD)	Mixed Mean (SD)			
There was enough time allotted to solve the problems during the task	1	3.3 (.47)	2.8 (.42)	0.5	2.74*	25
The task was difficult to complete	1	.88 (.47)	1.7 (1.1)	0.8	-2.76*	25
I was frustrated by differences of opinion between the other pods during the task	1	0.5(.51)	1.8(1.40)	1.3	-3.41*	25
Combined between pod frustration	1	.56(.50)	1.2(.86)	0.6	-2.48*	25
The people within my pod had frequent differences of opinion	1	.71 (.59)	1.4 (.84)	0.7	-2.52*	25
People from the other pods generated various alternative ideas	1	3.3(.69)	2.6(.52)	0.7	2.76*	25
People from the other pods generated various alternative ideas	2	3.2(.53)	2.7(.48)	0.5	2.33*	25
The pods communicated effectively with one another	1	3.1(.43)	2.6(.70)	0.5	2.13*	25
The people from the other pods were motivated to complete the task	1	3.4(.51)	2.9(.32)	0.5	2.87*	25
The pods were able to stay focused on the task	1	3.4(.61)	2.9(.32)	0.5	2.18*	25
People from the other pods were engaged in the decision making process	1	3.3(.47)	2.8(.42)	0.5	2.74*	25
People from the other pods were engaged in the decision making process	2	3.3(.47)	2.9(.32)	0.4	2.35*	25
Combined between pod engagement	1	3.0(.36)	2.7(.32)	0.3	2.17*	25
I trust the people in my pod	2	3.5(.51)	3.1(.32)	0.4	2.38	25
I agree with the decisions and outcomes from the task	2	3.5(.51)	3.1 (.32)	0.4	2.09*	25
I agree with the decisions and outcomes from the task	1	3.5 (.51)	2.7 (.95)	0.8	2.75*	25
I agree with the decisions and outcomes from the task	2	3.4(.62)	3.0(.00)	0.4	2.09*	25

Note. * = $p < .05$

3.1.4 Participant Type: Military, ICS, and Non-ICS

Recruiting participants from distinctly different orientations (Military, ICS orientation and Non-ICS orientation) provided the opportunity to determine what differed among these types of individuals when it came to management and response to an extreme event. Data varied in the area of participation for the public communications task.

Participation. Reported individual participation in the decision making process differed significantly across the three different participant types, F (2, 24) = 3.93, p=.033, during the public communications task. Self-reported active participation in the task (*"I participated actively in the decision making process"*) was lower among ICS orientated participants. In addition, reported individual perception of between pod engagement in the decision making process

differed significantly across the three different participant types, F (2, 24) =3.69, p=.040, during the public communications task. Reported individual perception of between pod engagement in the task *("People from the other pods were engaged in the decision making process"*) was lower among ICS orientated participants.

Table 3: One way ANOVA's of participant type

Measure	Task	Participant type			F	df
		Military Mean (SD)	ICS Mean (SD)	Non-ICS Mean (SD)		Between, Within
I participated actively in the decision making process	1	3.3(.50)	2.7(.82)	3.5(.54)	3.93*	2, 24
People from the other pods were engaged in the decision making process	1	3.3(.50)	2.8(.42)	3.3(.46)	3.69*	2, 24

Note. * = $p < .05$

3.1.5 Leadership: Non-leaders vs. Leaders

Multiple items measuring leadership (I participated in a leadership role within my own pod, I participated in a leadership role across the other pods, I facilitated discussion within my own pod, and I facilitated discussion between pods) were combined to create a single measurement of leadership (alpha=.841). This measure was used to determine what differed among those high on leadership and those low on leadership when it comes to emergency management and response. Data varied in the area of combined within and between pod engagement and within pod frustration.

Combined within and between pod engagement. Participants high on leadership reported their own pod as being more engaged during the tasks (Task1 – M=3.3, SD=.44, Task 2 - M=3.3, SD=.44) when compared with those low on leadership (Task1 – M=2.8, SD=.33, Task 2 - M=2.9, SD=.20); Task 1 -t(25)= -3.65, p=.001, Task 2 –t(25)= -2.55, p=.017. Participants high on leadership reported that there was more engagement between pods during the tasks (Task1 – M=3.0, SD=.36, Task 2 - M=3.1, SD=.30) when compared with those low on leadership (Task1 – M=2.7, SD=.30, Task 2 - M=2.8, SD=.26); Task 1 -t(25)= -2.53, p=.018, Task 2 –t(25)= -2.41, p=.024.

Combined within pod frustration. Overall, participants low on leadership were more frustrated with the people in their pod (Task1 – M=0.9, SD=.61) when compared with those high on leadership (Task1 – M=0.3, SD=.44); Task 1 -t(25)= 3.00, p=.006.

Table 4: Independent samples t-tests of non-leaders and leaders

Measure	Task	Pod type		Mean difference	t	df
		Non-Leaders Mean (SD)	Leaders Mean (SD)			
Combined within pod engagement	1	2.8 (.33)	3.3 (.44)	0.5	-3.65*	25
Combined within pod engagement	2	2.9 (.20)	3.3 (.44)	0.4	-2.55*	25
Combined between pod engagement	1	2.7 (.30)	3.0 (.36)	0.3	-2.53*	25
Combined between pod engagement	2	2.8 (.26)	3.1 (.30)	0.3	-2.41*	25
Combined within pod frustration	1	0.9 (.61)	0.3 (.44)	0.6	3.00*	25

Note. * = $p < .05$

3.1.6 Prior Relationships: No prior relationship vs. Prior relationship

Multiple items measuring prior friendship and working relationship (‘*Prior to today`s session I would describe my relationship with at least one of the people in my pod as a friendship, Prior to today`s session I would describe my relationship with at least one of the people in the other pods as friendship, Prior to today`s session, I have worked with at least one of the people in my pod, and Prior to today`s session, I have worked with at least one of the people from the other pods.*’) were combined to create a single measurement of prior relationship (alpha=.797). This measure was used to determine what differed among those who had no prior relationships in their sessions and those who had prior relationships in their sessions when it comes to emergency management and response. Data varied in the area of communication, participation in problem solving, engagement, focus, and consensus on decision outcome.

Communication during problem solving. An independent-samples t-test was conducted to compare perceptions of whether there were individual differences of facilitated discussion between pods across those who had no prior relationships and those who had prior relationships in the sessions (“*I facilitated discussion between pods”*). Those participating with no prior relationships were more likely to indicate that they facilitated higher levels of discussion (Task 2 - M=3.0, SD=.56) when compared with participants who had prior relationships (Task 2 - M=2.4, SD=.65); Task 2 - t(25)=2.65, p=.014.

Participation in problem solving. Participants with no prior relationships reported the people in their pod as participating more actively in the problem solving process during the task (“*The people in my pod actively participated in the problem solving process”)* (Task2 – M=3.4, SD=.51) when compared with those who had prior relationships (Task 2 - M=3.1, SD=.28); Task 2 –t(25)= 2.19, p=.038.

Engagement. An independent-samples t-test was conducted to compare perceptions of whether there were differences of engagement within pods across those who had no prior relationships and those who had prior relationships in the sessions(“*The people in my pod were engaged in the decision making process”*). Those participating with no prior relationships were more likely to indicate that the people in their pod had higher levels of engagement in the decision making process (Task 2 - M=3.4, SD=.51) when compared with participants who had prior relationships (Task 2 - M=3.1, SD=.28); Task 2 –t(25)= 2.19, p=.038

Focus. Participants with no prior relationships reported that the people in their pod had a higher level of focus during the task (“*The people in my pod were able to stay focused on the task”)* (Task2 – M=3.6, SD=.51) when compared with those who had prior relationships (Task 2 - M=3.1, SD=.28); Task 2 –t(25)= 3.08, p=.005. Participants with no prior relationships reported that overall the pod participants had a higher level of focus during the task (*“The pods were able to stay focused on the task”)* (Task2 – M=3.4, SD=.50) when compared with those who had prior relationships (Task 2 - M=2.9, SD=.56); Task 2 –t(25)= 2.52, p=.018.

Decision outcome. There was a stronger indication among those who had no prior relationships that the decisions were consensus based (Task 2 - M=3.5, SD=.52) when compared with those who had prior relationships (Task 2 - M=3.0, SD=.28); t(25)=3.56, p=.002 (*“Decisions made between my pod and the other pods were consensus-based”*)

Table 5: Independent samples t-tests of those without prior relationship and those with prior relationships

Measure	Task	Pod type		Mean difference	t	df
		No prior relationship (SD)	Prior Relationship Mean (SD)			
I facilitated discussion between pods	2	3.0(.56)	2.4(.65)	0.6	2.65*	25
The people in my pod actively participated in the problem solving process	2	3.4(.51)	3.1(.28)	0.3	2.19*	25
The people in my pod were engaged in the decision making process	2	3.4(.51)	3.1(.28)	0.3	2.19*	25
The people in my pod were able to stay focused on the task	2	3.6(.51)	3.1(.28)	0.5	3.08*	25
The pods were able to stay focused on the task	2	3.4(.50)	2.9(.56)	0.5	2.52*	25
Decisions made between my pod and the other pods were consensus-based	2	3.5(.52)	3.0(.28)	0.5	3.56*	25

Note. * = $p < .05$

Future analyses, beyond the timeframe of this report, will include analyses of communication patterns, assessment of solution/decision quality, and time function for convergence to a solution.

3.2 In-depth Qualitative Interviews with Decision-Makers

3.2.1 Participant Profile

The qualitative interviews were conducted with 14 professionals in senior decision-making roles within their organizations. Of the 14 interviewed, 7 were from organizations with an ICS-based approach to problem-solving and decision-making, 5 were from organizations that do not normally use an ICS-based approach, and 2 were current members of the Canadian Forces. Eight interviewees were associated with municipal organizations, 2 with provincial organizations, and 4 with federal organizations or agencies. Most interviewees were men (10 men; 4 women). The events that were focused upon during interviews included the Swiss Air Disaster (1998), H1N1 (2009), Vancouver Olympics (2010), G8/G20 Summit (2010), and a large apartment building fire in Toronto (2010).

3.2.2 Identified Themes

The analysis of qualitative interviews identified a number of themes that in some instances were quite similar across the three types of organizations, and in other cases seemed to differ. The main analyses examined key elements and components of the *Model* of inter-organizational problem-solving approaches as conceptualized according to organization type, along with concepts and constructs that were commonly provided during interview responses (Table 6, 8, 10, 12).

Interviewees were asked how their organizations were able to overcome the main challenges involving the participation of multiple organizations; in addition, their conceptualizations of the

different problem solving approaches (coordination, cooperation, collaboration) were explicitly explored. Based on their responses the trends illustrated in Table 6 were elicited.

Table 6: Problem solving approach by organization type

	ORGANIZATION TYPE		
THEME	**Non ICS-based**	**ICS-based**	**Military**
Problem solving	Reactive and responsive to a specific situation	Rely on experience accumulated from the occurrence of similar events	Pre event planning of all possible scenarios and then explore "breaking points"
Coordination	Based on information sharing, usually through informal channels.	Frequent information sharing to support the other services response.	Required to work in Canadian territory.
Cooperation	Conceptualized as working together	Conceptualized as integrating with other orgs to work together and focused on a common goal.	Conceptualized as providing help
Collaboration	Tends to be avoided given challenges with resources - only if really needed	Only in the impact phase if required	From the planning to the recovery stages as requested

Successful inter-organizational problem solving strategies were described by the interviewees based on their experiences. To exemplify these concepts, some quotations are shown below in Table 7

Table 7: Sample interview quotes illustrating problem solving strategies

"But we had to make them understand that it was something that may have to take place and that both of us needed to work together"
"Everyone has their own share in the stakeholders' group, I think everybody could come together in agreement after the end of the day that this may happen and here's what we had to do".
"It's impossible to work in isolation"
"The decision at what level of personal protective equipment we're going to wear. It's collaborative. It's not one service saying this is what we're going to wear".
"The collaborative decisions are the most effective because everybody's buying into it. Everybody has a piece of that decision-making process, and everybody has a piece of the operational side of that plan."
"The collaborative decisions are everybody's got an opportunity to say something about it, and it's not a consensus by any stretch of the imagination"
"I think the collaboration is really more about group problem solving"
"So it's really a combination of committee and negotiating committee thing. You've got to broker that deal that everybody feels that when they're working for you, they're getting something out of it. And then they work pretty good, really. They work pretty hard"

"*Smile in someone's face, but swear under your breath because it's that approach on how you deal with anything, it's what's going to get you what you need*"

Based on the descriptions from the participants' experiences, the theoretical conceptualizations of the inter-organizational problem solving approaches were analysed. The participants' descriptions also demonstrate learning and management opportunities for the different organizations, which could potentially facilitate problem solving during emergencies and extreme events.

Interviewees were also asked to identify the main challenges that the teams were required to overcome during the events. Responses across the different organizations described how asset management played a role along the different problem solving stages. Table 8 shows the different assets management strategies employed, sorted by organizational profile.

Table 8: Asset management approach by organization type

	ORGANIZATION TYPE		
THEME	**Non ICS-based**	**ICS-based**	**Military**
Asset: **Information and Communication**	Major challenge. Reliance on informal communication channels.	Required to teach other orgs the IMS/ICS terminology	Challenges with organizations not using same terminology/language
Asset: **Resources**	Compete for resources with other orgs; therefore, support received from or provided to other orgs needs to be justified.	Share resources with other ICS orgs but some reluctance to share with other types of orgs. Usually requires an official request	View themselves as providing resources on request.
Asset: **Power**	Required to accommodate other orgs' demands	Territorial and jurisdiction focused	View themselves as a support org
Asset: **Authority**	Need to be integrated / considered within the overall problem solving	View themselves as delegating authority while attempting to maintain power	Consider themselves to have no authority or power in Canada per se. Fits with perception as a support org

Examples of quotations describing the role of asset management in the overall inter-organizational problem solving process are shown below in Table 9. These are divided according to different categories of assets including communication and information sharing; resources; and power/authority.

Table 9: Sample interview quotes illustrating role of assets

Asset: Communication and information sharing
"I think one of the other things that ended up being a learning piece for all of us involved was again, trying to communicate to people who do work in a command and control, very hierarchal structure the way the decision-making in the health care system works because it is really never that direct."

"What I've seen here is a reluctancy to share information between the different departments or between civilian departments and law enforcement agencies or between civilian departments, law enforcement agencies and the Canadian Forces" *"I guess one of the big challenges is we all speak a different language. We all think you're speaking English, but really you're speaking your own organization's lingo. So getting to know each other's lingo is important"*
Asset: Resources
"So it's a matter of robbing Peter to pay Paul. The bottom line is I didn't have enough resources that day" *"So it's allaying the fear to those smaller services, hey, I'm going to use all of you. I'm going to coordinate"* *"But when you have another organization coming and saying no, no, we'll do this and we'll do that. Decisions being made that maybe weren't communicated with each other that had an impact on us because we're seeing different things happening and we were a little confused about that"* "*And that's what I found out is that what's opened the door on that whole thing is you finally have a whole lot more resources than we ever thought we did*"
Asset: Power and Authority
"And then you have to think is this the hill that I want to die on? Am I going to cause myself problems the next time if I push this issue too far or not?" *"So we had to make some concessions on our part as well"* *"So if I come to you with I'm in charge, this is what I want, and this is the way it'll be, I can tell you right now the cooperation I'm going to get is going to be almost nil, or it's going to be obstructive."* *"So they appreciate it's the local guy. I have the final authority, but it's going to be him. The messages will be coming from him"* *"When they come in and try and start dictating this is the way it'll be, my first reaction is go screw yourself. You don't have a clue what you're talking about"* *"La confiance n'exclut pas le contrôle »*

One component of the phenomenological analysis was to explore the elements and factors that could increase or decrease the level of event complexity. Many elements were described in interviewees' narratives, however accountability and/or liability, organizational structural flexibility and media and public visibility were salient themes along the different organizational categories (Table 10). It must be considered that the organizational background of the participants (mainly governmental senior positions at different mandate levels), may help explain the salience of these specific themes.

Along the different narratives, interviewees described a lack of inter-organizational sharing increases the level of complexity during the different stages of an event and within the different problem solving cycles. This includes the sharing of various assets such as information,

resources, power or authority. The rationale for lack of sharing was in part explained by interviewees as connected to the accountability and liability the various organizations have for decisions they make. Within the context of limited resources, accountability and liability is reported to be increased. In terms of decision-making structure, there tends to be more perceived flexibility among the non ICS-based organizations. This was described by some interviewees as "*committee based"*; however, their representatives still hold clear accountability lines. First responder organizations, on the other hand, explain how training had enabled their organizations to become somewhat structurally open and flexible, nevertheless maintaining personal liability / accountability for any decision taken. As for the Canadian Forces, participants described how their organization can be open and flexible with other response organizations, if they are ordered to do so.

