

# **An Assessment of Inter-Organizational Information Management in Initial Disaster Relief Operations: Existence and Causes of Communication Breakdowns**

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**Abstract:** During disaster relief operations, collaborative critical decisions are often made by decision-makers from many different organizations and from a diversity of professional fields. These collective decisions are made by teams of people separated by great distances, with differing goal values, who have never before worked together.

Communication breakdowns often hamper the effective coordination of a disaster response, particularly when a multiplicity of Federal, state, local and volunteer organizations take part in the effort. A communication breakdown is defined as the failure to communicate information due to 1) the inability to obtain critical and needed information and 2) the inability to obtain sufficient information quality to support decision-making. This paper presented the causes affecting communication breakdowns in past disaster responses. The research used these factors and functions in the development of a multi-attribute computer based model for prioritizing types of information and quality of data required to support decision-making within and among the response organizations. The model was based on an Analytic Hierarchical Process (AHP) was developed on focusing the first 72 hours of a response, and was used to elicit on the expert judgements from successful disaster response professionals. The model provided a method for comparing the importance types of information and the quality requirements during initial disaster relief operations. The results from acquisition of expert opinions demonstrate that the communication breakdowns that occur within and among disaster response organizations are often caused by characteristics that are organizationally dependent.

## **Introduction**

Throughout history, natural disasters have caused many deaths and caused much human suffering. Natural events such as earthquakes, landslides, tidal waves, hurricanes, tornadoes, floods, volcanic eruptions, and wildfires have claimed more than 2.8 million lives worldwide in the past 20 years<sup>1</sup>. Natural disasters are not confined by geographical and political boundaries. Almost every country in the world faces the risk of one natural disaster or another. However, the adverse effects of natural disasters -- death, economic loss and other negative impacts on society -- can be minimized

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<sup>1</sup>Confronting Natural Disasters, "International Decades for Natural Hazard Reduction", U.S. National Academy of Engineering Society., 2nd edition, 1987. p. 1-7

through disaster relief operations that are intelligently planned, properly coordinated and effectively executed.

The increased inter-dependence of global communities makes essential that we view the effective management of a disaster response to a natural disaster as an issue facing the entire world, not just the country where the disaster occurs. The problems that routinely arise during a disaster situation must often be solved collectively. In disaster relief operations, decision-makers include many experts from different professional fields and from different organizations. These collective decisions must often be made by teams of people who have never worked together, and who are sometimes separated by great distances. In additional complication in decision-making during events such as these is the uniqueness of a natural disaster: There is no practical way to train personnel how to respond to every potential natural disaster, nor is it likely that all personnel taking part in scheduled planning and readiness exercises will work together during a real emergency.

Uncertainty in disaster coordination can also affect subordinate personnel taking part in a disaster response. Lack of conviction in the operation's leadership can also prompt subordinate personnel to ignore or only partially execute instructions. Prompt and efficient acquisition, verification and transmittal of information among disaster relief organizations are critical to the effectiveness of disaster response operations, no matter if the disaster is small and localized, or if the disaster affects a huge geographical area. There is no precise definition of good communication but good communication obviously depends upon the transfer of good information. Good communication enhances the effectiveness of organizations responsible for emergency warning and notification, situation assessment, crisis decision-making, and the dissemination of information during the response. Policy-makers who shape and direct disaster response programs need better resources to enable them to effectively respond to the potential needs of our increasingly complex and hazardous society.

Faced with these trends, the American Red Cross (ARC) and federal emergency management agencies such as the Federal Emergency Management Agency (FEMA) are looking for ways to reduce death, injury and property damage caused by natural disasters. These disaster response organizations are hoping to achieve higher levels of effectiveness by standardizing a disaster management system that is durable and flexible, and which delivers in a timely fashion, accurate and comprehensive information to all parties who need it.

A communication breakdown is defined as the failure to communicate information due to 1) the inability to obtain critical and needed information and 2) the inability to obtain sufficient information quality to support decision-making. Good communication is defined in terms of reliability in transferring the right information with the required accuracy, completeness, consistency and timeliness. Often, miscommunication is exacerbated by the fact that there is no standardized technological approach to the increased need for leaders to quickly acquire and distribute information critical to an effective disaster response effort. Systems do exist with a capability to rapidly collect and distribute information in a timely fashion. Examples of suitable technological tools range from portable radios to complex satellite systems. However, these tools are not standardized and, when disasters threaten or strike, they are not always in the right place at the right time. Moreover, even when these technologies are in place, they often do not deliver information that is required or information that is accurate, consistent, complete or timely.

## **Research Methodology**

Many operations managers must often make decisions during the initial phases of a disaster relief operations. The complexity of the decision-making process is high. This complexity is due to several factors, including 1) the existence of multiple channels of information flow within and among disaster relief organizations, 2) the quality of the available information, 3) uncertainty of expectation, and 4) the obscurity of disaster information infrastructures. Factors that can lead to communication breakdowns include misleading information and ineffective information transfer among response organizations. Information can be misleading because of a failure to obtain

information on essential functions, or because of a failure to obtain data quality adequate to support decision-making. The quality of data is judged on four criteria: timeliness, accuracy, completeness and consistency.

