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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. Very often, these collective decisions are made by teams of people separated by great distances, with differing goals 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 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. The inability of response organization to adequately coordinate information among the response agencies creates problems for communities struggling to recover from a disaster.

This research investigated the causes affecting communication breakdowns in past disaster responses. It also investigated critical factors and functions that comprise disaster relief operations. 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 elicited on the expert judgements from successful disaster response professionals. The model, based on AHP, provided a method for comparing the importance types of information and the requirements for quality during the first 72 hours of disaster relief operations. Questionnaires ,developed based on the model, were used to elicited expert judgement to disaster response professionals. 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.

DEDICATION

I would like to dedicate this dissertation to my parents, Dong W. Jeong and Chung S. Seo, and my wife Yoon H. Choi.

ACKNOWLEDGMENTS

I would like to express my deep appreciation to Doctoral Advocate, Professor John R. Harrald, for guiding me through whole process of writing this dissertation. I also thank other committee members, who have supported and directed this research, include Dr. R. Scott, Dr. Mike Donnell, Dr. Tom Mazzuchi and Dr. Mike Lindell to complete this research. I am grateful to all of the participants who supported and the efforts by completing exert survey questionnaire.

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INTRODUCTION

1.1 THE DISASTER MANAGEMENT ENVIRONMENT

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 wild-fires have claimed more than 2.8 million lives worldwide in the past 20 years[1].

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 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

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[1]Confronting Natural Disasters,"International Decades for Natural Hazard Reduction", *U.S. National Academy of Engineering Society.*, 2nd edition, 1987. p. 1-7

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.

An 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.

Downward diffusion of authority, miscommunication, communication breakdowns, poor coordination, the need for faster decision-making, and poor utilization of resources are all symptomatic of information overload -- a component of managing responses to modern disasters that increasingly tests the cognitive limitations of decision-makers.

Uncertainty inherent in human thought is another factor affecting the value of decisions made during an emergency. When disaster coordinators feel uncertain, their decisions tend to be narrowly focused, contain limited options and lack innovation. Sometimes, uncertainty in disaster coordinators' thought processes will prevent them from

making any decision at all.

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.

Each year, teams from FEMA (the U.S. government's lead agency for disaster management) routinely and -- for the most part -- effectively respond to dozens of small natural disasters. However, in 1992 the nation's entire infrastructure for managing disasters -- which includes FEMA, as well as state, local and voluntary organizations like ARC -- was severely criticized for its mishandling of the devastation created by Hurricane Andrew in Florida, and by Hurricane Iniki on the island of Hawaii.

The inability to adequately respond to these two nearly-simultaneous hurricane disasters made it clear that the United States needs a better organized and more effective disaster management system which involves all levels of government, as well as private and non-profit business organizations, with the capability to effectively handle large and even simultaneous natural disasters.

One deficiency in the Federal government's strategy for responding to disaster was its lack of a provision for the immediate assessment of the physical damages, and the corresponding needs of disaster victims. This shortcoming was most evident in the U.S. government's intervention after Hurricane Andrew in South Florida. Complete coordination

of the response to this disaster was inhibited by a lack of standardized operational concepts and procedures. An official analysis of Washington's response to Hurricane Andrew and Iniki uncovered several problems, many exemplified by errors committed by officials attempting to intervene in South Florida.[2]

The study found that Washington's Federal Response Plan actually prevented disaster response officials did not enable to adequately dealing with the catastrophic events[3] The Plan, said the study, "lacked a provision for the comprehensive assessment of disaster-related damage and the needs of disaster victims."

Past responses to catastrophic disasters have suffered from inadequate assessments of physical damage and of the needs of disaster victims. Disaster responses were often ineffective because of poor communications, unclear legislative authority and the deployment of response personnel who were unprepared and untrained.

According to the study, the Federal disaster response to Hurricane Andrew in South Florida suffered from : 1) miscommunication 2) lack of clear definitions of the roles and responsibilities responding of agencies 3) lack of standard concepts of operations and

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[2]It was the largest loss from a natural disaster in U.S. history; an economic loss of about 30 billion, the destruction of or serious damage to at least 75,00 homes and 8,000 businesses, and the homeless of more than 160,000 people.

[3]Report to Congressional Requesters, Disaster Management, Improving the Nation's Response to Catastrophic Disasters, *United States General Accounting Office*, July 1993. p.5

procedures, and 4) inadequate coordination efforts, resulting in a inefficient and ineffective response. The resulting confusion also slowed the delivery of vital services to disaster victims.

1.2 INFORMATION TECHNOLOGIES IN DISASTER RELIEF OPERATIONS

There has been an on-going effort by many disaster relief authorities to develop an effective information management strategy which would improve disaster response and recovery operations. This effort has largely entailed the fielding of information technologies, including mobile information and telecommunications systems.

There has also been work to improve interactive communication between national and local disaster relief offices. These improvements seek uniformity of the overall mission, and attempt to balance this with the work requirements of agency program units.

The growth of data communication in the management of disaster response activities makes field-transportable computer network services not just desirable, but essential. When emergency communications technologies are fully fielded, they can be expected significantly to enhance the preparedness and responsiveness of disaster relief operation managers.

Communication technologies have evolved considerably in recent years. "Distributed communications architectures", for example, enable transmission systems to be less

centralized. Microprocessors and modular packaging have fueled the prodigious growth in "distributed architecture" communications, notably cellular telephone systems, local area networks (LANs), metropolitan area networks (MANs), Wide Area Networks (WANs), and the Internet. The compaction and modular architecture which these configurations exploit make them logical candidates for disaster relief applications.

1.3 STATEMENT OF THE PROBLEM

Improvement of the nation's ability to adequately respond to catastrophic disaster is an essential and widely supported goal. This is because of worsening weather presence and increasing disaster frequencies in recent years. Disasters or national emergencies whose effect could equal or exceed the damages and human sufferings caused by Hurricane Andrew have become the new standard for preparedness.

Federal agencies traditionally are prepared to a lead role in responding to catastrophic disasters, but other organizations, including state, local governments and private and voluntary organizations also need to be integrated with the plans and procedures of an effective national disaster response system. For a national disaster response system to have value, it must effectively coordinate activities between local, regional, state, and Federal agencies.

Officials taking part in an effective post-disaster response and recovery operation

require a clear chain of command, and need to share a commitment to work together within a common organizational structure.

Increasingly, disaster response relies on decisions being made by groups and teams, rather than decisions being made in a traditional "top-down" organizational structure. In order to improve the effectiveness of this team thinking, many organizations turn to computer-supported technologies. Advances in computer technologies, teleconferencing, computer networks, bulletin boards, and "collaboration laboratories" had been shown to enhance the performance of groups making collaborative decisions.

Despite these technological advances, however, the most common operational problem in disaster relief operations remains the breakdowns of communication among information-dependent, disaster relief organizations and government decision-makers.

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.

1.4 PURPOSE OF THE RESEARCH

The purpose of this research was to demonstrate how communication breakdowns occur during disaster relief operations among response organizations, and the types of information needs and quality of information required during relief operations to reduce the impact of a natural disaster. This research was focused on analysis of the information flows among participating organizations and on the decision-processes used to resolve problems during management of a response to catastrophic disasters.

The research also reviewed professional literature and research reports to determine the systemic relationship between the process of managing information and the process of making a decision in disaster operations. It also looked into how these processes enable disaster response organizations to effectively deal with a potential disaster situation. Finally, the research examined the role of communication technologies in facilitating effective decision-making.

The flow of information between Federal, state, local, and private sector organizations involved in disaster relief operations is dependent upon communication channels and resource mobilization channels. The research investigated causes and factors of communication breakdown in poorly coordinated and inefficient relief operations. The research analysis identified causes and factors related to essential functions in disaster relief operations.

During a disaster, coordinating the transfer of logistical resources is best accomplished after the location, custodial agency and point of contact are identified and queried. The research in this paper identifies "information dissemination/liaison" problems that occur among disaster response agencies during the early stages of an disaster response.

This research facilitated the development of a hierarchical model for adequate information flows and transfer within and among disaster response organizations in disaster relief operations during the initial stages of a disaster relief operation. The research did this by defining a "communication breakdown" during a disaster relief operation as either the inability to obtain essential information, or the inability to obtain information of sufficient quality required to support decision.

The research identified critical factors and functions during disaster operations. The results of the research demonstrate whether communication breakdowns that result in inability to obtain information are organizationally dependent, and whether the delivery of

poor-quality information is organizationally dependent.

The model developed by this research whether the communication breakdowns occurs within and among disaster response organizations in disaster response operations was based on a decision-making structure of "expert judgement". This model relied on the good examples set by decision-makers who successfully responded to previous disasters.

CHAPTER 2

REVIEW OF THE RELATED LITERATURE

This chapter contains literature reviews of 1) the problems encountered and the characteristics of decision-making in disaster relief operational environments, and 2) the requirements for information management systems to support effective disaster relief operations. It also identifies the information technologies and communication systems necessary to effectively support disaster relief operations, and reviews different organizational perspectives in disaster management.

2.1 PROBLEMS IN DISASTER RELIEF OPERATIONS

Disaster relief operations often overlook the need to communicate with the disaster victims themselves and their public officials, especially in remote areas and neighborhoods. These areas normally have little access to more formal community information networks. In smaller communities, public officials usually know how to conduct basic rescue operations, but seldom know how to conduct response and relief operations in the wake of a disaster.

After a disaster strikes, victims may need to be provided information critical to their

survival. Sometimes, this information must be distributed in foreign languages or through printed media. The news media will often communicate much of this critical information to the public, but it is likely that many disaster victims will not have access to (or not be able to) read newspapers, watch television or listen to the radio. Disaster relief agencies may need to turn to alternative means of communication (leaflets, posters, or loudspeakers mounted on air- and ground-based vehicles, for example) to get critical information to the public.

More formal communication may be necessary to reach government officials, particularly if they are people responsible for the well-being of the victims in their communities. Information that needs to be immediately conveyed to these officials includes: Data regarding the availability of disaster assistance; who can provide this assistance; and information about how constituents can take advantage of available recovery resources. Public officials and other disaster response agencies also need to be quickly tied into available emergency communication networks.

One of most commonly cited problems associated with ineffective disaster relief efforts is communication system breakdown. The effectiveness of a communication system depends upon how it is linked with other systems.

During the relief effort that followed the eruption of Mount St. Helens, a major problem cited by emergency personnel was the incompatibility of the various communication systems in use. In many cases, military radio operators responding to the emergency were

unable to communicate with their counterparts in police and disaster relief agencies.[1]

A contrast to this communication failure is seen in the disaster response mounted by the Federal Emergency Management Agency's (FEMA) in the wake of the catastrophic 1994 earthquake in Northridge, California. While mobilizing for this disaster, FEMA first considered establishing a headquarters at its regional offices in nearby San Bruno, California.

Incoming FEMA official immediately concluded that FEMA's San Bruno office was too small to accommodate the communication and personnel requirements. Rising to the occasion, FEMA's networking group set up a new, larger applications processing office, assisted by a team of more than two dozen technicians from the U.S. Navy Mobile Technical Unit. Working 18 hours in a day, 36,000 feet of local area network cabling and miles of power cable were set up and a new communication system was made on-line in only four days. It was the largest application processing system FEMA had ever built.

Communication mix-ups and role duplications can also impede a disaster relief operation. After Hurricane Hugo cut a devastating swath of destruction across South Carolina in 1989, the ability of disaster response agencies to effectively coordinate relief activities was hampered by organizational and communications problems, often at the state level.

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[1]Vessy, Robert D. and Aponte, Jose A., "Needed: The Right Information at the Right Time," Report of the International Disaster Communication Project (September 1989): p. 11.

Hurricane Hugo relief operations initially involved two state emergency operations centers, both set up -- unbeknownst to each other -- in Columbia, the state capital. One disaster relief operations center was operated by the South Carolina Emergency Preparedness Office (SCEPO). The other operations center was established by the governor of South Carolina within his office. The governor took this step to ensure he had immediate and direct control over his state's response efforts, and to field requests from state and local officials. The governor's staff set up the second office because it was felt that SCEPO was not being fully responsive to the disaster.

The Hurricane Hugo disaster response operation, with its two separate crisis centers, was ill-suited to the state's official emergency response plan, and often launched duplicate or conflicting relief efforts. While these two command posts were in existence, officials were uncertain where to submit requests for aid. According to state emergency preparedness officials, five requests from counties to the state for assistance were never acted upon because of coordination problems between the competing disaster relief centers.

About a week after Hugo struck, SCEPO's operations center began to receive follow-up calls on requests for aid from mayors and other local officials. Baffled, SCEPO called the governor's office and finally became aware that many urgent messages from disaster victims were being forwarded to the governor's operations center.

In its independent analysis of the Hurricane Hugo relief effort, the governor's

Emergency Management Review Panel reported[2] :

> "During Hurricane Hugo, the Governor's Office experienced information difficulties with the Emergency Preparedness Division. These problems were the direct result of the magnitude of the damage and overwhelming influx of information that the Emergency Preparedness Division received."

Hurricane Hugo disaster relief coordination activities were also hampered by communication systems that were rendered defective or inoperable as a direct result of the hurricane. Storm damage to electrical and telephone systems in South Carolina also impeded communication between agencies, and obstructed the ability of state and local personnel to respond effectively to the disaster. Many member radio stations in the State's Emergency Broadcasting System become inoperable due to power outages, lack of back-up generators or physical damage to equipment. As a result of this experience, South Carolina is planning a new emergency communication network.

During the 1992 Hurricane Andrew relief operation in South Florida, inadequacies in the emergency response plan became immediately apparent. State, local and volunteer agencies fell far short of providing the amount of life-sustaining services needed in the

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[2]General Accounting Office, Disaster Assistance: Federal, State, and Local Responses to Natural Disaster Needs Improvement, Washington: GAO/RECD, 1993, p. 12.

immediate aftermath of this disaster. In addition, local officials -- who in many cases were themselves victims of the storm -- had difficulty communicating with each another, and were often unable to make their assistance needs known to state authorities.[3]

The Federal Response Plan developed by FEMA after Hurricane Hugo in 1989 does not have a support function for damage and needs assessments, even though the plan itself recognizes that the magnitude of damage to structures and lifelines can rapidly overwhelm the capacity of state and local governments to assess the disaster and to identify and respond effectively to basic and emergency human needs.

Despite this obvious shortcoming, FEMA still relies on state and local governments to alert the Federal government of the relief services they require -- even though past experience had taught them that government officials at the local level are seldom able to adequately determine their disaster assistance needs.

Conducting damage and need assessments as soon as a disaster occurs enables local, state, and Federal agencies to know what type and how much of a response is needed within the first 48 hours of the disaster situation.

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[3]"Disaster Management, Recent Disasters Demonstrate Need to Improve the Nation's Response Strategy to Catastrophic Disasters". (Testimony before the Committee on Governmental Affairs, United States Congress). United States General Accounting Office, (May 18, 1993): p. 6.

The lack of a comprehensive damage assessment model and the inability to translate that assessment into an overall estimate of the services needed was one of the most glaring deficiencies in the response to Hurricane Andrew. Local officials in South Florida -- lacking provision for FEMA to either oversee or conduct a comprehensive damage assessment that could have been used to estimate the services needed by disaster victims -- adhered to disaster procedures drawn-up by officials in Tallahassee. These procedures were based on the assumption that state and local governments would immediately conduct damage assessment surveys. The data derived from these surveys -- according to Florida's disaster relief plan -- would have been used to formulate the state's formal request to the Federal government for disaster relief.[4]

2.2 INFORMATION MANAGEMENT IN DISASTER RESPONSE

Disaster relief operations are complex, and often must be organized under conditions of uncertainty. For these reasons, the management of information is critical to the ability of authorities to act effectively. The organization and flow of information -- particularly information regarding disaster conditions and disaster response needs -- dictate the actions of personnel working within a disaster management system. Designing procedures for regulating the amount, kind and sources of information transmitted within and between organizations engaged in disaster management is central to timely, informed choices by

[4]Traditionally, FEMA and state officials conduct a preliminary damage assessment before the state requests a presidential disaster declaration.

organizational decision-makers.

The skillful use of external memory devices -- including computerized decision-support systems, resource lists and maps -- increases the likelihood that relevant information is available to decision-makers at the appropriate time. During disaster situations, the types of information-search, processing and dissemination procedures determine the degree of organizational learning and the degree of organizational control of interdependent action.[5]

To effectively coordinate responses to a disaster, it is essential that relevant information be allowed to move freely within and between participating disaster relief organizations and agencies. The style, content and flow of this information is critical to gaining the attention and cooperation of organizations taking part in the search for disaster relief solutions.[6]

Flowing among these participating disaster relief organizations, information creates a basis of shared understanding of emergency requirements, and supports norms for collective action in the disaster management system. The ability to gather, process and disseminate information quickly and accurately throughout the multi-jurisdictional disaster management

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[5]Feldman, Martha and March, James G., "Information in Organizations as Signal and Symbol," Administration Science Quarterly 26, (1981): pp. 171-186.

[6]Nelson, Richard K. and Yates, Douglas, eds. Innovation and Implementation in Public Organizations. Lexington, MA: Lexington Books, 1987.

system reduces uncertainty at every level of disaster response organizations, thereby increasing the effectiveness of the system as a whole. Information processes, carefully designed and implemented, play an integral role in the disaster management system.

2.3 CHARACTERISTICS OF DECISION-MAKING IN DISASTER MANAGEMENT

The decision-making processes employed by a disaster response organization is distinctively different during emergency conditions. When a disaster strikes, problems are ill-structured. Environmental conditions are changing and dynamic. The number of involved respondents and victims can increase and decrease dramatically. Time is critical, and situation complexity increases geometrically with the severity of conditions and the amount of interaction among participants and conditions. Systematic methods of decision-making, based on the orderly search of all possible alternatives for action, prove less effective in a complex environment than "rules of thumb" or heuristic decision-making processes.[7]

In the uncertain environment of a disaster, heuristic search and problem-solving practices acknowledge the element of innovation involved in decision-making. The function of design in emergency decision-making processes is to structure the elements of decision-making -- information, timing, known constraints -- and then make the most appropriate choice in the most timely fashion. This process, while not rejecting systematic decision-

[7]Comfort, Louise, K. "Action Research: A Model for Organizational Learning," Journal of Policy analysis and Management 5. No. 1 , (1985): pp. 100-118.

making procedures, does not necessarily employ them for decisions made within the operating constraints of a typical emergency management cycle. Ideally, a designed decision-making process organizes and delineates relevant information in a sequence and format that can be quickly accessed by decision-makers.

However, the complexity of today's disaster management environment tends to invalidate existing rules for decision-making, particularly if these rules rely on definitions that are too narrow. Restating this dilemma in the parlance of "artificial intelligence" experts, the logic of decision-making in disaster environments is "imprecise".

Many disaster response organizations recognize the role of the computer as a tool for better disaster-related decision-making and efficient development of disaster management support systems. Scholarly papers have proposed ways in which computer technology is used to manage a response to a disaster. Some of the proposals, which advocate computer-based Decision Support Systems (DSSs) and other information management systems, have been applied to improve public disaster management decision-making.[8] The literature in this field identifies components of computer systems that can effectively distribute information among disaster management personnel, and explains how computers can be applied in the management of a disaster response.

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[8]Belardo, S.., K.R. Karwan and W.A. Wallace. "Managing the Response to Disaster Using Micro-computers," Interfaces 14. (April 1984): pp. 29-39.

Wallace describes the major components of an effective and fully functional disaster response support system[9] (Figure 2-1) This system includes:

Data bank. A data bank contains critical emergency response information, such as the status of the disaster, what response resources are available, and the weather situation. The data bank relies on data analysis or normative models software to organize relevant information from the domain that can be manipulated or analyzed.

The data analysis component of the Data Bank uses statistical techniques to establish trends (time series analysis), differences (analysis of variance) and relationship (regression) among the data. A normative modeling component of a Data Bank helps to provide solutions that are not readily apparent, and enables users to evaluate the trade-offs between alternative solutions and -- possibly -- recommends actions to be taken.

The data bank's "modeling" component refers to two distinct class of models: prescriptive models or normative models which (in a strict sense) search for the best or optimal solution from a set of alternatives (e.g., linear programming); and prescriptive models that examine implications of alternative courses of action (e.g.,simulation) (Friedman, 1975). Both classes of models use operations research and management science techniques.

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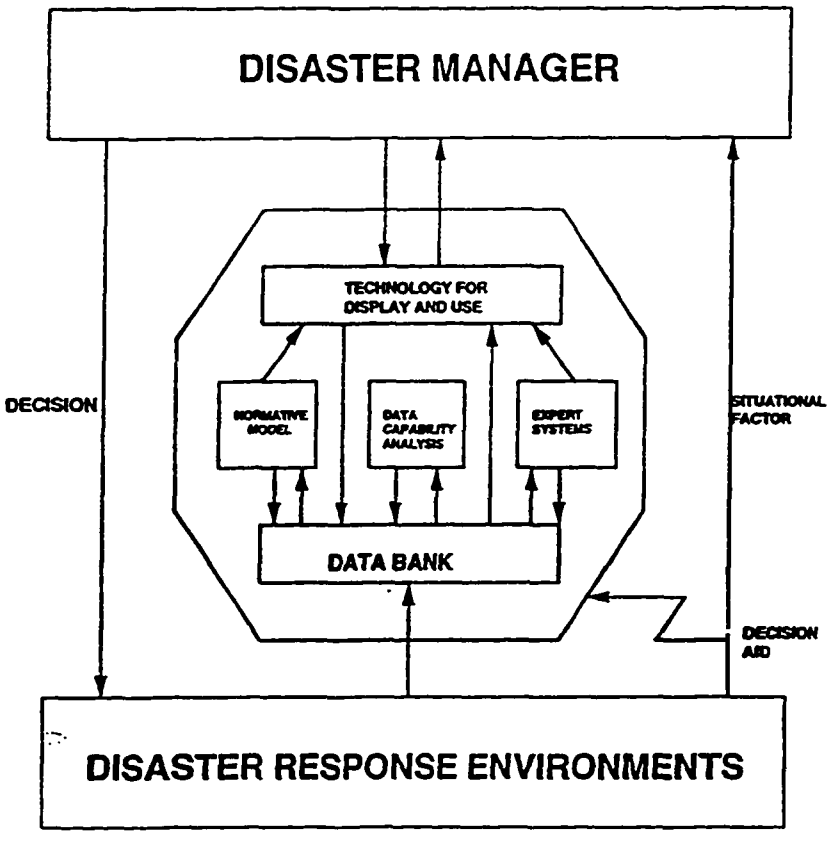
[9]Wallace, William A. and De Balogh, Frank. "Decision Support Systems for Disaster Management," Public Administration Review (special issue).(1985): pp. 134-145.