Another salient theme was the role of the media and the need for public visibility for some individuals and organizations, and how the media has a role in increasing the level of complexity along the different phases of the emergency and problem solving cycles. According to the interviewees, Non ICS-based organizations need to maintain or increase public acceptance in order to preserve or increase their funding and authority with other organizations. ICS organizations, on the other hand, already have public acceptance and are formally in charge of releasing public messages. The Military restrain from making public statements during domestic events, leaving this responsibility to ICS organizations. Interviewees also reported how the inclusion of organizations or individuals not directly involved with the response, may increase the level of complexity of the response. This is due to the fact that some organizations or individuals may not necessarily provide help per se, but may look to increase their organizations' or individual image by participating in the response.

Table 10: Complexity factors by organization type

	ORGANIZATION TYPE		
THEME	**Non ICS-based**	**ICS-based**	**Military**
Complexity	Increased by the novelty of the situation, uncertainty, lack of information and resource sharing, and number of orgs involved	Increased by the novelty of the situation, uncertainty, lack of information and resource sharing, and number of orgs involved.	Increased by the lack of information sharing between orgs and number of orgs involved. Planning becomes more complex to respond to possible scenarios.
Accountability / Liability	All actions must be justified in terms of budget and mandate. There are organizational repercussions for errors.	All actions must be justified in terms of budget and mandate. There is personal liability for errors.	Learn from experience and analysis, integrate that knowledge into current operations
Flexibility	Informally there is flexibility but also clear lines of accountability	Informally/ formally there is flexibility through training, but also clear lines of accountability	Limited flexibility - formal orders by command chain
Media / Public visibility	Need for public visibility to acquire	Media and public visibility is controlled	Restrain from making public statements - ICS

	more resources, authority	through official spokespersons. Granted positive public perception	orgs responsible for this. Ongoing attempts to modify public image of CF to gain public and other orgs' acceptance

Examples of quotations describing the role of complexity in the overall inter-organizational problem solving process are shown below in Table 11.

Table 11: Sample interview quotes illustrating complexity factors

Complexity
"And beyond the concepts of the decision-making, the implementation of decisions that are based on incomplete information is very difficult" *"Well, they weren't getting any information. They were just saying someone says they can't get out of the house, so we would all respond, trying to figure out where and what. So you had those legal issues, if you want, for us. Can we go in and force someone out?"* *"So now you've got people self-evacuating. You don't know if they should be or not there."* *"Those discussions were similar throughout the different networks through downtown core, both in the zone and out of the zone, because we didn't know what we were facing"* *"They don't release anything. It doesn't matter if you're another police agency or not and have the appropriate clearances. I'm not telling you. Which created some friction. And it still creates friction"* *"And my own staff sometimes not knowing what everybody else does. And then it creates some conflict"* *"But really, and then they'll self-deploy, which screws the whole thing up because that's like freelancing"*
Accountability / Liability
"Because once you allow that individual in, from my perspective, I go okay, what liabilities am I looking at by allowing a civilian into an event that we don't have control of yet? So am I opening up myself and the city on a liability by allowing non-uniform personnel or responders in?" *"But they won't ever say it's really agreeable, yes, we're good with it, because they don't want to be caught in bed with you if it goes sour and you kill someone"* *"And the problem is that it seems that in a lot of other organizations, if you break something that means that you're liable and you can end up being fired"*
Media / Public Visibility
"So what was happening was they were making statements and we'd be going where did they get that from? We were the ones who were making the decisions at the scene, yet they were making decisions without our knowledge. And it became very frustrating for us" *"The problem started occurring when the media started contacting the politicians who were making*

comments without any knowledge and started sort of, how do I put it, not meshing with what we were saying at the scene" *"That's very important because very few organizations have funds of their own. So when there's a crisis they have to raise funds, and they have to get the confidence from both the public, if they have a big share of the money coming from the public, or from the institutional donors"* *"So what was happening was they were making statements and we'd be going where did they get that from? We were the ones who were making the decisions at the scene, yet they were making decisions without our knowledge. And it became very frustrating for us"*
Flexibility
"I think anybody's who's going to be in a senior commandeering who's got to deal with all the different things is to keeping the open mind. It's the approach" *"But in this world, and with that tool, the people outside the tool, outside that structure, want to be involved very much, want to be involved in decision making, want to see what they are, and want to approve them. And that can slow down the response"* *"They don't want mistakes. But that doesn't make things happen very fast."*

A relevant pattern discerned from the interviews was that organizations with similar backgrounds tend to focus on similar objectives, to share paradigms, and to respond during the same phases of the emergency (Table 12). Non ICS-based organizations tend to focus on the wellbeing of emergency victims and responders. Their emphasis is placed more on the reaction to the emergency than on planning, with their organizational efforts directed primarily towards the rescue and recovery phases of the emergency. In contrast, ICS-based organizations tend to focus on operational targets (fire, security, rescuing people). In order to provide an efficient emergency response they implement ongoing training, which enables their organizations to offer improved reactions to the emergency challenges. Their overall focus is centered on the impact and immediate rescue phases. For military organizations, objectives are prioritized so as to provide overall support to the other organizations involved in the emergency. One of the major organizational strengths of the military is its capacity for planning for anticipated events. The military's organizational forte is in the prevention and planning phases, however their assistance can be offered at any phase if properly requested.

Table 12: Organizational emphasis by organization type

	ORGANIZATION TYPE		
THEME	**Non ICS-based**	**ICS-based**	**Military**
Phase of the event	Tend to emphasize rescue and recovery stages	Tend to emphasize impact and immediate rescue stages	Tend to emphasize planning stages
Planning	Often emphasis more on reaction than planning	Perceive a balance between planning and being reactive	Very focused on planning
Paradigm / Objectives	Focus is on the well-being of people in a broad sense	Overall focus usually on a specific operational target (fire, security, rescue)	Focus is conceptualized as backup help and support

Examples of quotations describing the organizational strengths and opportunity areas are shown below in Table 13:

Table13: Sample interview quotes illustrating organizational emphasis

"And obviously the training hasn't been comprehensive enough because we've had training before, or maybe it just needs to be repeated, and not long-time periods left in between"
"We didn't care what the hell happened to the people that were there afterwards. It's just weird. We never really did. Like it was like oh, we've done our thing. It's out. Somebody must look after this afterwards. We're gone"
"And it's very challenging, especially now when I say that the CNN effect is there, the cameras sometimes are here before even the humanitarian actors are on the ground. And you always have the first wave where everyone is doing great things and all that. After a week and a half then the criticisms are coming. Why isn't it distributed? Well, it's hard to explain why it's not done. And that's where it's critical for the agencies to be able to relay that to their constituencies. That's basically what it is"
"One of DND's strengths is the ability to plan"

4 Discussion

In summary, the findings from the study's various lines of investigation support the main tenants and components of the *Model* of inter-organizational problem-solving approaches. The PODS experiment produced empirical data that confirmed that when engaging in collaborative tasks, there are considerable challenges involved with respect to communication and the resources required; however, the outcomes from this investment may be more beneficial with respect to understanding a problem, and of higher quality with respect to decision-making. In addition, the PODS experiment provided empirical evidence that the challenges in participating in a multi-organizational environment increase as the diversity of organizations increase. These include challenges such as increased differences of opinion, less agreement on decisions made, and increased time pressures when compared to working in a more organizationally homogenous environment. As well, the data from the PODS experiment demonstrated that organizations could be "instructed" to solve tasks in either a collaborative or coordinated manner. This operationalization of two fundamentally different problem solving approaches across two different tasks is particularly useful when organizations and groups are planning and developing tasks and scenarios for training exercises.

Qualitative data from the interviews with senior decision-makers also confirmed some key components of the *Model* of inter-organizational problem-solving approaches. The interviews confirmed the significant impacts that modifiers of time, information, resources, power and authority can have on the capacity and willingness of organizations to coordinate, cooperate and collaborate in multi-organizational environments during extreme events. Across the interviews, examples were provided where each of these factors acted sometimes as a barrier, and other times as a facilitator of the three approaches to problem solving. Another important finding from the interviews was that distinctive patterns according to organization type were evident for some of the key model components and modifying factors. A considerable number of distinctions were made between military, ICS-based, and non-ICS organizations with respect to how problem-solving was perceived and exercised during extreme events.

The empirical data from the PODS experiment, qualitative data from the interviews, reviews of diverse literatures, and detailed case studies of domestic and international extreme events when combined together have produced an extensive, integrated evidence base accompanied by solid theoretical underpinnings that can be used for a number of purposes including developing training exercises and programs for problem-solving and risk management within a multi-organizational environment during extreme events.

By emphasizing in the project design a strong theoretical focus combined with establishing a solid evidence base for the "model", we are setting the ground work for various types of modeling that could now be developed and implemented as a next step (as illustrated in the current preliminary work underway by the study team in applying fuzzy logic models to computer simulations of collaboration – see Appendix B). The investment in developing empirical methods to collect observational data using *in vivo* setting proves to be very relevant and useful in collecting behavioural and attitudinal data to improve the predictive power, accuracy and validity of some of the current agent-based modeling underway in this area.

In addition to providing an evidence base, the study results have assisted in clarifying some potential modifications to the proposed *Model* of inter-organizational problem-solving approaches, provided insight into considerations when working in multi-organizational

environments during extreme events, and contributed to defining areas for further investigation and research.

4.1 Potential modifications to *Model*

While the study has confirmed many aspects of the *Model*, there are a few areas where the *Model* can be strengthened or further tested. Highlighted among the results is the potential modification to the original conceptualization of problem-solving approaches (i.e., coordination, cooperation, collaboration) to fully capture the multi-dimensional, fluid nature of these approaches. For simplicity and parsimony, the problem solving approaches were presented in the *Model* as three separate categories. After examining the data from the self-report questionnaires, observing sessions, and analysing the qualitative interviews, the results indicate that problem solving during extreme events is much more dynamic and fluid than would be represented by these three categories. As a result, it is likely more accurate and useful to begin to conceptualize problem solving approaches as multi-dimensional with various interactions and behaviours occurring at different times and in different conditions. For example, one dimension may remain sharing as present in the original *Model* (e.g., information, resources, power, authority); however, there may be additional dimensions such as conditionality/trust (e.g., sharing resources only with similar organizations), formality (e.g., MOUs for sharing information), and directional exchange (e.g., information flows in only one direction). This expansion to a multi-dimensional conceptualization of problem-solving approaches will also permit a more detailed understanding of what would be the optimal fit between approach, timing and task during extreme events. The other challenge in using the three main categories of coordination, cooperation and collaboration is that there is inconsistent understanding across various types of organizations as to what these terms mean. By modifying the *Model* to focus on a more interactive, multi-dimensional understanding of problem-solving, the resulting definitions of problem-solving approaches in a multi-organizational context during extreme events will be more accurate, useful, and refined. The expansion to a multi-dimensional understanding of problem solving is consistent with many of the assumptions and hypotheses developed in another paper produced as one component of the Technology Investment Fund project entitled *The Meta-Organization: A Research and Conceptual Landscape* (Okros, Verdun & Chouinard, 2011).

Another required modification to the original *Model* is the inclusion of organizational culture, identity and structure as important modifiers in determining which problem-solving approach is appropriate and possible. This was evident in the findings from the experimental sessions established to assess mixed and homogeneous pods, and through the interviews with professionals from different organizations. For example, working in mixed groups resulted in greater differences of opinion being expressed, perceiving the task as more complicated, less satisfaction with the amount of time required for the task, and lower levels of agreement on decisions and outcomes. The challenges with working in a multi-organizational context were partially confirmed from the interviews where the differences between various types of organizations were evident across a variety of themes from very broad overall paradigm differences through to specific organizational restrictions and constraints. While the study used relatively broad categories for organization type (i.e., military, ICS, non-ICS), it is likely that the differences assessed according to this grouping are actually as reflective of organizational cultures and identities as they are reflective of decision-making structures. For example, considerable challenges with multi-organizational problem-solving at the planning stage for an extreme event will likely occur if one organization has a culture and identity permeated by planning (e.g., military), while another organization identity consists of being reactive and responsive to change (e.g., NGO). In order to successfully address these types of challenges, there will need to be a

better understanding of how culture, identity, structure and problem-solving are interwoven. Organizational culture, identity and structure will also place most organizations in the position of having to balance internal organizational requirements and expectations with those emanating externally as a result of the situation. Some organizational cultures, identities and structures have more capacity than others in responding to this tension and achieving an accepted balance. These issues were discussed in detail in another TIF paper (Okros, Verdun & Chouinard, 2011) which outlined key hypotheses that gave prominence to the issue of organizational culture and identity. These included hypotheses such as: "*In order to work effectively with others under comprehensive approaches, those organizations that have tight cultures will have to adopt elements of loose cultures including flexible norms; accepting ambiguity and uncertainty; and living with fuzzy roles and values*"; and "*Evaluations of individual decision making need to go beyond the view of the person as a rational decision maker by adopting elements of actor analyses and, in particular, recognizing how deeply embedded elements of socialization as well as the temporal dynamics of team climate can influence decisions*".

The third main modification to the *Model* is in the area of understanding the dynamics of information, resources, power and authority. Similar to the conceptualization of problem-solving approaches, the definitions used for this component of the *Model* were relatively simple and not fully detailed. The findings from the study indicate that these concepts are likely more complex and interconnected than originally depicted in the *Model*. Further work will be needed to understand how best to represent these constructs and to understand how they impact as modifiers in the selection of optimal problem-solving approaches. For example, in security situations where some agencies are not permitted to share any information, does this automatically prevent coordination and cooperation from occurring? Can organizations with large power imbalances actually collaborate? Assuming power is multi-faceted, which facets are less/more readily shared?

4.2 Considerations when working in multi-organizational environments

The results from the study combined with observations made from the literature and case studies conducted earlier outlined a number of considerations when working in multi-organizational environments during extreme events.

4.2.1 Considerations according to event stages

Inter-organizational problem-solving occurs not only in the impact and rescue phases but throughout the extreme event timeline (see Figure 3). Moreover, practice with coordinated decisions, joint decisions, and shared decisions are needed in the preparedness and planning phases in order to create the network needed to facilitate collaboration during a crisis. The scenario used for the PODS experiment had participants being introduced to one another at the impact and immediate rescue stages of the event. This was somewhat artificial in that many of the participants had not previously known or worked with one another prior to the session. Data collected from interviews and case studies stressed the importance of pre-event experience working together as critical to successful preparedness and response for emergencies.

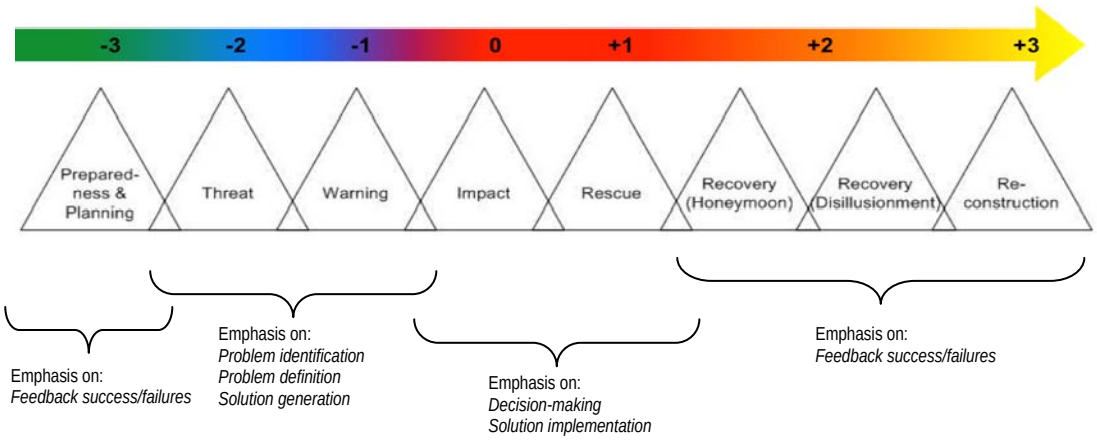

Figure 3: Extended timeline and emphasis on stages of the problem-solving cycle by time phase

Though the impact and rescue phases are often singled out as the most significant phases in emergency response, the preparedness and planning stage during the pre-event phase presents an opportunity to prevent negative effects from occurring during an incident, and to lay the groundwork for later collaboration as an event becomes complex. Training programs, exercises, planning and preparedness efforts should be focused on solid analysis of past events, lessons learned and feedback on past successes and failures from a multi-organizational perspective, not just a single organization perspective. It is during this time that reflection on lessons learned create the opportunity to influence planning, training and preparedness efforts, which have the capacity to reduce and even prevent harmful psychosocial effects at the individual, family, organization, and societal levels (Donahue & Tuohy, 2006). One approach to ensuring that the feedback/lessons learned are solid and from a useful multi-organizational perspective is to attempt to actually *collaborate* on collecting and analysing the evaluation data. This can avoid the less useful individual-based blaming or credit-taking that can occur with less collaborative approaches.