Ineffective information transfers with external organizations can result because of difficulties arising during information dissemination (intra-organizational information transmissions) and information liaison (inter-organizational information transmissions). Clearly, managers who hope to mount successful disaster responses should institutionalize an information model for the effective management of information during a real emergency. In an effort to develop such an information model, this research began by identifying problems in the communication patterns and information flows within and among disaster response organizations during the initial phase of a response. The objective of the pilot study was to develop a questionnaire instrument that could be used to identify the important factors and essential functions that contributed to successful disaster responses.

With the results from the pilot study, a hierarchical model was developed to prioritize the types of information and quality of data required to support decision-makings in disaster relief operations. This need was based on the fact that it is often difficult for a human being to make decisions about complex procedures that involve a multiplicity of mitigating factors. Analytic Hierarchy Process (AHP) was used to decompose conclusions drawn from the research to develop a model of how various response organizations might prioritize the information types and quality of the data required during a disaster response operation.

## **Pilot Study**

The research began with an analysis of the disaster relief operations. Interviews were conducted to identify and define the communication breakdowns during the disaster relief operations. In order to identify the causes and factors of communication breakdowns, the research also identified the causes and factors responsible for successful disaster response operations. The objective of the pilot study was to develop a questionnaire instrument to identify the important factors and functions that contributed to successful disaster responses. This pilot study consisted of interviews and surveys of people working for variety groups involved in disaster relief operations. Representative organizations included the Federal Emergency Management Agency, state and local agencies, the American Red Cross, and other private organizations such as Salvation Army and church groups.

A series of interviews and surveys were also conducted in order to identify the causes and factors of communication breakdowns, and essential functions for disaster operations. The disaster operation specialists interviewed during this phase of the research were selected on the basis of their expertise and availability. A survey instrument was developed that obtained information about internal and external organizational communications for disaster response. Interviews and surveys were informal. Respondents were specifically asked to define communication breakdowns and identify their causes and factors of communication breakdowns. The respondents identified these facts while recounting problems that arose during previous disaster responses.

The causes and factors of communication breakdowns raised and affirmed by the interviews and surveys are listed in Table 1. The functions related to those communication breakdowns also raised by the interviews are listed in Table 2. Following each factor also listed in Table 3-3. It must be stressed that the causes and factors identified in Tables 2 and the functions identified on Table 3 are more than simply issues of communication breakdowns -- these are identifiers of disaster operation management dysfunction during previous disaster response efforts that have failed to promptly and effectively meet the needs of disaster victims. Table 3, lists the causes and factors related to essential functions by internal and external coordination in disaster operations that respondents to the pilot study identified as the source of communication breakdowns.

The research presents results of disaster expert judgement on adequate information flows and transfer in disaster information management perspectives based on their experiences of the responsiveness and effectiveness of disaster relief operations in the U.S., notably Hurricane Hugo (1989), Hurricane Andrew (1992), and the Northridge earthquake in California (1994).

**TABLE 1  
PILOT STUDY RESULTS (CAUSES AND FACTORS)**

CAUSES AND FACTORS CONTRIBUTING TO COMMUNICATION BREAKDOWNS	NUMBER OF TIMES CITED
1 . Inefficiencies in human resource requirements	3
2. No standard communication procedures during the operations	4
3. Communication failure with other agencies	5
4. Difficulties in inter-organizational hierarchies and structures	5
5. Lack of standardized messages	2
6. Need more bilingual workers	3
7. Duplication of Service delivery	3
8. Misclassified personnel function in staffing	2
9. Lack of consistency on staffing procedures	3
10. Miscommunication on supply support	4
11. Discrepancy of damage assessment data with other agencies	5
12. Lack of understanding from other organization's line of communication and terminology	3

**Total Number of participants for pilot study** **20**

**Expert Judgement Elicitation**

The methodology selected for modeling the communication breakdowns of disaster information management in disaster relief operation was based on the following assumptions:

1. An analysis of rare events can be based on information acquired by the expert judgements of those who have experienced or have come close to experiencing these events.
2. The approach should be tailored to natural disasters, such as earthquakes or hurricanes, in order to integrate expert opinions for same or closely related event.

The use of expert judgement in the evaluation of fast-breaking events is not a new concept, and has been applied in a systematic way in a variety of fields, including the aerospace industry, military intelligence, nuclear engineering, reliability and safety analysis, the evaluation of seismic risk, weather forecasting, economic and business forecasting, and policy analysis. The elicitation, modulation, combination and use of expert judgement, however, are a formidable task that must be conducted with great care. The approaches documented in the literature often do not directly apply and must be tailored to the specific problem at hand. The method selected is strongly affected by the many factors including elements as the number of experts selected, the backgrounds and training of experts, the nature of the information required, the time allowed for the elicitation process, and the level of certainty required.