Components of a Disaster Response Decision Aid

Figure 2-1

Reproduced from "Decision Support Systems for Disaster Management", Public Administration Review ,1985

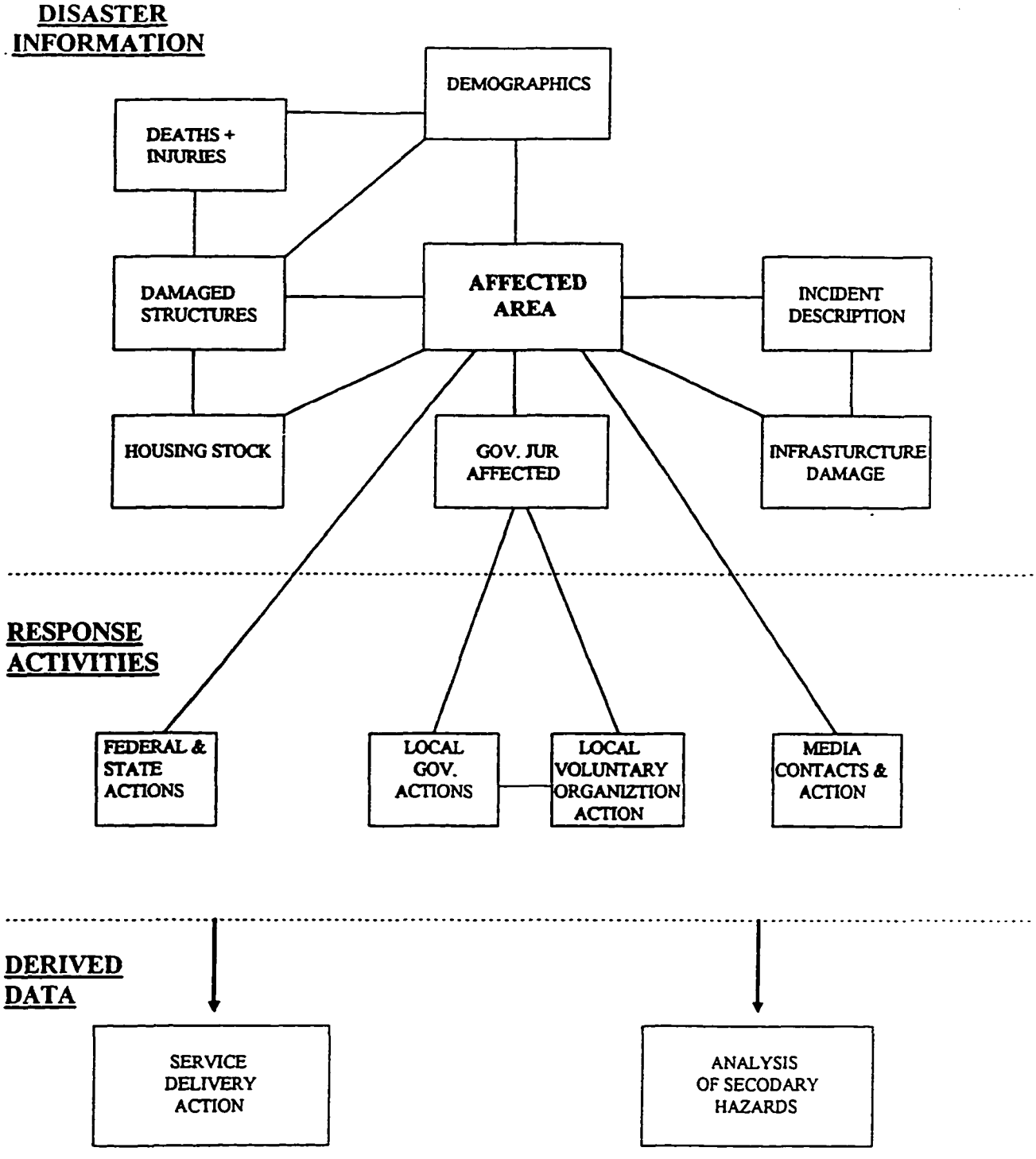
Many systems developed for emergency planning or response can be expressed in terms of these models.

Expert system. The expert system component of a decision- making system employs a rule-based view that has captured the expertise of expert disaster managers. Using this data, production rules offer response recommendations to the disaster managers.

Display/Interactive Uses. This final system component -- the technology needed for display and interactive use. This technology facilitates the linkage between the disaster managers and other components of the decision support system. This technology exploits data and models, a process of technology exploitation known as "user interface." User interfaces facilitate the formulation of user questions with various communication-related peripherals, such as light pens, keyboards, touch screens, and voice recognition/synthesis systems.

The quality of a decision made during an emergency is a function of the quality of the information received, the cognitive abilities of the decision-maker and whether the trade-offs associated with various alternatives are appropriately assessed and evaluated.

The information quality in the decision-making process depends upon the ability of the information system to gather and process data. Disaster support systems (figure 2-2) are intended to provide users with several applications: 1) automate clerical functions, thereby



Disaster Support Systems

Figure 2-2

increasing the time available for decision-making; 2) provide a structured framework for computational models; and 3) facilitate a better understanding of decision alternatives.[10]

The study performed by John R. Harrald and Salvatore Belardo represents an innovative framework for the application of existing Group Decision Support System (GDSS) technology to a problem of great importance to our increasingly technological society: the development of effective contingency plans for catastrophic events.[11]

Over the years, researchers have examined some of the variables which contribute to a crisis situation and which enable organizations to be better prepared for future crises. Studies have also examined the links between crises, technology, human factors, and organizational/communication systems. However, these studies have only examined the ways which organizations respond to different types of crises or their phases.

An extensive amount of literature and research has addressed the problems of disaster management and decision support. Decision-making during a crisis situation is distinguished by "the increase in rate of decision-making" and "number of decisions made" particularly at lower levels of the organization (Dynes and Quarantelli, 1976).

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[10]Kosy, D.W.,Knowledge-Based Support Systems for Long-Range Planning. Robotics Institute, Carnegie-Melon University, Pittsburgh, PA. (December 1983): pp. 45-84.

[11]Belardo, S. and J.R. Harrald. "A Framework for the Application of Group Decision Support Systems to the Problem of Planning for Catastrophic Events," IEEE Transactions on Engineering Management. Vol. 39, No. 4. (November 1992): pp. 400-411.

Dynes and Quarantelli (1977) also note that there is an increase in the rate of decision-making and the absolute number of decisions made during an emergency situation. They observe that organizational resources are committed quickly -- often to tasks outside of the organization's previous domain of competence. External frustration with this decision-making process often causes an organization to lose autonomy during a crisis situation, and may necessitate it being brought under the management umbrella of a new coordinating arrangement.[12]

During most disaster situations there is no lack of data, but -- often -- an inability to put the data into a form useful to decision-making[13]. Often, decision-makers in an emergency situation are unable to define their decision-making environment (through the historical data and current procedures), since each new emergency seldom exactly matches prior emergencies.

Based on a review of existing plans and an assessment of actual response activities, the ability of disaster response personnel to create realistic procedural scenarios is difficult for the following reasons: 1) planners are unable to conceive of true worst case scenarios, 2) planners are unable to create a comprehensive model of the impact of the catastrophic event (e.g. for a scenario to have value to disaster response planners, it must identify

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[12]Dynes, Russell and Quarantelli, E.L.. Organizational Communication and Decision Making in Crisis, Disaster Research Center, University of Delaware, Newark, DE, 1976.

[13]Salvatore Belardo, K. R. Karwan, and W. Wallace. "Managing the Response to Disasters Using Microcomputers," Interfaces. 14:2. (1984) pp. 29-39.

environmental conditions, response options, tactical problems, and critical concerns), and 3) planners are unable to integrate diverse and conflicting views of experts.[14]

2.4 ORGANIZATION STRUCTURE ISSUES IN DISASTER MANAGEMENT

Dynes and Quarantelli of the Disaster Research Center at the University of Delaware developed an organizational topology describing the evolution of organizations during a crisis situation. (Figure 2-2 : established, extending, expanding, and emergent). Disaster tasks undertaken by an organization are identified as one dimension of an organization that evolves during a disaster; the structure of the organization is another dimension.[15]

Organizations that evolve during a disaster situation are necessary because of: 1) the heightened necessity for organizational coordination during a crisis, 2) conditions which create changes in the communication patterns within disaster relief organizations, and 3) the significant change in communication patterns among and within relief professionals during a disaster will inevitably effect organizational coordination.

Disaster response organizations must be flexible enough to react to these

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[14]John Harrald and Salvatore Belardo. "Framework for Application of Group Decision Support Systems to the Problem of Planning for Catastrophic Events," IEEE Transactions On Engineering Management. Vol. 39, No 4. (November 1992).

[15]Dynes, Russell and Quarantelli, E.L.. Organizational Communications and Decision Making During Crises. Disaster Research Center. University of Delaware, Newark, DE. Report Number 17. (January 1976): pp. 1-20.

DISASTER ORGANIZATIONAL TOPOLOGY

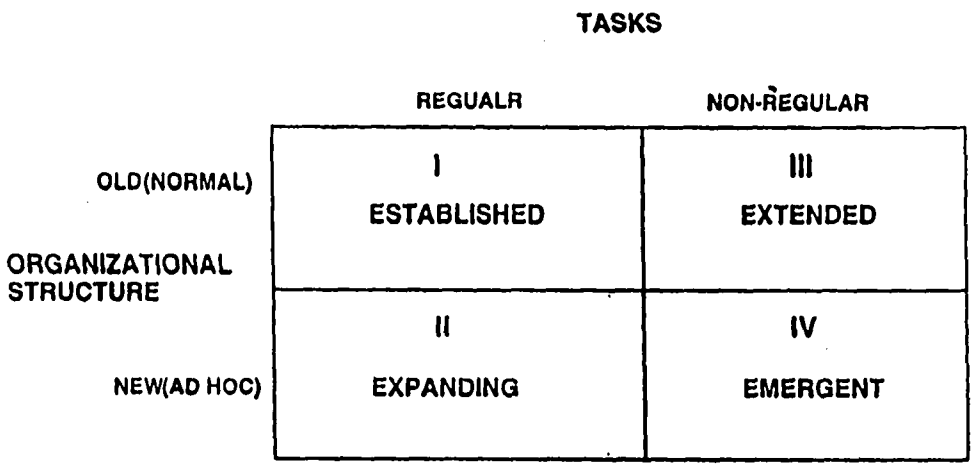

Figure 2-3

Reproduced from Dyne, Russel and Quarantelli, "Organizational Communications and Decision Making During Crisis", Uiviversity of Delaware Research Report , 1976

circumstances, and to accept problem-solving by ad hoc organizational elements which emerge during each emergency.

Research has examined the factors that determine organizational performances during crisis. A variety of structural, systematic and political factors determine organizational performance.[16] [17] Other research has determined that organizational performance is dependent on several factors, including the cognitive capabilities and experience of the individual decision-makers,[18] [19] the quality of information[20] [21] and the degree to which different personnel in the organization share the same information.[22] This research also demonstrates that communication breakdowns and incorrect information have negative effects on

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[16]Kemedy, J.G. Report of President's Commission on the Accident at Three Mile Island. New York: Pergammon Press, 1981.

[17]Metcalf, J. . "Decision Making and The Grenada Rescue Operation". In: J.G. March and R. Weissinger-Baylon, Ed. *Ambiguity and Command: Organizational Perspective on Military Decision Making*. Pitman, Marshfield, MA. (1986): pp. 277-297.

[18]Metcalf J. "Decision Making and The Grenada Rescue Operation". In: J.G. March and R. Weissinger-Baylon, Ed. Ambiguity and Command: Organizational Perspective on Military Decision Making. Pitman: Marshfield, MA. (1986): pp. 277-297.

[19]Shrivastava, P., Bhopal: Anatomy of a Crisis. Ballinger: Cambridge, MA, 1987.

[20]Kemedy, J.G., Report of President's Commission on the Accident at Three Mile Island. Pergammon Press, New York, 1981.

[21]Rodgers, William, P., Chairman, Report of the Presidential Commission on the Space Shuttle Challenger Accident. Washington: U.S. Government Printing Office, 1986.

[22]Metcalf, J. "Decision Making and The Grenada Rescue Operation". In: J.G. March and R. Weissinger-Baylon, Ed. Ambiguity and Command: Organizational Perspective on Military Decision Making. Pitman: Marshfield, MA. (1986): pp. 277-297.

[22]Shrivastava, P., Bhopal: Anatomy of a Crisis. Ballinger, Cambridge, MA, 1987.

organizational performance during a crisis situation.

Mounting an effective organizational response under the complex, uncertain operating conditions of a major disaster poses a reasonable challenge to disaster response agencies. Organizational structure and behavior are observed to undergo profound change in response to a crisis.

During the early stages of a disaster, response procedures designed in an hierarchical organizational format are utilized by reactive agency operations. However, as the disaster progresses, the limitations of time, resources and available skilled professionals demand that responsibilities be shared and integrated.

These changes manifest themselves in new coordination mechanisms, lower decision efficacy and frictional group dynamics. These negative manifestations are the product of a downward diffusion of authority, an increased rate of decision-making and poor utilization of resources. This abandonment of established emergency response plans is symptomatic of information overload, and supports the assumption that individual cognitive limitations significantly influence emergency organization decision- making.

Empirical observations suggest that all organizations, have enormous difficulty dealing with crises (Shapiro and Cummings, 1976). Information enables disaster relief officials make optimal decisions during a disaster. The information generated during a disaster depends on

an effective communication network between multiple agencies. It requires a communication network to coordinate information search and exchange among multiple agencies and jurisdictions. Allen Barton describes rescue operations undertaken by government agencies aided by communications networks such as this.[23]

Integrating organizational action through the use of information search and exchange appears to be a critical issue for agencies hoping to increase the effectiveness of disaster response. The dynamic environment of inter-organizational operations -- in theory and practice -- requires continual learning between multiple agencies. The dynamic model of an inter-organizational approach in disaster management does not require massive structural reorganization, or major allocation of equipments or funds. However, it does require reconceptualization of organizational priorities, a redesign of organizational functions and reconsideration of information processing with awareness of individual and organizational learning processes.[24]

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[23]Barton, Allen H.,"The Emergency Social System". In: G.W. Carley, K. and Harrald, J.R.. Organizing for Response: Comparing Practice, Plan, and Theory. Quick Response Grant Report 23-92. Natural Hazards Research and Applications Center, Boulder, Colorado. (1993): p. 28.

[24]Baker, L.M. and D.W. Chapman, eds. Man and Society in Disaster. New York: Basic Books, Inc.. (1962): p. 252.

"The ability of modern societies to create an "emergency social system" of such scope, encompassing such wide areas and vast resources, is uniquely dependent on long-range instant communications..... Sudden disaster, with its urgent needs for rescue and medical care, requires a broadly based system which can respond in minutes to save lives: rapid communications makes this possible, so long as disaster strikes a relatively small segment of the community."

Organizations commonly experience transfers of erroneous information and other forms of communication breakdown in dynamic environment. These communication errors are often the product of equipment malfunctions and the unavailability of key decision-makers.

Ideally, an organization engaged in complex-task decision-making processes should adhere to an information management model that enables any key member of an organization to be instantly aware of the important choices made by other key members.

This idealized model of adaptive organizational performance was developed by Kathleen Carley. The implication of the Carley model is this: When teams collaborate in an effort to solve a problem (and they have the resources necessary to have simultaneous knowledge of important decisions), the people responsible for having direct access to this information should be assigned to individual groups rather than a single team. Another implication of the Carley model is that organizations should devote more effort to the acquisition of correct information than in setting up extra communication channels.[25]

2.5 ORGANIZATION STRUCTURE V. INFORMATION PROCESSING OF DECISION-MAKING PROCESS IN DISASTER MANAGEMENT

[25]Carley, Kathleen M. "Designing Organizational Structures to Cope With Communications Breakdowns: A Simulation Model,". Industrial Crisis Quarterly. Vol 5 (1991): pp. 19-57.

The structure of an organization affects information processing and decision-making through its impact on communication channels, in terms of both its inherent networks and choice of media, and through its interpretation of messages.[26] Implicit in the normative approach to organizational design is the notion that official departmental grouping and hierarchical authority relationships determine communication patterns, whether to optimize accountability, work flow, information processing, or decision-making.[27] Organizational structures are designed to facilitate the vertical flow of task-related information, and provide horizontal coordination while preventing overload and reducing illicit communication. Organizations are essentially constrained communication networks.[28]

Theoretical models have been developed of the relationships between organizational structure, decision-making and information flow in disaster management.[29] This research indicates that distributed decision-making in a turbulent environment may actually be the most effective decision-making structure, assuming that information can be centrally coordinated

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[26]Daft, R.L., and Huger, G.P. "How Organizations Learn: A Communication Framework". In: Bacharach, S.B. and DiTomasso, N. (Eds.), Research in the Sociology of Organization. Vol.5, London, England.(1987): pp. 1-36.

[27]Huger, G.P., and McDaniel, R.R., "The Decision-Making Paradigm of Organizational Design". Management Science. No. 32 (1986): pp. 572-589.

[28]Katz, D., and Kahn, R.L.. The Sociology Psychology of Organizations (2nd ed.). New York: Wiley. (1978): pp. 40-65.

[29]Carley, K. and J.R. Harrald. Organizing for Response: Comparing Practice, Plan, and Theory. Quick Response Grant Report 23-92. Natural Hazards Research and Applications Center, Boulder, Colorado, 1993.

and distributed.

The research findings of Michael Cohen indicate that two strategies and one outcome contribute significantly to increased effectiveness in decision-making under conditions of complexity. First, information search processes conducted in parallel will result in more timely, accurate and effective decisions. Second, decision-making errors were corrected earlier, and the results of corrective actions were more substantive. Cohen also found that decisions made by multiple centers with shared authority resulted in more appropriate decisions than those made by a single center with global authority.[30]

2.6 USE OF INFORMATION TECHNOLOGY FOR DISASTER MANAGEMENT IN GOVERNMENT AGENCIES

Electronic communications offer the possibility of increasing the amount and content of information distributed to all levels of an organization, and solving the logistics problems of collecting information from distant employees and vice versa. Workers can sends message at their convenience without having to wait for an appointment or to catch the manager in the office. Such a system is free of geographical and organizational constraints; the connections can cut across conventional organization boundaries.

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[30]Cohen, M. "The Power of Parallel Thinking," Journal of Economic Behavior and Organization (1981): pp. 285-306.

Communicating electronically can enhance morale and productivity. For example, an experiment conducted by the Land Corporation demonstrated that peripheral members of their staff people who communicated electrically felt and, indeed, became better integrated into the organization.[31]

Governments have taken action to improve intra- and inter-organizational communication to ensure a quality response to a disaster. They have invested millions of dollars in information technologies to ensure operations staff can quickly acquire information.

Additionally, Federal government response agencies are beginning to respond to disasters with an array of new and emerging communications and sensor technology.

These technologies include:

1. Air- and space-based remote sensors, which provide users with infrared, millimeter wave and video imagery of affected areas

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[31]Eveland, J.D., and Bikson, T.K., "Work Group Structures and Computer Support: A Field Experiment". Transactions on Office Information Systems. 6(4) (1988): pp. 354-379.

Two corporation task forces were formed to investigate how employees make the transition to retirement, and to develop a set of recommendations about preretirement planning. Each task force had forty members -- half recently retired from the company and the other half still employed but eligible for retirement. The only difference between the two groups was that one of them was given electric communication technology and the other given was not.

2. Satellite telecommunications

3. Computer-based geographical information systems that electronically capture, store, update, analyze and display geographic data[32]

2.7 CHAPTER SUMMARY

This chapter reviewed literature related to problems and characteristics of successful decision-making in a disaster relief operational environment. The literature review also identified the requirements for information systems to support effective disaster relief operations. Additionally, the reviewed literature identified the information technologies and communication systems necessary to effectively support disaster relief operations, and focused on the various organizational perspectives of disaster management.

The reviewed literature supports the following useful perspective : The methods and models applicable to organizational design and organizational development appears to be

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[32]"Understanding GIS: The Arc/Info Method", Environmental Systems Research Institute, Inc., (1990): pp. 1-2.

"Using the geographical information system component, data from the field status board can be displayed graphically at remote sites, enabling managers at different locations to visualize operating conditions in the actual disaster situation. Adding to the capability of computerized local inference routines, disaster operation personnel can access data from multiple sources to produce a calculated set of alternatives for response under specified conditions. Such routines can be used by disaster managers to explore alternative actions against existing data from the knowledge base. The operations of these three components produce information that is stored in a multi-jurisdictional database and time phase in a disaster operation."

applicable to the problems associated with organizing a disaster response. There is a significant body of literature that dealing with the issue of decision-making under stress and on the use of information technologies during a disaster response.

The overall literature review revealed that the disaster information management in situation involving disaster response among multiple decision-makers has often involved the systemic decision-making approach. The more structured approaches to the disaster management would enable individual organizations responding to a disaster to collectively and interactively coordinate their actions for improved overall effectiveness.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 DISCUSSION

Decisions must often be made by many operations managers 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.

Of crucial importance in disaster relief operations is cooperation and coordination among disaster relief agencies. 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 (data reflect current condition?), accuracy (data correct?), completeness (critical data missing?) and consistency (conflicting

value?).

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.

A review was conducted of literature related to the problem domain. This literature review focused on the disaster management environment and the characteristics of decision-making in disaster relief operations. Based on this literature review, communication breakdown problems were identified relating to the management of disaster information during times of disaster response.

Having identified communication problems, the pilot study was carried out to assure the causes and critical factors identified at the literature review and define the communication

breakdowns during the disaster relief operations. Then, additional analysis identified causes and factors related to essential functions in disaster relief operations. The objective of the pilot study was to develop a questionnaire instrument that could be used to identity the important factors and essential functions that contributed to successful disaster responses.