Continuing with the concept of a multi-phase extreme event, Figure 4 outlines the main areas of emphasis of organizations by phase of the event. The qualitative interviews indicate that the main areas of emphasis of organizations differ from one another, yet are complementary with each other's strengths to assist and respond during emergencies and extreme events. According to interviews, one of the military's main areas of emphasis and strength is during planning phases, into which learning from previous episodes is integrated to improve their own capabilities. However, during the impact phase of a domestic event, the military does not have the jurisdiction to participate in the response unless the appropriate authority requests their assistance. As a result, it is generally during the latter stages, i.e., the rescue and recovery stages, when their assistance is requested.

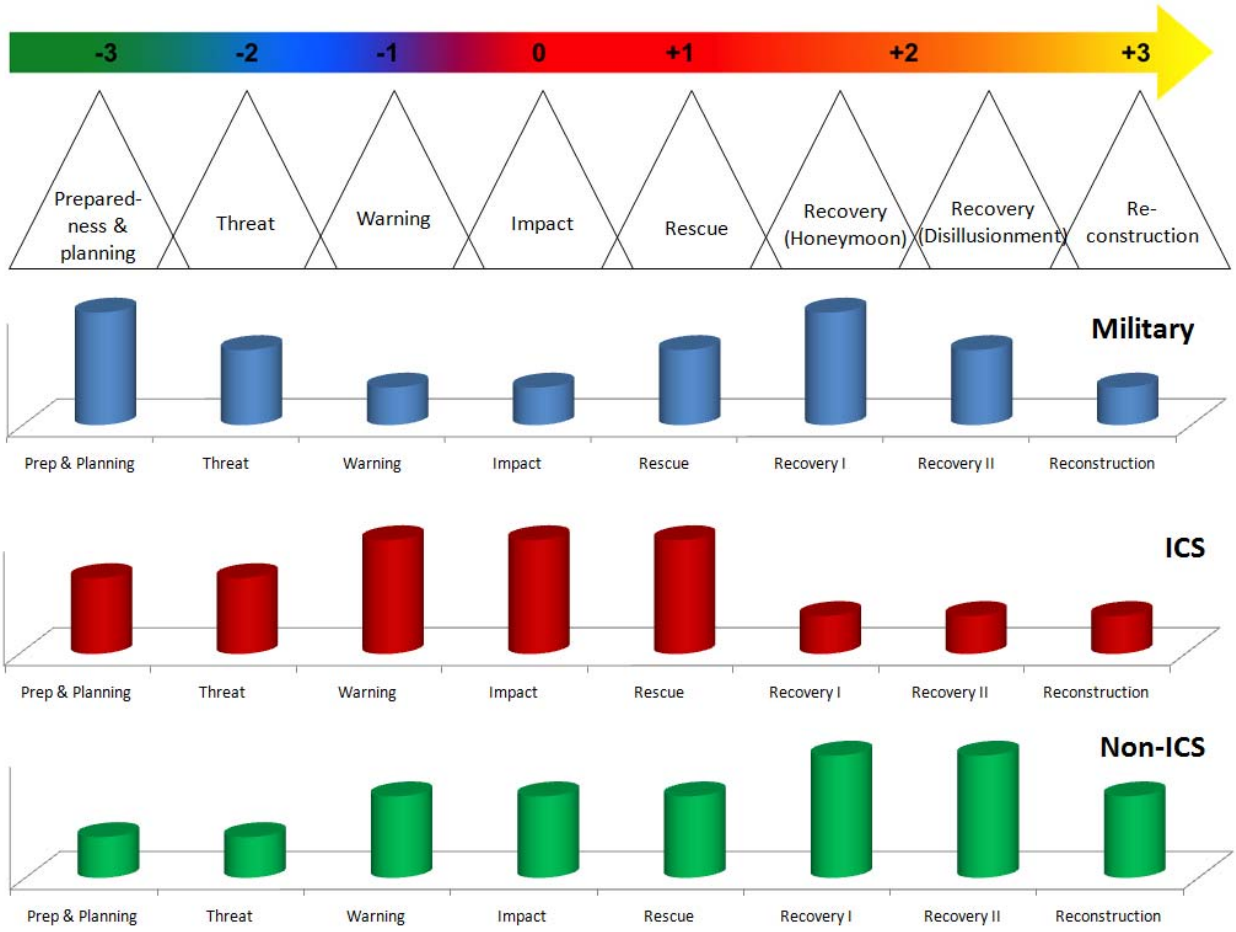

Figure 4: Organizational emphasis and strengths by emergency phase

In contrast, ICS-based organizations identified their main area of emphasis and strength during the impact and immediate rescue phases, given that their specialized functions are to solve the problems and challenges of these critical phases in the most expedited ways possible. ICS-based organizations train during the planning and preventions stages with other fellow ICS-based organizations to improve the response provided during the impact and rescue phases. However, once the rescue phase is over, these organizations will generally leave the event given that they lack resources to provide assistance in the following phases.

The Non ICS-based organizations generally were found to fill the gaps in those phases that are not areas of emphasis for the military or ICS-based organizations. Non ICS-based organizations' objectives are usually aligned to assist in the well-being of the general population, whether it is responders or members of the general public. Their efforts can commence at the impact and rescue phases but extend over the recovery and reconstruction stages. According to the interviewee's descriptions, this requires an enormous effort from these organizations in order to keep in line with public demands for these extended periods. Decision-making and problem solving processes can become more complicated due to lack of resources and support from other fellow organizations to assist during these stages. Interviewees reported that in their experience,

limited efforts in their organizations had been focused on prevention and planning.

A consideration that needs to be made in working towards increased levels of collaboration at the preparedness and planning stages is that some organizations that will be potential key collaborators in the latter phases of an event (e.g., recovery), may have little interest or experience in planning at a pre-event stage. As illustrated in the interviews, many of the Non-ICS organizations reported that they focus on being reactive and customizing their responses to situations. In addition, with fewer resources available, these organizations will need to have the benefits clearly identified in order for it to make sense for their organization to collaborate at this early stage. A consideration for the military will be how to collaborate in planning and pre-event stages. While focussed very heavily on planning, the military will likely need to consider how to engage in pre-event planning that involves collaboration with other organizations that differ substantially in terms of approach, mandate, and resources.

Another consideration that emerged from the study was that the unidirectional representation of the emergency event (as represented in Figures 3 and 4) may be more accurately depicted as a reflexive process. This would be similar to how the problem-solving process is represented as a recursive, iterative process with one specific stage focused on feedback and evaluation to inform the round of problem solving (see Annex A for details on problem solving approach). Similarly, feedback and monitoring within the event timeline could be used in a reflexive manner and integrated into new cycles of knowledge creation, and inform the next opportunities for multi-organizational preparedness and planning. Reflexivity is a theme from social theory that looks at systems where participants and observers are involved in determining the structure of the system (Flanagan, 1981). In this sense Nousala and Jastroch (2011), explain that cross-fertilization has the potential to increase organizational knowledge, where domain specific clusters could potentially assemble different organizational strengths. Figure 5 shows these relationships.

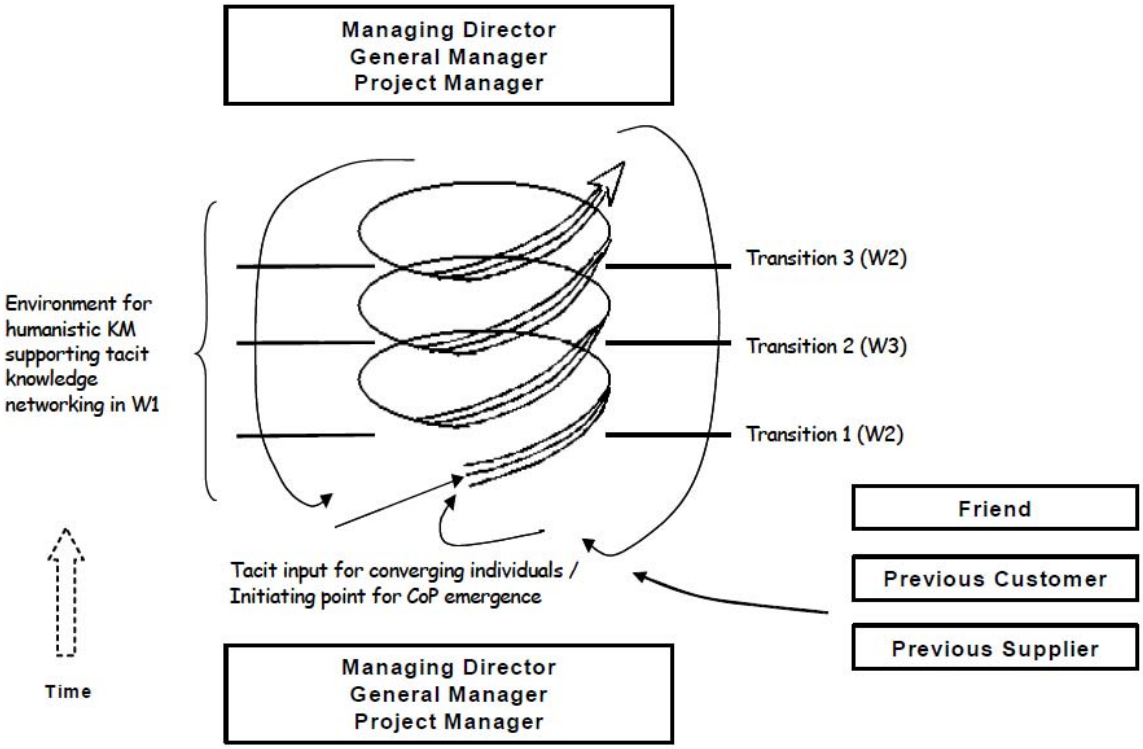

Figure 5: Cycles in building organizational knowledge through time (Nousala, 2010)

4.2.2 Considerations according to event complexity and problem-solving approaches

The study was able to categorize and characterize problem-solving approaches in different types of multi-organizational environments during extreme events. Overall, a greater emphasis was placed on more complicated and complex events compared to simple events. In addition, to provide contrast in operationalizing problem-solving approaches as an independent variable, greater emphasis was placed on coordination and collaboration rather than cooperation during the PODS experiment. The qualitative interviews, case studies and literature reviews provided some balance to the more focused emphasis of the experiment. All study components contributed to the development of considerations for working in multi-organizational contexts during extreme events. An overview of these considerations is presented in Table 14 according to event complexity and problem solving approaches.

Table 14: Considerations according to situation complexity and problem solving approach

<table>
<tr><td></td><td></td><td colspan="3">Problem-solving approach</td></tr>
<tr><td></td><td></td><td>Coordination</td><td>Cooperation</td><td>Collaboration</td></tr>
<tr><td rowspan="6">Level of complexity</td><td rowspan="2">Simple</td><td>Optimum Problem Solving Stages
• Solution Generation
• Decision-making
• Solution Implementation</td><td>Optimum Problem Solving Stages
• Problem Identification
• Problem Definition
• Feedback Success/Failure</td><td>Optimum Problem Solving Stages
• Not appropriate</td></tr>
<tr><td colspan="3">Considerations
• Various barriers and challenges to sharing information
• Resource sharing may be conditional resulting in sharing only among similar/familiar organizations
• Cooperation may be challenging given that resources among some organizations will be limited
• Potential for inefficiency if cooperation and collaboration are used when not necessary
• Potentially could be used as a “sand-box” for practicing collaborative approaches and building trust among orgs</td></tr>
<tr><td rowspan="2">Complicated</td><td>Optimum Problem Solving Stages
• Solution Generation
• Decision-making
• Solution Implementation</td><td>Optimum Problem Solving Stages
• Solution Generation
• Decision-making
• Solution Implementation</td><td>Optimum Problem Solving Stages
• Problem Identification
• Problem Definition
• Feedback Success/Failure</td></tr>
<tr><td colspan="3">Considerations
• Potential for gaps in response if coordination is the only approach used when cooperation or collaboration is more appropriate
• Can be used as practice in conceptualizing situations as made up of multiple sub-events that can be assessed on different levels of complexity (ranging from simple to complex) and then appropriate approaches applied
• Balance selecting an approach that meets the demands of the situation while avoiding gaps in response.
• Important to collaborate at problem definition stage to ensure that changes in complexity can be identified during evolving situations
• Feedback, if done collaboratively, can feed into pre-planning for next event
• Collaboration can result in greater participation, greater communication, and a more accepted decision/outcome</td></tr>
<tr><td>Complex</td><td>Optimum Problem Solving Stages
• Not appropriate for truly complex problem-solving</td><td>Optimum Problem Solving Stages
• Solution Implementation</td><td>Optimum Problem Solving Stages
• Problem Identification
• Problem Definition
• Solution Generation</td></tr>
</table>

				• Decision-making • Feedback Success/Failure
		Considerations • Potential for gaps in response if situation is truly complex and coordination/cooperation are used as main approach • May be some aspects of any complex event (sub-events) that are less complex that can be addressed through coordination and cooperation • Complex problems are sometimes defined and addressed in a manner that the core problem is avoided – this needs to be balanced with previous point which identifies sub-events or situations that may be less complex. • Complex situations may not have a correct solution and may need to instead be considered as "good enough" solution. • Collaborative problem solving requires sufficient resources such as potentially additional time, space, staff and funds. • Collaboration requires practice, but organizations can learn how to do this – most extreme event training focuses on coordination and cooperation, and less on collaboration.		

One main theme running throughout the experimental sessions, interviews, case studies, literature reviews and as a component of the *Model* was the sharing of information including challenges and opportunities encountered while doing this within various types of events. Information sharing is conceptualized as the cornerstone in developing a coordinated response characterized by efficiency, and the prevention of overlapping or duplicating of tasks. Information sharing is also a precursor to effective cooperation and collaboration in more complicated or complex events. This fundamental step towards building an effective inter-organizational response faces significant challenges with respect to technology, security, and organizational culture. Barriers to information sharing may occur at the individual, agency or inter-organizational level (Bharosa, JinKyu and Janssen, 2010).

Barriers to information sharing between organizations may arise due to conflicting goals or mandates, mismatched security clearances, organizational silos, and insufficient informal and formal meetings between organizations. Information sharing may be limited within an organization due to vertical information sharing structures, lack of appropriate security clearances for staff members, or an overreliance on existing plans or protocols. Problems with information sharing may be enacted on an individual level as well with technical problems, judgement issues with respect to what should and should not be shared, cognitive overload, misinterpretation of data, and problems with the quality, quantity and access to raw information sources. High reliability organizations provide a number of best practices with respect to information sharing using transactive memory (Xiao, Plasters, & Seagull, 2004), no fault reporting of problems (La Porte, 1996), communication pattern rehearsal to familiarize everyone with the same jargon and vocabulary (Bierly & Spender, 1995; Quarantelli, 1988), and redundant methods of communication (Roberts & Bea, 2001). Though these techniques are intended for use within an organization, they are likely equally applicable to organizations of organizations, or meta-organizations, as well.

The cooperative approach to problem-solving emphasizes joint decision-making and sharing of resources to fill gaps in response. It is important to note that a lack of resources is fairly typical during response to a complex extreme event (Comfort, Ko and Zagorecki, 2004), but that this factor alone does not explain gaps in response. Sharing resources assists in filling gaps, but through cooperation, the allocation of resources to the areas that are most needed will have the greatest benefit in response. Thus the bigger issue at hand becomes resource allocation rather than

resource scarcity, which, in complex events, is often a given. During impact it becomes necessary for resources to be distributed to areas where the demand is highest. However, in order to do this effectively, good quality information about the situation is critical. The cooperative approach therefore involves both the sharing of information between organizations and the strategic allocation of resources according to need.

One consideration highlighted in the study was that resource sharing is often agreed to with conditions attached. For example, during interviews, there was greater likelihood of sharing if it was with similar organizations (e.g., other ICS-based organizations). Another consideration is that the distribution of resources across organizations will vary considerably with some organizations relatively resource "rich" while others have limited resources and are highly competitive for tangible resources, but perhaps can contribute experience, knowledge of population, etc. These limitations on sharing resources and subsequently the cooperative process to problem-solving will need to be addressed in order to effectively problem-solve.

