Social Connectedness and Adaptive Team Coordination during Fire Events

Alireza Abbasi, University of Sydney
Christine Owen, Liaquat Hossain, Jafar Hamra, Christine Owen, Liaquat Hossain, Jafar Hamra
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Alireza Abbasi 1, Christine Owen 2,3, Liaquat Hossain 4, Jafar Hamra 3,4

1 School of Engineering & IT, University of New South Wales Canberra, ACT 2600, Australia
2 Faculty of Education, University of Tasmania, Hobart, TAS 7001, Australia
3 Bushfire CRC, Melbourne, VIC 3002 www.bushfirecrc.com
4 Faculty of Engineering & IT, The University of Sydney, Sydney, NSW 2006, Australia

Abstract— Preparing for fire-related emergencies and consequence management is considered to be dynamic and challenging in managing crises, preventing losses, and in the allocation of resources. In this study, we argue that improving plans and operations of personnel involved in managing fire-related emergencies is an important area of investigation. Here, we investigate the effects of social connectedness among different team members to manage bushfires. We further analyze response coordination by exploring variables such as participants’ preparedness quality, quality of incident action planning, and quality of accessibility of resources. In doing so, we also test the effects of these variables on improved adaptive behavior. Our results show high positive correlation between social connectedness for team members and coordination quality and also adaptive behavior. We also found significant relationship between coordination and adaptive behavior. Applying regression analyses, the results indicate positive significant effect of social connectedness on coordination and adaptive behavior and also the effect of coordination on adaptive behavior. By exploring the proposed model, we are able to develop a better understanding of the factors that support adaptive behavior in incident management teams responding to Bushfire events.

Keywords: Team Connectedness, Coordination, Participants Adaptive Behavior, Disaster Management, Incident Management Team

1. Introduction

Fires present specific risks to life and the environment. When bushfires turn into large-scale extreme events, they occur at the interface between natural, social and human systems and are often called “disasters” [1]. A disaster is defined as a destructive event creating negative social and economic conditions that interrupt the day-to-day activities of a society [2-4]. Disasters which are unexpected, dangerous and serious are considered emergency events since these situations require immediate action. In Australia, for example, bushfires are one of the most prevalent natural emergency events that can lead to disasters. There are circumstances when a bushfire becomes so overwhelming it is impossible to contain or control unless weather changes to more favorable conditions [5]. Worldwide, losses from emergencies related to natural hazards have risen dramatically [6, 7] and more natural hazard events are expected as a result of human-induced climate change [8].
In fire-related emergencies different organizations and agencies need to coordinate in order to manage and respond to the events in a timely manner to mitigate the event. In addition, it is important for organizations to form cooperative information exchanges in order to respond to the disaster effectively and efficiently. Poor coordination is a fundamental problem for an emergency response, and is primarily due to lack of good communication between organizations; a lack of up-to-date and relevant information circulating through the emergency response network; and insufficient access to data and action plans [3, 9].

We argue that social network analysis, which includes a focus on network structure, can represent team connectedness which is an important factor in the performance of organizations. The social environment can be expressed as patterns or regularities in relationships among interacting units [10]. This is in keeping with a system approach to fire safety management reported previously [11, 12]. Previous researchers suggested that there are particular patterns that can be identified in human behavior in fires as well as in their management (see for example [13, 14]). From a social network analysis perspective, simple static networks frequently perform better when they have a centralized actor as the manager and coordinator of the network; while in the case of complex and dynamic networks decentralization can frequently yield better results [15-18]. Therefore, it can be helpful to find the network structures and the way they indicate connections of individuals within and between agencies, which can have a significant impact on coordination. Doing so can then be used to improve network configurations so that coordination may be optimized.

Coordinating activities or tasks for effective response in a complex system during a disaster is one of the most important issues to protect human lives. It is argued that better coordination in addition to direct impact on the control and management of disasters can lead to better adaptive behavior which can influence performance. By using social systems theories in conjunction with coordination indicators of participants’ adaptive behavior during emergency management, we present a research model that can then be tested through empirical validation which allows us to explore the effect of network relations among team members on coordination, and also the relation between coordination and adaptive behavior.