**TABLE 2**

**PILOT STUDY RESULTS (FUNCTIONS)**

FUNCTIONS CONTRIBUTING TO COMMUNICATION BREAKDOWNS	NUMBER OF TIMES CITED
1. Public Affairs	5
2. Federal agreements	3
3. State/Local agreements	5
4. Voluntary organization agreements (VOLAG)	3
5. Damage Assessments	7
6. Public Relations	3
7. Communication Support Equipment	4
8. Service Delivery Transportation Logistics	3
9. Mass Care and Supply Logistics	4
10. Political Relations	5
11. Financial logistics	4
12. Client Relations(Special Needs, Ethnic Issues)	3
13. Inefficiencies in staffing recruitment	4
14. Resource Acquisition Logistics	3

**Total Number of participants for pilot study**

**20**

**TABLE 3**

**PILOT SURVEY RESULTS**

	FUNCTIONS	FACTORS OF COMMUNICATION BREAKDOWNS
INTERNAL	Damage Assessment	<ol style="list-style-type: none"> <li>1. Initial response based on inaccurate data</li> <li>2. No reflection of interior damages or after-shock damages</li> <li>3. Need a more comprehensive survey</li> <li>4. Getting inconsistent data</li> <li>5. Missing Data</li> <li>6. Did not inform what happened</li> <li>7. Duplication of damage info from others</li> </ol>
	Resource Acquisition	<ol style="list-style-type: none"> <li>1. Communication equipment's failures</li> <li>2. Communication process failure during the operations</li> <li>3. Hardware/Software conflict</li> <li>4. Critical shortage of local trained staff</li> <li>5. Acquisition Logistics</li> <li>6. Miscommunication of needs</li> <li>7. Did not interact with organizations</li> </ol>
	Delivery of Service	<ol style="list-style-type: none"> <li>1. Transportation Logistics</li> <li>2. Inefficiencies in human resource requirements</li> <li>3. Duplication of Service</li> <li>4. Mass Care and Supply Logistics</li> <li>5. Need standard procedure of getting status report</li> <li>6. No status report from other organizations</li> </ol>
EXTERNAL	Dissemination Liaison	<ol style="list-style-type: none"> <li>1. Problems in Agreement <ul style="list-style-type: none"> <li>-State/Local Agreements</li> <li>-Federal Agreements</li> <li>-Voluntary Organization Agreements (VOLAG)</li> </ul> </li> <li>2. No interactions with media</li> <li>3. Public Relations (Special needs and ethnic population issues)</li> <li>4. Political Relations <ul style="list-style-type: none"> <li>- Not clear lines of authorities</li> <li>- No immediate contact with other organization</li> </ul> </li> </ol>

For this research, a framework for eliciting and structuring the expert opinions was developed. The model was formulated as a series of decision hierarchies. This approach also enabled the use of Analytic Hierarchy Process(AHP) as an analysis tool.

### **Analytic Hierarchy Process (AHP)**

The Analytic Hierarchy Process is a method for organizing a problem in a hierarchy to make a sound decision regarding its objectives. The first level of the hierarchy contains the goals of the problem. Subsequent levels contain a breakdown of the factors and sub-factors that affect the achievement of the task. And the final level of hierarchy contains the various alternatives available to the decision-maker in reaching a solution to the question at hand. Quantitative values and qualitative judgements are accommodated within the AHP. The following sections explain the development of the hierarchy:

- 1) The first level of the hierarchy describes the goal of the initial disaster relief operations; for example, better performance of the disaster operations.
- 2) The second level of the hierarchy includes the internal and external essential functions and factors to make more effective and efficient relief operations.
- 3) The third level of the hierarchy describes the sub-factors influencing the second level of the hierarchy.
- 4) Finally, the disaster relief operation is time constrained and trade-off must be made among four criteria of data quality:
  1. Timeliness (Do data offer current conditions?)
  2. Accuracy (Are data correct?)
  3. Completeness (Are critical data missing?)
  4. Consistency (Are there any conflicting values?)

The research questionnaire asked respondents to define communication breakdowns, and to share their opinions on what caused these communication breakdowns. The decisions include: 1. Assessing and determining the scope (and potential scope) of the disaster and determining how much aid will be required for the affected area; 2. Determining where to acquire the resources needed to aid the affected area; 3. Implementing appropriate service delivery actions if any one of these three decisions is flawed, the disaster response may be inadequate or inappropriate to the needs of victims.

Figure 1 describes the objectives needed to develop a hierarchical model includes factors and essential functions responsible for successful disaster response among disaster relief response agencies. These hierarchical tree lists the decision-making factors identified by surveyed disaster relief management personnel. In accordance with Figure 1, the Information Coordination level in the hierarchical model should be replicated to the same functional level on the Information Dissemination/Liaison level -- this applies equally for government, non-government, the public and the media.

However, the questionnaire was developed based on a truncated hierarchy because the relative importance of the one organization's activities on another was not to be explored due to the fact that disaster experts were not able to answer the relative importance of activities on detailed questionnaire to a specific organization. Therefore, the hierarchical model for expert judgement is developed to prioritize the types of information and quality of data required and depicted in Figure 1.