Collaboration is most likely to form from the push of public opinion on a specific issue or through incentives such as financial assistance (Cigler, 1999). Collective action does not occur spontaneously. Rather, it is often arduous, time-consuming and costly. This was partially confirmed in the experiment with collaboration tasks being characterized by higher levels of participation and involvement at the individual and pod level. Collaborative inter-organizational relationships require sufficient resources to facilitate this form of interaction (Imperial, 2005). Collaborative relationships require additional time, staff, space and money. The results of the experiment indicate that, on average, participants required additional time to reach collaborative decisions. An increased amount of dialogue is needed to reach collaborative decisions as the volume of communications increases in order to share differing points of view. The additional time needed with this approach may require additional staff in order to complete collaborative decision-making tasks, as staff members will need to spend more time liaising with other organizations.

The greater the number of parties involved in the collaboration, the more socially complex the inter-organizational relationship becomes (Conklin, 2005). However, social complexity also arises out of structural relationships among the stakeholders in the group. The fragmentation of perspectives, understandings and intentions of the members of the group can impede the problem-solving process if there is not a shared vision for the outcome and a shared commitment to solving the issue. At times, organizations will each have their own terminology to define a shared concept, which can derail the problem-solving process as the parties involved become focused on determining which term to use. Political pressures within a social complex collaboration can result in organizations defining the problem in terms of their respective organization's mission, service area or region. Diverse points of view and organizational structures also increase social complexity. However, the potential benefit of this diversity is added creativity, a more comprehensive definition of the problem, more options during solution generation, and a wider range of resources and skills from which to draw. This requirement for diversity is similar to the hypothesis outlined by Okros et al (2011) that speculated: "*When seeking to address wicked social problems, failure to adopt an appropriate approach to framing questions will result in inaccurate or inadequate problem definition resulting in ineffective strategies to attempt to resolve the underlying problems(s)*".

Technical complexity also has the ability to complicate collaborative problem-solving (Conklin, 2005). Problems with software, hardware or incompatible communication technologies make it more difficult for collaborative partners to grasp the problem. Though technical complexity certainly has the capacity to complicate the problem-solving process significantly, social

complexity is more often overlooked and thus requires additional attention, particularly in the earliest stages of problem-solving as organizations come to a shared understanding of the problem.

Like coordination and cooperation, collaboration requires practice. Collaboration is not a spontaneous occurrence. Instead, it is borne out of practice and planning. Collaborative relationships must be worked on in order to be in place and effectively function when they are needed. Though training exercises that involve coordination are widely used to practice tackling simpler problems, the cost and difficulty with creating complex training scenarios has limited the amount of time spent on practicing collaborative techniques. As virtual meeting tools, such as the ones used in the *in vivo* experiment, become easier to use and more widely accessible, the costs of running these types of exercises may be reduced, facilitating exercises that span multiple regions, jurisdictions and levels of government.

4.3 Considerations for future research.

Given the funding and timelines available for this project, the collection and analysis of data had to be adapted to fit these constraints. While the study was overall very successful in developing an evidence base, there are a number of areas that future research could contribute significantly to expanding this base. The *Model* of inter-organizational problem-solving approaches and current study results provide guidance and direction on potential future research related to problem solving in multi-organizational contexts during extreme events. These include:

- *Analysis of observational data* – To date, given the time and resource restrictions, the main emphasis on analysing data collected during the PODS experiment has been on the quantitative self-report measures. There have been some limitations with this data such as sample size. In addition to these data, the PODS sessions provided copious amounts of observational data as all sessions were video and audio recorded resulting in approximately 40 hours of tapes that capture attempts at coordinating and collaborating by a cross-section of senior decision-makers with a complex scenario. This provides a rich data set for which the study team can develop coding schemes for identifying various key characteristics of collaboration and coordination behaviour, examining different problem-solving approaches according to organization type, and determining common communication patterns within both mixed and homogenous multi-organizational environments. Additional resources would be required to run more sessions which itself would result in an even richer data analyses with more robustness to observations and self-report data.

- *Further development and definition of problem-solving approaches* – As noted in Section 4.1, the findings from the current study highlighted the need to re-conceptualise and define the approaches to problem solving beyond the three categories of coordination, cooperation and collaboration. This may be assisted to some extent with further analysis of the observational data as noted above, along with some further phenomenological investigation as to how problem-solving is conceptualized by practitioners.

- *Assessment of communication and information seeking patterns* – An important next step is to analyse the current observational data available from the PODS experiment via video/audio recordings to identify various communication and information seeking patterns across the temporal dimension of tasks and scenario. From this, computer-based

modeling could be undertaken to predict how these patterns change/remain the same across time, stages, task type, and organizational environment.

- *Determine the "decision points" of when organizations decide to collaborate* – The current study tested the extent to which collaboration could be instilled via instructions provided during scripted tasks. Of equal importance would be the understanding of how organizations decide to collaborate (in the absence of instructions) given the often heavy investment this requires. Hypotheses would be that key factors that impact decision points include organizational culture similarity; familiarity linked to trust; severity of the problem; and complexity of the situation.

- *The role of organizational culture in multi-organizational problem solving* – This relatively broad area appears to have a large impact on how multi-organizational problem solving is undertaken; however, limited empirical studies appear to have been designed and implemented in this area.

- *Further investigation of the decision-making approaches as related to the extended event timeline* – For the experimental portion of the current study, emphasis was placed on a relatively limited portion of the event timeline (impact and rescue). It is expected that collaboration at the planning and preparedness stage may be implemented and experienced quite differently when compared with collaboration at the recovery stage.

- *Inter-organizational relationships under complex and uncertain situations.* This stream of the research project will involve a mixed methods approach, entailing a networking analysis of social and professional ties from the *In vivo* experiment participants. The doctoral student will look at multi-dimensional networking constructs and metrics, and their relationship with observed communication patterns, behaviours and effects over the organic evolution of the organizational command structures. A second study of this doctoral thesis will include a phronetic analysis to identify elements applied by expert decision makers to overcome the challenges faced in emergencies. These elements complement and go beyond both the procedural steps and activities (*teckne*) typically undertaken, and the normative rules inherent to their professional roles and responsibilities (*episteme*). The third study will elicit fuzzy logic models that will enable the translation of these findings into fuzzy algorithms that potentially facilitate the design, development and implementation of networking and decision systems.

- *Investigation into the relationship between team performance and shared mental models*– This area of research is fairly limited in the arena of emergency management. Current PhD proposal expects that emergency manager teams coordinate, cooperate and collaborate to a higher level when team members share similar organized structured patterns of knowledge (i.e. mental models). Sharing similar mental models increases the quality of performance as it allows managers to better understand one another by being able to predict and explain behaviour, and identify and recall relationships between the events and their components. This student's thesis aims to identify differences across a variety of managers' mental models through the analysis of qualitative interviews, and by linking mental model similarity and team performance through observational studies, and demonstrating that mental model similarity among teams can foster better team performance through the use of simple cross-training methods.

5 Conclusion

The study provides findings that contribute to an understanding of interagency collaborative behaviour, the effects of inter-agency relationships on collective decision making and the influences of psycho-social factors. The study has contributed to TIF's overall objective by producing an extensive, integrated evidence base accompanied by solid theoretical underpinnings that can be used for a number of purposes including developing training exercises and programs for problem-solving and risk management within a multi-organizational environment during extreme events. The study confirmed that when engaging in collaborative tasks, there are considerable challenges involved with respect to communication and the resources required. The study also empirically confirmed that challenges in participating in a multi-organizational environment increase as the diversity of organizations increase.

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Annex A Overview of SDM Framework

A.1 Rationale for moving towards SDM Model for complex events

According to the overview of the Technology Innovation Fund (TIF) project (Chouinard, 2009), the Canadian Forces have become increasingly involved with complex events that defy easy solutions. Complex events result in ripple effects that extend beyond immediate impacts, and are exacerbated by existing vulnerabilities and by the uncertainties inherent in large scale threats and emergencies. As the effects of these events are mitigated, the Canadian Forces must engage with traditional, non-traditional, and international partners to collaborate on and contribute to solutions to challenging problems. As part of Task 1 of this research project a shared decision-making (SDM) framework, called the *Model for Inter-organizational Problem-solving* (*see Figure A.1*), was developed to assist in the understanding of decision-making and problem-solving approaches used in multi-stakeholder partnerships during complex emergency events.

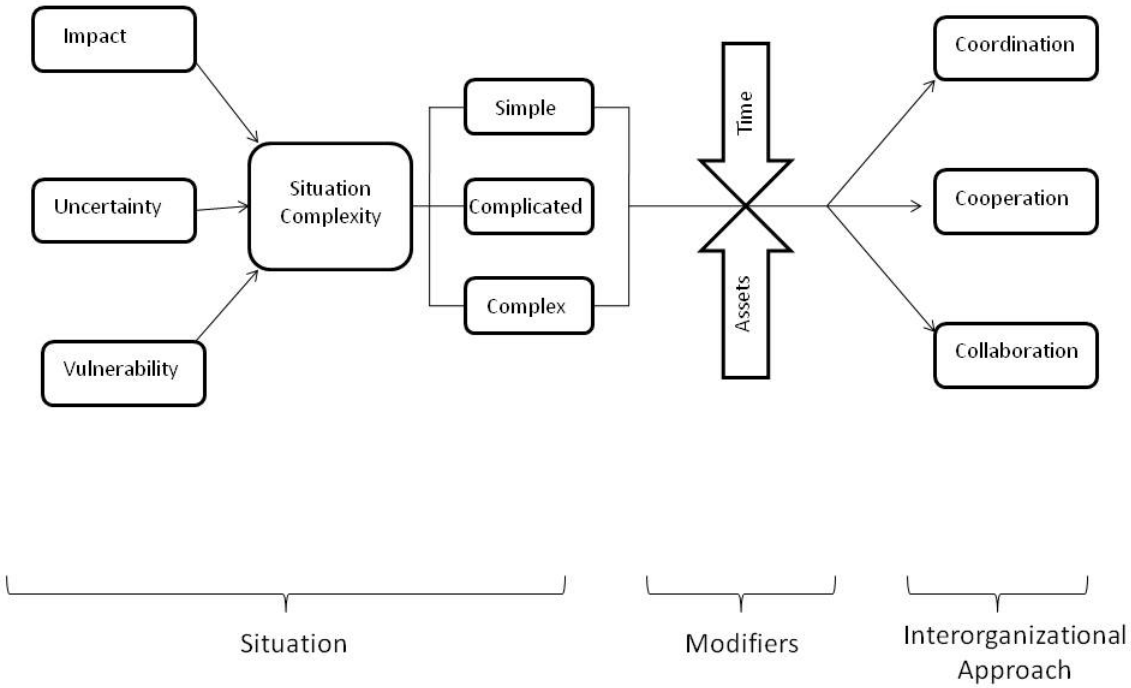

Figure A.1: Generic model of inter-organizational problem-solving approaches as a function of situation complexity, assets of organizations and time phase

As illustrated in *Figure A.1* above, the *Model* developed to enhance the understanding of inter-organizational problem-solving contains two main components: 1) *Situation*, which is characterized in terms of complexity (simple, complicated and complex); and 2) *Approach to problem-solving*, which is characterized by inter-organizational approach (coordination, cooperation and collaboration). Though this figure is linear in its depiction of problem-solving, it is important to note that the relationship between situation and problem-solving approach is both dynamic and continuous. Situation complexity fluctuates, rises, and falls according to a number of factors and elements, including impact, uncertainty and vulnerability. Problem-solving approach is also modified by *time*, as the optimum approach needed varies from one stage to the next (e.g., problem definition, solution implementation).

The general assumption of this *Model* is that while complexity rises, the need for a more collaborative approach also rises as more actors from different domains become involved in the response. However, it is important to recognize that complex events are made up of "kernels" of simpler problems as well as more complicated problems. Additionally, diverse workplace cultures and organizational types dictate that inter-organizational relationships are unlikely to be homogeneous, containing "kernels" of coordination, cooperation and collaboration that shift according to the groups involved, the complexity level, and the problem-solving stage.

There are a number of benefits that the *Model for Inter-organizational Problem-solving* provides. A few of these benefits are:

- *Differentiating the appropriate organizational approach according to time phase* – The *Model* does not suggest that a collaborative approach be used for all problems. Collaboration takes more time and can be more frustrating than other approaches. Given that the approach is dialogue intensive and challenging on an interpersonal level, collaboration would be best suited to problem-solving more complex aspects of the situation (e.g., problem definition, solution generation). Solution implementation requires a faster, less resource intensive approach such as cooperation or coordination depending on the level of complexity of the situation.

- *Relationship-based approach is compatible with the "All-Hazards Approach" to emergency management* – The *Model* is not specific to particular types of events and could be applied to the planning, response and recovery phases of natural hazards and disasters, CBRNe threats and events, pandemics, terrorist events and large-scale political or sporting events.

- *Allows organizations to maintain organizational integrity (identity, specialties, etc.) within a larger collaborative network* – In constructing meta-organizational networks, organizations maintain their uniqueness while simultaneously recognizing the unique perspectives and resources of other organizations. The *Model* encourages cooperation and collaboration without sacrificing the unique organizational traits that various traditional and non-traditional response groups possess.

A.2 Situation complexity

Following case study analysis and literature reviews conducted in Task 1 of this project, three factors consistently emerged as contributing to the overall complexity of a situation. These factors are:

- Factor A: *Impact* of the event (potential, perceived and actual);

- Factor B: *Uncertainty*; and,

- Factor C: *Vulnerability* (or resiliency) of the affected population, including the response organizations.

These three factors include a number of sub-elements that are depicted in the figure below. These elements contribute to the rise and fall of complexity within a given event and act in dynamic ways as elements interact with one another to improve or exacerbate situational complexity.

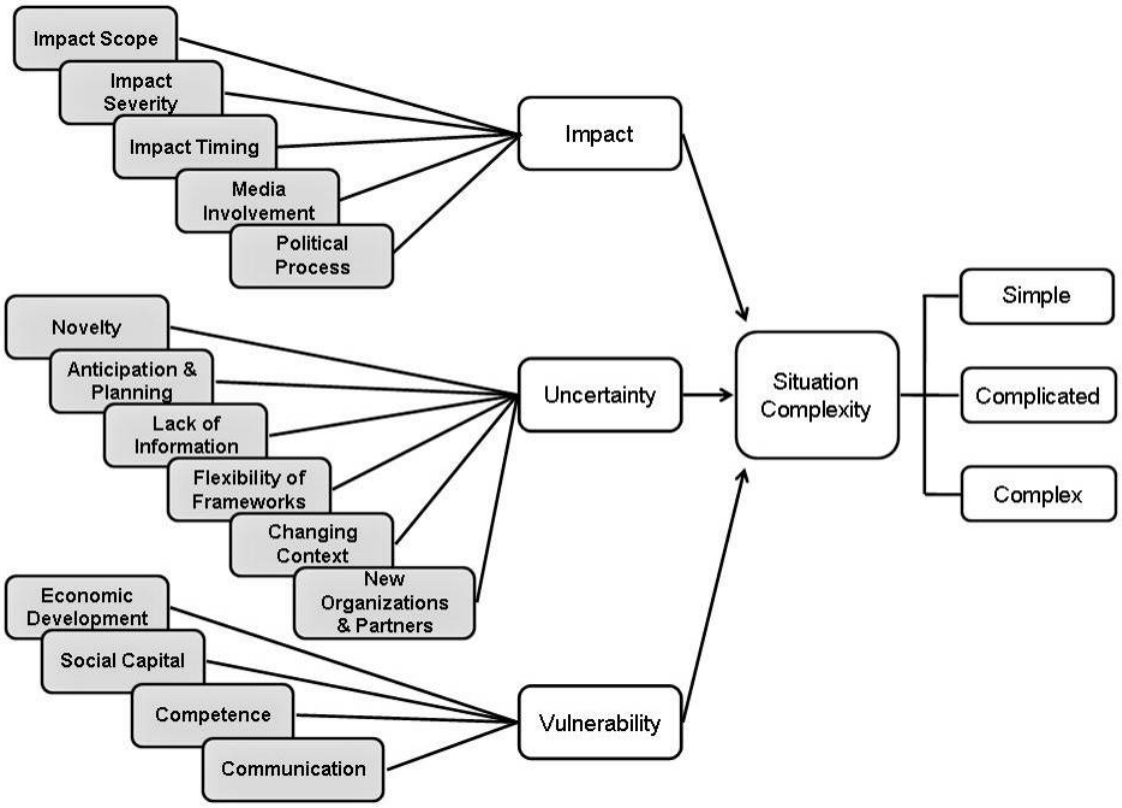

Figure A.2: Factors and elements contributing to situation complexity

Factor A – Impact

The event impacts include potential impacts (as in the case of threats), actual impacts, and perceived impacts (in cases where perceptions amplify or deviate from real impacts). Potential impacts refer to instances where a threat exists, causing concerns during the pre-event phase. These impacts may be felt even when the threat is not realized. Actual impacts include physical damages, economic costs and social costs that are felt as the result of direct impacts. Included in this grouping of impacts would be such figures as the number of mortalities, or the number of houses without power. A good example of perceived impacts would be the H1N1 pandemic, during which pork producers had to contend with unfounded fears that pork could pass along the virus to humans via consumption of cooked pork products.