In this area of research, we have found that tools and measures to evaluate the effectiveness of inter-organizational coordination are limited. In addition, there are few systematic empirical studies examining the relationships within social networks, particularly in relation to coordination in dynamic environments. Thus, our aim is to study the effect of relational network structures on coordination and the relationship with participants’ adaptive behavior. Our study is guided by the following three questions:
1. What is the relationship between social connectedness of team members and their adaptive behavior?

2. What is the relationship between social connectedness of team members and coordination in managing emergency events?

3. What is the relationship between coordination and teams’ adaptive behavior?

The second section of this paper provides a review of the existing literature in the context of theories of social systems, including aspects of coordination theory and application of coordination in disaster management studies. Next, we provide details of our proposed model leading to the development of a set of hypotheses. In section three, an overview of the methods used for data collection and analysis is presented. Analysis and discussion of findings are presented in section five. Lastly, conclusions highlighting the contribution of this study on research and practice are also provided.

2. Literature Review

2.1. Theories of Social Connectedness

Social connectedness can promote sharing of professional knowledge in a simple way and assist in the evaluation of the performance of individuals, groups, or an entire network [19]. Investigations of relational networks can be effective in identifying network properties such as strength and direction of network relations among actors [20, 21].

Several studies in different disciplines have shown the important role network structure plays on organizations’ performance [15-18]. Previous researchers suggested that simple static networks have better performance when they have a centralized actor as the manager and coordinator of the network, while in the case of complex and dynamic networks decentralization is the best solution. These studies have inferred that centralization was as the most influential factor on performance [15]. Later, Guetzkow and Simon [18] found that decentralized structures (e.g., a circle network) led to more efficient performance in complex tasks.

Granovetter’s [22] theory of ‘strength of weak ties’ suggests that individuals obtain new and novel information from weak ties rather than from strong ties within the individual’s group structure: weak ties serve as a bridge to a different cluster of people, allowing the new information to permeate [23]. This theory suggests that “homophilic” behaviors, (that is, the bonding of strongly connected actors to each
other) shape clusters (cliques) among the actors in that network. Homophily among actors with strong ties creates a cluster of actors with similar (redundant) knowledge, skills and experiences.

In contrast, Pool [24] asserted that the usefulness of strong ties when an individual is not in a secure position comes from the protection they give against uncertainty [25]. Strong ties could be indicated as connections with high intensity emotional closeness and frequent communication [22, 26]. Krackhardt [27] showed that strong ties are important in the generation of trust. Also, Levin and Cross [28] found strong ties, more so than weaker ties, led to the receipt of useful knowledge for improving performance in knowledge-intensive work. Although weak ties facilitate faster project completion times when the task is simple, and enable faster search for useful knowledge among other organizational subunits, strong ties foster complex knowledge transfer, as the transfer process is slowed down when knowledge is highly complex [29, 30].

In network analysis there are several proxies (surrogates) to indicate and quantify the strength of actors’ ties (e.g., interpersonal link weight), for example, the duration of time a link has taken to be established; as well as the emotional intensity; the intimacy, and the reciprocity between actors [22]. The interaction amongst the individuals creates opportunity for knowledge sharing and information exchange and sets up opportunities to get to know team members which then makes it easier for each party to predict how the others will use any shared information [27].

**Social Connectedness and Coordination in Fire-related Emergency Response**

Usually, during fire situations, several individuals from different agencies (or different parts of the same agency) need to coordinate to respond to the incident. Participants need to interact and communicate with each other through sharing information and experience, reporting and briefing, requesting resources and so on. Therefore, a network of cooperation will form which includes participants as nodes, and their communication (interaction) represents the links or ties between the nodes. The strength of ties can be measured not only by the frequency of communication, but also by assessing the extent to which the information is exchanged clearly, accurately and in a timely manner among the participants; emotional feelings such as trust between participants, and their level of comfort and ability to contact each other will also be an indicator.

Lin [31] investigated dynamics of inter-organizational links (ties) during emergency situations and showed that participants rely on stronger ties first until there are additional resource needs leading them
to activate weaker ties. While there are studies analyzing inter-organizational coordination networks in emergency response management [2], there are few network analysis related studies looking at the network structure of individuals and teams. Recently, Hossain and Kuti [3] proposed a social network-based coordination model to explore the state of readiness of individuals within organizations in extreme events, and found that changes to interconnectedness of individuals in an organizational network have implications for coordination. Other studies [32, 33] show that individuals’ interconnectedness within teams in an emergency management network are implicated in the potential to learn and improvise during disasters. Therefore, individuals’ connectedness is an important factor to support effective performance.