## **Results**

The expert survey was used to prioritize the type of information needed and quality of information

Figure 1

**DISASTER RELIEF OPERATIONS**

**EXPERT JUDGEMENT MODEL FOR**

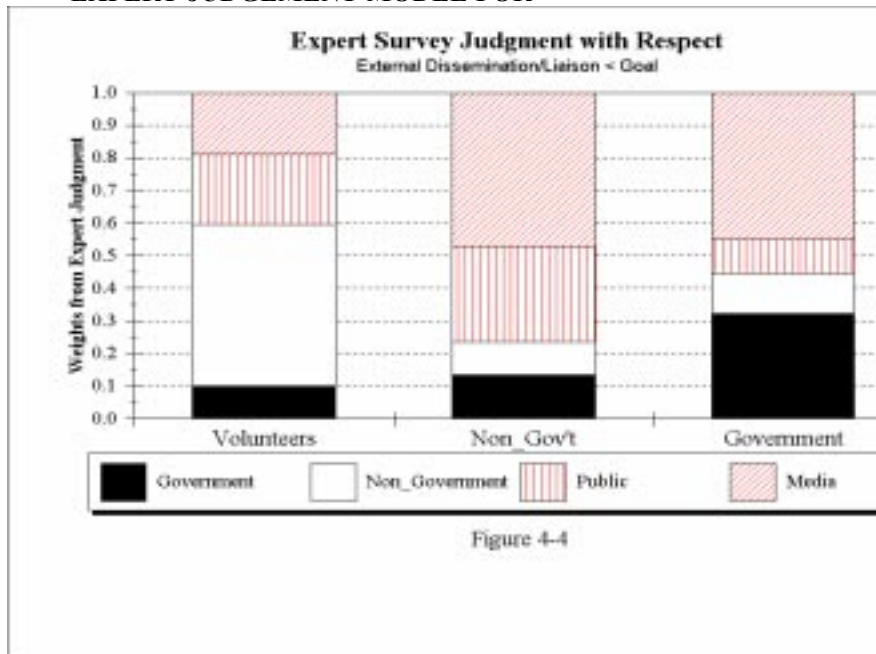


Figure 4-4

- ACCURACY** --- **Accuracy of Information:** An operation is flawed when information is error-prone. A system produces invalid results when it suffers information that lacks reliability and validity.
- COMPLETE** --- **Completeness of Information:** Information must be presented with critical data. For example, A person's SOC number must be presented with name.
- CONSIST** --- **Consistency of Information:** Consistency follows from the control or elimination of redundancy. For example, if a person's address appears in only one place, there is no possibility that his/her social number 111-11-1111 will have the address at one spot within data.
- DAM\_STRU --- Damaged Structure(Types of Property, Seriousness of Damage)
- DEATH&IN --- Death and Injury Information
- DISASTER --- Disaster Assessment Information Coordination
- EQUIPMT --- Equipment Support (Telephone, Communication Support)
- FACILITY --- Facility Operations (Health, Medical and Feeding Facilities)
- FEDERAL --- Federal Agencies
- GEOGRAPH --- Geographical Information
- GOV'T --- Coordination with Government Organizations
- INCIDENT --- Incident Description
- INFO\_COR --- Information Coordination
- INFO\_LIA --- Information Dissemination/Liaison
- INFRA\_ST --- Infrastructure Damage
- LOCAL --- Local Agencies
- MEDIA --- Coordination with Media
- NON\_GOVT --- Coordination with Non-Government (ARC, Salvation Army)
- NON\_VICT --- Non-Victim
- PUBLIC --- Coordination with Public
- RESOURCE --- Resource Requirement/Mobilization Information Coordination
- SERVICE --- Service Delivery Information Coordination
- STAFFING --- Staffing Requirement/Allocation
- STATE --- State Agencies
- TIME** --- **Timeliness of Information:** Timeliness relates more to the transmission of information than to processing or storing of it. An operation suffers from the problem of timeliness if information is available but can not be retrieved when and where it is needed.



VICTIM --- Victim of Disaster Events

required supporting decision-making in initial disaster relief operations management. These results indicate possible reasons for communication breakdowns that occur in relief operations during the initial stages of a disaster response. The sample population was selected on the basis of their past experiences in disaster relief operations.