Within the impact factor, there are a number of sub-elements that contribute to the severity of impacts:

- *Scope of impacts* – The scope of impacts refers to the number of tiers within a society that are affected. First tier impacts are often considered the direct effects on the population as the results of the event (e.g., number of people injured, number of mortalities). Second tier impacts include interruptions to essential societal functions (e.g., food and water delivery, shelter, primary healthcare, electrical power). Third tier impacts involve long term societal impacts (e.g., political and economic costs). These tiered impacts are depicted below in a figure developed in the EU project ASSRBCVUL, 2006.

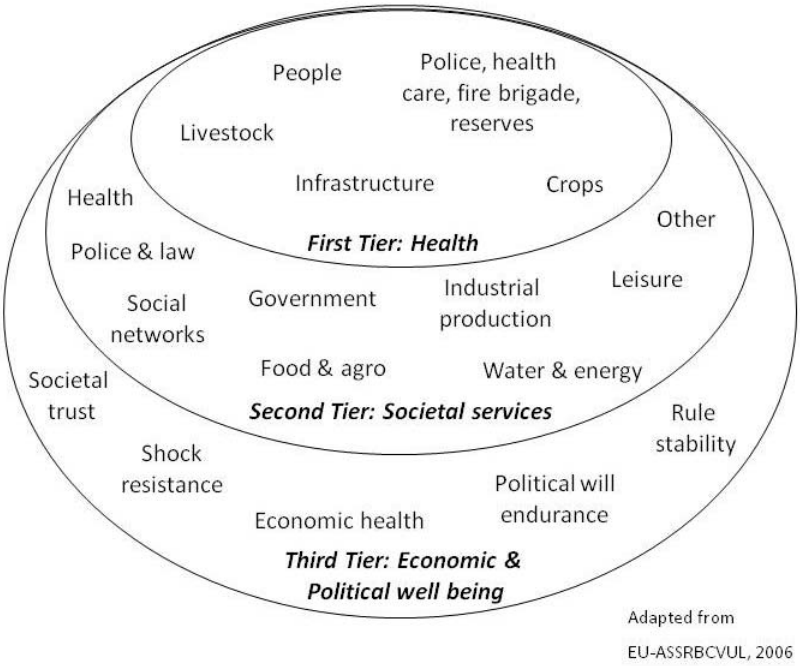

Figure A.3: Risk assessment and management tiers

- *Severity of impacts* – The severity of impacts refer to the "ripple effects" that occur as a result of the major event. These impacts are felt on multiple levels as individuals, families, and communities are affected to varying degrees.

- *Timing of impacts* – The timing of impacts refers to time pressures that result of impacts occurring in close succession. However, at times, delayed impacts can also increase complexity as slow onset emergencies unfold.

- *Involvement of media* – The media may increase situation complexity when amplifying threats and event impacts. The media may also increase complexity by relaying stories with misinformation. The media also acts as an important vector for communicating risks and safety messages, which may reduce the overall complexity level of the situation if delivered effectively. Equally, social media has an impact on the level of complexity as it may be used for the purposes of risk communication or it may be facilitate the rapid sharing of misinformation or rumours among members of the public.

- *Political processes* – Political considerations may add to the complexity of a situation as pressures to gain favour with the public may affect decision-making processes. There are also political considerations at play between and within organizations involved in the event. For example, there may be political pressures to minimize the impacts, or maintain existing power structures.

Factor B – Uncertainty

Uncertainty is the second main factor contributing to the complexity of the situation. There is a positive correlation between uncertainty levels and complexity levels (Alberts & Hayes, 2007;

Moffat, 2003; Rosenau, 1997). For example, the initial complexity level was high in the 2003 Blackout because the cause of the power outage was not immediately apparent. Complexity decreased as more became known about the situation.

A number of sub-elements contribute to the rise and fall of uncertainty, which, in turn, changes the overall level of complexity. These elements include:

- *Novelty of situation* – Novel problems have the potential to be more complex. Conversely, experience with similar events that have occurred in the past can inform re-occurrences, decreasing both uncertainty and complexity.

- *Anticipation and planning* – Planning during the pre-event phase and anticipatory thinking have the potential to reduce the level of uncertainty as well as the complexity level. As organizations become more familiar with existing plans and integrate multi-level, multi-jurisdictional response plans, the strain on the earlier phases of problem-solving (e.g., solution generation) are reduced.

- *Lack of data/information* – Lack of available information is directly linked to uncertainty. Information may not be known, may not be in an accessible format, or may not be shared between organizations. In some cases differing levels of security clearance can contribute to lack of information.

- *New organizations and partners* – New organizations can bring new services, knowledge and resources that may decrease the level of complexity by filling gaps. However, new organizations also increase the number of "unknowns", which can contribute to increased complexity. New organizations will not have had the opportunity to interact with existing organizations and build the relationships and trust that facilitate collaboration.

- *Rapidly changing context* – At times, aspects of a situation can change quickly, affecting the context of a situation. Rapidly occurring interactions between impacts, hazards, populations and response organizations can increase complexity as traditional and non-traditional responders continually need to reassess the situation and redefine the problems faced.

- *Flexibility of interpretive frameworks* – Organizations that operate under rigid interpretive frameworks, or mental models, may be unable to evaluate the situation from multiple perspectives. Lack of "big picture thinking" can increase complexity as organizations define problems based on limiting frameworks (e.g., the erroneous assumption that the public is prone to panic). Analysing the situation from a variety of points of view and perspectives has the potential to decrease the level of uncertainty, and ultimately the level of complexity.

Factor C – Vulnerability

The third factor that contributes to complexity is vulnerability and resiliency. Vulnerability is strongly associated with susceptibility to certain impacts (Lemyre et al., 2009). The concept of vulnerability includes at-risk populations, which may feel impacts more severely. Also included is resilience, as some populations are more resilient to extreme events than others. Moreover, resilience may be found even among those who are also considered at-risk. At an individual level, resilience has been described as "the capacity to rebound from adversity, strengthened and more resourceful…it is an active process of endurance, self-righting and growth in response to crisis and challenge" (Walsh, 2003, p. 4). At a collective level, resilience is defined as: "The ability of community members to take meaningful, deliberate, collective action to remedy the impact of a

problem, including the ability to interpret the environment, intervene, and move on" (Pfefferbaum, Reissman, Pfefferbaum, Klomp, & Gurwitch, 2005).

A number of sub-elements have been linked to vulnerability/resilience. These elements are:

- *Economic development* – Economic development refers to the distribution of wealth, economic resources available, the diversity of activities present in the economy and the overall economic health of the affected region.

- *Social capital* – Social capital consists of important concepts including social support, social embeddedness, organizational linkages and cooperation, citizen participation, sense of community, and attachment to place.

- *Community competence* – Community competency refers to the collective capacity to respond to event impacts, and to recover through community action, critical reflection, flexibility, creativity, collective efficacy, and political partnerships.

- *Information and communication* – Information and communication also play a part in vulnerability and resilience. Responsible media, trusted information sources, communication technology, and communication systems redundancy all contribute to vulnerability/resiliency.

A.3 Problem-solving approach

The second main component of the *Model* is the inter-organizational problem-solving approach. Three problem-solving approaches are used in this *Model*: Coordination, Cooperation and Collaboration. The *Model* assumes that there is no singular "best" approach to inter-organizational problem-solving. Instead, it is more likely that these approaches will be used concurrently or consecutively depending upon the stage of problem-solving and the level of situational complexity. These three approaches should not be considered as strictly trichotomous but as a range of approaches used that involve a cumulative increase in the sharing of the modifying variables of information, resources and power (see *Table A.1* below).

Table A.1: Modifying variables of power, resources and information (adapted from Crosby & Bryson, 2005)

		Problem-Solving Approach		
		Coordination	Cooperation	Collaboration
What is shared?	Power	No	No	Yes
	Activities and Resources	No	Yes	Yes
	Information	Yes	Yes	Yes

Following the literature review undertaken in Task 1 of this project, a set of definitions were adopted to describe coordination, cooperation and collaboration. These definitions can be summarized as follows:

- *Coordination* – Taylor-Powell et al. (1998), define coordination as a process of communication, and the planning and sharing of resources, risk, and rewards for the purposes of efficiency and effectiveness in achieving complementary goals. This approach involves an emphasis on efficiency and on preventing overlapping of resources and services. Activities and decision-making occur within organizational silos in parallel with other organizations. These parallel activities are represented by the vertical groupings of organizations (blocks) below.

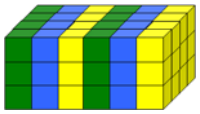

Figure A.4: Representation of coordinated organizations

- *Cooperation* – This approach to problem-solving is conceptualized as a process where parties with similar interests plan together, negotiate roles, and share resources to achieve joint goals, but maintain separate identities (Taylor-Powell et al., 1998). With a cooperative approach to problem-solving, resource and service gaps are filled by additional organizations. Organizations are more interdependent under cooperation, with joint decision-making and joint outcomes a key feature of this approach. This interdependency is represented in the figure below with the horizontal integration of organizations (blocks) and the introduction of new partners to fill resource gaps (red blocks).

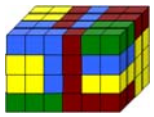

Figure A.5: Representation of cooperating organizations

- *Collaboration* – This approach is defined as a process whereby organizations see different aspects of the problem, identify a common goal, and explore solutions within their differences; as a result, solutions go beyond their individual limited visions of what is possible (Taylor-Powell et al., 1998). The collaborative approach places an emphasis on a shared definition of the problem as well as on the generation of creative solutions. Under this approach, decision-making can be described as "shared" or "networked". In addition to information, activities, resources, power, and authority are all shared. While organizations maintain their unique identities when collaborating, the process may require the organizations to accommodate different visions of the problem using flexible interpretive frameworks. Collaboration is represented below as a bridge that is made up of organizations that support one another, fill in service gaps, and adapt their frameworks (shape) to respond to the complexity of the situation.

Figure A.6: Representation of collaborating organizations

A.4 Time

A major modifying variable used in the *Model of Inter-organizational Problem-Solving* is time. This modifier refers both to the stage of the event from pre-event through impact and recovery, but also to the stage of problem-solving. Different phases in the event timeline and different stages of problem-solving require differing approaches to inter-organizational decision-making.

A.4.1 Problem-solving stages

One of the modifiers that influences the relationship between complexity and inter-organizational relationships is time, including the stage of problem-solving that organizations are engaged in at particular points in time. A generic model of problem-solving was adopted to demonstrate the relationship between complexity, problem-solving approach, and problem-solving stage. The stages are:

1. Problem identification;
2. Problem definition;
3. Solution-generation;
4. Decision-making;
5. Solution implementation; and
6. Monitoring/feedback on success/failure of solutions.

As illustrated in the figure below, the problem-solving process is recursive in that feedback on successes and failures will often lead to the revisiting of problem identification, and at times, additional stages the entire cycle over and over again until the problem is resolved. Problem-solving cycles occur concurrently during an event. Moreover, the problem-solving process can occur within itself, as larger problems are divided into smaller, more manageable steps.

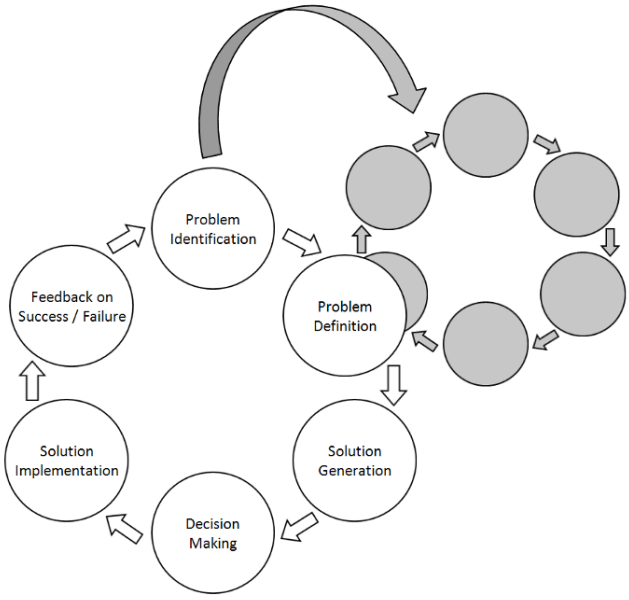

Figure A.7: Generic stages of problem-solving

A.4.2 Stage of event

A key guiding principle in the creation of the *Model* is the use of an extended timeline from pre-event phases to impact and recovery phases. The evolution of a given event can be better understood using this extended timeline (pictured below). Included in this extended event timeline are pre-event phases (preparedness and planning; threat; and warning), the impact phase, and the post-impact phases (rescue; recovery; and reconstruction). These phases are portrayed on a timeline from -3 to +3.

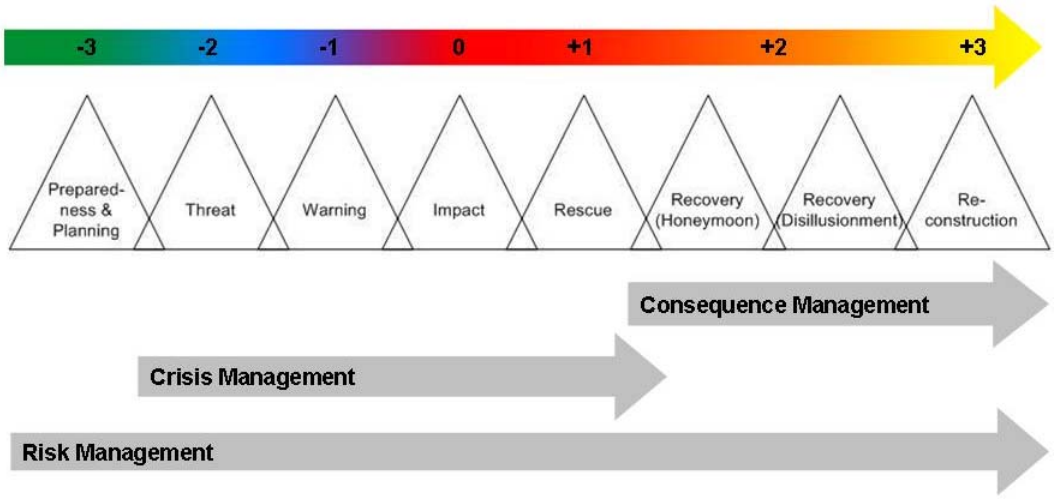

Figure A.8: Extended timeline by time phase

As shown above, approaches to emergency management can encompass the complete event timeline or they may focus on just a subset of these event stages. Of the three approaches

described here (risk management, crisis management, and consequence management), risk management has the widest scope and involves the complete event timeline, including the pre-event phase of preparedness and planning. Under risk management, hazard mitigation is an ongoing process, whereby interventions are continually monitored (Lemyre et al., 2005). Crisis management is concentrated on containment and control of the scene, investigation, preservation of life and harm reduction. These activities are generally completed during the threat, warning, impact and rescue stages. Consequence management, on the other hand, is concerned with righting the damages caused by the incident after its occurrence (Harrold et al., 2004); these tasks are completed during the recovery and reconstruction phases as the public moves through the honeymoon period to disillusionment and, finally, to rebuilding.

Annex B Additional Presentations of Project Results

Listed below are a number of dissemination activities related to project results. Papers presented for items 1 and 2 are provided in Annex B. Abstracts are included for the remaining items.

1. Lemyre, L., Pinsent, C., Johnson, C., Boutette, P., Corneil, W., Riding, J., Lemus*, C., Blust*, S., Riding, D. (2011, June) Developing collaboration in complex events: A model for civil-military inter-organizational problem-solving and decision-making, *16th ICCRTS "Collective C2 in Multinational Civil-Military Operations"*, Quebec, Canada. (Best Paper Award – Stream 2. Approches)

2. Lemus, C., Lemyre, L., Pinsent, C., Boutette, P., Riding, J., Riding, D., Johnson, C., Blust, S,.(2011, July). "*Fuzzy Logic: A Link for Behavioural Computer Simulations of Collaboration in Emergency Management"*. Models and Modeling Methodologies in Science and Engineering, 15th World Multi-Conference on Systemics, Cybernetics and Informatics: WMSCI . Orlando, Florida, July 19-22.