2.2. Coordination in Fire-related Emergency Response Management

Coordination is an essential activity in distributed systems which permits participants to perform complex composite tasks and achieve shared (common) goals by interaction [34, 35]. However the problem of a lack of coordination is most frequently cited in coordination related studies [36, 37]. The study of coordination attracts attention from different disciplines and there is a considerable body of knowledge on it from areas such as organization theory, management science, computer science, economics and psychology. Coordination is defined as “the additional information processing performed when multiple connected actors pursue goals that actors pursuing in the same goals would not perform” [37] (p. 11) or “managing the dependencies between activities” [36] (p. 90).

Coordination can be regarded as one of the elements associated with the disaster management process. The coordination of participants and organizations involved in extreme events during the process of emergency response is challenging due to the unique circumstances that contribute to the nature of an extreme event (e.g., uncertainty; sudden and unexpected events; mass casualty; time pressure and urgency; resource shortages; damage) [38].

McEntire [39], in his study about the tornadoes in Ft. Worth, Texas in March 2000, suggested that major factors which facilitate coordination include preparedness activities, networking, and access to resources including technology, and the factors which reduce it include lack of information, blocked access, and language barriers [40].

Dynes and Aguirre [41] highlight two different types of coordination in organizations: coordination by plan and coordination by feedback. The pre-established preparedness, planning and activities directing and standardizing the functioning are considered as coordination by plan. This kind of coordination is
most commonly used by traditional emergency organizations. On the other hand, *coordination by feedback* is about the learning process and sharing of new information in order to facilitate the mutual adjustment of actors or what we call adaptive behavior.

Given that emergency events are often dynamic, coordination by plan is frequently less optimal and coordination by feedback (adaptive behavior) more desirable. In general, in extreme events the rate of communication increases and this creates the conditions where organizational structures need to move in the direction of coordination by feedback to exchange new information, and away from coordination by plan [41]. However, optimal performance in the management of emergencies ideally utilizes a mix of both types of coordination.

The challenge is to ensure that coordination by feedback is not locked into centralized structures that are bureaucratic and become inflexible and untimely. It is contended that network relationships will yield higher levels of information exchange and better levels of coordination under dynamic conditions. From reviewing the literature, we contend that there are two key factors that are important supporting mechanisms needed for effective coordination: preparedness and accessibility to resources.

- **Preparedness**

Preparation by utilizing planning and disaster rehearsal activities is kind of mix of coordination by plan, which can involve organizations aiming to improve their practices and coordination by feedback prior to a real disaster. Previous research demonstrates that joint planning and disaster rehearsal activity facilitates capability and strengthens personal relationships among participating agencies [42]. It is therefore apparent that establishing proper networks for flow of information and materials is an important preparation during an emergency for coping with the increased need for information and resources [43].

Preparedness (readiness) is considered to be one of the key foundations in emergency management [44]. One of the main goals of preparedness activities is to expect problems and project possible solutions [44, 45]. Preparedness therefore helps to prevent a disaster, minimize its impact, protects community values, reduces the *unknown* during a disaster, and may even allow for enhanced flexibility in response [45, 46]. Preparedness is also important as it facilitates inter-organizational coordination and communication and helps to identify resources that a community may need for the response and recovery phases of disaster [47]. Preparedness clarifies the roles and responsibilities of key players during emergency response [45]. A further benefit of preparedness is that it clarifies and reinforces functions that need to be performed in times of a disaster [47].
• **Accessibility of Resources**

Resources (e.g., personnel, knowledge, communication tools, technology) are some of the main factors which facilitate coordination to mitigate and control the incident. For instance, information technologies have been identified as important tools to achieve effective communication and decision-making goals in emergencies [48]. Due to the increasing need of resources during extreme events, accessibility to the resources in a timely manner is also essential.

Some coordination mechanism is required to allocate scare resources (e.g. money, space, workers’ time, equipment) to competing activities [36, 49]. In order to manage an emergency or provide proper support in the aftermath, emergency managers need to know both quantity and quality of accessible resources to allocate them effectively.

2.3. **Adaptive Behavior**

An emergency response plan is a key factor for effective emergency management [50] and is usually provided in order to cope with an emergency situation. However, as the nature of extreme events is complex and dynamic, it is probable that personnel involved in emergency management face situations that may fall outside those which are covered by the emergency plan. Despite having proper preparation activities and programs, the situation is not always predictable during an emergency (disaster), so it is necessary to understand the potential for participants to adapt to a new situation utilizing skills, knowledge and experience as a supplement [50].