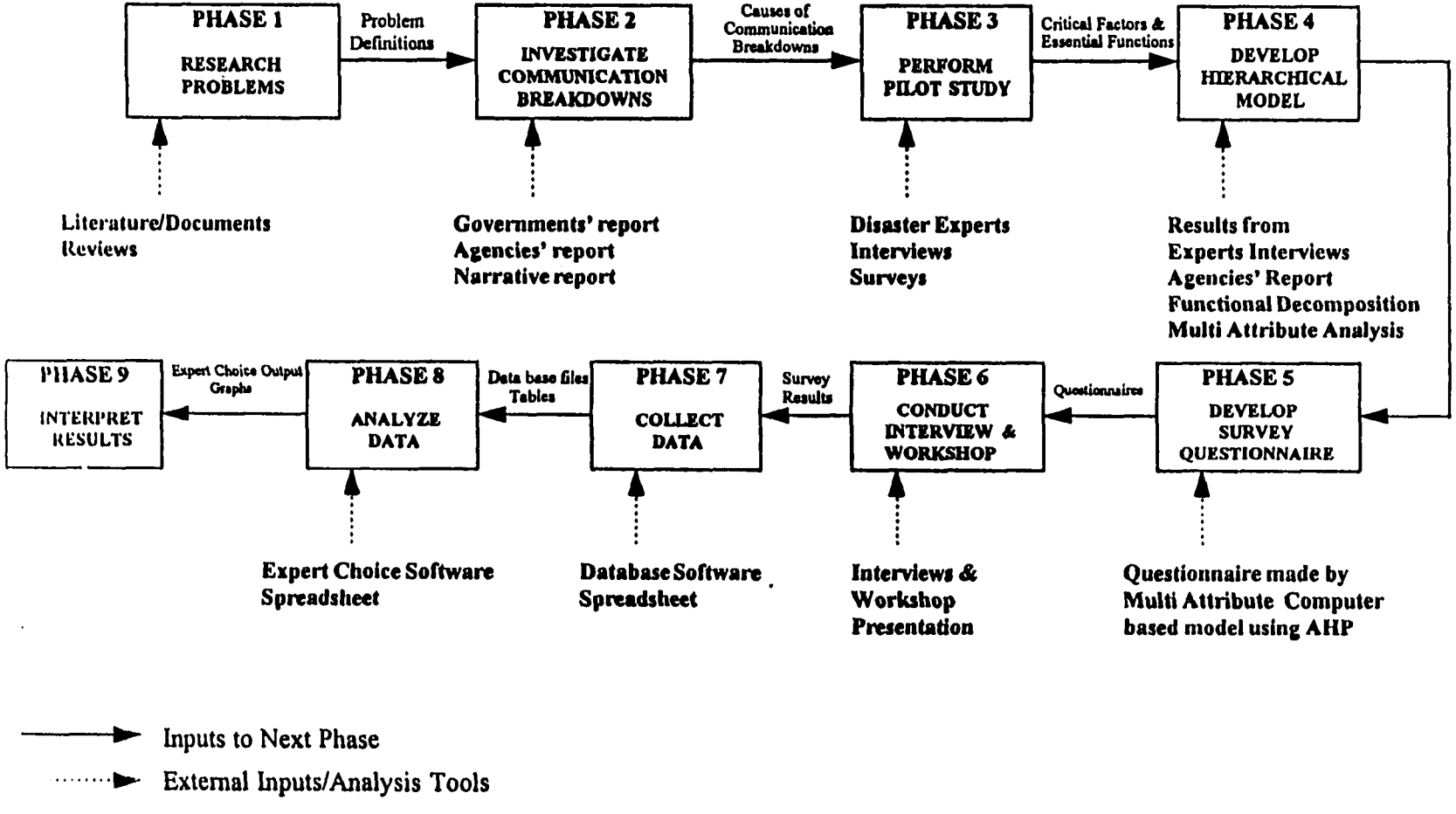
With the results from the pilot study, a hierarchical model was developed to prioritize the types of information and quality of data required to support decision-makings in disaster relief operations. This need was based on the fact that it is often difficult for a human being to make decisions about 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.

A questionnaire were designed to ask disaster operation experts to determine by the relative importance of the types of information using technique of pairwise comparison that is available to them during the disaster relief operations. Lastly, the respondents were asked to identify the criteria describing data qualities required for each type of information.

3.2 RESEARCH PHASES

The flowchart in Figure 3-1 summarizes the phases of the research. Descriptions of each phase of the research are as follows;

RESEARCH PHASES



RESEARCH PHASES

Figure 3-1

1. Research problem domains and Define problems

A review was conducted of the literature related to the problem domain. This literature review focused on the disaster management environment and the characteristics of decision-making in disaster relief operations. Additionally, the literature review focused on disaster information systems needed to support the management of an effective disaster response operation. Based on this literature review, several problems were identified relating to the management of information during times of crisis.

2. Define Communication Breakdown Problem

One of the key problems identified while reviewing the literature and documents was the problem of communication breakdowns. Communication breakdowns are defined as 1) the failure to obtain information or 2) the failure to obtain information that lacks sufficient quality (accuracy, completeness, consistency or timeliness for example) to support decision-making during disaster relief operations.

3. Perform Pilot Study

Interviews were conducted to identify and define the communication breakdowns during the disaster relief operations. Then, additional analysis identified causes and factors

related to essential functions in disaster relief operations. In order to identify the causes and factors of communication breakdowns, the research also identified the factors and functions responsible for *successful* disaster response operations. The objective of the pilot study was to develop a questionnaire instrument to identity the important factors and functions that contributed to successful disaster responses.

4. Develop Hierarchical Model

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.

As the research methodology, an expert judgment-based model was selected for pair-wise comparison for each type of information and quality of data: a multi-attribute computer based model by Analytic Hierarchy Process (AHP). AHP was used to decompose conclusions drawn the research to develop a model for how various organizations might rank the value and required quality of the data available during a disaster response operation.

5. Develop Questionnaire

Based on the developed hierarchical model, A multi-attribute computer-based model questionnaire was developed to query organization personnel on how they would prioritize

the importance of various types of information available during a disaster response, and how they would prioritize the qualities that they hope this information would possess. This hierarchical model replicated all functional decision-making levels in an organization. However, the model's hierarchy was truncated in places, due to the fact that the questionnaire did not ask individual organizations to rate the importance of activities or functions of other organizations relative to their own activities and functions.

6. Conduct Interview and Survey

Once the questionnaire was structured, it was presented to a number of disaster management experts. The questionnaire asked respondents to make choices by pair-wise comparisons, and asked to determine pair-wise comparisons of importance on the types of information that is the most important to them. Lastly, the respondents were asked to identify the criteria of data qualities they seek in this needed types of information. Many of the questionnaires were completed during face-to-face interviews. Some of these face-to-face interviews involved as many as four disaster experts while they were attending professional workshops.

7. Collect Data

It took an average of one hour and forty minutes (1 hr. and 40 min.) to obtain questionnaire data from each respondent during a face-to-face interview. Approximately one hour (1 hr.) was this time was spent filling out the questionnaire; the balance of the time was

spent answering respondent questions.

8. Analyze the Data

Questionnaire responses were entered into an Expert Choice computer software. The processed results, also available in database and spreadsheet formats, revealed where respondents were in consensus or were at odds over the priorities they attached to the various types of information they believed were necessary to a disaster response, and over the qualities that the respondents hoped this data would possess.

9. Interpretations of the Results

A analysis of the results was performed to determine whether or not the impact of communication breakdowns are organizationally dependent. Additionally, the an analysis of the results was performed to determine if data quality during the disaster is organizationally dependent.

Once these interpretations were drawn, the results were analyzed to determine whether this information model created can predict the organizationally and functionally dependent information requirements for disaster response operations.

3.3 PILOT STUDY

Based on the literature review, communication breakdown problems were identified relating to the management of disaster information during times of disaster response. The study began with an analysis of the disaster relief operations. Interviews were conducted to identify and define the communication breakdowns during the disaster relief operations. Then, additional analysis identified causes and factors related to essential functions in 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 identity the important factors and functions that contributed to successful disaster responses. This pilot study consisted of interviews and surveys of people working for a 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. These interviews and surveys were also done with disaster operation personnel at various organizations.

The disaster operation specialists interviewed during this phase of the research were selected on the basis of their expertise and availability (Table 3-1). 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. Suggestions offered by respondents about how to change or improve disaster relief operations were also the product of previous experiences.

TABLE 3-1

EXPERTS INTERVIEWED FOR PILOT STUDY

ORGANIZATION	FUNCTIONAL RESPONSIBILITY OF PERSONNEL INTERVIEWED	NUMBER OF PERSONNEL INTERVIEWED
American Red Cross (ARC)	Disaster Service Managers	3
	Assistant Disaster Service Managers	2
	Disaster Preparedness Managers	2
Federal Emergency Management Agency (FEMA)	Special Representatives for ARC & FEMA	2
	Region Representative	2
STATE/LOCAL	Office Of Emergency Service(O.S.)	2
Collaborating Agencies to Responding Disasters (CARD) Projects	Participants of Local Volunteers	3
Northern California Disaster preparedness Network(NCDPN)	Project Manager	1
Others	Volunteers & Others	3
Total		**20**

It appears that this diversity of information requirements was largely the product of inconsistent and incomplete information distribution, and these distribution flaws often created confusion. In order to identify the sources of communication breakdowns and the causes of these breakdowns, the study analyzed information flows between Federal, state and local disaster response organizations, as well as between other private and voluntary response groups. The causes and factors of communication breakdowns raised and affirmed by the interviews and surveys are listed in Table 3-2. Following each factor listed in Table 3-2, the number of the times the factor was raised ("Number of Times Cited") are also noted. The functions related to those communication breakdowns also raised by the interviews are listed in Table 3-3. Following each factor also listed in Table 3-3, the number of the times the factor was raised ("Number of Times Cited") are also noted.

TABLE 3-2

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 terminologies	3

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

TABLE 3-3

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 recruitments	4
14. Resource Acquisition Logistics	3

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

It must be stressed that the "causes and factors" identified in Tables 3-2 and the "functions" identified on Table 3-3 are more than simply issues of communication breakdowns -- these are identifiers of disaster operation management dysfunctions during previous disaster response efforts that have failed to promptly and effectively meet the needs of disaster victims. Table 3-4, lists the causes and factors related to essential functions by internal and external coordinations in disaster operations that respondents to the pilot study identified as the source of communication breakdowns. The factors are categorized into the functional activities commonly performed during a disaster operation. To obtain this information, the research queried various personnel in the public and private sectors who had positive experiences in previous disaster responses. Interviews and surveys targeted personnel who had worked for a variety of organizations and volunteer groups.

3.4 SCOPE AND LIMITATION OF THE RESEARCH

In general, the time period under examination is the first 72 hours after a disaster strikes. This research focus was chosen because communication breakdown and lack of coordination within and among disaster relief organizations were found to have greatest impact to occur during this period of time.

TABLE 3-4

PILOT SURVEY RESULTS

	FUNCTIONS	FACTORS OF COMMUNICATION BREAKDOWNS
INTERNAL	Damage Assessment	1. Initial response based on inaccurate data 2. No reflection of interior damages or after-shock damages 3. Need a more comprehensive survey 4. Getting inconsistent data 5. Missing Data 6. Did not inform what happened 7. Duplication of damage info from others
	Resource Acquisition	1. Communication equipments failures 2. Communication process failure during the operations 3. Hardware/Software conflict 4. Critical shortage of local trained staff 5. Acquisition Logistics 6. Miscommunication of needs 7. Did not interact with organizations
	Delivery of Service	1. Transportation Logistics 2. Inefficiencies in human resource requirements 3. Duplication of Service 4. Mass Care and Supply Logistics 5. Need standard procedure of getting status report 6. No status report from other organizations
EXTERNAL	Dissemination Liaison	1. Problems in Agreement -State/Local Agreements -Federal Agreements -Voluntary Organization Agreements (VOLAG) 2. No interactions with media 3. Public Relations (Special needs and ethnic population issues) 4. Political Relations - Not clear lines of authorities - No immediate contact with other organization - Need better understanding of others'

Whether the disaster response process is short-term recovery or long-term recovery, all disaster responses begin with two phases: The initiation and mobilization phase, and the integration phase.

During the initiation and mobilization phase of disaster response, disaster response professionals diagnose the problem to mobilize their resources. Available personnel are also engaged other initial response activities, including the gathering of information and the analysis of this information.

During the integration phase, information and resources are integrated to support effective response organizations.

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).

This research examines various disaster relief organizations in a controlled environment, and is based on historical experiment. Because no two disasters are alike, it is difficult to create or anticipate the nuances of a potential disaster.

The research is based on data collected from a limited number of disaster response organizations. Since there are many small organizations involved in disaster relief operations, the data collection was limited to disaster operation experts from disaster response organizations which are considered the major players such as the Federal Emergency Management Agency, state emergency service organizations, the American Red Cross, the Salvation Army and volunteer groups in the field.

The processing of research information is the most rudimentary function underlying all disaster relief activities. However, this research is not meant to test how fast, accurate, complete and consistent disaster information is processed by response organizations. Rather, the research investigates what organization officials *perceive* to be the information requirements on essential functions and adequate quality of data in the successful management of disaster relief information.

Because the scope is this research is limited to the first 72 hours of a disaster response, there is little attention focused on the role of information technologies or the functional response activities of each organizations. At some future date, it would appropriate for these issues to be researched more fully.

3.5 RESEARCH QUESTIONS

The following research questions from a review of disaster operation, the related

literatures and pilot study are developed to research communication breakdowns in disaster information management during the initial phases of disaster relief operations:

Research Question 1:

What are the patterns of communication breakdown exist among organizations involved in disaster relief and disaster response operations? What are the causes and factors of these communication breakdowns?

Research Question 2:

How are these causes and factors of communications breakdown related to the essential functions of a disaster response operation? Having determined how these causes and factors of communication breakdown are related to the essential functions of a disaster operation, is it possible to prioritize the types of information and quality of data that best enables individual response organizations to function effectively and efficiently ?

Research Question 3:

Having determined how communication breakdown are related to the essential functions of a disaster operation, how do these communication breakdowns impact on essential functions of disaster operations and vary among different response organizations ?

Research Question 4:

Having learned the information requirements of individual organizations, can a model be developed that predicts the organizationally and functionally dependent information requirements of the disaster relief organizations ?

3.6 METHODOLOGY OF 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. A 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, is 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.

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.

3.6.1 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 which 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. Saaty and Kearns (1985) defines the AHP as follows:

"A systematic procedures for representing the elements of any problem,

hierarchically. It organizes the basic rationality by breaking down the problem into its smaller and smaller constituent parts and then guides decision makers through a series of pair-wise comparison judgements (which are documented and can be re-examined) to express in the hierarchy. The judgements are the translated to numbers."[1]

The AHP is based on three consistent activities:

1. Development of the problem's hierarchy: complexity is dealt with by decomposing the elements of a given problem into a few manageable elements and each element is, in turn, decomposed into another set of elements. This process continues down to the most specific elements of the problem, typically the specific courses of action considered, which are represented at the lowest level of the hierarchy.

2. The use of a measurement methodology : The methodology of pair-wise comparison is utilized within each level of the hierarchy. This is accomplished by asking the participating managers or decision-makers to evaluate each set of elements in a pair-wise fashion with respect to each of the elements in a higher stratum. This measurement methodology provides the framework for data collection and analysis and constitutes

[1]Saaty, Thomas L. and Kearns, Kelvin, Analytic Planning: The Organization of Systems, New York: Pergman Press (1985), p. 19.

the heart of the AHP.[2]

3. A measurement theory is used to establish the priorities of the hierarchy and the consistency of the judgmental data provided by the group of respondents.

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-offs must be made among four criteria of data quality :

1. Timeliness (Do data offer current conditions ?)

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[2]Wind, Yoram and Saaty, Thomas, "Marketing Applications of the Analytic Hierarchy Process," Management Science, Vol 26, No 7 (July 1980): p.642-643.

2. Accuracy (Are data correct ?)

3. Completeness (Are there critical data missing ?)

4. Consistency (Are there any conflicting values ?)

The AHP uses the process of pair-wise comparisons to determine the level of dominance of one factor, or element of a problem, over another. In other words, the pair-wise comparison approach provides the analyst with the means to calculate the importance of decision-makers participating in the problem-solving approach. The process involves "setting up a matrix to carry out pair-wise comparisons of the relative importance of the elements in a hierarchy level with respect to the elements of the level immediately above it. This matrix is used to generate ratio scales."[3]

To make comparisons among the elements of the hierarchy, one needs to ensure that any comparison will reflect the proper relationship between elements in one level with respect to the property in the next higher level. One also needs to establish a procedure for obtaining the judgements of each of the negotiating parties.

AHP allows for three types of comparisons among elements of a hierarchy level: 1) importance of one element over another, 2) the likelihood of occurrence of one factor over another, and 3) the preference of the decision-maker of one element over another. It must be

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[3]Harker and Vargas , The Theory of Ratio Scale Estimations, Pergamon Press, N.Y. : (1983) : p. 1384.

emphasized that the use of any of these modes depends on what is being compared. The main objectives of three types, therefore, is that they will make it easier for the decision-makers to understand how they can structure the problem, along with providing them with a solid frame of reference in order to solve it.

3.6.2 Expert Choice Software

Expert Choice data analysis software was selected to eliminate the need for performing the mathematical calculations to obtain results of the Analytic Hierarchy Model (AHP). Once all the judgements are incorporated into the model, the analyst can synthesize the data to calculate the results.

The Expert Choice software employs a computer-based model which was created to deal with "what if?" types of problem analysis. This model allows decision-makers or analysts to weigh options and consider the effects of a potential choice. This dynamic feature of the Expert Choice software enables users to determine if changes in the amount or quality of available data affects the outcome of a potential choice.

To deal with inconsistency ratios in the expert judgement, Expert Choice calculates the inconsistency for each level in the AHP model as well as the top level of the model. In addition, if the inconsistency ratio is greater than 10 percent, the decision-maker can interact with Expert Choice to see which of the inputs are the most inconsistent, along with

suggestion on how to improve their consistency.

Since this expert survey questionnaire contained a large number of questions that asked respondents to compare factors associated with quality of data required, the "ratings component" of Expert Choice was put to full use when processing the survey results.

Research indicates that an additional strength of the Expert Choice software is that it provides users with an excellent graphical interface. Expert Choice stands out as a sophisticated means of implementing AHP when compared with another computer packages which attempt to implement models. It also provides the user with a wide range of applications, and comes with a well-written user's manual.[4]

3.7 MODEL DEVELOPMENT

In order to identify the communication breakdowns on the effectiveness of operations conducted during the initial stages of a disaster response, a detailed analysis was conducted to investigate disaster information management essential functions that made a response succeed.

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[4]Golden, Bruce L., Henver, A., and Power, D., "Decision Insight System For Microcomputers: Critical Evaluation", *Computer and Operations Research*, Vol. 13, (1986): p. 296.

For this study, Analytic Hierarchy Process (AHP) models were used to evaluate importance on which types of information and quality of data required directly are related to communication breakdowns contribute to the effective and efficient movement of disaster information management within and among disaster response organizations.

This analysis was based on answers disaster operation experts gave to questions asked of them during face-to-face interviews, and on responses disaster management experts gave to questions put to them in a written survey.

3.7.1 Experiment Design

The need to develop a hierarchy for a problem situation arises from the fact that it is often difficult for a human being to make decisions about complex procedures that involve a multiplicity of mitigating factors.[5] A hierarchy is defined to be "an abstraction of the structure of a system to study the functional interactions of its components and their impact on the entire system"[6]

In order for the study to evaluate the impact of the information management model, it was important to analyze the knowledge of disaster operation experts in a reliable and valid

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[5]Saaty, Thomas L. and Kearns, M. , Analytical Planning : Organization of Systems, N.Y.:Pergman Press (1985): p. 4.

[6]Saaty, Thomas L., The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation. New York: Mcgraw-Hill. (1980): p. 5.

fashion.

This analysis involved the following steps:

1. Extensive review of the documentation of communication patterns during the disaster operations
2. Results from Pilot Study
3. Interviews and surveys with disaster specialists of different organizations

The literature shows that a decision-making process that relies on expert reactions based on sparse data is not an unusual occurrence for many experienced disaster relief managers. In a disaster, relief operation managers face a unique decision-making process. Dynes and Quarantelli state that decision-making during crisis is marked by a rapid increase in the number of decisions made, coupled with the need to process a large volume of information. As a result, disaster operation managers can not keep analyzing the options available to them.

A hierarchical model with two main branches was developed.

1. COORDINATION MODEL

(INTERNAL)

A. Disaster Assessment Operation Model

B. Resource Acquisition Operation Model

C. Service Delivery Operation Model

2. INFORMATION DISSEMINATION/LIAISON MODEL (EXTERNAL)

A. Government Agency Relations

B. Non-Governmental Agency Relations

C. Public Relations

D. Media Relations

3.7.2 Functional Decomposition Of The Disaster Relief Operation Process

A process model of the disaster response operations was done by reviewing appropriate documents such as congressional hearings, reports to the President by GAO, internal reports from the American Red Cross and the Federal Emergency Management Agency, and -- to develop a sense of the effectiveness and efficiency of past disaster relief operations -- narrative interviews with Red Cross clients and with various other people who routinely take guidance from senior disaster response organizations.

Those sources indicate that , during the initial hours of a disaster, a fully functioning disaster response information management system is engaged in three, sequential major processes:

1. Damage Assessments (to determine needs requirements) are made. These assessments are conducted in the field, and are conducted by personnel dispatched from the headquarters established by the various relief organizations responding to the disaster

2. Resource Acquisition requirements are made.

3. Service Delivery requirements are determined and implemented

The research questionnaire asked respondents to define communication breakdowns, and to share their opinions on what caused these communication breakdowns. Based on responses to these questions, it was determined that disaster response personnel several must make several critical decisions during the initial phases of a disaster relief operation. These 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.

1. Information Coordination Sub-Model (Internal Coordination)

Figure 3-2 shows an upper-level disaster response system.