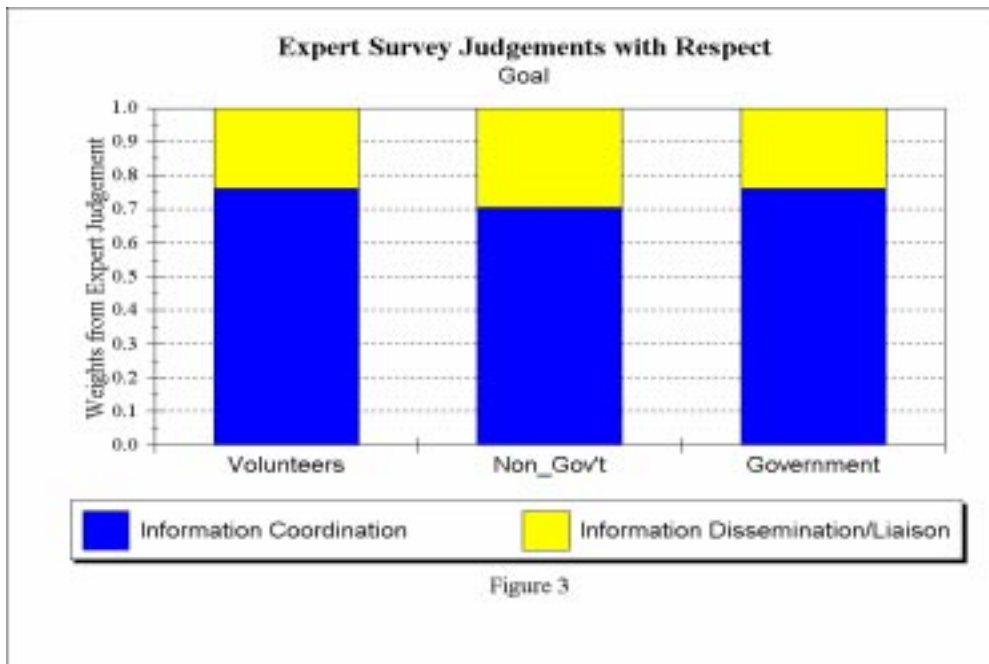
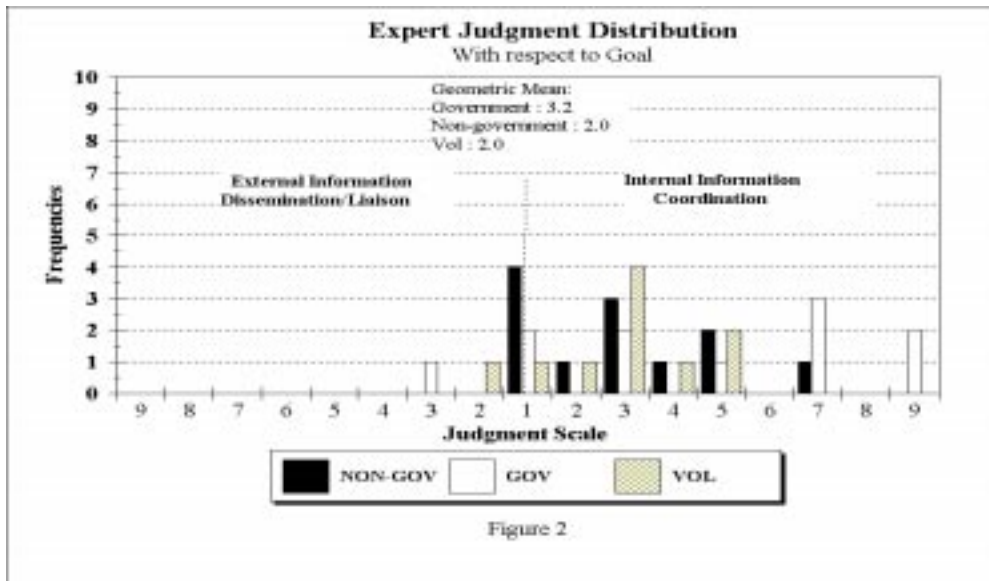
An effort was made to ensure the survey sampled a target population that worked for a variety of disaster relief organizations (i.e. Government agencies, non-government agencies and volunteers), and that the respondents had at least three years of experience on disaster operations. A total of 33 disaster relief experts participated in the survey. There was a 67% rate of response from experts whom the researcher personally interviewed. The distribution of responses is divided into three groups of organizations: Government organizations, non-government organizations and volunteers groups. The surveyed organizations were selected to ensure that -- as a sample population -- they adequately reflected the organizational characteristics of participants in many disaster responses. These characteristics including their funding sources, organizational objectives and employee status.

### **Analysis of Critical Functions**

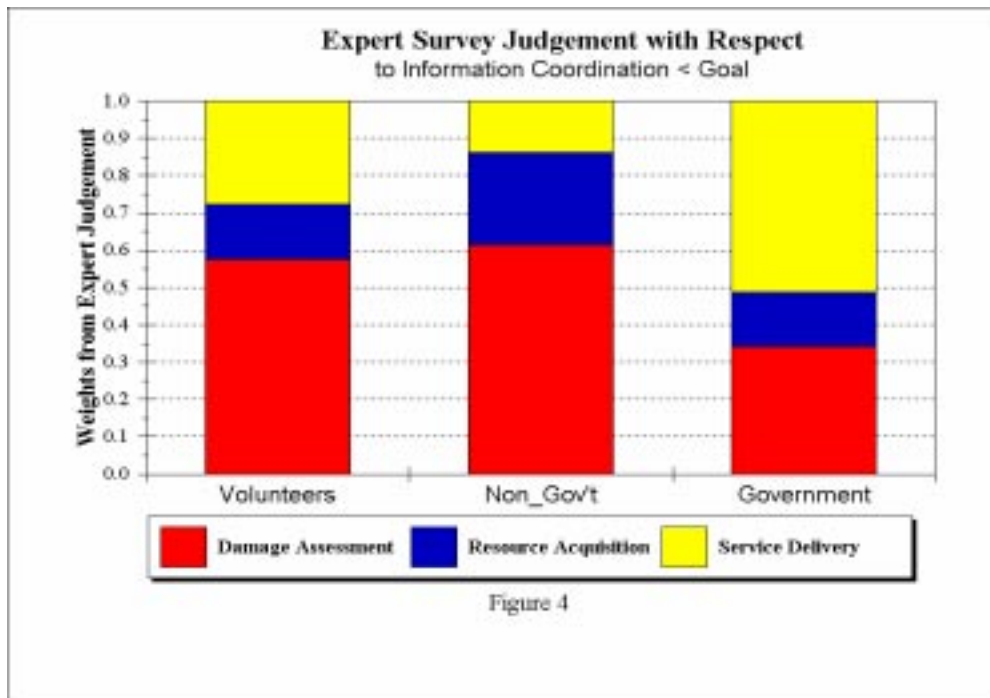
Geometric means from the survey responses were used as input data for the Expert Choice software, assigning a geometric mean to its related factor. Geometric means of expert judgement by three organizations are presented for the top level comparison: Internal Information coordination vs. External information dissemination/liaison in Figure 2. The pairwise comparison used in the survey allows the experts to choose which attribute is more important in each pair and express the strength of comparison on a scale of 1 to 9. Judgement scales are used from AHP modeling process - 9 to 9. The frequencies, vertical axis of the figure, are presented the number of experts answered the relative importance of internal information coordination vs. external information dissemination/liaison on the survey. For practical reasons, it is not possible to present here all of the comparative graphs and other raw data generated by the Expert Choice software. However, the analysis presented here will reveal significant findings in the data.