Flexibility and adaptability give the involved participants the ability to respond to unanticipated events. During an emergency situation, flexibility enables organizations to be more properly prepared and promote improvisation to fit the requirements of the current situation [51]. A dynamic emergency management system combining both social and technical systems, which is flexible enough to adjust to rapidly changing emergency conditions, is required for reducing the vulnerability of local communities [52].

When a problem occurs during the emergency management process, the teams should be able to recover quickly and, as the situation changes, effectively reallocate roles. So, during an emergency event individuals and teams need to be adaptive in a variety of situations, in time and in space [53]. Also, personnel involved in managing emergencies need to be adaptive to adjust strategies in a timely manner.
when problems arise. Thus, having adaptive behavior particularly in complex and dynamic events is essential. The degree to which various forms of coordination (preparedness and planning) and the role of team connectedness indicated by team communication and feedback supports adaptive behavior is thus the focus of this paper.

2.4. Research Model and Hypotheses

Figure 1 summarizes our proposed research model to evaluate the impact and relationship between team members’ interconnectedness and specific coordination factors that we have examined in our literature review.

![Figure 1. Research Model](image)

- **Team Communication**

  It is argued that team member interconnectedness leads to better mutual understanding of the abilities and skills which also improves trust and understanding among members. This mutual understanding can help to improve the coordination and consequently the efficacy of performance. It is expected, therefore, that higher levels of connectedness among personnel involved in managing emergencies within teams will be positively associated with higher perceptions of coordination quality. Therefore, the hypothesis is formally derived as:

  (H1): *Social connectedness* among team members will be positively related to perceptions of *coordination quality*. 

"
• **Adaptive Behavior**

In addition, the stronger relationships that form among personnel allows for better mutual understanding and collective cooperation which is indicated by better adaption to the demands of the dynamic conditions of the situation. Therefore, we are proposing the following hypothesis that:

(H2): *Social connectedness* among team members will be positively related to perceptions of *adaptive behavior*.

• **Coordination Quality**

Having personnel who have developed capability by preparing and planning through rehearsal activities; and through clarifying functions and engaging in planning will be better able to collectively cooperate and manage the demands of the situation [47]. Co-ordination quality will be indicated by the level of satisfaction with the dynamic planning with the event evident in perceptions of quality, accuracy, timeliness and relevance of incident action planning. Therefore, we are proposing the following hypothesis that:

(H3): *Coordination* mechanisms of team members will be positively related to perceptions of *adaptive behavior*.

3. **Data**

3.1. **Data Source**

The data used in this analysis comes from primary research collected by a research team supported by the Bushfire CRC and led by one of the authors. The analysis reported here is thus a secondary analysis conducted as part of a subsequent collaboration. We used the results of a survey which has been reported as the first systematic review of the Australasian Inter-Service Incident Management System (AIIMS) to be conducted since its national introduction in 2004 [54]. The purpose of the survey was to review information and communication flows; to understand better how teams work within the AIIMS system; and to identify opportunities for improvement [54].
The results of this study are based on 579 responses from fire and emergency services personnel who worked within 25 agencies representing all Australian states and territories and a sample from New Zealand.

It is important to note that one survey participant was reporting on one incident. Respondents reported on incidents they were involved with in the previous twelve months. The nature of the incidents reported on is largely forest/scrub fires. Also included are fires on the urban/rural interface, structure fires as well as cyclones, floods and storms. The majority of incidents reported (71%) are complex in nature, involving a large number of people managing the incident. Close to one third of incidents (27.4%) involved more than 250 people at the peak of the incident. They also required a large amount of inter-agency cooperation. Close to one half of all incidents (47%) involved seven or more support agencies [54].

The survey was divided into six sections which sought information about: the incident; the area of responsibility of the respondent, and activity during a particular shift; perceptions of teamwork as well as identification of which team the respondent worked within; perceptions of interaction between the Incident Management Team and those working on the fire/incident ground; levels of satisfaction with AIIMS/organizational procedures and processes; and respondent demographics.