3. Lemus, C., Lemyre, L., Pinsent, C., Boutette, P., Riding, J., Riding, D., Johnson, C., Blust, S,.(2011, July) "*Video Conference Platforms: A Tool to Foster Collaboration During Inter-Organizational in vivo Simulations"*. Collaborative Enterprises Symposium, 15th World Multi-Conference on Systemics, Cybernetics and Informatics: WMSCI Orlando, Florida, July 19-22.

4. Lemus, C.; Lemyre, L.; Pinsent, C.; Boutette, P.; Johnson, C.; Blust, S., Corneil, W. "Risk Communication in Multi Organizational Complex Crisis: Experiences from Key Decision Makers" (2011, December, accepted). *Poster for the Annual Meeting of the Society for Risk Analysis*, Charleston, SC.

5. Blust, S., Lemyre, L. Pinsent, C.; Boutette, P. Johnson, C.; Lemus, C.; Corneil, W. "Inter-Organizational Problem Solving in Emergency Management: Coordination and Collaboration" (2011, December, accepted). *Presentation for the Annual Meeting of the Society for Risk Analysis*, Charleston, SC.

6. Lemus, C., Blust, S, Lemyre, L., Pinsent, C., Boutette, P., Corneil, W., Riding, J., Riding, D., Johnson, C., Markon*, M.-P.L., Gibson*, S.,.Kitchener, H.M., Dennie-Filion, E. & Simpkins, L. (2010, November) "*Résilience Inter – Organisationnelle: Analyse différentielle de la coordination, coopération et collaboration"*. Entretiens Jacques Cartier (2010) Grenoble, France, November 22nd

1. Lemyre, L., Pinsent, C., Johnson, C., Boutette, P., Corneil, W., Riding, J., Lemus*, C., Blust*, S., Riding, D. (2011, June, accepted) Developing collaboration in complex events: A model for civil-military inter-organizational problem-solving and decision-making, *16th ICCRTS "Collective C2 in Multinational Civil-Military Operations"*, Quebec, Canada.

Please refer to the next page.

16th ICCRTS

"Collective C2 in Multinational Civil-Military Operations"

Developing collaboration in complex events: A model for civil-military inter-organizational problem-solving and decision-making

Topic 2, 5, 9

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With the financial support of DRDC-CORA TIF Initiatives, SSHRC and The R.S. McLaughlin Foundation.

Abstract

Stewardship of complex extreme events requires effective civil-military collaboration. This paper examines the organizational roles and pre-conditions for this collaboration. Firstly, a review of the relevant interdisciplinary literatures identifies various models of problem-solving and decision-making across the range of organizations involved in major events. Secondly, findings from a series of Canadian and international extreme events involving civil-military interaction are examined to identify situational characteristics and features of inter-organizational relationships across an extended event timeline. Finally, a framework for understanding inter-organizational problem-solving and decision-making is presented. Two interrelated components drive the process: situational complexity and approach to problem-solving. The relationship between these components is modified according to problem-solving stage, and various assets such as power, resources and information. Three elements identified as contributing to situational complexity include impact, uncertainty and vulnerability. These elements interact to determine whether the situation is categorized as simple, complicated or complex. Problem-solving is characterized in time as a recursive six-stage process including problem identification, problem definition, solution generation, decision-making, solution implementation and feedback. Three main approaches to inter-organizational problem-solving are described as coordination, cooperation and collaboration. Methods involving the development of an experimental environment for *in vivo* simulation to test the inter-organizational problem-solving model are described.

Keywords: collaboration; coordination; cooperation; military; inter-organizational; decision-making; complexity

Introduction

Large scale emergencies often present a multitude of challenges that are complex and difficult to solve not only due to high levels of uncertainty but also, in part, because of the demands presented by inter-organizational decision-making. A review of the literatures revealed that reports on lessons learned following disasters frequently call for collaborative behaviour between organizations. However, there is a gap in the literature in terms of understanding collaborative behaviour in the context of situational complexity. This paper aims to address this gap through the development of a model of inter-organizational problem-solving spanning the complete event timeline with applications to pre-event, impact and recovery phases of extreme events. The evidence base for the model consists of two independent lines of investigation: a) an extensive review of relevant literatures from multiple disciplines and b) a series of cases studies of Canadian and international events. The intention of this line of research is to shed light on the relationship between complexity and collaboration in addressing complex problems by examining the situational complexity of extreme events, and in particular events involving civil-military collaboration.

The inter-organizational problem-solving model presented in this paper was developed in response to the defined need to better understand collaborative behaviour between different types of organizations engaged in extreme events, such as the Canadian Forces and partnering agencies. A more thorough understanding of the factors contributing to collaborative inter-organizational relationships and collective decision-making processes will assist participating organizations in overcoming social and cognitive barriers to collaboration (Chouinard, 2009, p.2). Given the wide adoption of principles and structures associated with the Incident Command System (ICS) in emergency management, it was critical that the problem-solving model be compatible with existing ICS structures and processes.

Methods

The two main methods implemented to develop the model were a targeted review of relevant literatures of both peer-reviewed and grey literature from a diverse array of disciplines, and case studies of decision-making and problem-solving during recent Canadian and international complex events.

Literature Review – Relevant literature was initially identified using key word searches in electronic citation databases from various disciplines. From this interdisciplinary base, relevant articles and reports were identified and further reviewed according to topics of investigation (e.g., decision-making, problem-solving, collaboration), and organizational type and structure (e.g., meta-organization, ICS). Overall, 198 articles and reports were selected for in-depth review.

Case Studies of Extreme Events – Six Canadian case studies were selected from our compiled list of 63 extreme events that had occurred in Canada ranging from small events to large scale disasters. The research team outlined *a priori* criteria to be considered during the case selection process including timeframe, multi-jurisdictional and multi-level involvement, impacts, involvement of multiple responders, and availability of literature and documents. International case studies were used for comparative purposes, matching on similar timeframes to the Canadian case studies; multiple populations impacted; and the involvement of multiple responder organizations. In addition, consideration was given to cases that included an aspect of success in key aspects of the response. By seeking out key successes, the research team was able to learn not only the challenges facing inter-organizational relationships in disaster response but also the factors that might lead to a more effective response and management. The cases were analysed

systematically using a grid that outlined the key analytic dimensions, crossing them with the timeline of the event. The analytic dimensions used to understand key decisions and problem-solving processes were: organizations involved with the decision; content and outcome of the decision; timing of the decision in relation to the event timeline; location where the decision was being made; and the approach used to make the decision (e.g., unilaterally, coordinated, cooperatively, collaboratively). These various decisions were then positioned within the event timeline of pre-event (planning and preparedness, threat, warning), during the event (impact), and post-event (rescue, recovery, reconstruction). Additionally, observations were made on the outcomes or impacts of the decisions, and the complexity of the event at that particular stage.

Considerations in Model Development

The model of inter-organizational problem-solving was developed based on the findings from the literature review and case studies. In addition, the research team was guided by the following considerations:

1. *Use of an extended timeline* – The model was conceptualized within a risk management paradigm in which extreme events are understood on an extended timeline, from the pre-event phases, to the more acute stages of crisis management, and finally to the recovery and reconstruction phases where the focus is on consequence management. Under this paradigm, hazard mitigation is a constant process whereby the monitoring of interventions is ongoing (Lemyre et al., 2005). A central tenant of the approach assumes that it is important to situate any event within an extended timeline to accurately understand how events evolve into complex situations, along with how organizations work together within these events, and especially so in the early phases when uncertainty is maximum and even before occurrence at time of threat or warning.

2. *No one approach is "best"* – Complex situations require diverse approaches – no single problem-solving approach is best. Organizations must engage and consider multiple perspectives in understanding and defining problems. Moreover, these approaches may combine, unroll in parallel, and interact in a recursive fashion.

3. *Decision-making is only <u>one</u> stage in problem-solving* – Decision-making is just one stage within the overall problem-solving process. Other stages include identifying the problem, defining the problem, generating solutions, decision-making, implementing solutions, and monitoring implementation.

4. *Multi-disciplinary approach is appropriate* – A multidisciplinary approach, which integrates findings from diverse disciplines and fields of practice will lead to a more robust and relevant model of inter-organizational problem-solving.

Findings from Literature Review

The purpose of the review was to gain a broad understanding of the various types of organizational structures potentially involved with problem-solving during complex events, decision-making strategies used by different organizational structures, and key organizational characteristics such as types of authority, interaction and roles. Organizational context is central to the way that organizations make decisions both within organizations and between them (Cray et al., 1988; Nutt, 1976). Decision-making and organizational context mutually influence one another and co-evolve within organizations (Gaudine & Thorne, 2001). Consequently, it was

necessary to examine the context of a number of special types of organizations. The literatures covered by the review included: risk, crisis and consequence management; individual and organizational decision-making; Incident Command Systems (ICS); meta-organizational decision-making; decision-making in a public administration context; approaches to decision-making in inter-jurisdictional partnerships; the public policy consultation model; approaches to decision-making in a community development model; private sector organizations; high reliability organizations (HRO model); learning organizations; and the role of technology in collaborative decision-making. The review of the literature also identified the benefits and challenges of organizational structures within an inter-organizational problem-solving context with similar and dissimilar organizations.

The review found that decision-making strategies varied considerably from one type of organization to another. For example, while a strong hierarchical approach was found to be appropriate within the context of ICS-based organizations, hierarchy is weakened in the context of a meta-organization (or organization comprised of other smaller organizations as members) because of the meta-organization's dependence on its members for survival and its lack of central authority structure (Ahrne & Brunsson, 2005; Ahrne & Brunsson, 2008; Brunsson & Jacobson, 2000). The main findings from the literature review are presented in Table 1 which includes a breakdown of the key organizational types and structures, problem-solving and decision-making characteristics, distribution of authority, interaction and role patterns, and associated sectors.

Table 1 Overview of organizational types

Organizational Type	Organizational structure	Problem-solving & Decision-making	Authority	Interaction / Roles	Sector
Incident Command System (e.g., emergency management organizations, National Incident Management System (NIMS))	-Top-down -Expands and contracts according severity of situation	-Hierarchical -Based on guidelines and on the scene information	Hierarchical	-Defined roles	-Government -Military
Meta-organizations (e.g., United Nations (UN), World Trade Organization (WTO), European Union (EU))	-Organization of organizations -Membership orgs. of the same type or of the same field	-Consensus building -Deferral to experts	Shared	-Shared vision -Strengthened by similarities	-Government -Military -Business -Healthcare -Non-governmental organizations
High Reliability Organizations (HRO)'s (e.g., air traffic control, chemical processing plants, space programs, nuclear power plants, hospitals)	-Centralized knowledge and goals -Decentralized tasks and responsibilities	-Distributed	Hierarchical	-Decentralized -Organic network	-Government -Military -Business -Healthcare
Community Development Partnerships (e.g., Needs based issues such as: health, housing, neighbourhood safety)	-Issue focus -For the community, with the community -Partnered with researchers, granting agencies, etc.	-Bottom-up -Community consultation	Shared	-Diverse, fluid membership -Community empowerment	-Government -Healthcare -Non-governmental organizations
Private Sector (e.g., sole proprietorships, multi-national corporations, publicly-traded corporations)	-Variable	-Hierarchical -Analytic -Speculative	Hierarchical	-Profit driven	-Business
Public Sector (e.g., crown corporations, Federal, provincial/territorial, municipal department and agencies)	-Top-down	-Hierarchical -Public consultation -Networking	Hierarchical	-Equality -Impartiality -Rationality	-Government

Findings from the Canadian and International Case Studies

The case studies focused on inter-organizational problem-solving and decision-making processes associated with six recent extreme events in Canada, and three international events. Based on the selection criteria, the Canadian cases selected include: the Eastern Canada ice storm (1998), the Red River flood (1997), SARS (2003), the Kelowna fires (2003), Gander, Operation sleepover (2001), and the Blackout (2003). The criteria for selection of these case studies are summarized in Table 2. The international cases included: Hurricane Katrina (2005), the London transit bombings (2005), and the Indian response to the Tsunami (2004).

Table 2 Canadian and International Case Studies

Event	Timeframe	CF Involvement	Multi-jurisdictional	Multi-level	Multiple populations impacted	Multiple responder organizations
Ice Storm	1998	✓	✓	✓	✓	✓
Red River Floods	1997	✓	✓	✓	✓	✓
Kelowna Fires	2003	✓	✓	✓	✓	✓
SARS	2003		✓	✓	✓	✓
Operation Sleepover	2001	✓	✓	✓	✓	✓
Blackout	2003		✓	✓	✓	✓
Hurricane Katrina	2005		✓	✓	✓	✓
London Transit Bombings	2005		✓	✓	✓	✓
Indian Tsunami	2004		✓	✓	✓	✓

These cases, in total, provide some insights into different approaches to planning for and responding to an extreme event, and illustrate a variety of inter-organizational problem-solving approaches. A number of observations were derived from the various details and descriptions outlined in the case study analytic grids. These are described in general terms below in Table 3.

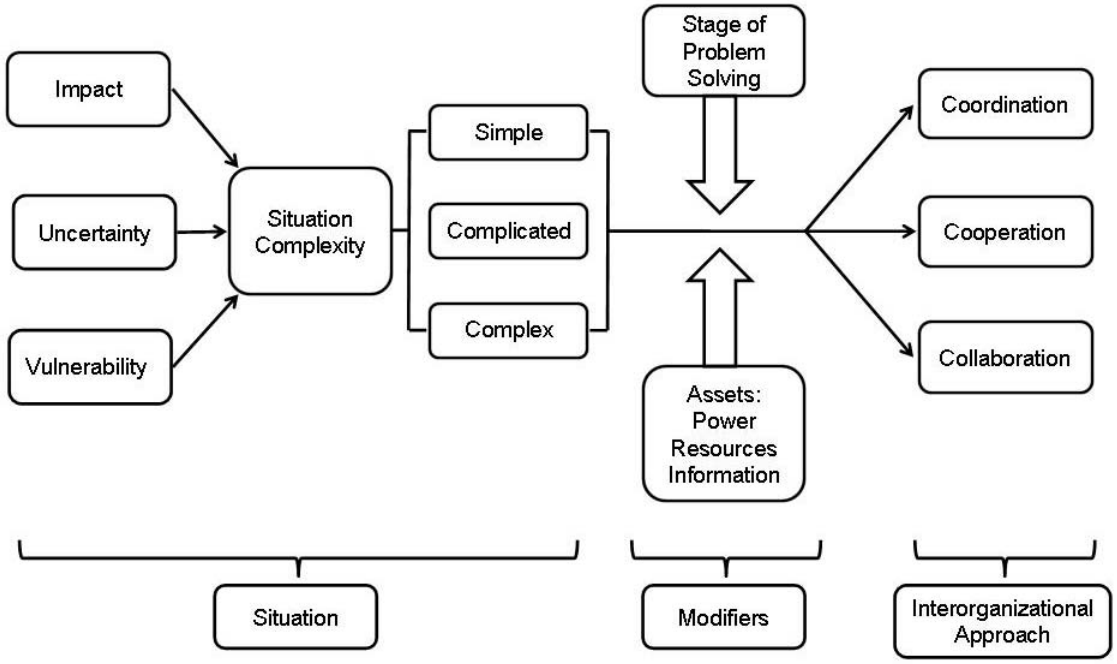
Table 3 Summary of Case Study Findings

Event	Key Findings
Ice Storm	• Communication difficulties contribute significantly to the complexity of a situation, particularly when communication methods are not pre-tested and rehearsed in training exercises
Red River Floods	• The absence of coordination and transparency between municipalities can inhibit effective decision-making in the impact and rescue phase; sharing emergency plans pre-event is essential • Integrating lessons learned post-event into emergency plans may result in a more agile response in the future
Kelowna Fires	• Establishing clear jurisdictional boundaries and corresponding roles and responsibility in the pre-event phase can decrease the level of complexity during the event • The inter-organizational adoption of a homogenous emergency preparedness and management plan in the pre-event phase facilitates problem-solving • Transparent communication with the public can improve public trust, reducing anxiety levels and uncertainty
SARS	• Emergency plans and emergency infrastructure must be in place during the pre-event phase • A lack of inter-organizational communication during the event can increase the level of uncertainty and amplify complexity
Operation Sleepover	• Established inter-organizational networks notably diminish the complexity of the situation during the event phase • Decision-making both during the event and post-event can be facilitated by developing flexible preparedness and response plans as well as training programs in the pre-event phase
Blackout	• A lack of communication between organizations as well as between officials and the public increases both uncertainty and complexity
Hurricane Katrina	• Decision-making benefits from local knowledge and partnerships created during the pre-event stage with businesses and volunteer organizations when frontline members are given the authority to indentify how to best proceed with on-the-ground work • Lack of planning and anticipation of needs can contribute significantly to complexity • Private sector companies operating independently but working within pre-existing networks can contribute significantly to lessening the impacts of an extreme event
London Transit Bombings	• The provision of accurate, timely information to a wide-range of organizations and individuals contributes to decreasing the overall complexity of an event • Joint exercises involving multiple agencies provide the opportunity for multiple agencies to practice working together, contributing to a more effective, coordinated response
Indian Tsunami	• Post-event recovery and reconstruction periods allow opportunities for different types of organizations to cooperate and collaborate, building resilience • Informal networks involving local organizations within villages can provide significant, timely information for the population to prepare for an extreme event
Multiple Events	• Emergency planning can suffer from the recency effect bias, limiting planning to the mitigation of events similar in severity and scope to events that have previously occurred

Model of Inter-organizational Problem-Solving

Based on the findings from the literature review and case studies, a model of inter-organizational problem-solving was developed that consists of two main components: 1) situational complexity; and 2) inter-organizational approach to problem-solving. As illustrated in Figure 1, the relationship between these two components is modified by the specific stage of problem-solving involved, and the various assets available such as power, resources, and information.