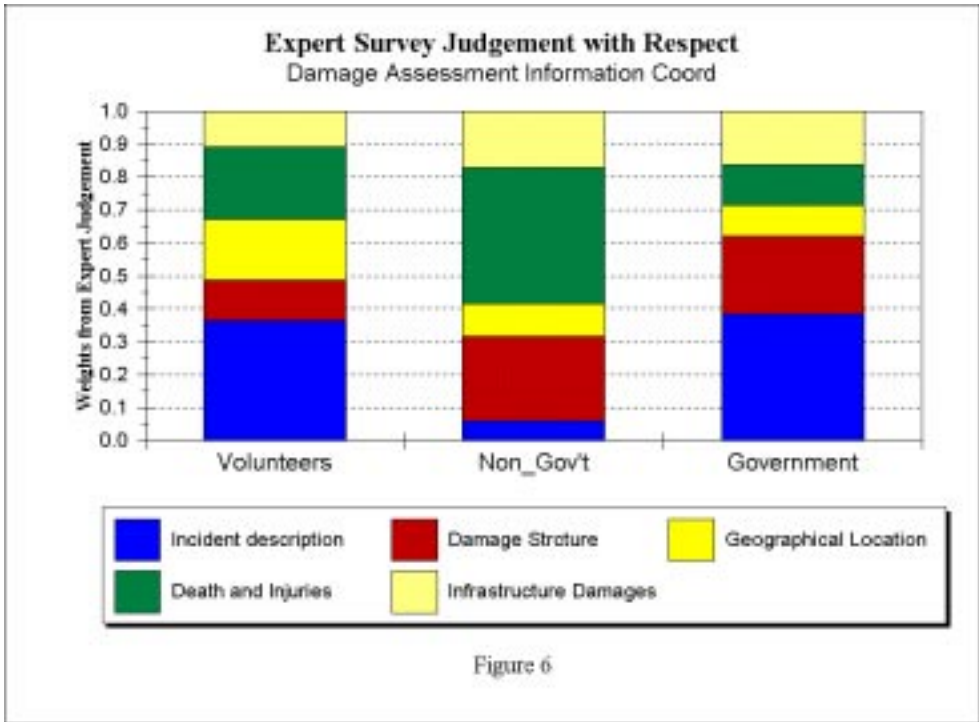
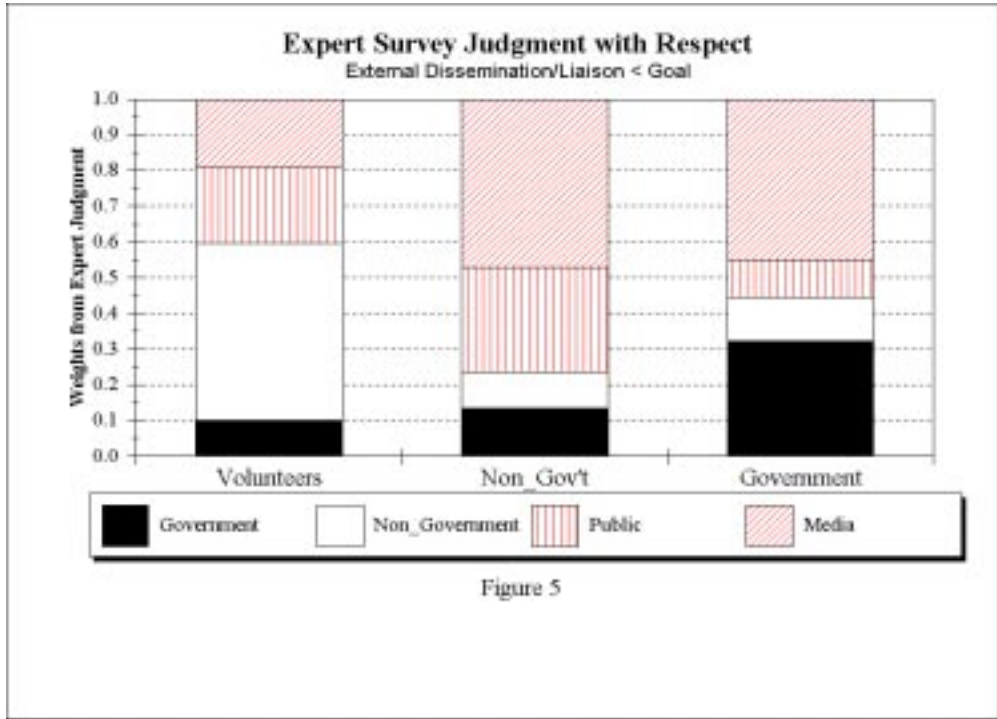
Factors contributing to communication breakdowns in disaster information management were different for some organizations. However, it is clear that, for all three organizations, the timeliness factor is the most important factor for disaster response operations. Timeliness is defined as having information at the right time.