In order to define the variables in the model we identified items that measured aspects found to be important in the literature: These were social connectedness variables (i.e., team members’ internal communication and feedback); coordination quality variables (i.e., coordination of IMT’s planning quality, participants’ preparedness quality, and quality of accessibility of resources); and participants’ adaptive behavior variables (i.e., timeliness of adjustment strategies; capacity to recover quickly from setbacks and capacity to re-allocate roles). To see the list of statements for each variable, please refer to appendix 1.

3.2. Unidimensionality and Reliability

Once the responses to the questions were collected, a group of statistical techniques were employed to assess unidimensionality and reliability as a precursor for scale development, [55, 56]. Unidimensionality was assessed through factor analysis and reliability is assessed through Cronbach’s alpha. These complementary procedures test whether each question or item included in a scale really do belong to that scale, by measuring if each particular included question measures the same underlying concept [57].
We sought to categorize several items that may form the basis of the scales (based on the literature) and then tested their unidimensionality and reliability. The Factor Analysis (using maximum likelihood estimation) demonstrated that the items did load as separate dimensions. The factor analysis achieved a Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) of .926 and the 5 factors reported 66% of the variance. Cronbach’s α is a measure of internal consistency, that is, how closely related a set of items are as a group. Table 1 demonstrates the reliability test results for the scales we use in this study. The list of finalized questions (items) for each scale has been shown in Appendix 1. As seen in Table 1 all measures can be considered reliable as the Cronbach’s α coefficient computed is larger than 0.7 [58-60].

<table>
<thead>
<tr>
<th>Measures (scales)</th>
<th>Cronbach α</th>
<th>No. of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Connectedness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teams Internal Connectedness</td>
<td>.942</td>
<td>6</td>
</tr>
<tr>
<td>Coordination quality (composite)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant Preparedness Quality</td>
<td>.849</td>
<td>7</td>
</tr>
<tr>
<td>Incident Action Planning Quality</td>
<td>.933</td>
<td>6</td>
</tr>
<tr>
<td>Accessibility of Resources Quality</td>
<td>.734</td>
<td>5</td>
</tr>
<tr>
<td>Adaptive Behavior</td>
<td>.888</td>
<td>5</td>
</tr>
</tbody>
</table>

### 4. Analysis and Results

#### 4.1. Correlation Analysis

We used the Pearson correlation to test the measures of association between independent and dependent variables which have been presented in our model (Figure 1). For any correlation test technique including Pearson test, a higher correlation coefficient, both in a positive or negative direction, indicates stronger relation between the independent and dependent variables involved in that correlation test.

To test the hypotheses, Pearson correlation coefficient values stated in Table 2 show high positive correlations between all pairs of measures. The correlation coefficient values for all relations are significant at the 0.001 level. Thus, the results demonstrate high positive correlation between participants’ and teams’ social connectedness and their coordination quality and also their adaptive behavior (H1 & H2); also between participants’ adaptive behavior and their coordination quality (H3).
Table 2: Pearson correlation test

<table>
<thead>
<tr>
<th></th>
<th>Coordination Quality</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Participants’ Preparedness</td>
<td>Incident Action Planning</td>
<td>Accessibility of Resources</td>
<td>Adaptive Behavior</td>
</tr>
<tr>
<td>Social Connectedness</td>
<td>Teams Internal Connectedness</td>
<td>.338 *</td>
<td>.464 *</td>
<td>.455 *</td>
</tr>
<tr>
<td>Coordination Quality</td>
<td>Participant Preparedness</td>
<td>-</td>
<td>.300 *</td>
<td>.497 *</td>
</tr>
<tr>
<td></td>
<td>Incident Action Planning</td>
<td>-</td>
<td>-</td>
<td>.614 *</td>
</tr>
<tr>
<td></td>
<td>Accessibility of Resources</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*. Correlation is significant at the 0.01 level (2-tailed).

Correlation coefficients between the measures of social connectedness and coordination quality indicate significant positive associations between connected team members and their satisfaction with the timeliness, accuracy, relevancy and completeness of their coordination incident action planning during the event.

Considering the significant associations between all measures of coordination quality and adaptive behavior, this indicates these are likely to be important in success. However, as discussed, correlation is a useful, though limited statistical means of prediction so for that purpose a more sophisticated means of analysis is needed.

4.2. Regression Analysis

We applied regression analysis to test our hypotheses about the directional effect of social connectedness on coordination quality. Table 3 indicates that social connectedness has a positive effect on coordination quality.