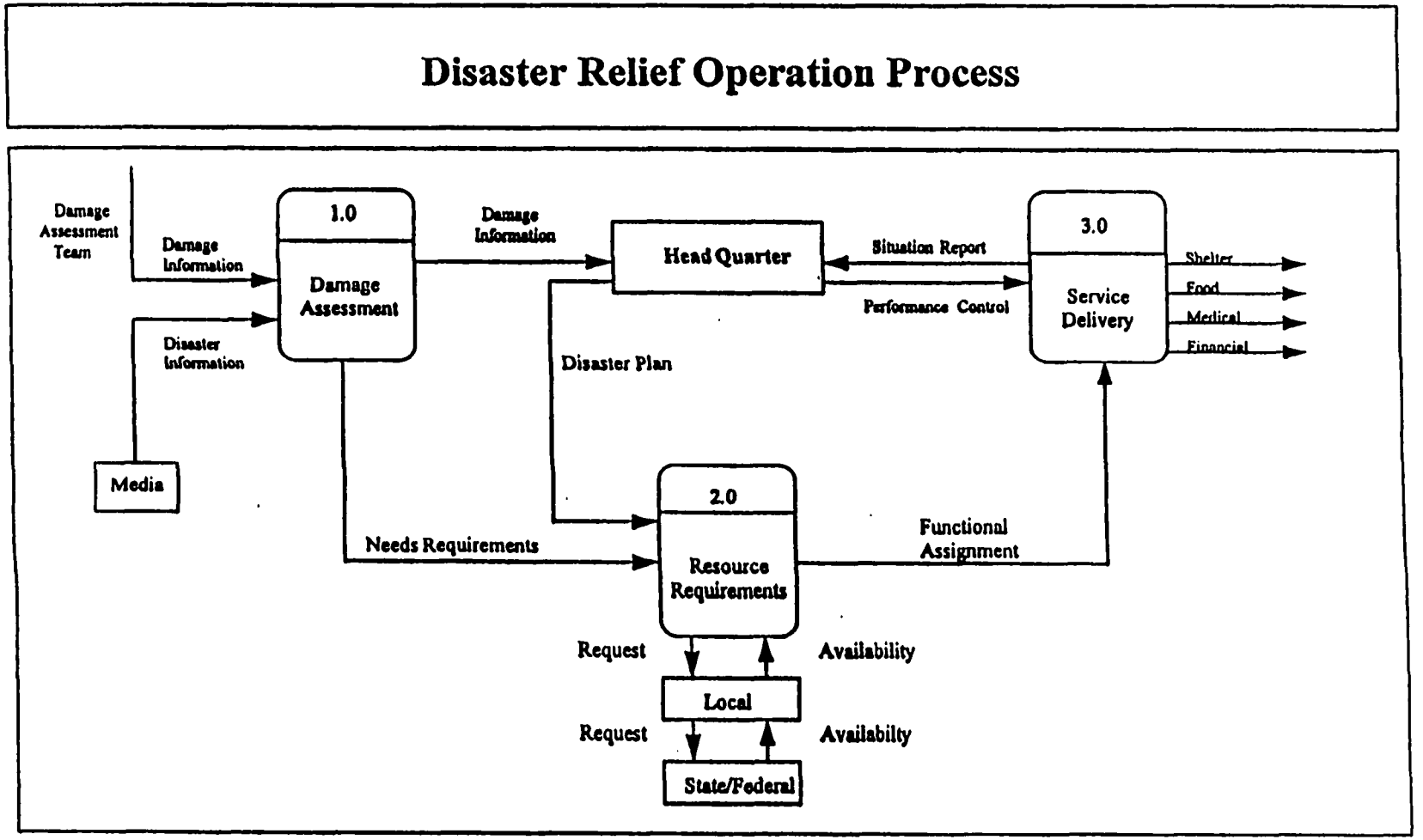


Figure 3-2

This system consists of three major processes:

1. **Damage Assessment** must be performed to determine the requirements for the affected area. Disaster response organizations must have the capability to mobilize personnel to obtain, process and communicate disaster information to senior decision-makers. This information will enable operation personnel to determine what resources will be required.

2. **Resource Acquisition Activity** is performed to determine functional assignments such as providing shelter or medical supplies, personnel, and communication support such as computers or mobile phones. The capability to establish effective multi-organizational response is important to the success of the response. Once resources are in place, it is important to identify and mobilize needed resources, and then integrate these response resources.

3. **Service Delivery** is performed at the disaster relief operation site. It is important for a disaster response organization to have the capability to ascertain needed support and sustain subsequent emergency response activities. Since each organization supports different services during a relief operation, it is not always possible to develop a generic model for service delivery processes.

2. Information Dissemination/Liaison

One of the objectives of an effective disaster relief operation is to develop and maintain a capability to disseminate in a timely manner official emergency public information about potential hazardous threats. While being interviewed and questioned in pilot study, disaster operations personnel were asked by the researcher to share their opinions about the value of inter-organizational contact during disaster operations. Respondents indicated that it is important to fully inform the public, media and other response organizations about the facts surrounding the disaster and the response. This information should include facts regarding the disaster damage assessment information, service delivery information and facility information such as damage types , casualties, staffing needs and shelter information. It is also important to provide the public with information regarding where it can seek medical assistance, such as the location of hospitals.

Figure 3-3 describes the objectives needed to develop a hierarchical model includes factors and essential functions responsible for successful disaster response among disaster relief response agencies. This hierarchical tree lists the decision-making factors identified by surveyed disaster relief management personnel.

In accordance with Figure 3-3, 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

FUNCTIONAL DECOMPOSITION OF INFORMATION MANAGEMENT IN DISASTER RELIEF OPERATIONS

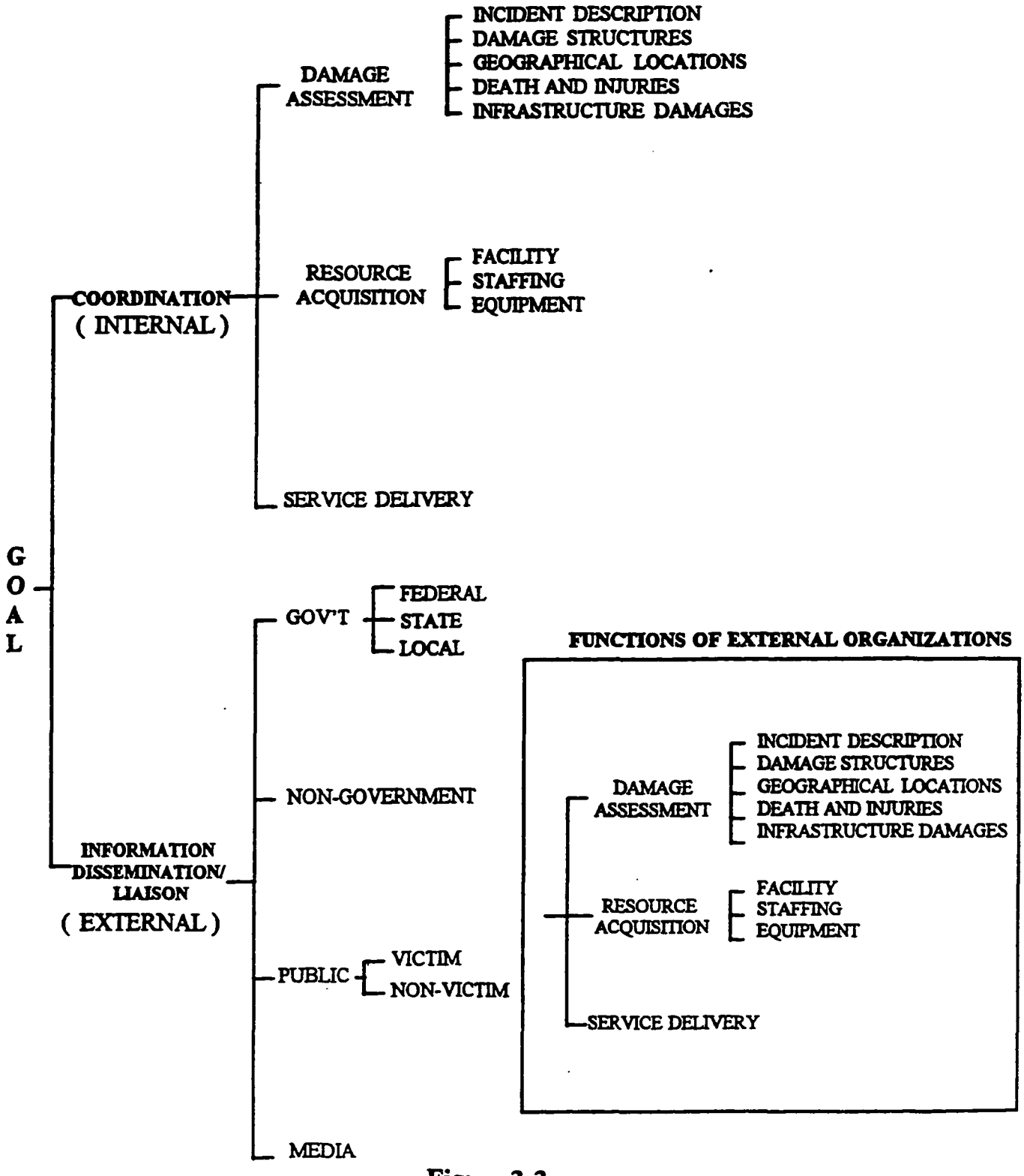


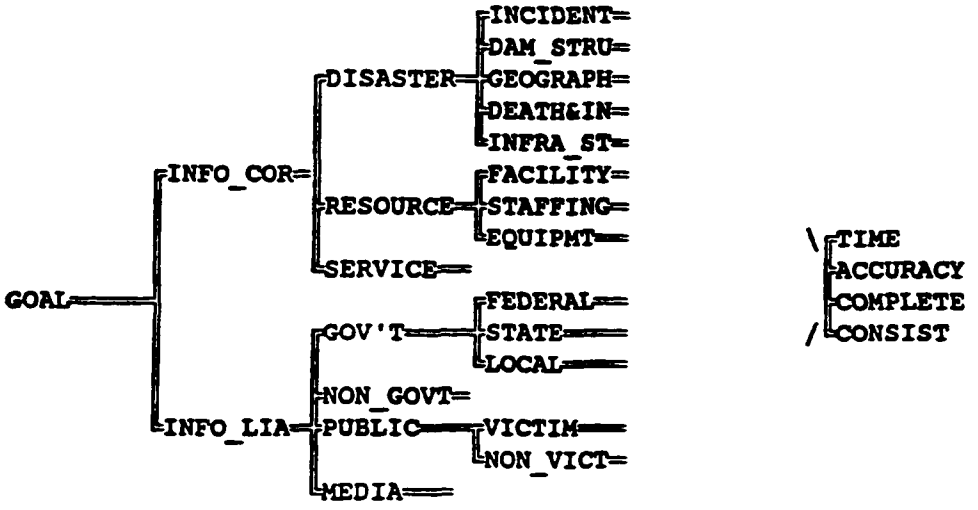
Figure 3-3

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 3-4.

Figure 3-4

EXPERT JUDGEMENT MODEL FOR SUCCESSFUL INITIAL DISASTER RELIEF OPERATIONS



ACCURACY --- **Accuracy of Information : A 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. A 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

3.7.4 Description of Data Analysis, Objectives and Measures of Effectiveness

Level 1.1 Coordination (Internal)

Level 1.1.1 Damage Assessment

Damage assessment is a systematic collection of information across different disaster response agencies about damaged structures and casualties. Effective mobilization of resources and prompt delivery of services requires an ability to quickly estimate the disaster-caused needs of victims.

Often, initial efforts to identity areas that have been affected by a disaster are complicated by the fact that communications are sporadic and available information is incomplete. During the first hours of a disaster, media reports often greatly overestimate casualties. By focusing on dramatic examples of damage, the media sometimes gives the impression that the destruction caused by a disaster is wider than it really is.

Examples of false impressions purveyed by the press during a disaster are found in media accounts of the earthquake in Oakland, California, in 1989. The news reports of this catastrophe only focused on earthquake damage in areas accessible to the media, such as San Francisco's Marina District. During the first hours of this disaster, the press under-represented

the losses in smaller, more remote areas such as Santa Cruz and Watsonville, and failed to put the amount of damage that had been done into proper perspective.

The importance of media during a catastrophic disaster depends on whether its reports about the disaster are accurate, and whether these reports serve as official guidance for management of the emergency.

The presence of the media can also affect the nature of the disaster. For example, during Hurricane Andrew, some of the problems that the state of Florida experienced were in part due to the media's underestimation of the impact. In the case of the 1993 Los Angeles riots, the media at first implied that no police were responding to the looting and violence. This misinformation exacerbated and contributed to the contagion of violence and civil disorder during the first night and into the second day.

The media also tends to be selective in how it reports the news, so it is advisable for disaster relief professionals not to depend on mass media reports as reliable sources of information on a disaster. Not all disaster response officials heed this advice. For example, following the 1989 Loma Prieta earthquake disaster responders were heavily influenced by media accounts. Local officials in Santa Cruz County – which was at the epicenter of the quake – watched television broadcasts of fires raging in San Francisco and damage to the San Francisco-Oakland Bay bridge, and never sought disaster assistance from neighboring

counties because they assumed the devastation affected the entire region. [7]

Level 1.1.1.1 Incident Description

Incident description is critical during the initial phase of a disaster operation. An incident description is a description of the overall disaster situation. Questions that need to be answered by an incident description include: What occurred? Is the incident still happening? At what time of the day did the incident occur? Where were large segments of the population congregated at time when the incident occurred? Do these population congregation patterns change during a holiday or weekend? What was the duration of the incident? Is the weather predicted to change later ? If so, will the new weather pattern affect disaster relief efforts?

Level 1.1.1.2 Description of Damaged Structures

Descriptions of damaged structures should include:

Types of Property

Homes

Buildings

Natural Resources

---

[7]City of Watsonville, Local Hazard Mitigation Plan: October 17, 1989 Earthquake, Watsonville, CA: City of Watsonville, 1990.

Fields

Seriousness of Damage

Major

Minor

Destroyed

Level 1.1.1.3 Geography Of Affected Area

It is important for disaster responders to determine the boundaries of the areas affected by the disaster. Once these boundaries have been determined, planners need to look at the populations that occupy these areas, and translate these information into demographic data.

Information required by disaster response managers about the geography of the affected area should include:

Geographical information

Location

What other areas might be affected by the disaster

Topographies of affected area

Level 1.1.1.4 Death and Injuries

It is critical for disaster relief officials to know how many casualties have been created by the disaster, and the seriousness of the injuries sustained by survivors. It is also important to have demographic information about survivors to determine how to adequately serve them, and how to best mount fund-raising appeals. Additionally, planners need to know the ages, ethnicity and other demographic information about victims in shelters in order plan for their needs.

Data needed by disaster response officials about deaths and injuries includes:

Identification of Victims

Name, Address, Social Security Number, Employer

Number of Deaths

Number of Injuries (Minor or Major?)

Special Needs (disabled, elderly, ...)

Damaged Population demographics

- Ethnic Group
- Economic status

Home owners/renters, single/multiple dwellings

Family information (size, income)

Level 1.1.1.5 Infrastructure Damages

It is critical for disaster response officials to have as much information as possible about all utility outages. As the relief effort gets underway, response planners should receive daily reports indicating which of the affected utilities have been restored.

It is also important for disaster response officials to know the anticipated duration of utility outages scheduled for restoration. This information will enable officials to inform the public when they can return to their homes.

Infrastructure damage information also helps the public better understand what sort of condition they will find their home when they return.

Emergency response teams also need to know how the disaster has affected public transportation (highways, railroads, seaports, airports, et cetera) and community hubs (shopping centers, industrial areas, et cetera).

Level 1.1.2 Resource Acquisition

Disaster relief planners need to provide for the prompt and effective acquisition to distribute and use of personnel and material resources in the event of a catastrophe.

Essential supplies, equipment and services that should be considered for disaster relief operations include :

Level 1.1.2.1 Facility Information

It is essential for responders to a catastrophic disaster to provide suitable temporary emergency shelter and essential life-support systems to people displaced from their homes as the result of disaster-related events. It is also necessary to know the local capability of staff at each relief shelter. Disaster operation managers need to know which shelters have an ability to quickly obtain food and supplies to provide needed assistance. Additionally, it is critical to create an open flow of communication between shelters and disaster response agencies.

It is also important for disaster response officials to coordinate medical support available from health and medical facilities, and from medical personnel (e.g. blood collection and dispensing of pharmaceuticals and supplies).

It is essential for the organizers of a disaster relief operation to be able to identify what areas are most in need of food. These areas may not necessarily be parts of the region worst-affected by the disaster, nor are they limited to evacuation centers. Instead, food could be needed most by people living in partially-damaged homes.

The first priority for relief operations are areas where people do not have sufficient food resources or shelter. The second priority is to support people who are evacuating areas. The third priority may be to feed people who are remaining in damaged homes. Their fourth priority may be to feed workers in inaccessible areas.

If possible, all urgent feeding should start immediately. Disaster operation managers need to determine what would be the best types of feeding, as well as when and what other supplies may be required. Some questions may want to answer include: When is hot food better than cold ? When are sandwiches and easy-to-handle foods best? Is water needed in addition to processed beverages? Will this be the only food source for victims, or will it be supplemental? What are the ethnicities of clients (i.e., what types of foods are most compatible with their usual diet)?

Level 1.1.2.2 Staffing (Personnel)

It is necessary for organizers of a response to a disaster to know the recruitment, classification and utilization of personnel.

Level 1.1.2.3 Equipment Support

One of the most important objectives of emergency equipment support is to have a reliable emergency communication capability to permit key officials to direct operating forces

in an emergency. Even if extensive communication systems designed to meet day-to-day needs of government already exist, it may be necessary to plan for more effective use of these communication resources. Privately-owned communication systems -- if they are available -- should also be adapted to serve the needs of government officials during a disaster. New or expanded government communications systems should be designed, if possible, to ensure reliability and usefulness during emergencies.

Level 1.2 Information Dissemination/Liaison (External)

The greatest burden placed upon disaster management -- and upon the resources needed to support it -- is the need to develop a close working partnership among all levels of government (Federal, state and local) and the private sectors. The ability of disaster response officials to draw on the full range of support available from these potential sources of disaster relief is important.

The objective of effective disaster information management is to develop and maintain a capability to disseminate in a timely manner official emergency public information about potential hazardous threats.

It is important to provide shelter information to the public. This often includes information regarding the location of shelters, their availability and the remaining capacity of these shelters. It is also important to provide the public with information regarding where it

can seek medical assistance, such as the location of hospitals, nursing homes, offices of the Public Health Department, et cetera.

Questions that planners should answer regarding health care facilities include:

What are the locations of the hospitals, nursing homes, public health departments and other medical facilities where the public can seek medical support?

If possible, what should potential aid victims brings to these health care facilities (prescribed medication, medical records, et cetera)?

Level 1.2.2 Government

Given the staggering cost of mounting a response to a major disaster, it has become necessary for Federal, state and local government agencies to share the financial burden and risk associated with rendering assistance to disaster victims.

These shared responsibilities of government agencies include: planning, resource coordination and all decision-making associated with disaster relief operations.

Level 1.2.2.1 Federal

Throughout the Federal government, there exist vast resources which can be rallied to respond to a disaster. Federal Emergency Management Agency serves as the principal point of contact within the Federal government for emergency management activities.

As the national coordinator of disaster management activities, it is FEMA's task to pull these resources together. In partnership with state and local government, FEMA supports their preparedness efforts by providing national program policy and guidance, as well as technical and financial assistance. In the event of a major disaster, FEMA is ready to provide assistance when the demand exceeds the capacity of state and local resources. It is FEMA's responsibility to coordinate the disaster response of other Federal agencies -- some which administer their own disaster relief programs.

FEMA is to be used to coordinate state/federal/VOADs response agreements, written and active needs information on agreements with government agencies as well as non-government agencies and organizations (which include VOADS, as well as associations, and others.)

Level 1.2.2.2 State

The role of state disaster relief agencies is similar in many ways to that of local agencies. The state must have an effective disaster response organization, and must develop and maintain a response plan, emergency facilities and equipment.

The state is in a unique position to ascertain, through contact with local officials, the disaster response needs of its political subdivisions; assess state and Federal government resources; and facilitate the acquisition, application and coordination of those resources.

The state provides direct guidance and assistance to its local jurisdictions, and serves as a conduit for Federal guidance and assistance to local levels. In a disaster situation, state officials ensure a coordinated response through the combined efforts of local government, state and Federal agencies, and private sector organizations.

Level 1.2.2.3 Local

Local government is recognized as the first line of official public responsibility for disaster response activities. State and Federal Governments can be counted on for major support only when the disaster-related damage is unusually severe or widespread.

Level 1.2.3 Non-Government Organizations

An important component of a initial disaster response is the full utilization of the assets available from the private sector. Coordinated disaster relief operations require that manpower and material resources of both the government and private sector be utilized effectively by both entities during a response to a disaster.

Sources of invaluable assistance during a disaster are private, volunteer and charitable institutions. These can include: The American Red Cross, Salvation Army, the Mennonite Disaster Service, local affiliates of labor unions, communications clubs, search and rescue groups, the Civil Air Patrol, community service organizations, and professional associations (state nursing associations, psychological associations, and others). These agencies and organizations can be involved in activities such as the mass feeding, clothing and housing of disaster victims, thus freeing local government to focus on other relief functions. Written agreements, such as memoranda of understanding, make disaster coordination efforts automatic and prevent duplication of effort. Through these agreements, the role of private sector groups is clearly defined, and their resources can be fully integrated into disaster relief operations.

Level 1.2.3 Public

1.2.3.1 Victim

Public who are victims from disaster

1.2.3.2 Non-Victim

Public who are non-victim from disaster

Level 1.2.4 Media

During the disaster response, public affairs professionals of every organization involved in a disaster response need to be provided with timely and accurate information to

release and receive to the media during the initial phase of the disaster operations. Public affairs staff need to have comprehensive lists of all media in order to effectively "get the word out" during a disaster.

3.8 TARGETED POPULATIONS AND RESEARCH ORGANIZATIONS

The survey was developed to prioritize the types of information needs and the quality of data required adequate to support in disaster relief operations among various disaster response organizations. The survey was also used to determine how these information requirements contribute to communication breakdowns that occur in relief operations during the initial stages of a disaster response. The next step in the expert judgement based approach was to select experts with appropriate domain knowledge. The surveyed population of disaster operation experts were selected on the basis of their background and past experiences in disaster relief operations. Experts were defined for the purpose of the study as individuals who had served for at least three years in disaster relief operations, served for at least three years in disaster relief organizations and have had considerable contact with other disaster response organizations (i.e. Government agencies, non-government agencies and volunteers).