Judging from the results in figure 3, all three types of surveyed organizations believe that during an emergency response operation Internal Coordination is more important than the external Information Dissemination/Liaison. In figure 4, it is clear that among the three types of information that are sub-components of the Internal Coordination (Damage Assessment, Resource Acquisition and Service Delivery), Damage Assessment was found to be most important to Non-Government Agencies (0.614) and to Volunteers (0.574). Figure 4 also reveals that Service Delivery information is of the greatest interest to Government agencies (0.513). However, the Damage Assessment and Resource Acquisition function information within Internal Coordination have different degrees of importance to different organizations. Both Government and Non-Government organizations believe that accurate Damage Assessment data is the most important, but volunteers groups consider that -- regarding Damage Assessment data -- timeliness of this data is the most important.

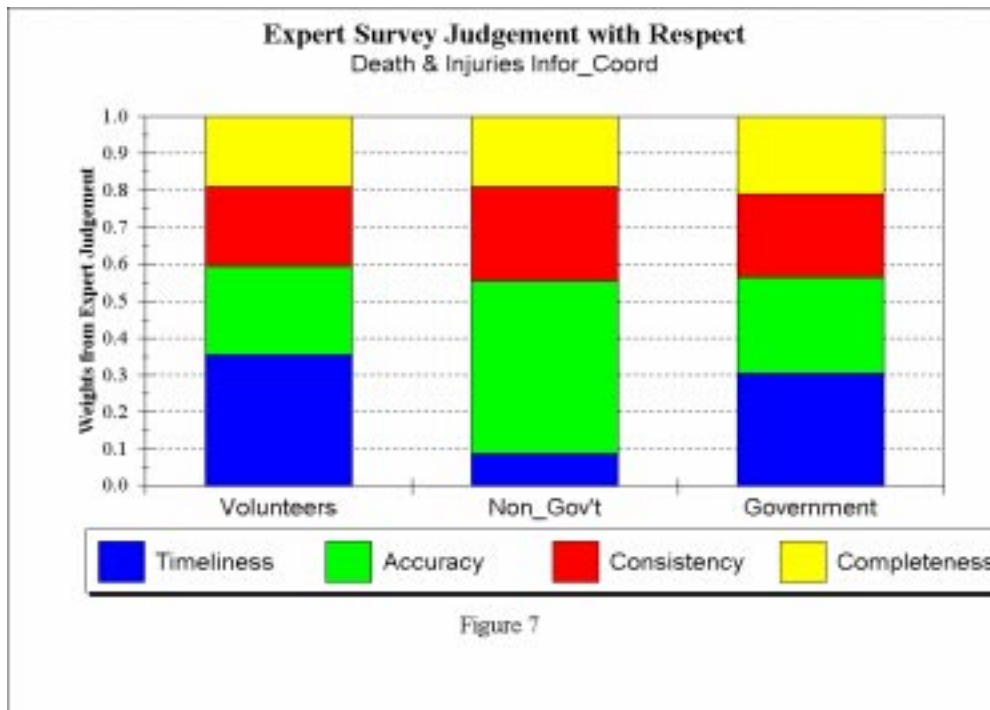


Organizations) is a priority concern for the Volunteers groups (0.497), and reveals that External Information Dissemination/Liaison (with the Media) is of greater importance to both Non-Government agencies (0.470) and Government agencies (0.451). Figure 6 presents survey data regarding the importance of five types of disaster assessment information, Incident Description, Damage Structure, Geographical Location, Death and Injuries and Infrastructure Damages. Incident Description Information is most important to the Volunteer group (0.365) and to Government agencies (0.385); however, this factor is of least importance to Non-Government Agencies (0.059) such as the American Red Cross and the Salvation Army. This figure also shows that "Death and Injuries" data is information that is most important to Non-Government agencies (0.412), but is not of primary interest to Volunteers and Government officials. The timeliness of data quality in Incident Description Information coordination activities is also shown by figure 5, to be of greatest importance to volunteers (0.419), but Non-Government and Government agencies (0.456 and 0.419, respectively) gave greater priority to accuracy.





However, the accuracy data quality within death and Injuries Information Coordination factor (Figure 7) is of greatest importance to Non-Government agencies (0.469), and completeness of data quality is the second-most important factor to Non-Government officials. Timeliness of data quality for casualty information is the least important to Non-government organizations. However, this figure also shows that Volunteers (0.356) and Government agencies (0.306) have concerns which are more focused on the "Timeliness" of death and injury information.