Figure 1: Model of inter-organizational problem-solving

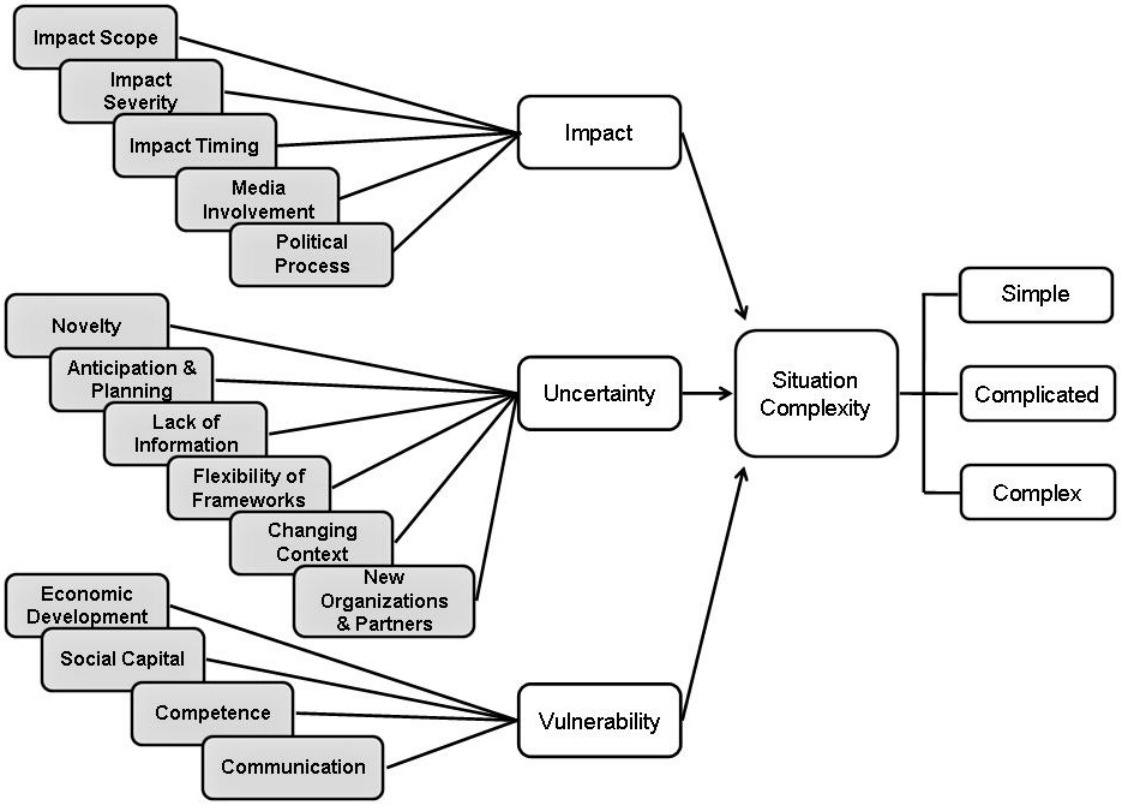


Model Component: Situation

Situational complexity can be broken down into three main factors: the impact of the event, including actual, perceived and potential impacts; the uncertainty of the situation; and the vulnerability, or conversely, the resiliency of those who may be impacted, which includes the organizations themselves. As illustrated in Figure 2, these three factors combined determine the overall complexity of the situation. Each factor is composed of multiple elements of varying magnitudes that contribute to the factor, and ultimately to the complexity of the situation. Even though they are graphically depicted in the diagram in a linear fashion, each element could potentially either contribute to or detract from the complexity of the situation. Rather than independent and unidirectional, the element should be conceptualized as dynamic, changing frequently depending on the interplay of the multiple elements and factors present in the situation. Additionally, it is important to note that within overall situation complexity there are smaller "kernels" that may be simple, complicated and complex. For example, while a situation may be assessed as predominantly simple, it is likely to also have some complicated and complex aspects, however small. Similarly, even the most complex situations are likely to have some aspects that

are relatively simple. Aspects of these three factors as they relate to complexity have been highlighted in diverse fields such as determinants of stress levels in individuals (Lemyre & Tessier, 1988; Lemyre & Tessier, 2003), challenges in managerial decision-making and leadership (Youssef & Luthans, 2005), military strategy (Albert & Hayes, 2007; Pfeifer, 2005), environmental and ecological systems (Adger, 2000; Folke, 2006; Gallopin, 2006), community development (Paton & Johnston, 2006), and risk perception (Lee & Lemyre, 2009; Lee, Dallaire & Lemyre, 2009; Lemyre et al., 2009b).

Figure 2 Three factors contributing to situation complexity



As illustrated in Figure 2, there are a number of elements within each factor (depicted by vectors in the diagram) that contribute to the factor's overall impact on the complexity of the situation. While some elements contribute to the complexity of the situation, others detract from the complexity. This represents the dynamic nature of the interplay of these elements, and the potential speed at which the complexity of a situation can change.

Situation Complexity – Event Impacts

More than just the actual impacts of the events, this factor also refers to potential impacts as well as perceived impacts. Often the potential impacts can contribute as much to the complexity of a situation as the actual impacts (Lemyre et al., 2005). Similarly, perceptions of impacts can also contribute significantly to the complexity of the situation (Ibitayoa, Mushkatelb, & Pijawkac, 2004). For example, in the case of SARS, much of the complexity of the situation was due to the public's perception of impacts, rather than the actual impacts that had occurred directly from the disease. Each type of impact (actual, potential, and perceived) is important in determining the extent to which impacts are contributing to the complexity of the problem.

Some key elements that contribute to the impact factor are:

1. *Scope of impacts* – The scope of impacts can be defined according to various levels or tiers. First tier impacts are generally defined as direct effects sustained by the event itself: the direct damage. Second tier impacts are those that impact on essential societal functions, services and utilities such as food and water delivery, shelter, primary healthcare, electrical power. Critical infrastructure and vital functions may be interrupted. Finally, third tier impacts are those that are generally measured in political and longer-term economic costs associated with an event: social order and trust in institutions.

2. *Severity of impacts* – The severity of impacts is related somewhat to the scope. The severity of impacts are measured in part by the "ripple effect" that occurs as a result of the major event. The ripple effect can be quite extensive, impacting individuals, families, organizations, communities and society in a variety of ways. As the severity of the impacts increase or decrease, so will the level of complexity of the situation.

3. *Timing of impacts* – The time parameters involved often increase the complexity of the situation. Given the urgency of responding in many of these events, there are often considerable time pressures adding to the perceived complexity of issues and decisions.

4. *Involvement of media* – The media can add to the complexity of the situation, often by amplifying the perception of risk or perceived impacts, by creating greater confusion, misinforming, and by contributing to some organizations' decision to not openly communicate information about the event or actual risks associated with the event.

5. *Political processes* – If there are political considerations at play between and within organizations involved in the event, then this may contribute to additional complexity. For example, there may be competition between organizations, or political pressures to minimize the impacts, to maintain existing power structures, or to showcase more control of the situation than there actually is.

Situation Complexity - Uncertainty

The second factor identified as contributing to the complexity of the situation is uncertainty. As the level of uncertainty rises, so does situation complexity (Alberts & Hayes, 2007; Moffat, 2003; Rosenau, 1997). Conversely, as more becomes known about a situation, and useful information becomes available, the complexity of the situation decreases. There are a number of key elements that contribute to the uncertainty factor by either increasing or decreasing the overall complexity of the situation. These elements are:

1. *Novelty of situation* – If a situation is new, then it has the potential to be more complex. Experience with similar situations that have occurred in the past can decrease uncertainty.

2. *Anticipation and planning* – In most situations, it is likely that anticipation and planning will decrease the level of uncertainty. This will in turn decrease the potential complexity of situations.

3. *Lack of data/information* – Directly linked to uncertainty is the availability of data or information. Availability hinges on information sharing between and within groups and organization. An absence of accurate information or data overload is also likely to increase

complexity. The availability of feedback information is also important in determining whether or not interventions or actions are effective.

4. *New organizations and partners* – The presence of new organizations and partners in multi-organizational response can impact the number of "unknowns" and thus the uncertainty factor (both positively and negatively). There is likely to be a certain level of uncertainty that results with the inclusion of new organizations with respect to the coordination of tasks and areas of responsibility. In other cases, the presence of new organizations may decrease the level of uncertainty and complexity of a situation by providing new services, and contributing new knowledge and experience about the situation.

5. *Rapidly changing context* – There are certain aspects of a situation that can change quite quickly, contributing to a rapid change in the overall context of the situation. The interactions between hazards, populations, and organizations involved, and impacts can produce a quickly evolving, changing context for the situation that creates uncertainty and contributes to complexity.

6. *Flexibility of interpretive frameworks* – The frameworks used to identify and understand the situation may have an impact on complexity. Looking at the situation with an inflexible framework may limit the understanding of events as multiple perspectives are not explored. Thus a rigid framework may lead to increased uncertainty, while an exploration of the situation from multiple perspectives may decrease uncertainty, thereby decreasing the level of complexity as well.

Situation Complexity – Vulnerability (Resilience)

The third factor that has been identified as contributing to situational complexity is vulnerability. There is a growing literature on vulnerability and resiliency in various domains, often with each concept being positioned as the converse of the other (e.g., Smith, Smoll, & Ptacek, 1990). For the purposes of this framework, it is assumed that people or groups that are high in resiliency can be considered less vulnerable. Conversely, those who are more vulnerable likely have lower resiliency to the impacts of the situation. *Vulnerability* is strongly associated with susceptibility to certain impacts (Lemyre et al., 2009a). Originally presented as an individual characteristic within the child development literature (Masten, Best, & Garmezy, 1990), and as a characteristic of ecological systems (Holling, 1973) the concept of resiliency has more recently been applied in a broader context to various collectives such as organizations (Hind, Frost & Rowley, 1996), communities (Norris, Stevens, Pfefferbaum, Wyche & Pfefferbaum, 2008; Red Cross, 2004), and societies (Paton & Johnston, 2006). At an individual level, resilience has been defined as "the capacity to rebound from adversity, strengthened and more resourceful…it is an active process of endurance, self-righting and growth in response to crisis and challenge" (Walsh, 2003, p. 4). At a collective level, resilience has been defined as: "The ability of community members to take meaningful, deliberate, collective action to remedy the impact of a problem, including the ability to interpret the environment, intervene, and move on" (Pfefferbaum, Reissman, Pfefferbaum, Klomp, & Gurwitch, 2005).

The elements that can modify levels of the vulnerability or resiliency of those who are likely to be impacted by an event are numerous (Norris et al., 2008). Some of the key elements that would modify levels of resiliency, and thus contribute to the complexity of the situation include:

1. *Economic development* – Economic development can include elements such as equity of resource distribution among organizations and individuals within the area being impacted by the event, as well as the actual level and diversity of economic resources available.

2. *Social capital* – Social capital consists of many different elements including social support, social embeddedness, organizational linkages and cooperation, citizen participation, sense of community, and attachment to place.

3. *Community competence* – Community competency refers to the collective capacity to undertake various activities such as community action, critical reflection and problem-solving skills, flexibility and creativity, collective efficacy, and political partnerships.

4. *Information and communication* – Key to the concept of vulnerability is information and communication, characterized often as available narratives, responsible media, skills and infrastructure, and availability of trusted sources of information.

Model Component: Inter-organizational Approach to Problem-Solving

The other main component of the model is the type of inter-organizational approach used to problem-solve. For the purposes of the model, three overall approaches to problem-solving were identified: Coordination, Cooperation and Collaboration. Keeping with the assumption outlined previously that there is no "best" approach to inter-organizational problem-solving, the model assumes that aspects of all three approaches will likely be used during the problem-solving process either concurrently or consecutively, depending on the problem requirements. To describe these approaches to problem-solving as strictly trichotomous would be an oversimplification of the problem-solving process.

Given the wide diversity of fields in which the concepts of coordination, cooperation and collaboration are used, definitions and conceptualizations are numerous. For the purposes of the current model, a set of definitions commonly used in community planning have been adapted. This set of definitions emphasizes the unique characteristics of each approach, and has previously been used to evaluate the collaborative nature of various inter-organizational structures (Taylor-Powell, Rossing & Geran, 1998).

Coordination can be defined as a process of communication, planning and sharing of resources, risk and rewards for the purposes of efficiency and effectiveness in achieving the complementary goals of the parties involved (Taylor-Powell et al., 1998). With coordination, there is an emphasis on ensuring that use of similar resources does not overlap, and that resources are used efficiently. With this approach information is shared and organizations are likely to be relatively independent, with each organization engaging in independent decision-making. Moreover, activities occur within organizational silos in parallel with other organizations. Coordination is effective once a plan of action has been determined.

Cooperation is conceptualized as a process where parties with similar interests plan together, negotiate mutual roles, and share resources to achieve joint goals, but maintain separate identities (Taylor-Powell et al., 1998). Cooperation involves not only coordinating existing resources, but also ensuring that additional organizations are brought in to fill resource gaps. With cooperation, information is shared along with activities and resources. Organizations are likely to be more interdependent in some key stages of the problem-solving process (particularly around the problem definition stage and solution implementation stage, with more joint decision-making occurring). A key feature is the sharing of resources in view of a joint outcome.

Collaboration is defined as a process through which parties who see different aspects of the problem can constructively identify a common goal and explore within their differences how to implement solutions that go beyond their own limited vision of what is possible (Taylor-Powell et al., 1998). Collaboration emphasizes the ability to develop a conceptualization or definition of the problem as well as to develop innovative solutions. Decision-making can be characterized as "shared" or 'networked''. In addition to information, activities, resources, power and authority are also shared. As well, the organizations, while maintaining their individual organizational identity, in collaborating with one another may be required to alter their approach to accommodate different visions. By working together, organizations may become slightly transformed through such compromises (Taylor-Powell & Rossing, 2009).

Model Component: Modifier – Stage of Problem-solving

As the model indicates a variable that will modify the relationship between situation complexity and inter-organizational approaches to problem-solving is the particular stage of problem-solving in which organizations are engaged at various points in time. As illustrated in Figure 3, the generic logical stages in problem-solving[4] can be characterized in a manner similar to the following six recursive steps: 1) problem identification; 2) problem definition; 3) solution generation; 4) decision-making; 5) solution implementation; and 6) monitoring/feedback on success/failure of solutions. The process is recursive to the extent that the monitoring and feedback on success or failure of solutions will lead problem-solvers to often revisit problem identification, and if necessary, continue through the stage until resolution is achieved.

[4] It is noted that this is the "normative" approach to understanding problem-solving. In many instances, this does not accurately reflect how decision-making is carried out; however, it is often viewed as the desired approach, and what decision analysis strives to replicate in determining how best to assist people and organizations make "good" decisions.

2. Lemus, C., Lemyre, L., Pinsent, C., Boutette, P., Riding, J., Riding, D., Johnson, C., Blust, S,. "*Fuzzy Logic: A Link for Behavioural Computer Simulations of Collaboration in Emergency Management"*. Models and Modeling Methodologies in Science and Engineering, 15th World Multi-Conference on Systemics, Cybernetics and Informatics: WMSCI (2011). Orlando, Florida, July 19-22.

Please refer to the next page.