The section below describes the surveyed disaster relief organizations, and how they contributed to this study. It should be noted that though the surveyed experts in these organizations have worked at different levels and served in many functions, all share the common quality of having served during the initial phases of a disaster response operation.

3.8.1 American Red Cross

The purpose of American Red Cross (ARC) disaster services is to provide timely and effective help to disaster victims to begin and complete their disaster recovery efforts.[6] ARC policies, regulations and service delivery procedures have evolved with changes in government-funded disaster programs, technological advances in weather forecasting and relief activities, collaborative efforts between the Red Cross and other voluntary agencies, measures to expand hazard mitigation efforts, and adjustments in the public's expectations of relief operations. The lines of authority and communication in the nationally-administered disaster operations of ARC are described, as well as its functional activities in a relief operation.

Functional activities of ARC include:

1. Management Function

-Administration

2. Direct Service Function

-Mass Care

-Family Service

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[6]American Red Cross, Disaster Services Regulations and Procedures, ARC 3015, 1991.

-Health Service

-Disaster Welfare Inquiry (DWI)

3. Support Service Functions

-Damage Assessment Functions

-Records and Reports

-Building and Repair

-Supply

-Communications

-Staffing

-Voluntary Agency Liaison

-Labor Participation

-Training

-Public Affairs

-Government Liaison

-Human Relations

-Fund-Raising

-Accounting

The American Red Cross does not conduct response efforts in a vacuum. Because the government is responsible for the protection of life and for a variety of emergency services in time of disaster, it is essential that county and municipal government leaders -- especially those responsible for public safety and emergency response -- be made fully aware of the

capabilities of the Red Cross. Federal, state and local disaster plans should be developed in consultation with ARC in order to fully exploit ARC's resources and potential role as coordinator of other voluntary response groups.

All government disaster response planners and ARC should be agreed as to when the Red Cross will be notified of a disaster. Communication between state agencies and local ARC units can be handled by ARC division headquarters and the Red Cross state relations representative.

A wide variety of local resources, both government and non-government, are available to disaster victims. Resources may include Comprehensive Employment and Training Act(CETA) funds for emergency personnel; specific emergency assistance programs funded through the Department of Health and Welfare or Human Services but administered locally; Lions Club eyeglass funds; personnel, equipment, and material supplies available from other voluntary agencies; supplies of goods, serviceable clothing and furniture; and volunteers with specific skills who can be trained to assist in Red Cross disaster services.

3.8.2 Salvation Army

The Salvation Army has institutionalized such that offices within its organization at the national, regional and local level that can disaster assistance. The Salvation Army is active in the functions of disaster preparation and response, assuming a lesser role in the functions

of mitigation and recovery.

The Salvation Army disaster assistance offices include:

A. *National Public Affairs Office and Disaster Service* - A department of Salvation Army National Headquarters, this office has been established in Washington D.C. in order to maintain close contact with Federal government agencies and the national headquarters of volunteer groups.

B. *Territorial Disaster Services* - Each territorial emergency disaster services director is responsible for maintaining relationships at the territorial level and for coordinating disaster work training and service within the territory.

C. *Divisional Disaster Service* - The disaster service director serves in the same capacity as the territorial service director, but at the divisional level.

3.8.3 Voluntary Organizations

In 1970 several voluntary groups began to meet informally to form an alliance called National Voluntary Organizations Active in Disaster (NVOAD). As the number of organizations in NOVAD grew, the group formalized its structure.

NVOAD's member organizations are primarily churches and church organizations, plus many voluntary groups with a diversity of public service interests. Most NVOAD member groups, like the Salvation Army, primarily provide non-relief services. However, if necessary, these NVOAD organizations can respond to human needs whenever a disaster occurs.

NVOAD members include: American Radio Relay League, Inc.; the American Red Cross; the Boy Scouts of America; Church World of Service; the Civil Air Patrol; the Mennonite Disaster Service; National Catholic Disaster Relief Communities; Presbyterian Church; St. Vincent de Paul; and the United Methodist Committee. The volunteers can be belong to organizations, or there are other volunteers are form local and not belong to those organizations. For example, the project called " CARD (Collaborating Agencies Responding to Disaster)" in California, there are group of volunteers are not belong to any other disaster response agencies.

3.8.4 Federal Emergency Management Agency (FEMA)

The Federal Emergency Management Agency (FEMA) was established to prepare for and respond to catastrophic disasters of all kinds, natural and man-induced, including attacks on the United States. Specifically, FEMA plans for and coordinates the protection of

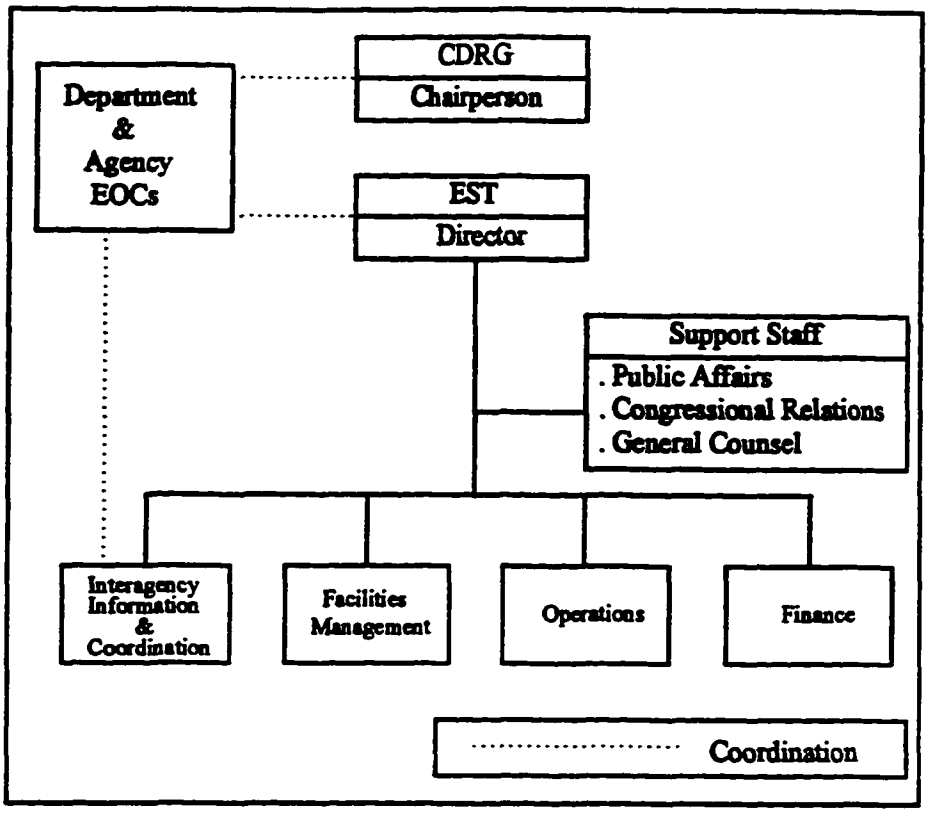

Figure 3-5 : FEMA National Level Response Structure

America's civilian population and resources, including continuity of the national government in a time of emergency.[9] These efforts are overseen by a sub-organization within FEMA, the State and Local Program, and Support Directorate. These organizational relations are shown above (Figure 3-5).

FEMA's Federal Response Plan (FRP) is designed to address the consequences of any

[9]The major programs of FEMA include, but are not limited to Civil Defense, Continuity of Government, Comprehensive Emergency Preparedness Planning for State and Local Governments, Preparedness Program, the National Defense Stockpile, Training and Fire Program, Radiological Emergency Preparedness, Disaster Relief Administration, and Flood Insurance. Overall, the mission responsibilities of FEMA, defined as a nine "mission areas ," are outlined in ACT, Title II, Section 201.

disaster or emergency situation in which there is a need for Federal response assistance under the authority of the Stafford Act (Figure 3-5). It is a basic mechanism for coordination of Federal, state and local relief activities. The plan consists of four components: 1) the Basic Plan, which describes the purpose, scope, situation, policies and concepts of operations; 2) Appendices, which include a list of acronyms/abbreviations, terms and definitions, and authorities and directives; 3) Support Annexes, which describe the areas of financial management, public information and congressional relations; and, 4) Functional Annexes, which describe the policies, situation, planning assumptions, concepts of operation and responsibilities for each Emergency Support Function (ESF).[10]

Emergency Support Functions (ESF) Defined by the Federal Response Plan :

1. Transportation
2. Communication
3. Public Works and Engineering
4. Fire-fighting
5. Information and Planning
6. Mass Care
7. Resource Support
8. Health and Medical Care

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[10]Federal Emergency Management Agency, The Federal Response Plan, Pubic Law 93-288, amended April 1992.

9. Urban Search and Rescue

10. Hazardous Material

11. Food

12. Energy

The FEMA director will provide information on the requirements for Federal response assistance to the White House and to senior-level Federal government officials. The FEMA associate director will activate the Catastrophic Disaster Response Group (CDRG) and the Emergency Support Team (EST). The interagency EST will assemble in the Emergency Information and Coordination Center (EICC) within two hours of notification to initiate headquarters interagency operations. The EST will provide support for regional response activities. At the call of CDRG chairperson, the CDRG will convene in the FEMA EICC. Members will report on their agency deployment actions and initial activities in support of Emergency Support Functions (ESFs). Federal departments and agencies will activate their headquarters EOCs to provide coordination and support to regional response elements in the field.

FEMA activities in the field will initially consist of an Emergency Response Team (ERT), and the Advance Element of the ERT (ERT-A)

ERT-A is the first FEMA group to deploy to the field in response to a disaster event. The ERT follows soon after.

ERT is an interagency team, consisting of the lead representative from each Federal department or agency assigned primary responsibility for an ESF and key members of the Federal Coordinating Officer's (FCO's) staff. The ERT helps the FCO carry out his or her coordination responsibilities.

The ERT provides a forum for coordinating the overall Federal response, reporting on the conduct of specific operations, exchanging information, and resolving issues related to ESF and other response requirements.

ERT members respond to and meet as requested by the FCO to include designated representatives of other Federal departments and agencies as needed.

Back at FEMA headquarters in Washington, the EST oversees and directs the activities in the field. The EST is an interagency group, and coordinates activities with EST primary and support agencies. The EST provides administrative, logistical and operational support to the CDRG.

Shortly after FEMA's response to the disaster is established, the White House will appoint FCO to oversee the endeavor at the Federal level.

The FCO is usually a senior Federal official whose appointment is in accordance with provisions Section 303, Public Law 93-288. The FCO serves as the President's legal

representative for the purpose of coordinating the Federal relief activities in the designated disaster area.

The FCO is delegated responsibilities and fulfills them for the FEMA Director as outlined in Executive Order 12148, and those responsibilities delegated to the FEMA Regional Director in Title 44 Code of Federal Regulations, Part 205.

FEMA will intervene in a disaster only after a governor of a state requests it. This request will be forwarded to FEMA, which will take the necessary actions to expedite the processing of the governor's request for presidential major disaster assistance or an emergency declaration. When an event occurs that requires a Federal response, the FEMA regional director will implement initial Federal response activities. Once FEMA and other Federal agencies activate a regional operation center and established communications links to state disaster relief officials, an ERT will deploy to the affected area.

The FEMA regional director, with the support of ESFs, will initially deploy members of the ERT to the affected region to conduct field operations. FEMA's regional director will coordinate the Agency's support needs of state disaster relief officials until the FCO arrives on the scene and assumes control. Meanwhile, ESFs will assess the impact of the disaster, and will identify, mobilize and deploy response personnel and resources.

After the occurrence of a major disaster, the governor(s) of affected state(s) will

request a presidential disaster declaration under the provisions of the Stafford Act.[11] The president will declare a major disaster or emergency, as warranty, for the affected area. Based on response requirements of the situation, FEMA will activate part or all of the structure of the plan. Funding for Federal response will be made available from the Disaster Relief Fund, under the provision of the Stafford Act.

In order for a county to declare a disaster, two or more municipalities must be involved. The county then assumes overall coordination for response, but not fiscal responsibility. For Federal assistance, first the Office of the Governor must be petitioned, and then the Governor's Office petitions the President. Along with the declaration of a federal disaster comes the state's commitment of 25 percent of the funding. At the county level, the issue is resources, not funds. At the state level, a declaration allows for the use of contingency funds. National Academy of Public Administration (NAPA) and General Accounting Office (GAO) authorities agree that local governments are the first respond to a disaster. The key level often is county government. County emergency agencies usually work with municipal officials in disaster and emergency response. These governments receive FEMA funding

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[11]ROBERT T. STAFFORD DISASTER RELIEF AND EMERGENCY ASSISTANCE ACT (P.L. 93-288, AS AMENDED), IMPLEMENTED BY FOOD DISTRIBUTION REGULATIONS, PART 250.1(b)AND 250.8

These provisions allow any person/household temporarily displaced by a disaster to obtain USDA foods in congregate feeding provided by a volunteer organizations such as the American Red Cross and Salvation Army; no formal approval is required from the USDA. Additionally, low income families can receive household distributions of food in situations where a Food Stamp Program is not available (e.g.,commercial channels of trade are distributed); formal USDA approval is required.

passed through their respective state emergency management agencies.

Not all disasters warrant federal assistance. Typically, before FEMA and other federal agencies provide assistance to state and local governments, the governor must request assistance and the president must then make a declaration of major disaster or emergency.

The disaster declaration process is as follows:[12]

1. A contact is made between the affected state and the FEMA regional office. This contact may take place prior to or immediately following the disaster.

2. If it appears the situation is beyond the state and local capacity, the state requests FEMA to conduct a joint Preliminary Damage Assessment(PDA). Participants in the PDA will include FEMA, state and local government representatives and other federal agencies.

3. Based on the PDA findings, the governor submits a request to the President through the FEMA regional director for either a major disaster or an emergency declaration.

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[12]This information is obtained from FEMA's homepage on the world wide web. The universal resource locator(URL) is (http://www.fema.gov).

4. The FEMA Regional Office submits a summary of the event and a recommendation based on the results of the PDA to FEMA headquarters, along with the governor's request.

5. Upon receipt of these documents, headquarters' senior staff convene to discuss the request and determine the recommendation to be made to the president.

6. FEMA's recommendation is forwarded to the White House for review.

7. The president declares a major disaster or an emergency.

CHAPTER 4

RESULTS

4.1 SURVEY SAMPLE AND SURVEY RESPONSES

The expert survey was used to prioritize the type of information needed and quality of information required to support 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 was as follows (table 4-1);

Table 4-1

Distribution of Expert Survey Response

Organization	Interview & Survey	Supplementary Survey	Total Response
American Red Cross	8/7	6/2	9 (3)
Salvation Army and other Private Organizations	2/2	2/1	3 (3)
Local Government	3/2	2/1	3 (2)
State Government	2/2	4/1	3
Federal Emergency Management Agency	4/4	4/1	5 (1)
Volunteers	9/8	4/2	10 (4)
TOTAL	*27/25	*22/8	33

* (Number of survey distributed / Number of responses)

( ) : Drop out due to incomplete/misunderstanding of Questionnaire

The multi-attribute questionnaire by AHP used to elicit responses from the target population consisted of tables of pair-wise comparisons. Respondents were asked to consider pairs of "decision-making factors" (see Chapter 3), and determine which factor is more important and deserved immediate attention.

The pairing of different types of information and information quality required of various decision-making factors was the product of a hierarchical analysis of all decision-making factors traditionally confronted by disaster relief officials. The top hierarchy consists of two levels, and every level has number of factors described in Chapter 3. Each comparison of factors in the hierarchy was rated by the participants, and these are noted in Chapter 3.

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.

The government organizations are run by government employees and funded by federal, state or local governments. Non-government organizations (NGOs) such as the American Red Cross and Salvation Army are funded primarily by the public donations, have a national organization base and have paid employees and non-paid volunteers. The volunteers groups are localized and have non-paid employees. The volunteer organizations often have very narrow disaster response missions.

1. Government Agencies
2. Non-government Agencies
3. Volunteers

4.2 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 4-1. 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.

1 : indicate equal importance of the two elements

3 : indicate weak importance of one over the other

5 : indicate strong importance of one over the other

7 : indicate demonstrated importance

9 : indicate absolute importance

2,4,6 & 8 indicate intermediate values

Judgement scales on the Figure 4-1 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. The Expert Choice put is also attached in the Appendix C. The arranged output table based on Expert Choice software is presented in the Table 4-2. For practical reasons, it is not possible to present here all of the comparative graphs and other raw data generated by the Export Choice software. However, the analysis presented here will reveal significant findings in the data. The rest of graphs and data are attached in Appendix.

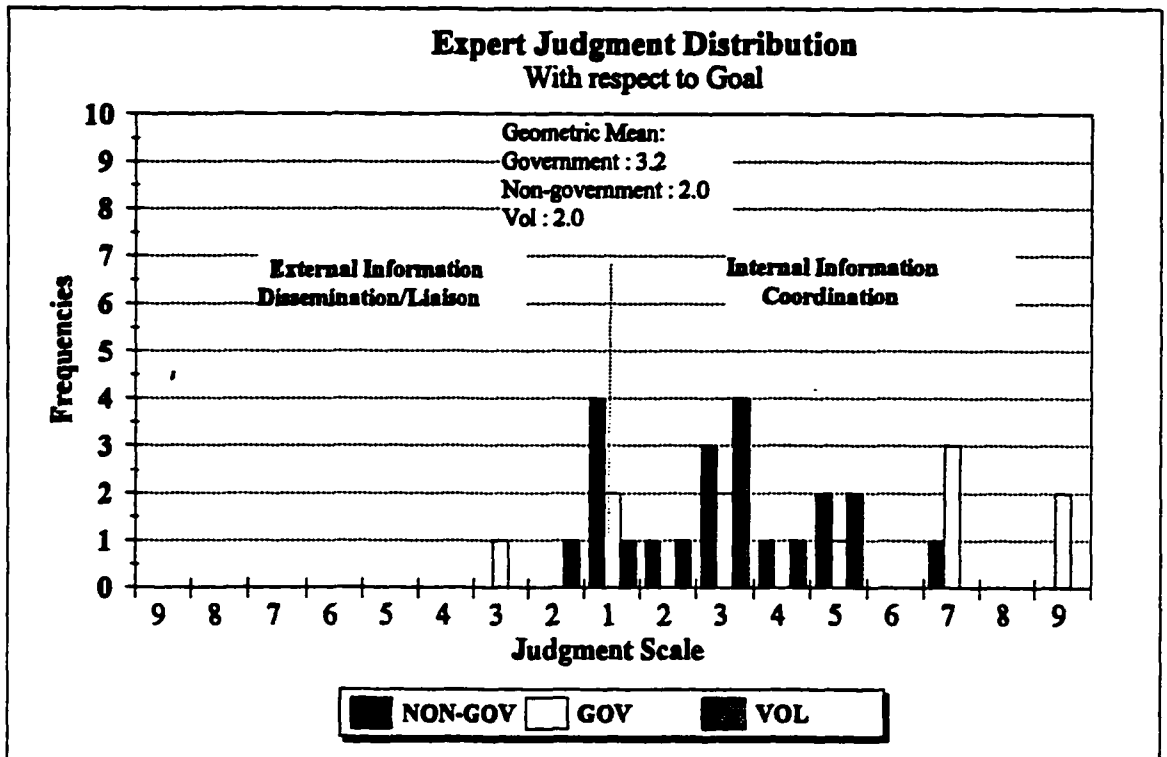


Figure 4-1

Table 4-2
EXPERT CHOICE OUTPUT
(WEIGHTS FROM EXPERT JUDGEMENT)

		Volunteers	Non_Gov't	Government
FUNCTION				
Goal	Internal Coordination	0.762	0.706	0.762
	External Information Dissemination/Liaison	0.238	0.294	0.238
Internal Coordination	Disaster Assessment	0.574	0.614	0.341
	Resource Acquisition	0.151	0.249	0.146
	Sevice Delivery	0.275	0.137	0.513
External Information Dissemination/ Liaison	Government	0.101	0.133	0.323
	Non_Government	0.497	0.104	0.122
	Public	0.213	0.292	0.104
	Media	0.189	0.470	0.451

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".

4.2.1 Top level (Internal Information Coordination vs. External Information Dissemination/Liaison)

Judging from the results in figure 4-2, all three types of surveyed organizations believe that during an emergency response operation "Internal Coordination" is more important than the "External Information Dissemination/Liaison".

With respect to Internal Coordination and External Information Dissemination and Liaison, "Timeliness" data quality clearly exceeds the other factors in importance for all three groups (Figure 4-2). However, the "Accuracy" data quality within "Internal Coordination" is the most important on Non-Government sectors and the "Consistency" data quality within "External Information Dissemination/Liaison" is considered more important than "Completeness" of data to "Non-Government" sectors (Figure 4-2).