## Conclusions

The research identified the causes and factors of communication breakdowns as hardware failures, software failures, organizational failures, and human failures. The research grouped the essential functions of disaster operations into three categories: damage assessment, resource acquisition and service delivery. Linkages that can be drawn from causes and factors to functions were discussed and were also represented graphically. The research found that the need for information and the degree of required quality for that needed information varies from one disaster response organization to another. With respect to expert judgements on prioritizing the types of information and quality of data required during disaster operations, opinions were significantly varied regarding the factors of "Internal Coordination" and "External Information Dissemination/Liaison".

The research revealed that accuracy of data quality is the most important on "Internal Coordination" to Non-Government organizations, and timeliness of data quality is the most important on Internal Coordination to Government organizations. Consistency of data quality is more important than completeness on External Information Dissemination/Liaison to Non-Government organizations, however, completeness of data quality is more important on external Information Dissemination/Liaison to Government organizations. One of the most critical problems facing respondents to a major disaster is the inability to obtain a practical understanding of the needs

created by the disaster. These different perceptions of data quality between internal and external information coordination indicate how communication breakdowns can occur. Opinions varied widely when the research asked representatives of various types of disaster relief organizations to prioritize the three types of essential function within the Internal Coordination factor. Discrepancies in the quality of data requirements in essential functions -- timeliness accuracy, completeness and consistency -- among the response organizations also contributed to information breakdowns on essential functions in disaster operations. For both Non-Government and Government organizations, accuracy of data quality is the most important on Damage Assessment function, and timeliness of data is the most important on Resource Acquisition function and Service Delivery function. Non-Government respondents felt that the completeness of data quality is more important than accuracy of data quality on the Resource Acquisition function..

The research showed that differing perceptions of information requirements for various functions were often the source of communication breakdowns. The research also revealed that these differing priorities often lead to overestimated or underestimated damage assessments being delivered within and among organizations. There was also consensus among respondents that the Staffing function is the most important function in the Resource Acquisition function. However, Non-Government respondents judged completeness of data was more necessary than accuracy of the quality of data. Accuracy and timeliness the qualities of data were almost equally important to Government organizations. Most respondents felt that the transfer of poor quality of data among organizations often lead to inefficient recruitment and deployment of human resources needed to respond to the disaster.

This discrepancy of opinion indicates that communication breakdowns are often problems endemic to an organization, and are not always a component of its relationship with another organization. Therefore, the research indicates that communication breakdowns that occur within and among organizations are organizationally dependent. With respect to question four, the model developed in this research found that communication breakdowns indeed do occur among organizations. However, because the research did not statistically measure the data requirements (Timeliness, Accuracy, Completeness, and Consistency) for all essential functions of each organization, it was not possible to predict organizationally dependent information requirements. At the very least, the research partially proves that the causes and factors of information breakdowns have ultimately led to organizationally dependent communication breakdowns among response organizations.

### **Implication of the Research**

Every government agency involved with disaster response operations has its own legislative mandate and, in general, each entity is diligent in carrying out its mandate. However, if all organizations hope to achieve full cooperation during a disaster response, many inconsistencies in the management of information within and between organizations will have to be eliminated. The functional responsibilities of every relief organization are different, and understanding how to translate differing capabilities and concerns into a unified inter-organizational interaction is a major priority. One way to achieve this interaction -- and, thereby, enable organizations to execute high-performance and high-reliability disaster operations -- is to field a standardized communications network which will permit all participating response organizations to share information that meets their requirements for availability and quality.

Among many disaster response organizations, there is a coordinated effort to develop disaster management information technologies. To date, however, there is no standardized set of requirements for the types of information to be shared among disaster relief organizations, nor have any standards been set on the quality of this shared information.

The research showed that disaster response organizations had differing priorities regarding the quality of information within the external Information Dissemination/Liaison factor. Timeliness of data quality was most important to Non-Government Agencies; whereas, accuracy was the biggest

concern to Government Agencies. These differing priorities may be responsible for overestimated or underestimated damage assessments being delivered to the media. Another research finding which offers potential guidance to information managers involves the findings that differences in perception of organizational data quality requirements (Timeliness, Accuracy, Completeness, and Consistency) often leads to poor quality of data transfer among disaster response organizations. In order for planners to select the best technologies for collecting, processing, and transmitting information, they must first establish priorities for what types of information they require. Next, they must plainly describe the quality of the data they require. In the wake of recent technological and natural disasters, large amounts of money have been spent on developing information technologies for improving disaster relief operations. Additionally, disaster simulation exercises have lately been used to test and evaluate state and local governments' operating plans, and to assess if they are capable of responding to an emergency effectively. Clearly, a large amount of money has been invested to improve disaster response and recovery information technology. Though response organizations have made significant improvements in the technology systems to support disaster operations, impartial assessments to determine what does and what does not work have not been done. Very often, information technology put in the field to speed the flow of information could actually impede -- rather than enhance -- a disaster response effort.

Communication breakdowns created by misleading information flows and other factors have yet to be adequately identified. Effective disaster information management implies the ability to collect, verify, manage, distribute, and share information with other response organization, decision making groups and individuals. This research concentrated on the management of disaster information within and among disaster response organizations during the first 72 hours of a disaster. In order to adequately analyze the efficiency and effectiveness of information management within and among disaster relief operations, it is recommended that future research focus on how the disaster information requirements change during later phases of a disaster response.



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