Table 3. Regression model to test social connectedness effect on coordination quality (H1)

<table>
<thead>
<tr>
<th>Model</th>
<th>Beta (Standardized Coefficients)</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td></td>
<td>14.087</td>
<td>.000</td>
</tr>
<tr>
<td>Team Internal Connectedness</td>
<td>.526</td>
<td>10.805</td>
<td>.000</td>
</tr>
</tbody>
</table>

*a Dependent Variable: Coordination Quality
Table 4 indicates that the social connectedness’ coefficients are statistically significant (at the .01 level). This indicates that highly connected teams report more adaptive participant behavior.

**Table 4.** Regression model to test *social connectedness* effect on *adaptive behavior* (H2)

<table>
<thead>
<tr>
<th>Model (^a) (Adj. (R^2 = 0.667))</th>
<th>Beta (Standardized Coefficients)</th>
<th>(t)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td></td>
<td>11.223</td>
<td>.000</td>
</tr>
<tr>
<td>Team Internal Connectedness</td>
<td>.817</td>
<td>30.566</td>
<td>.000</td>
</tr>
</tbody>
</table>

\(^a\) Dependent Variable: *Adaptive Behavior*

From testing the effects of coordination quality on participants and teams’ adaptive behavior, it can be seen in Table 5 that only the coefficients for *participant preparedness* and *incident action planning* are statistically significant (at the .01 level). This indicates that the higher the coordination quality (in preparedness and dynamic incident management planning) the higher reporting of adaptive behavior.

**Table 5.** Regression model to test *coordination quality* effect on *adaptive behavior* (H3)

<table>
<thead>
<tr>
<th>Model (^a) (Adj. (R^2 = 0.377))</th>
<th>Beta (Standardized Coefficients)</th>
<th>(t)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td></td>
<td>4.755</td>
<td>.000</td>
</tr>
<tr>
<td>Participant Preparedness</td>
<td>.277</td>
<td>4.833</td>
<td>.000</td>
</tr>
<tr>
<td>Incident Action Planning</td>
<td>.358</td>
<td>5.351</td>
<td>.000</td>
</tr>
<tr>
<td>Accessibility of Resources</td>
<td>.147</td>
<td>2.095</td>
<td>.037</td>
</tr>
</tbody>
</table>

\(^a\) Dependent Variable: *Adaptive Behavior*

Thus, the results of Table 3 to Table 5 indicate that we can accept all hypotheses (H1-H3).

In addition it is important to ascertain the relative strength of the variables in accounting for adaptive behavior during emergency events. Using the enter model for multiple regression, a significant model emerged (\(F_{4,220} = 103.44, p < .001\). The model explains 65% of the variance. Table 6 gives information for the predictor variables entered into the model. It is interesting to note that access to resources were not a significant predictor but the other variables were.

**Table 6.** Multiple Regression model to test *social connectedness and coordination quality* effect on *adaptive behavior*

<table>
<thead>
<tr>
<th>Model (^a) (Adj. (R^2 = 0.647))</th>
<th>Beta (Standardized Coefficients)</th>
<th>(t)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td></td>
<td>3.343</td>
<td>.001</td>
</tr>
<tr>
<td>Team Internal Connectedness</td>
<td>.523</td>
<td>13.643</td>
<td>.000</td>
</tr>
<tr>
<td>Participant Preparedness</td>
<td>.215</td>
<td>4.401</td>
<td>.000</td>
</tr>
</tbody>
</table>
5. Discussion

During an extreme event, work is organized in work teams. The Incident management team (IMT) has the role of managing the incident and is involved in dynamic decision making [52] and needs to adapt to changing conditions. The communication and connectedness within the IMT preparedness activities and coordination quality in developing incident action plans as the event unfolds; and availability of resources are all important to the level of adaptation needed to support the response operation.

We investigated the effect of social relations among teams involved in managing emergencies and their perceptions of incident coordination effectiveness and their perceptions of adaptive behavior. The positive significant effect of social connectedness on coordination supports the strength of strong ties for the links among team members and the way they effectively organize. The connectedness of team members has been measured considering the trust and supportive behavior among team members, the quality of information exchange and the effectiveness of interaction among team members.