Fuzzy logic: A link for behavioural computer simulations of collaboration in emergency management

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ABSTRACT

Emergencies are events that vary in complexity and dynamically shift along different phases of evolution, requiring different types of participants. Emergency management is an interdisciplinary field that involves multiple organizations holding different mandates and structural chains of command. This poses a challenge for collaboration in the way strategic problems are solved at each stage of the emergency, given that they may not follow the traditional normative linear patterns of decision making. To address this query, this work explores the application of fuzzy logic to characterize the problem solving approach used – coordination, cooperation, or collaboration -, with the level of complexity of the emergency and the type of inter-organizational interaction. Of special interest here is the capacity offered by fuzzy logic to operationalize experiences and perceptions of expert emergency managers. Fuzzy logic provides the framework to model these elements under flexible patterns of interaction. In addition, fuzzy logic allows connecting diverse epistemological fields such as behavioural cognitive psychology and management, and linking them to computer sciences and systems engineering. Hence, the results from **t**his paper presents fuzzy logic from a modeling perspective that aims to contribute to achieve an efficient inter organizational emergency management response along the different phases of the crisis, by rendering fuzzy logic models of inter organizational coordination, cooperation and collaboration, which can then be applied to develop behavioural computer simulations. The expected contribution of this document is to facilitate the interaction within and across diverse fields of study involved in emergency management, by translating and interpreting their individual contributions into fuzzy logic models that can inform and complement the interdisciplinary effort.

Keywords: Fuzzy logic, Emergency Management, Collaboration, simulation, multi-organizational problem solving, model, complexity.

With financial support of DRDC (Canada), NSERC (Canada) and CONACYT (Mexico)

3. Lemus, C., Lemyre, L., Pinsent, C., Boutette, P., Riding, J., Riding, D., Johnson, C., Blust, S., "*Video Conference Platforms: A Tool to Foster Collaboration During Inter-Organizational in vivo Simulations"*. Collaborative Enterprises Symposium, 15th World Multi-Conference on Systemics, Cybernetics and Informatics: WMSCI (2011) Orlando, Florida, July 19-22.

Please refer to next page.

Video conference platforms: A tool to foster collaboration during inter-organizational *in vivo* simulations

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ABSTRACT

Inter organizational decision making and problem solving of emergencies and extreme events are complex research fields where scarce experimental data is available. To address this problem, Lemyre et al (2010) developed the *Inter-GAP In Vivo System*, a HYDRA like simulation system (Alison & Crego, 2008) to run behavioural experiments of complex crisis. The system design and testing included three different categories of participants: for pilot testing, first year university students; for theoretical validity, college students engaged in emergency management programs; and for field validity, expert decision makers who had managed major crises in their career. A comparative assessment was performed to select the most suitable video conferencing software commercially available since in terms of costs it was more efficient to acquire a tool already developed and customized it to the experiment needs than it was to design a new one. Software features analyzed were: ease of use, recording and chat capabilities, format delivery options and security. The *Inter-GAP In Vivo System* setup was implemented on the video conference platform selected (Nefsis™). The overall system performance was evaluated at three different levels: technical setup, task design and work flow processes. The actual experimentation showed that the conferencing software is a versatile tool to enhance collaboration between stakeholders from different organizations due to the audiovisual contact participants can establish where non verbal cues can be interchanged along the negotiation processes. Potential future system applications include: collaborative and cross – functional training between organizations.

Keywords: Collaboration, simulation, video conference, inter-organizational problem solving.

With financial support of DRDC (Canada), NSERC (Canada) and CONACYT (Mexico)

4. Lemus, C.; Lemyre, L.; Pinsent, C.; Boutette, P.; Johnson, C.; Blust, S., Corneil, W. "Risk Communication in Multi Organizational Complex Crisis: Experiences from Key Decision Makers" (2011, December, accepted). *Poster for the Annual Meeting of the Society for Risk Analysis*, Charleston, SC.

Abstract

Risk Communication in Multi Organizational Complex Crisis: Experiences from Key Decision Makers

Crisis risk communication is one core element of response and mitigation efforts of complex multi organizational crisis and extreme events. During these incidents the levels of uncertainty, complexity and risks increase, and so do the challenges entailed in conveying the multiple stakes implicated throughout the risk decision making development. Given that the levels of risk and uncertainty cannot be avoided, the objective of this work is to bring forth facilitators for inter organizational communication during crisis to overcome the many fold barriers found in these complex events. Ten interviews were run with senior decision makers from organizations governed by dissimilar command structures, who have managed complex events and crises such as H1N1, SARS, the G8-G20 summits, and the 2003 Blackout. The interview guide design was based on a modified version of the critical decision method, under a semi-structured format. Relational and phenomenological analyses were used to elicit trends and patterns from the interviews' verbatim transcripts with the use of the NVivo software. Results indicate that communication is one of the main challenges to overcome during emergencies, should information pieces be missing, the process of strategic risk decision making could potentially be blocked. Therefore, in the experience of the interviewees, information sharing plays a major role in the negotiation needed for the risk decision making process. On the other hand, patterns elicited, showed a positive relationship between organizational resources shared and communication levels, similar patterns were found in the interaction between power and authority with inter-organizational communication. The expected contribution of this work is to provide knowledge tools to enhance organizational capabilities that allow efficient risk communication between organizations from dissimilar governance and command structures, during complex extreme events.

With financial support of DRDC, NSERC and CONACYT.

5. Blust, S., Lemyre, L. Pinsent, C.; Boutette, P. Johnson, C.; Lemus, C.; Corneil, W. “Inter-Organizational Problem Solving in Emergency Management: Coordination and Collaboration” (2011, December, accepted). Presentation for the Annual Meeting of the Society for Risk Analysis, Charleston, SC.

Abstract

Inter-Organizational Problem Solving in Emergency Management: Coordination and Collaboration

Effective emergency management often requires inter-organizational problem solving. Unfortunately, despite managers and planners’ best efforts, optimal problem solving is not always achieved within multi-organizational environments. What hinders and facilitates optimal inter-organizational problem solving? Based on a complex emergency event scenario requiring responses from multiple organizations, an experiment with a sample of 33 junior-level emergency response professionals was performed to determine the potential impact of problem-solving approach on various decision processes and outcomes. Differences in participants’ satisfaction in the quality of the outcome were analyzed by inter-organizational problem solving approach (coordination vs. collaboration) and by level of self-reported frustration working with other groups. Based on analysis of variance, findings demonstrated that both problem solving approach and level of frustration had an impact on satisfaction with problem solving outcome. Collaboration and frustration levels both had a negative impact on the satisfaction with the quality of the decision outcome. Main effects were further explored with respect to interactions and other variables such as leadership. These findings suggest implications for inter-organizational decision making in risk management.

With the financial support of DRDC, SSHRC, NSERC and the McLaughlin Research Chair on Psychosocial Risk

6. Lemus, C., Blust, S, Lemyre, L., Pinsent, C., Boutette, P., Corneil, W., Riding, J., Riding, D., Johnson, C., Markon*, M.-P.L., Gibson*, S.,.Kitchener, H.M., Dennie-Filion, E. & Simpkins, L. *"Résilience Inter – Organisationnelle: Analyse différentielle de la coordination, coopération et collaboration"*. Entretiens Jacques Cartier (2010) Grenoble, France, November 22nd

Abstract

Résilience Inter – Organisationnelle: Analyse différentielle de la coordination, coopération et collaboration

When critically important decisions need to be made in risk management, it is rare to find one individual or one organization in control of it all; rather, important decisions often require multi-organizational coordination, cooperation, or collaboration. Unfortunately, despite disaster managers and planners' best efforts, the optimal approach is not always used. What facilitates and hinders the optimal inter-organizational problem solving approach? The Gap Santé Lab at the University of Ottawa addresses this question in their Shared Decision making model. This model reflects a thorough literature review and a series of Canadian and International emergency case studies. The model will be tested through an in-vivo experimental design using emergency managers and actors as participants. In addition, the presenters' will focus on two streams which concern their thesis topics: system modeling and the role of mental models.

With the financial support of DRDC, SSHRC and the McLaughlin Research Chair on Psychosocial Risk

Abstract

Résilience inter-organisationnelle: analyse différentielle de la coordination, coopération, et collaboration

Dans la gestion de risque, de crise ou de désastre, il est rare de trouver un seul individu ou organisation affecté par la situation ou en charge de tout. Les décisions importantes requièrent souvent de la coordination, de la coopération, ou de la collaboration multi-organisationnelles. Malheureusement, en dépit des efforts de chacun, une approche inter-organisationnelle optimale n'est pas toujours employée. Quels facteurs facilitent ou gênent la résolution inter-organisationnelle des problèmes? Le laboratoire de GAP-Santé de l'Université d'Ottawa aborde cette question selon un modèle multi-niveau multi-phase de prise de décision partagée. Ce modèle est issu d'une recension des écrits et d'une série d'études de cas basées sur des situations d'urgence canadiennes et internationales. Le modèle donne lieu à un plan d'expériences in-vivo impliquant comme participants divers acteurs décisionnels lors de désastres. En outre, les doctorantes présenteront deux composantes centrales à leur thèse: la modélisation de système et le rôle des modèles mentaux.

Avec l'aide financière des RDDC, CRSH, CRSNG et de la Chaire McLaughlin sur le risque psychosocial

List of symbols/abbreviations/acronyms/initialisms

ANOVA	Analysis of Variance
CBRNe	Chemical, Biological, Radiological, Nuclear, Explosive
CF	Canadian Forces
CORA	Centre for Operational Research and Analysis
DRDC	Defence Research & Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
FC	Forces canadiennes
GAP	Groupe d'Analyse Psychosociale
ICS	Incident Command System
IMS	Incident Management System
MOU	Memorandum of Understanding
NGO	Non-governmental Organization
Non-ICS	Non-Incident Command System
ORG(s)	Organization(s)
PDF	Portable Document Format
PODS	Problem solving and Organizational Decision making Simulation
R&D	Research & Development
SDM	Shared Decision-making
TIF	Technology Innovation Fund

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.)

Defence R&D Canada – CSS
222 Nepean St.
Ottawa, Ontario K1A 0K2

2. SECURITY CLASSIFICATION (Overall security classification of the document including special warning terms if applicable.)

UNCLASSIFIED

3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.)

Research Using In Vivo Simulation of Meta-Organizational Shared Decision-making (SDM): Task 4– Modeling of Communication and Decision Functions within a Shared Decision-making (SDM) Framework

4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used)

Lemyre, L. et al.

5. DATE OF PUBLICATION (Month and year of publication of document.)

December 2011

6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.)

95

6b. NO. OF REFS (Total cited in document.)

15

7. DESCRIPTIVE NOTES (The category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Contractor Report

8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.)

Defence R&D Canada – CSS
222 Nepean St.
Ottawa, Ontario K1A 0K2

9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.)

9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)

W7714-083659/001/SV

10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.)

DRDC CSS CR 2011-33

10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.)

11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.)

Unlimited

12. DOCUMENT ANNOUNCEMENT (Any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in (11) is possible, a wider announcement audience may be selected.))

13. ABSTRACT (A brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual.)

Background: This report presents *Task 4*: *Modeling of Communication and Decision Functions within a Shared Decision-making (SDM) Framework* of the work stream "Research Using in Vivo Simulation of Meta-Organizational Shared Decision Making (SDM)". This component of the Technology Innovation Fund (TIF) program on Meta-organizational Collaboration was designed to assist in understanding challenges faced by the Canadian Forces (CF). The objective of the stream is to conduct basic research into shared decision making through the analysis of case studies, exercises and live simulations, as well as to test the shared decision making framework *in vivo*.

Method: Activities under *Task 4* focused on the completion of sessions of the *in vivo* simulation of shared decision making in a complex scenario with experienced high level responders, as well as completing additional qualitative interviews with key decision makers involved with one or more extreme events. The data generated was analyzed with the aim to validate the *Model of Inter-organizational Problem-solving Approaches* developed under Task 1 and to develop potential considerations and guidelines with respect to communication, decision-making and problem-solving in multi-organizational environments during extreme events. The approach to validating the theoretical *Model* was to test various hypotheses using an experimental design that allowed for actual *in vivo* sessions during which senior decision-makers performed specific tasks in relation to a complex scenario. Qualitative methods consisted of in-person, semi-structured interviews with professionals from a variety of organizations and jurisdictions in senior decision-making roles related to emergency management.

Results: In general, the study findings support the main components of the *Model* as to the critical role of time, information, resources and authority. The simulation experiment confirmed that there are considerable challenges when engaging in collaborative tasks, yet it showed higher levels of participation, higher satisfaction with the results, and higher engagement. The finding that organizations could be "instructed" to solve tasks in either a collaborative or coordinated manner, offers insight on the important role that training can play in eliciting collaborative behaviours. Interviews confirmed the significant impacts that modifiers can have on the capacity and willingness of organizations to coordinate and collaborate in multi-organizational environments. Results indicated differences in the subgroups' understanding of complexity, accountability, relationship with the media and timing of role. Hence, the *Model* has to articulate the problem solving approaches as multi-dimensional with various interactions and behaviours occurring at different times and in different conditions; adding other dimensions such as trust ; including organization culture and identity as modifiers to selecting approach to problem solving) would be useful. The research raises a number of considerations about the need to initiate inter-organizational problem-solving over the complete event timeline, particularly during the preparedness and planning phases in order to create the network needed to facilitate collaboration during a crisis. Suggestions are offered for future research.

Contexte : Ce rapport présente la Tâche 4 : *La modélisation des fonctions de communication et de prise de décision dans le cadre de la prise de décision partagée (PDP)* du volet de travail « *Recherche par la simulation in-vivo sur la prise de décision partagée des méta-organisations* ». Cette composante du programme du Fond pour l'innovation technologique (Technology Innovation Fund - TIF) sur la Collaboration méta-organisationnelle a été conçue

afin d'aider à comprendre les défis que doivent affronter les Forces canadiennes (FC). Le but de ce volet est de faire une recherche fondamentale sur la prise de décision partagée au moyen d'études de cas, d'exercices et de simulations, ainsi que de tester le cadre de prise de décision partagée *in-vivo*.

Méthode : Les activités de la *Tâche 4* visaient à achever les sessions de simulation *in vivo* de prise de décision partagée avec des intervenants de haut niveau dans le cadre d'un scénario complexe, ainsi qu'à mener de entrevues qualitatives additionnelles auprès de décideurs principaux impliqués dans un ou plusieurs événements extrêmes. Les données produites ont été analysées dans le but de valider les *démarches du Modèle pour la résolution inter-organisationnelle des problèmes* développées lors de la Tâche 1 du projet ainsi que de cerner les facteurs éventuels et d'élaborer des lignes directrices en matière de communication, de prise de décision et de résolution des problèmes dans des environnements multi-organisationnels lors d'événements extrêmes. La démarche visant à valider le *Modèle* théorique consistait à tester diverses hypothèses à l'aide d'un concept expérimental qui permettait la tenue de sessions in-vivo au cours desquelles des décideurs principaux effectuaient des tâches précises en réponse à un scénario complexe. Les méthodes qualitatives consistaient en des entrevues personnelles semi-structurées auprès de professionnels de diverses organisations et compétences assumant les principaux rôles décisionnels en matière de gestion des urgences.

Résultats : Dans l'ensemble, les résultats de l'étude corroborent les principales composantes du *Model* quant au rôle crucial que joue le temps, l'information, les ressources et l'autorité. L'expérience de simulation a permis de confirmer que des tâches collaboratives présentent des défis considérables; par ailleurs cela a démontré des niveaux plus élevés de participation, de satisfaction face aux résultats, et d'engagement. Les défis liés à la participation dans un environnement multi-organisationnel augmentent au fur et à mesure que s'accroît la diversité des organisations. Le résultat voulant que les organisations puissent « recevoir l'ordre » de résoudre les problèmes liés aux tâches de manière collaborative ou coordonnée permet de mieux comprendre le rôle important que peut jouer la formation pour susciter des comportements de collaboration. Les entrevues ont permis de confirmer les conséquences importantes que les modificateurs peuvent avoir sur l'habileté et l'empressement des organisations à coordonner et à collaborer dans des environnements multi-organisationnels. Les résultats montrent des différences entre les groupes dans leur vision des notions de complexité, de responsabilité, de relation avec les médias et des aspects temporels de leur rôle. Conséquemment, le Modèle doit articuler les approches à la résolution de problèmes de façon multidimensionnelle, et tenir compte de divers comportements et interactions se produisant à des périodes différentes et dans des conditions différentes; ajouter d'autres attributs dont la confiance; considérer la culture et l'identité de l'organisation comme étant des modificateurs qui entrent en jeu dans le choix de la démarche de résolution des problèmes). La recherche fait ressortir plusieurs facteurs liés au besoin de procéder à la résolution inter-organisationnelle des problèmes pendant toute la durée de l'événement, et plus particulièrement pendant les phases de préparation et de planification afin de mettre en place le réseau nécessaire pour faciliter la collaboration en période de crise. Des suggestions de recherches futures sont présentées.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS Inter-organizational; collaboration; cooperation; coordination; decision-making; problem-solving; complex situations; meta-organization