For Government sectors, the "Accuracy" and "Timeliness" elements of data quality within "Internal Coordination" are almost equally important to Government sectors. The

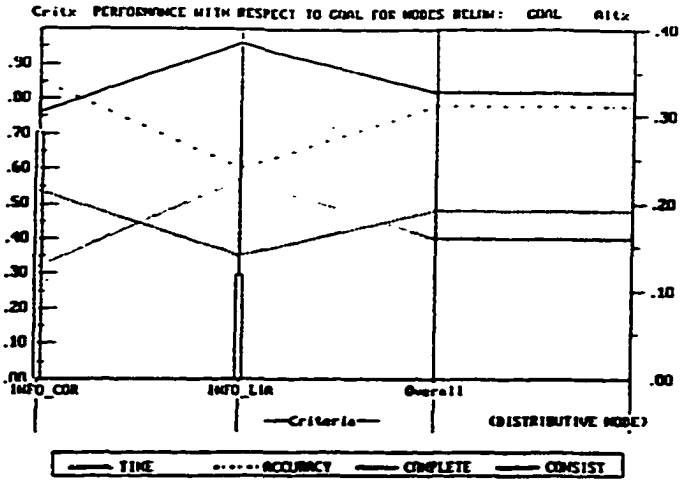


FIGURE 4-2A PERFORMANCE WITH RESPECT TO GOAL (NGO)

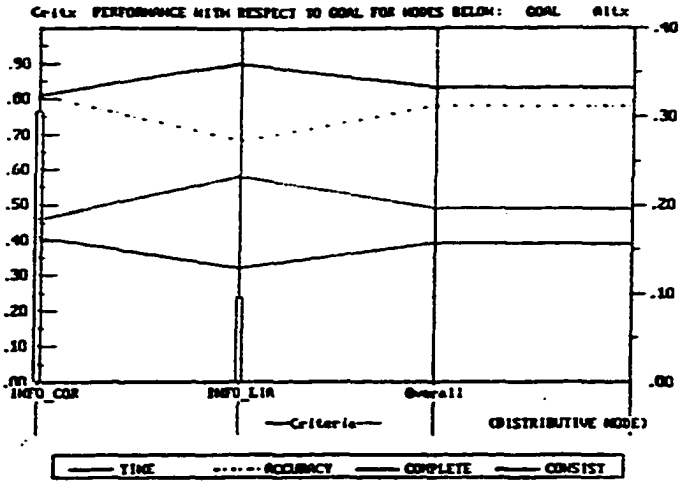


FIGURE 4-2B PERFORMANCE WITH RESPECT TO GOAL (GOV)

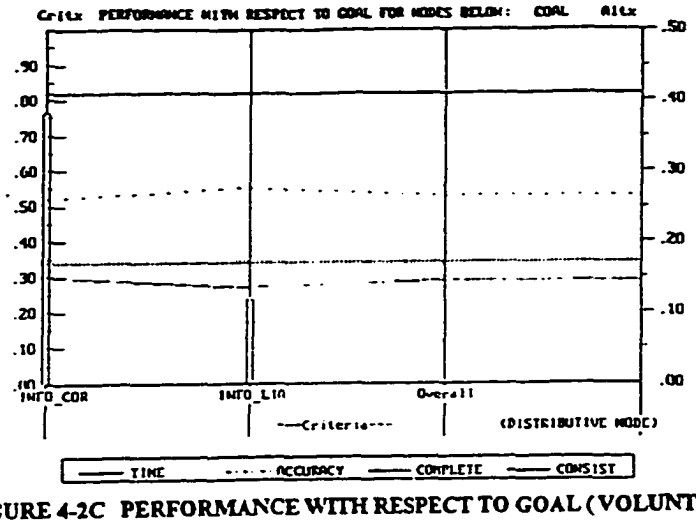


FIGURE 4-2C PERFORMANCE WITH RESPECT TO GOAL (VOLUNTEER)

FIGURE 4-2 WEIGHTS BASED ON EXPERT JUDGEMENT

"Completeness" of data quality within "External Information Dissemination/Liaison" is more important than "Consistency" data quality to Non-Government sectors (Figure 4-2).

In Figure 4-3, 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 4-3 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. For "Resource Acquisition" function information, "Completeness" of data quality is more important than "Accuracy" of data quality to Non-Government organizations (Figure 4-3). All of the responding organizations apparently believe that the most important quality of data in "Service Delivery" function is "Timeliness" data quality.

Figure 4-4 shows that "External Information Dissemination/Liaison" (with Non-government Organizations) is a priority concern for the Volunteers groups (0.497), and reveals that "External Information Dissemination/Liaison" (with the Media) is of greater

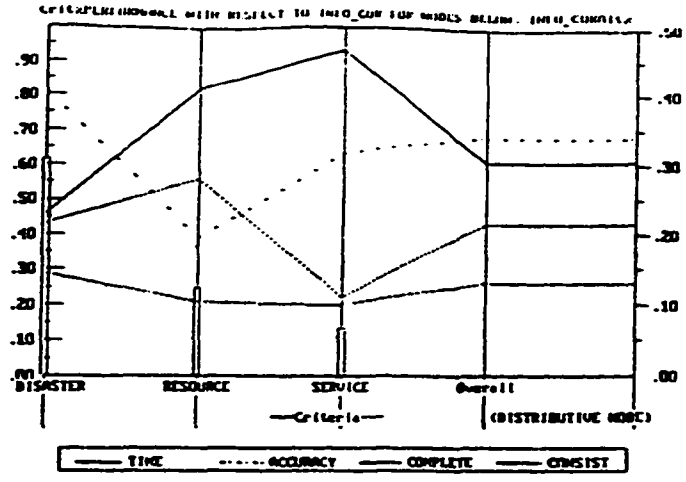


FIGURE 4-3A PERFORMANCE WITH RESPECT TO INFORMATION COORDINATION(NGO)

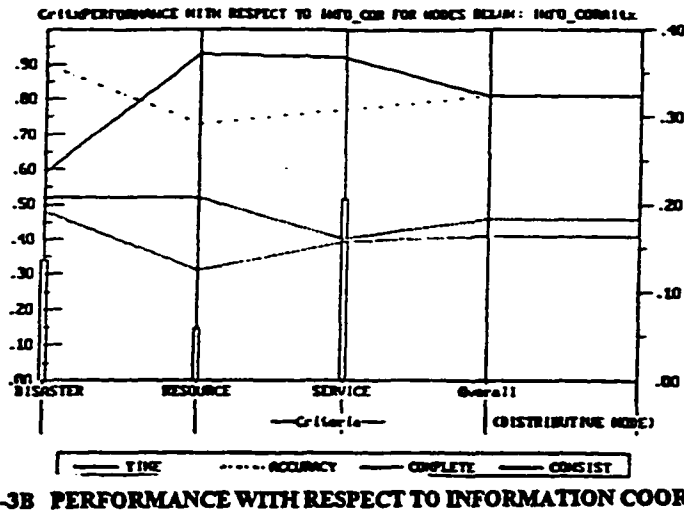


FIGURE 4-3B PERFORMANCE WITH RESPECT TO INFORMATION COORDINATION(GOV)

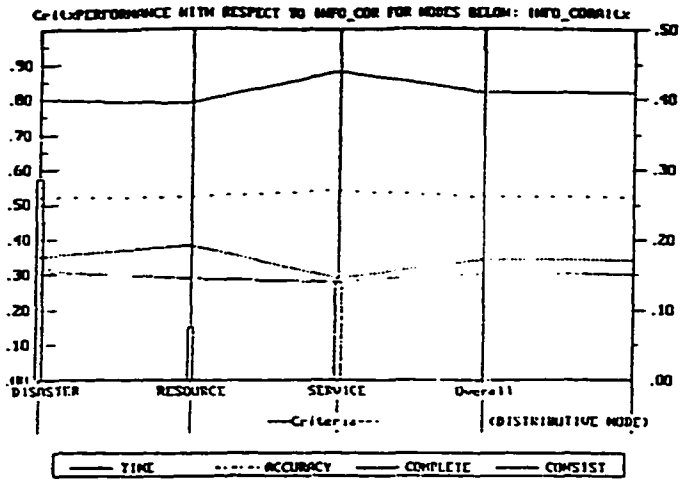


FIGURE 4-3C PERFORMANCE WITH RESPECT TO INFORMATION COORDINATION (VOLUNTEER)

FIGURE 4-3 WEIGHTS BASED ON EXPERT JUDGEMENT

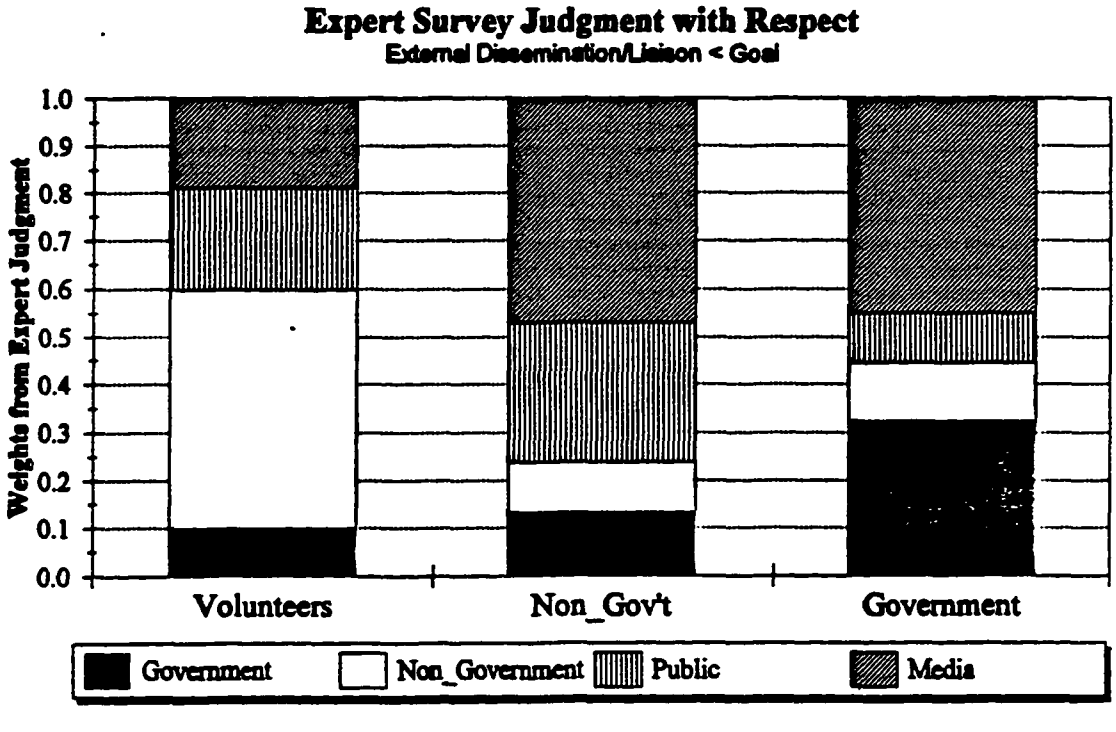


Figure 4-4

importance to both Non-Government agencies (0.470) and Government agencies (0.451).

4.2.2 Level Two (Critical Functions and Data Quality)

Figure 4-5 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 4-5, 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 4-5) is of greatest importance to Non-Government agencies (0.469), and "Completeness" of data quality is the second-most important factor to Non-

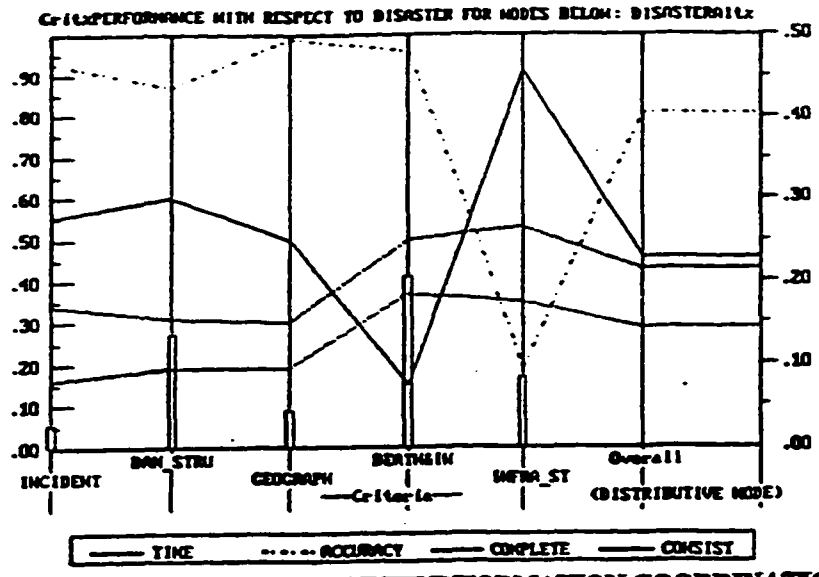


FIGURE 4-5A DAMAGE ASSESSMNET INFORMATION COORDINATION(NGO)

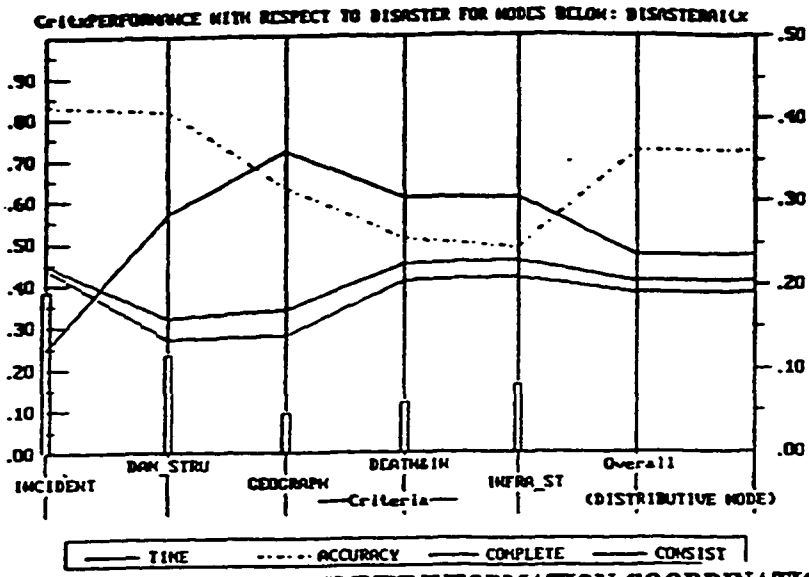


FIGURE 4-5B DAMAGE ASSESSMNET INFORMATION COORDINATION(GOV)

WEIGHTS BASED ON EXPERT JUDGEMENT

FIGURE 4-5 WITH RESPECT TO DAMAGE ASSESSMNET INFORMATION COORDINATION

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.

Survey results detailed in Figure 4-6 reveal that the "Staffing" function within "Resource Acquisition" function information is a concern common to all three types of represented disaster response organizations. However, for quality of data requirements, the "Completeness" of data quality is more important than "Timeliness" data to Non-government organizations.

All three types of disaster response organizations also believe that, in matter of "External Information Dissemination/Liaison with Government" (Figure 4-7), access to Local Governments is of primary importance.

Figure 4-8 shows that "Completeness" of data in "External Information Dissemination/Liaison with Non-Government" is the most important factor to non-government agencies (0.425). Figure 4-8 also reveals that "Timeliness" data in "External Information Liaison with Media" is the highest priority item for Non-government agencies (0.439). However, Government agencies feel "Accuracy" of data destined for the media should take priority (0.414).

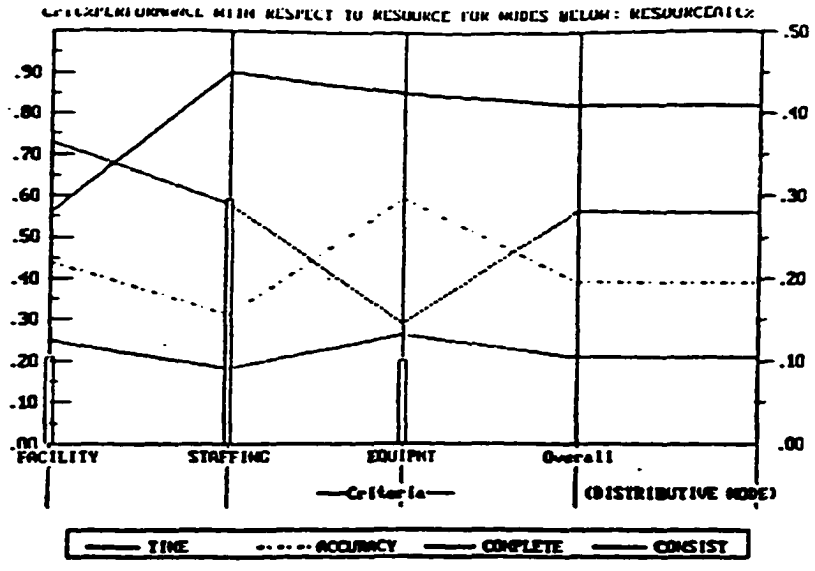


FIGURE 4-6A RESOURCE ACQUISITION INFORMATION COORDINATION(NGO)

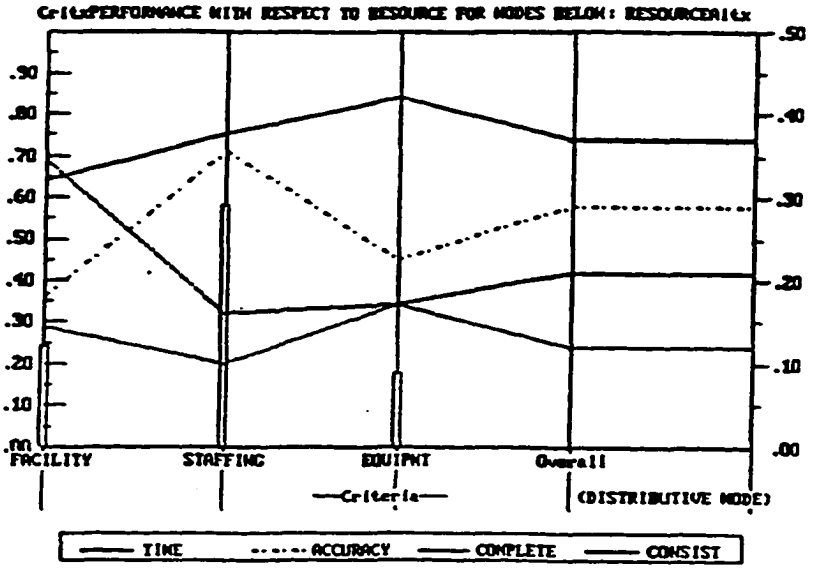


FIGURE 4-6B RESOURCE ACQUISITION INFORMATION COORDINATION(GOV)

FIGURE 4-6 WEIGHTS BASED ON EXPERT JUDGEMENT WITH RESPECT TO RESOURCE ACQUISITION INFORMATION COORDINATION

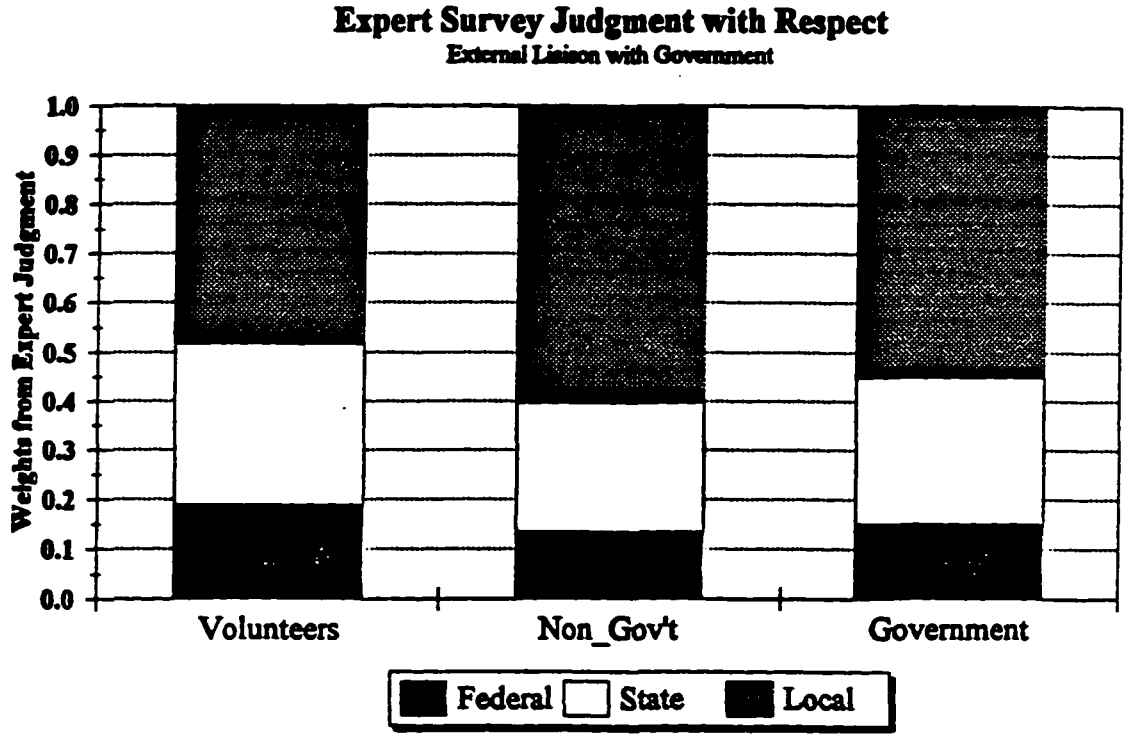


Figure 4-7

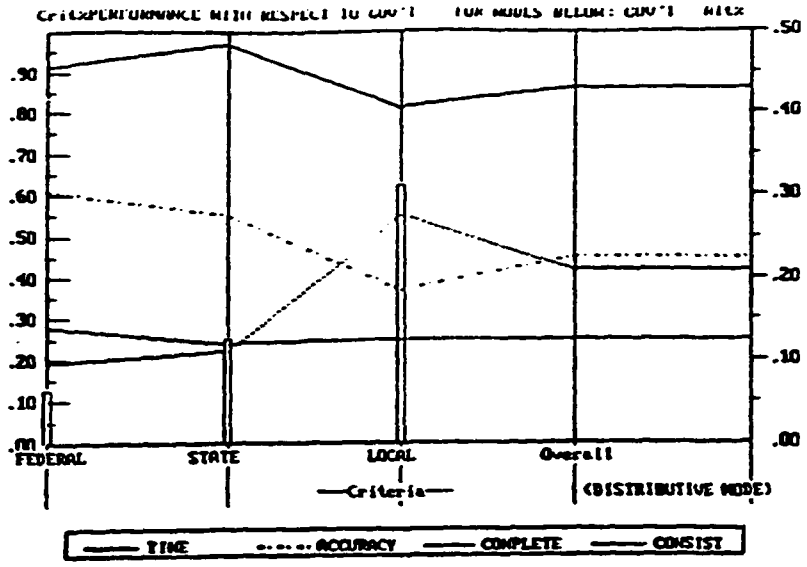


FIGURE 4-8A EXTERNAL INFORMATION DISSEMINATION/LIASION WITH GOV'T(NGO)

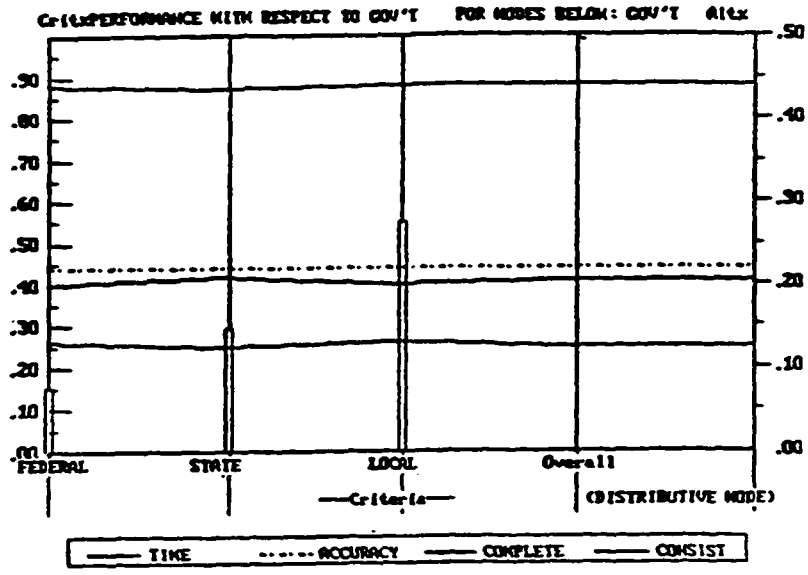


FIGURE 4-8B EXTERNAL INFORMATION DISSEMINATION/LIASION WITH GOV'T(GOV)

FIGURE 4-8 WEIGHTS BASED ON EXPERT JUDGEMENT WITH RESPECT TO EXTERNAL INFORMATION DISSEMINATION/LIASION WITH GOV'T

Lastly, Figure 4-9, "Information Liaison with Non-Victims", shows that "Consistency" data quality is of greatest importance to Non-Government agencies (0.397), but is of little concern to Volunteers and Government agencies.