![Figure 2. Research Model with Regression Coefficients](image)

Team’ connectedness is indicated to have a positive significant effect on and the capacity for personnel to adaptively respond to dynamic situations. This study highlights the effect of various incident
management organization tools on enabling adaptive behavior and supports Petersen and Eriksson [50] that improvisation and adaptation is necessary for an efficient emergency management system.

If policy makers and managers want to enhance adaptive behavior in complex emergency events then these results indicate that they would do well to concentrate on the internal connectedness of teamwork as this provided the strongest path in the regression model considered in Figure 2. It is interesting that access to resources was not as important as a path in the analysis. This finding is intriguing and needs further attention in future research. The findings support the idea that incident management teams will make do with what they have available to them at the time. While planning and access to resources are clearly important, the model suggests that it is the internal connectedness between actors in the team that will give the most leverage in terms of enabling adaptive behavior.

6. Conclusion and Limitations

We have highlighted the importance of adaptive behavior and the relationship of internal team connectedness as well as the relationship between coordination quality in supporting adaptive behavior in coordination for complex disaster response scenarios.

There are two main limitations that can be identified in this research. First, the sample might not reflect the entire population of personnel involved in incident management even though the questionnaire includes a sizeable proportion of the emergency management population across Australia and New Zealand. Second, as in most self-completion surveys, the responses might be biased through memory and the motivations of people who took the time to complete it. From this point of view it is important to review the results cautiously and to consider the directions they might indicate for further research validation.

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# APPENDIX 1

<table>
<thead>
<tr>
<th>Measures</th>
<th>List of questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Team’s Internal Connectedness</strong></td>
<td>Team members provided helpful advice</td>
</tr>
<tr>
<td></td>
<td>Team members provided constructive feedback</td>
</tr>
<tr>
<td></td>
<td>Team members exhibited a strong ‘we are in this together’ attitude</td>
</tr>
<tr>
<td></td>
<td>Team members operated in an open and honest manner</td>
</tr>
<tr>
<td></td>
<td>Team members kept each other well informed</td>
</tr>
<tr>
<td></td>
<td>Team members trusted each other</td>
</tr>
<tr>
<td><strong>Participants’ Preparedness</strong></td>
<td>Participant’s Working Knowledge of systems in use</td>
</tr>
<tr>
<td>Quality</td>
<td>Participant’s Training for the incident</td>
</tr>
<tr>
<td></td>
<td>Participant’s level of Experience</td>
</tr>
<tr>
<td></td>
<td>Participant’s Familiarity with IMS</td>
</tr>
<tr>
<td></td>
<td>Participant’s Certainty of what needed to be done</td>
</tr>
<tr>
<td></td>
<td>Participant’s Understanding of policies</td>
</tr>
<tr>
<td></td>
<td>Participant’s Understanding of who to contact for info</td>
</tr>
<tr>
<td><strong>Quality of Incident Action Planning</strong></td>
<td>Incident Action Plan Accuracy</td>
</tr>
<tr>
<td></td>
<td>Incident Action Plan Timeliness</td>
</tr>
<tr>
<td></td>
<td>Incident Action Plan Relevancy</td>
</tr>
<tr>
<td></td>
<td>Incident Action Plan Completeness</td>
</tr>
<tr>
<td></td>
<td>Incident Action Plan Conciseness</td>
</tr>
<tr>
<td></td>
<td>Incident Action Plan support of objective</td>
</tr>
<tr>
<td><strong>Quality of Accessibility of Resources</strong></td>
<td>Adequacy of Resources</td>
</tr>
<tr>
<td></td>
<td>Confidence in resource being accounted for</td>
</tr>
<tr>
<td></td>
<td>Effectiveness of Technological Systems</td>
</tr>
<tr>
<td></td>
<td>Effectiveness of Policies/Procedures</td>
</tr>
<tr>
<td></td>
<td>Compatibility of technological systems</td>
</tr>
<tr>
<td><strong>Adaptive Behavior</strong></td>
<td>Strategies were adjusted in a timely manner as the incident unfolded</td>
</tr>
<tr>
<td></td>
<td>Roles were effectively re-allocated as the situation changed</td>
</tr>
<tr>
<td></td>
<td>New team members were quickly integrated into the team</td>
</tr>
<tr>
<td></td>
<td>Team members’ co-ordinate their activities to achieve the best possible outcome.</td>
</tr>
<tr>
<td></td>
<td>When problem occurred the team was able to recover quickly and…</td>
</tr>
</tbody>
</table>