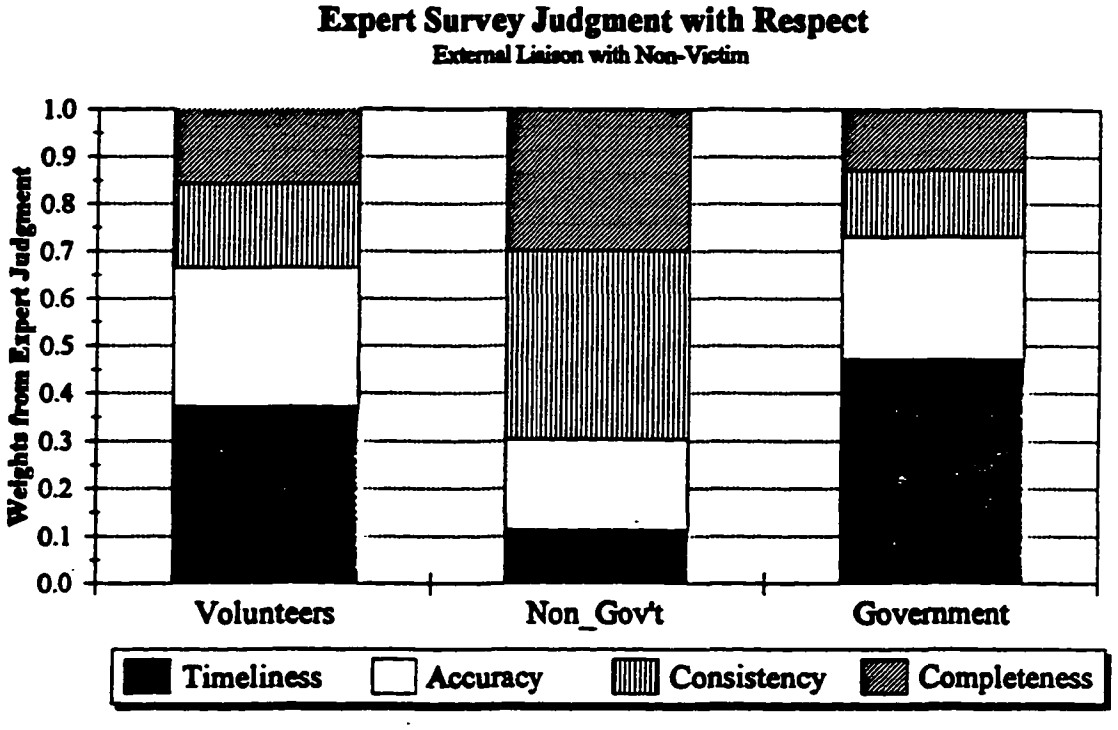


Figure 4-9

4.3 SENSITIVITY ANALYSIS

The Expert Choice software provides four graphical sensitivity analysis modes to investigate the sensitivities to change in criteria importance, based on the priorities of the alternatives.

The four types of graphical sensitivity analysis modes are available in the Expert Choice Software as follows;

1. Dynamic Sensitivity
2. Gradient Sensitivity
3. Performance Sensitivity
4. Two-Dimensional Sensitivity

In order to investigate how well each factor performs on each criterion, the Gradient Sensitivity graphs are presented in Appendices. Due to the fact that many of the sensitivity analysis graphs are similar to each other, only selected significant examples of "Sensitivity" level graphs by organizations are included in this analysis.

Expert Choice Software is designed to consider any changes in value of 0.1 or more to be a major change. Therefore, if data did not respond or change differently within a parameter of 0.1, this indicates data insensitivity.

4.3.1 Non-Government Organization(NGO) VS Government Organizations

Judging from the results in figure 4-10, "Accuracy" and "Timeliness" data quality with respect to the goal are sensitive since "Accuracy" data quality requirement becomes more important than "Timeliness" of data if "Internal Coordination" factor increases to 0.8 (currently 0.7) to the Non-government organization. Figure 4-10 also reveals that "Completeness" and "Consistency" data quality with respect to the goal are sensitive since "Consistency" of data quality requirement becomes more important than "Completeness" of data if "Internal Coordination" factor decrease (or increase "External Information Dissemination and Liaison" to 0.5 currently 0.29) to 0.5 (currently 0.7).

Figure 4-11A shows that "Accuracy" and "Timeliness" data quality requirement within "Damage Assessment" function are also sensitive since "Accuracy" of data requirement becomes more important than "Timeliness" of data if "Damage Assessment" function increases to 0.7 (currently 0.62) to Non-government organization. Judging from the results in figure 4-11B, "Accuracy" and "Timeliness" of data quality with respect to the goal are sensitive since "Accuracy" of data becomes more important than "Timeliness" data if "Disaster Assessment" function increases to 0.5 (currently 0.33) to the government organization.

Figure 4-12 shows that "Accuracy" and "Timeliness" data quality requirement within "Resource Acquisition" function are also sensitive since "Accuracy" of data requirement

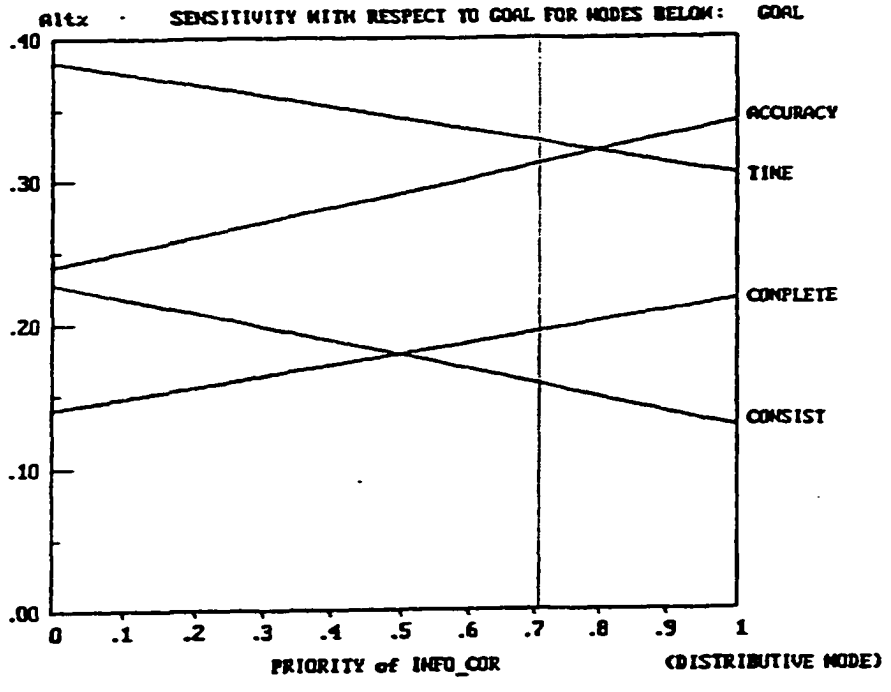


FIGURE 4-10 SENSITIVITY ANALYSIS WITH RESPECT TO GOAL (NGO)

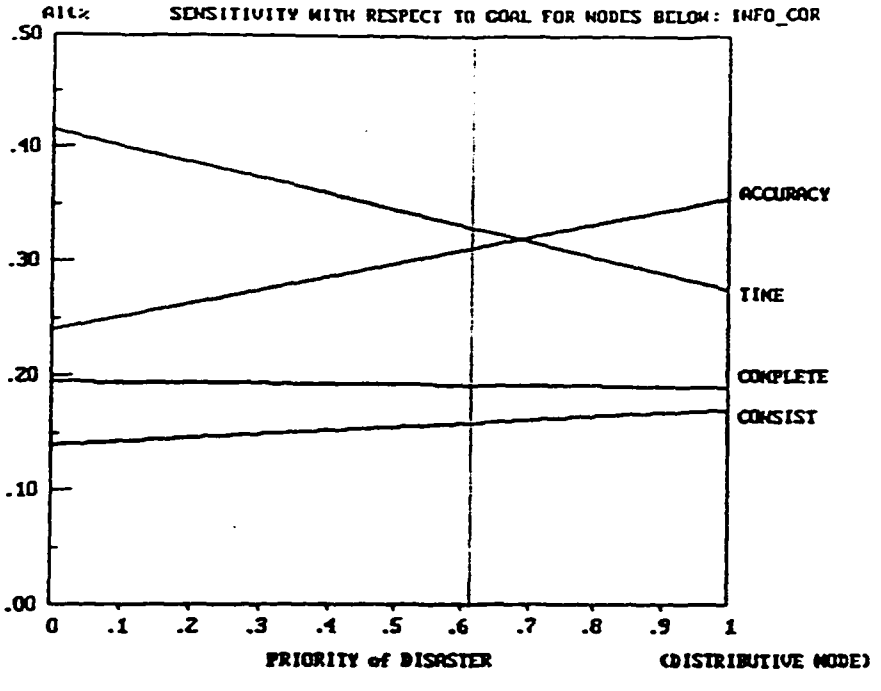


FIGURE 4-11A SENSITIVITY WITH RESPECT TO GOAL: PRIORITY OF DAMAGE ASSESSMENT (NGO)

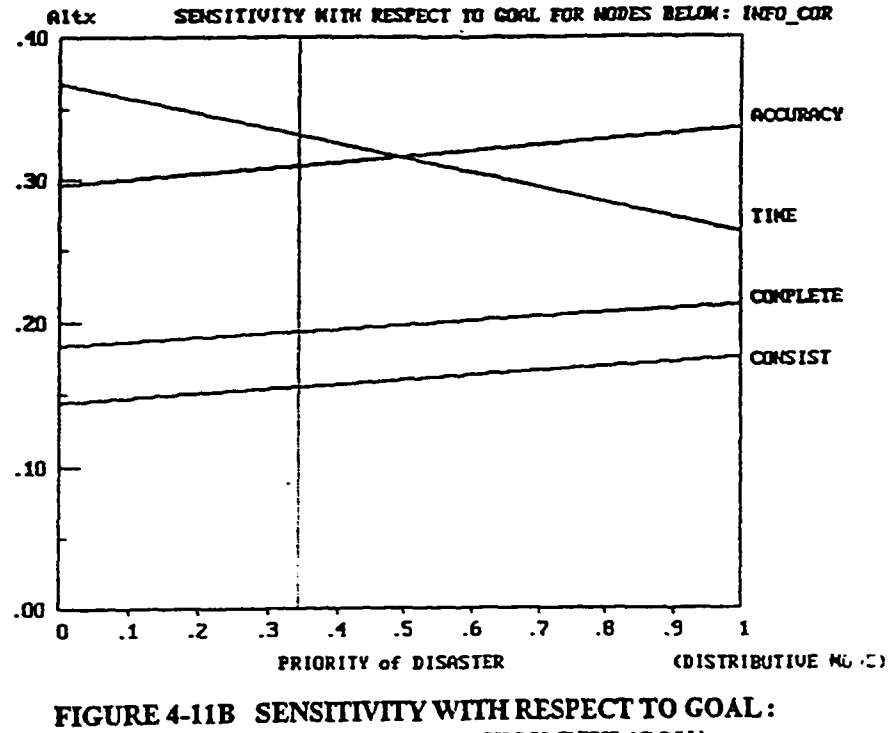


FIGURE 4-11B SENSITIVITY WITH RESPECT TO GOAL: PRIORITY OF DAMAGE ASSESSMNET (GOV)

FIGURE 4-11 SENSITIVITY ANALYSIS WITH RESPECT TO GOAL

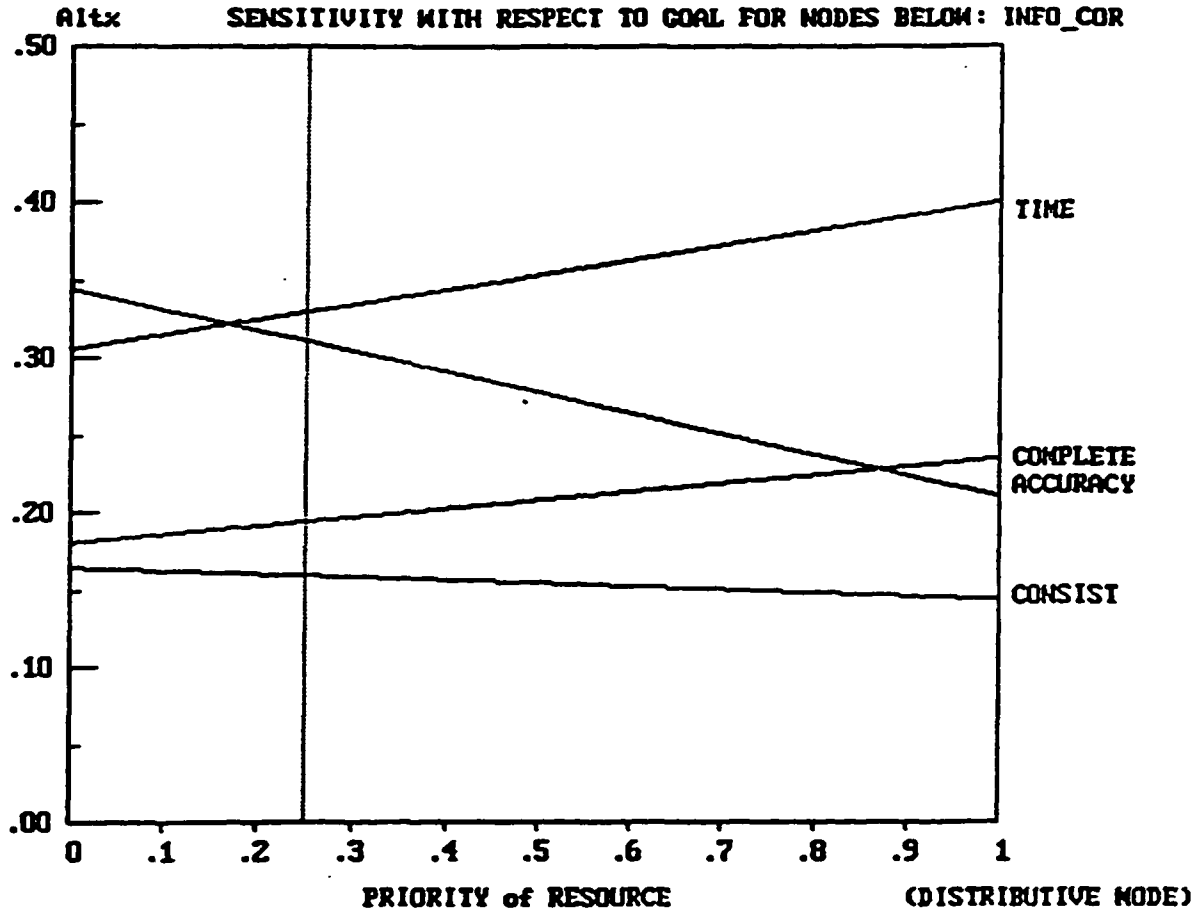


FIGURE 4-12 SENSITIVITY ANALYSIS WITH RESPECT TO GOAL PRIORITY OF RESOURCE ACQUISITION (GOV)

becomes more important than "Timeliness" of data if "Resource Acquisition" function decreases to 0.18 (currently 0.25) to Non-government organization.

Based on the results, Figure 4-13, "Accuracy" and "Timeliness" factor within "External Information Dissemination/Liaison" with respect to the goal are sensitive since "Accuracy" becomes more important than "Timeliness" if "Media" factor increases to 0.8 (currently 0.45) to the Volunteers group.

4.4 SUMMARY OF RESULTS

An analysis and prioritization of both the types of information by the essential function and quality of information needed for effective decision-making during a disaster response revealed only a few examples of shared opinion among the respondents, and many instances of dissension, and significant differences between groups indicating underlying differences in value of types and quality of information.

There is consensus of among all three types of the disaster experts surveyed -- Government, Non-Government and Volunteer -- that "Timeliness" data quality requirement of greatest concern. However, the organizations were significantly divided on various functions in the lower detail levels of function in the disaster information management hierarchy should take priority concerns.

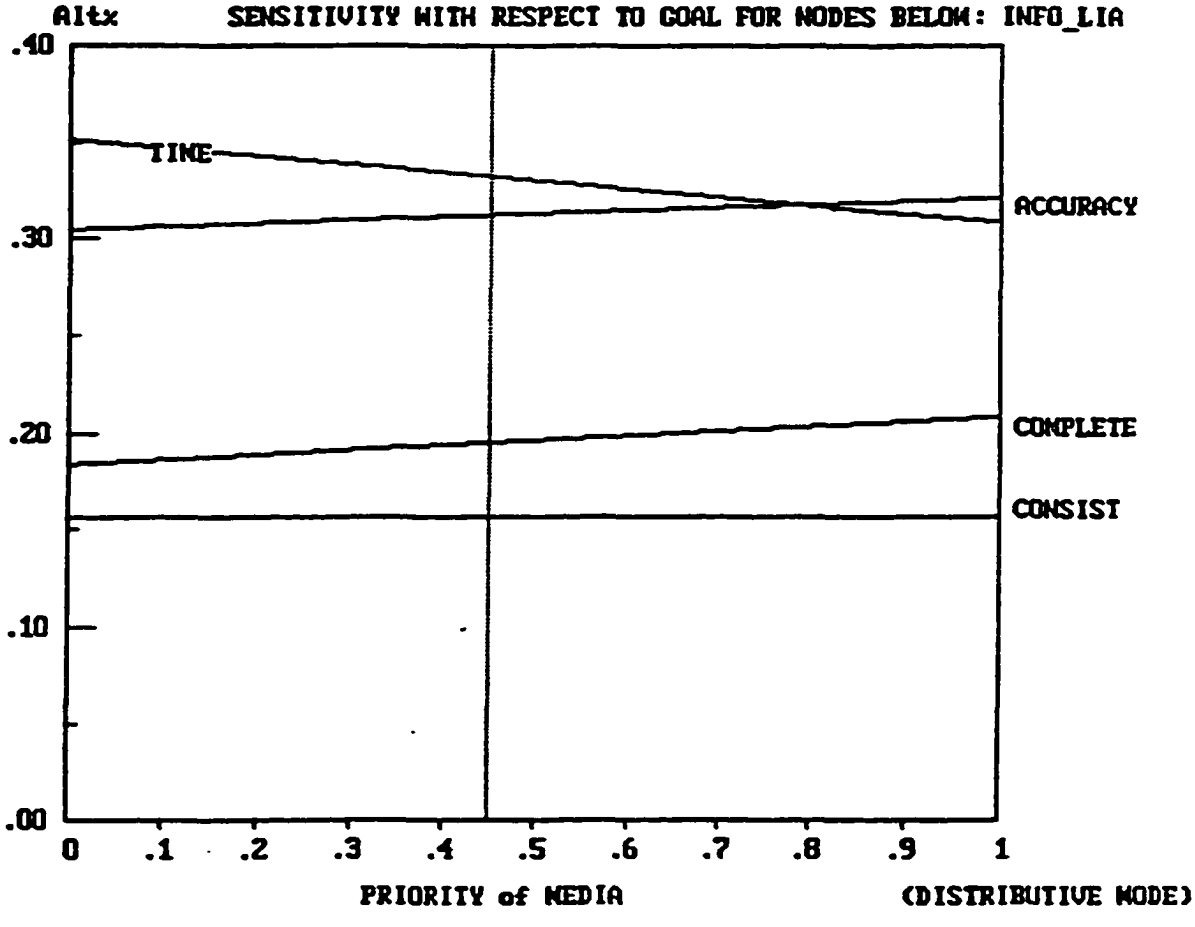


FIGURE 4-13 SENSITIVITY ANALYSIS WITH RESPECT TO GOAL PRIORITY OF MEDIA (VOL)

CHAPTER 5

CONCLUSIONS

5.1 CONCLUSIONS

The following research questions were addressed in Chapter 3:

Research Question 1:

What are the patterns of communication breakdown exist among organizations involved in disaster relief and disaster response operations? What are the causes and factors of these communication breakdowns?

Research Question 2:

How are these causes and factors of communications breakdown related to the essential functions of a disaster response operation? Having determined how these causes and factors of communication breakdown are related to the essential functions of a disaster operation, is it possible to prioritize the types of information and quality of data that best enables individual response organizations to function effectively and efficiently ?

Research Question 3:

Having determined how communication breakdown are related to the essential functions of a disaster operation, how do these communication breakdowns impact on essential functions of disaster operations and vary among different response organizations ?

Research Question 4:

Having learned the information requirements of individual organizations, can a model be developed that predicts the organizationally and functionally dependent information requirements of the disaster relief organizations ?

With respect to the first question, patterns and causes of communication breakdowns were identified based on a literature review of reports issued by the U.S. Government, academic research papers and narrative reports assessing the internal functions of disaster response organizations. Additionally, a series of interviews and surveys were made of various disaster operations professionals to affirm the causes and factors identified in the literature review.

During past disaster responses, problems have sometime arisen within and among the response organizations. The research associated with the second question revealed that one of the consistent problems encountered within and among disaster response organizations was a breakdown in communication. These communication breakdowns were due to either a

failure to obtain needed information, or a failure to exchange information of a quality adequate to support effective decision-making.

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 in Chapter 3 and were also represented graphically.

With respect to the third question, 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. While "Accuracy" of data quality on the "Resource Acquisition" function is more important to Government organizations than "Completeness" of data. Government organizations judged "Service Delivery" to be the most important function, and Non-government organizations felt "Damage Assessment" is the most important 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" of the quality 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.

Within the "External Information Dissemination/Liaison" factor -- which is also critical during the early phase of an operation -- respondents revealed that the requirements for data quality requirement varied from one type of response organization to another. The research revealed that the "External Information Dissemination/Liaison" with the "Media" factor was of primary concern to Government and Non-Government agencies, and was of less concern to Volunteer groups.

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 which 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.

5.2 IMPLICATIONS OF THE RESEARCH

Disasters often create a suspension of "normal life" in the affected area. Whether potential disasters are natural or man-made, it is clear that municipalities and regions within the United States must be prepared for them, and must continually upgrade their ability to respond to disaster. Foremost, there is a need for disaster response organizations to fully coordinate and better cooperate with one another when disaster strikes.

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 is 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 mangers 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.

The American Red Cross has initiated development of an integrated information system to support their mobilization and relief efforts. However, this new Red Cross system was not subjected to an evaluation of its ability to effectively manage information.

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 an disaster response.

APPENDIX A

STATISTICAL INFORMATION FOR BACKGROUND

STATISTCAL INFORMATION FOR BACKGROUND

33 respondents

PART I : BACKGROUND INFORMATION

To be able to provide profiles for the range of participants of the survey, please answer to the following questions.

1. Which organization do you work for ? _____

ARC	9 (27%)
SALVATION ARMY	3 (9%)
FEMA	5 (15%)
STATE(OES)	3 (9%)
LOCAL	3 (9%)
VOLUNTEERS(CARD)	9 (27%)
OTHERS	1 (3%)

2. What is your job title (function) during non-emergency situation and emergency situation ?

NON-EMERGENCY :_____

_____

EMERGENCY :

_____

_____

3. What are your responsibilities in job during non-emergency situation and emergency situation ?

NON-EMERGENCY :_____

_____

EMERGENCY :

_____

_____

4. How many years have you served in the disaster response or disaster relief operation area ?

1. 1-4 Years	2 (6 %)
2. 5-9 Years	7 (21%)
3. 10-14 Years	11 (33%)
4. 15-24 Years	9 (27%)
5. 25 or More Years	4 (12 %)

5. How many years have you worked at your organization ?

1. 1-4 Years	6 (18%)
2. 5-9 Years	9 (24%)
3. 10-14 Years	12 (37%)
4. 15-24 Years	5 (12%)
5. 25 or More Years	3 (9%)

6. Have you had education on disaster related field ?

Yes 24 (73 %) No 9 (27 %)

7. What is your sex and age ?

Male : 21 (64 %) Female : 12 (36 %) Age : 51.6 (mean)

8. How many years of education have you been completed ?

Less Than High School : 0 (0%)	High School : 10 (30 %)
College : 14 (42 %)	Graduate School : 3 (9 %)
Professional Degree : 5 (15 %)	Higher Than Graduate Degree : 1 (3 %)

PART II : GENERAL INFORMATION TO DISASTER RESPONSE ORGANIZATION

1. Does your organization have an disaster plan that it uses in the case of disaster response ?

   Yes 26 (79 %) No 7 (21 %)

2. In emergency, what organization or person does your organization report to ?

   _____

   _____

3. In an emergency, what other organizations report to your organization ?

   _____

   _____

4. In an emergency, what other organizations or groups does your organization work with ?

   _____

   _____

5. During an emergency what is the first organization your organization contact ?
   (According to the plan or standard operating Procedure)

   _____

   _____

6. What other organizations usually contact your organization in an emergency ?

   _____

   _____

7. How often do you contact the following organization (day-to-day operation) ?
(D=Daily, W=weekly, M=monthly, A=Annually, N=not at all)

Telephone Company	2 (6 %)
Electric Company	5 (1 %)
American Red Cross	18 (54%)
Salvation Army	3 (9 %)
Public Work	2 (6 %)
Catholic Charity	2 (6 %)
FEMA	9 (27%)
County Emergency Office	4 (12 %)
State Emergency Office	5 (15 %)
City Emergency Office	12 (36 %)
Local Emergency Office	19 (58 %)

Other organizations(If any, please specify organization and frequency)

19 (58 %)

APPENDIX B

EXPERT SURVEY QUESTIONNAIRE

EXPERT SURVEY

ASSESSMENT OF IMPACT ON INTER-ORGANIZATIONAL INFORMATION MANAGEMENT IN INITIAL DISASTER RELIEF OPERATION

JUNE 1996

OVERVIEW

A model has been developed that organizes the various factors that may influence disaster relief operations following a natural disaster such as floods, earthquake or hurricanes. A hierarchical model structure that may be used to assess the impact of inter-organizational information management on the initial disaster relief operations (first 12-72 hours) was developed using the commercially available software package, EXPERT CHOICE.

The objective of this questionnaire is to evaluate the relative contribution to the importance of initial disaster relief/response operations of each factor at each level in the hierarchy.

1. PURPOSE

This survey is designed to assess inter-organizational information management techniques based on past experiences and current disaster response procedures that have a direct impact on the disaster relief operations. It will used to identify and determine prioritized area for performance improvement in the disaster information management.

2. SURVEY STRUCTURES

PART I	:	BACKGROUND INFORMATION
PART II	:	GENERAL INFORMATION TO DISASTER RELIEF ORGANIZATION
PART III	:	IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL DISASTER RELIEF/RESPONSE OPERATIONS

PART I : BACKGROUND INFORMATION

To be able to provide profiles for the range of participants of the survey, please answer to the following questions.

1. Which organization do you work for ? _____

2. What is your job title (function) during non-emergency situation and emergency situation ?

NON-EMERGENCY :_____

_____

EMERGENCY :

_____

3. What are your responsibilities in job during non-emergency situation and emergency situation ?

NON-EMERGENCY :_____

_____

EMERGENCY :

_____

4. How many years have you served in the disaster response or disaster relief operation area ?

1. 1-4 Years
2. 5-9 Years
3. 10-14 Years
4. 15-24 Years
5. 25 or More Years

5. How many years have you worked at your organization ?

1. 1-4 Years
2. 5-9 Years
3. 10-14 Years
4. 15-24 Years

5. 25 or More Years

6. Have you had education on disaster related field ?

Yes _____ No _____

If yes, please explain the subject of study (e.g. Planning, Mitigation)

_____

_____

7. What is your sex and age ? (Optional)

(Male, Female) Age :

8. How many years of education have you been completed ?

Less Than High School _____ High School _____
College _____ Graduate School _____
Professional Degree _____ Higher Than Graduate Degree _____

PART II : GENERAL INFORMATION TO DISASTER RESPONSE ORGANIZATION

1. Does your organization have an disaster plan that it uses in the case of disaster response ?

Yes_____ No_____

2. In emergency, what organization or person does your organization report to ?

_____

_____

3. In an emergency, what other organizations report to your organization ?

_____

_____

4. In an emergency, what other organizations or groups does your organization work with ?

_____

_____

5. During an emergency what is the first organization your organization contact ?
(According to the plan or standard operating Procedure)

_____

_____

6. What other organizations usually contact your organization in an emergency ?

_____

_____

7. How often do you contact the following organization (day-to-day operation) ?
(D=Daily, W=weekly, M=monthly, A=Annually, N=not at all)

Telephone Company _____
Electric Company _____
American Red Cross _____
Salvation Army _____
Public Work _____
Catholic Charity _____
FEMA _____
County Emergency Office _____
State Emergency Office _____
City Emergency Office _____
Local Emergency Office _____
Other organizations(If any, please specify organization and frequency)

_____

_____

_____

PART III. IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL DISASTER RELIEF/RESPONSE OPERATIONS

You will be asked to compare factors two at a time and enough independent comparison will be made to ensure that each factor is compared with every other factor.

Your rating should answer the following questions:

1. Which factor is more important ?
2. How many times more important is it ?

For each set of objective descriptions, circle one number comparison on the side of the scale of the objective that you think more important in determining disaster information management. If you think that the factors are equally important circle "1". Otherwise, the number circles should indicate the relative importance of the factor compared to its row companion using the following scales :

9	VERY MUCH MORE IMPORTANT
7	MUCH MORE IMPORTANT
5	MODERATELY MORE IMPORTANT
3	SOMEWHAT MORE IMPORTANT
1	EQUALLY IMPORTANT

Enclosed in this packet are some helpful aids to enable you to answer to fill out the questionnaire in an easier manner :

1. A graphical presentation of the model. This enables you to follow the logic of the questionnaire at a single glance.

2. A dictionary of the variable names used in the model listed by the level of the hierarchy.

3. A collection of pairwise comparison chart and local variable definitions for all comparison.

The following is an example illustrating the technique:

Goal : Assess the likelihood of a lion attack

Instruction : Circle one number on the side of the factor that you consider more important in determining the chance of a lion attack. If you think the factors are equally important circle "1". Otherwise, the number circles should indicate the relative importance of the factor compared to its row companion using the following scales :

Circle one number per comparison using the following relative importance scales:

1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

1	Hungry Lion	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 Sleeping Lion

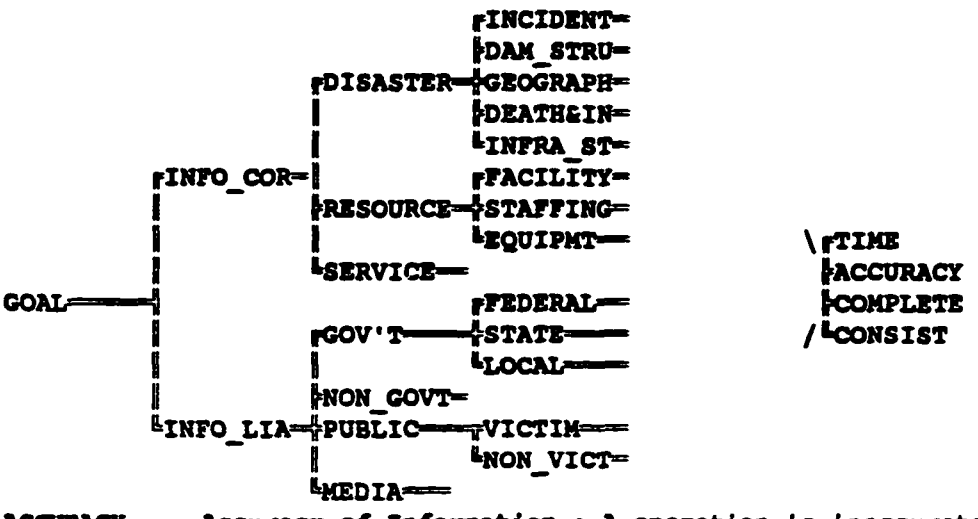
Variable Definition :

Hungry Lion — A lion which is hungry
Sleeping Lion — A lion which is sleeping

By circling 7 on the left side you imply that a hungry lion is very strongly more likely to attack is a sleeping lion.

GRAPHICAL PRESENTATION OF MODEL

IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL DISASTER RELIEF OPERATIONS



ACCURACY --- **Accuracy of Information** : A operation is inaccurate when information is error-prone. A system produce invalid results when it suffers from the problems in reliability, validity and correctness of information.
COMPLETE --- **Completeness of Information** : Data must include all critical information. The critical data should not be missing.
CONSIST --- **Consistency of Information** : Consistency follows from the control or elimination of redundancy and conflicting values. For Example, if a person's address appears in only one place, there is no possibility that his/her soc 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 Organization
INCIDENT --- Incident Description
INFO_COR --- Information Coordination
INFO_LIA --- Information Dissemination/Liaison
INFRA_ST --- Infrastructure Damages
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 Acquisition/Mobilization Information Coordination
SERVICE --- Service Delivery Information Coordination
STAFFING --- Staffing Requirement/Allocation
STATE --- State Agencies
TIME --- **Timeliness of Information** : Data must present currect conditions. A timeliness relates more to the transmission of information than to processing or storing of it. A operation suffers from the problem of timeliness if information available but can not be retrieved when where it is needed.
VICTIM --- Victim of Disaster Events

Compare the relative IMPORTANCE with respect to: GOAL

For each row, circle the more IMPORTANT element and indicate how many times more IMPORTANT it is in the intensity column (enter 1 for equality).

Intensity

INFO COR	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	INFO LIA

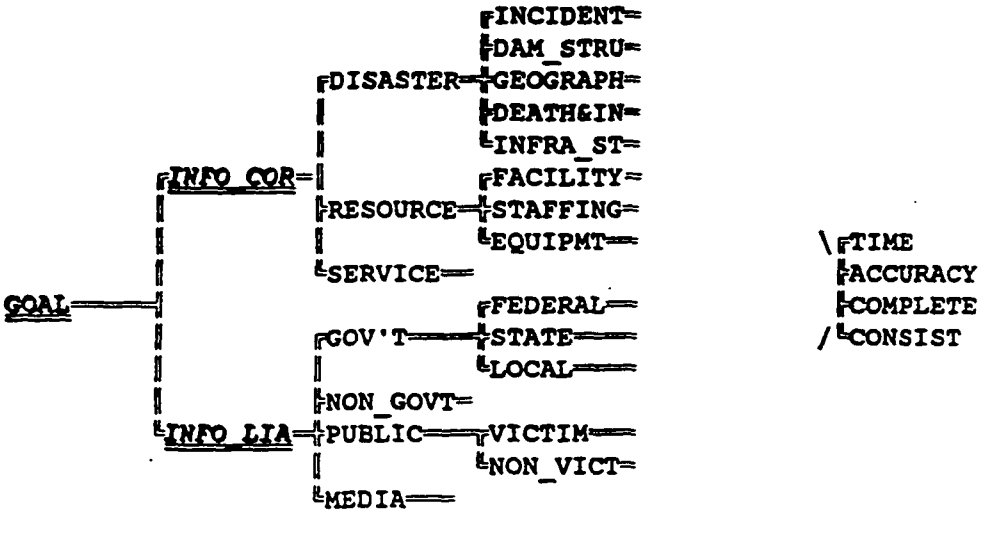
GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

INFO_COR --- Information Coordination Factors among disaster response organizations that influence the disaster relief operation efforts specific to your organization; for example damage assessment, resource Requrement/mobilization or service delivery information coordination.

INFO_LIA --- Information Dissemination/Liaison Factors among disaster response organizations that influence the disaster relief operation efforts specific to your organization; for example liaison with government, state/local, public or media.

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to: INFO_COR < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

1	DISASTER	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 RESOURCE
2	DISASTER	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 SERVICE
3	RESOURCE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 SERVICE

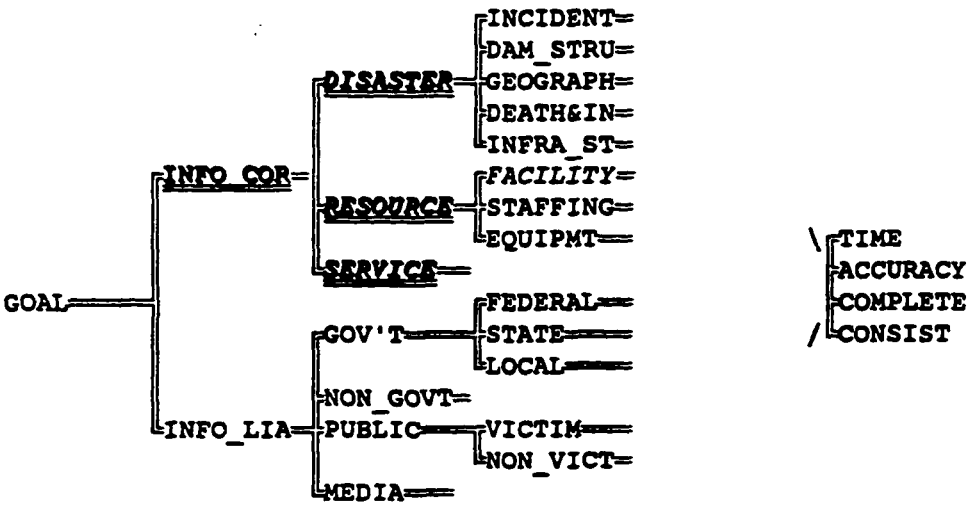
Local Variable Definition :

DISASTER --- Damage Assessment Information Coordination
Systematic collection of damage information across different response organizations; for example, information of incident description, damage structure, geographical location, death & injuries,

RESOURCE --- Resource Acquisition/Mobilization Information Coordination
Information of effective acquisition of resources for use of personnel and material resources across different organizations

SERVICE --- Service Delivery Information Coordination
Information of effective distribution and allocation of resources for the use of personnel and material resources across different organizations

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
DISASTER ASSESSMENT INFORMATION COORDINATIONS< INFO_COR < GOAL

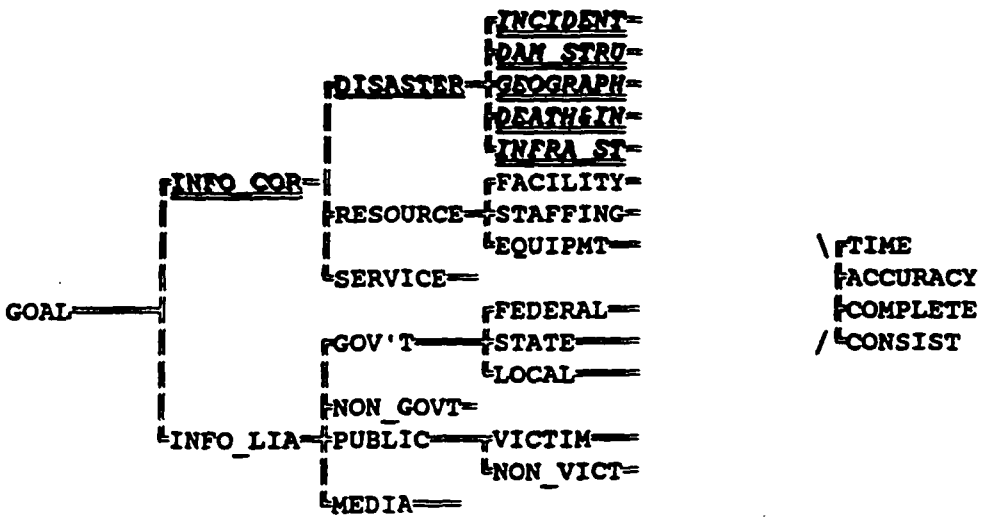
Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

1	INCIDENT	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	DAM_STRU
2	INCIDENT	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	GEOGRAPH
3	INCIDENT	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	DEATH&IN
4	INCIDENT	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	INFRA_ST
5	DAM_STRU	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	GEOGRAPH
6	DAM_STRU	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	DEATH&IN
7	DAM_STRU	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	INFRA_ST
8	GEOGRAPH	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	DEATH&IN
9	GEOGRAPH	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	INFRA_ST
10	DEATH&IN	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	INFRA_ST

Local Variables Descriptions on next page....

DAM_STRU --- Damaged Structure Information
Types of Property
--- Homes, Building, Natural Resources or Fields
Seriousness of Damage
--- Major, minor or Destroyed
DEATH&IN --- Death and Injury Information
Identification of Victims
--- Name, Address, SOC and Employer
Number of Death and Injuries (Major or Minor)
Special Needs (disable or elderly)
Damaged Population Demographics
--- Ethnic Group, Economic Status, Family size
GEOGRAPH --- Geographical Information
Geographical Location
--- What area might be affected by the disaster
Topographies of Affected Area
INCIDENT --- Incident Description
What occurred ? Time of the day ? Duration of Incident ?
Weather,
INFRA_ST --- Infrastructure Damages
Utility Outage
Transportation Damages
--- Highways, Railroads, Airports and Sea Ports
--- Community Hubs (Shopping Center, Industrial Area)

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
INCIDENT < DISASTER < INFO_COR < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

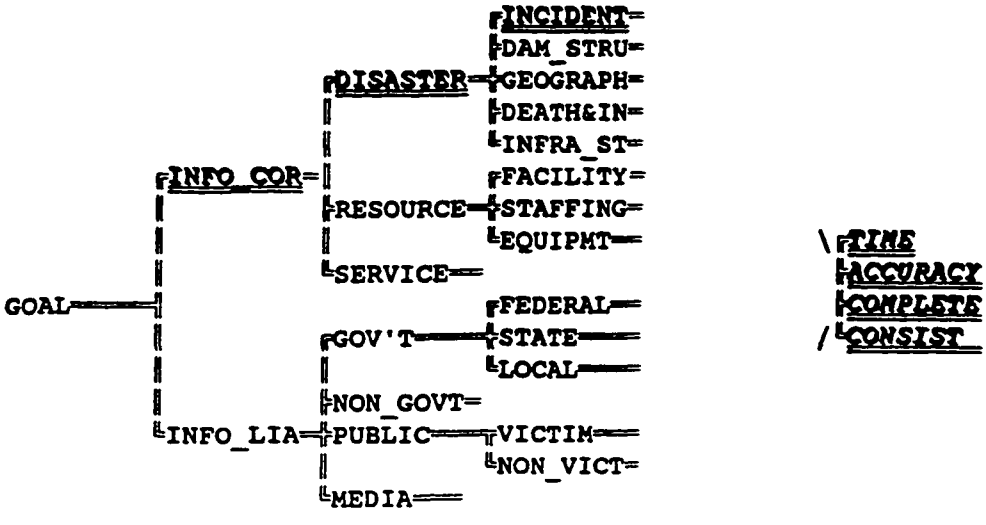
1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
TIME --- Timeliness of Information

INCIDENT --- Incident Description
What occurred ? Time of the day ? Duration of Incident ?
Weather,

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
DAM_STRU < DISASTER < INFO_COR < GOAL

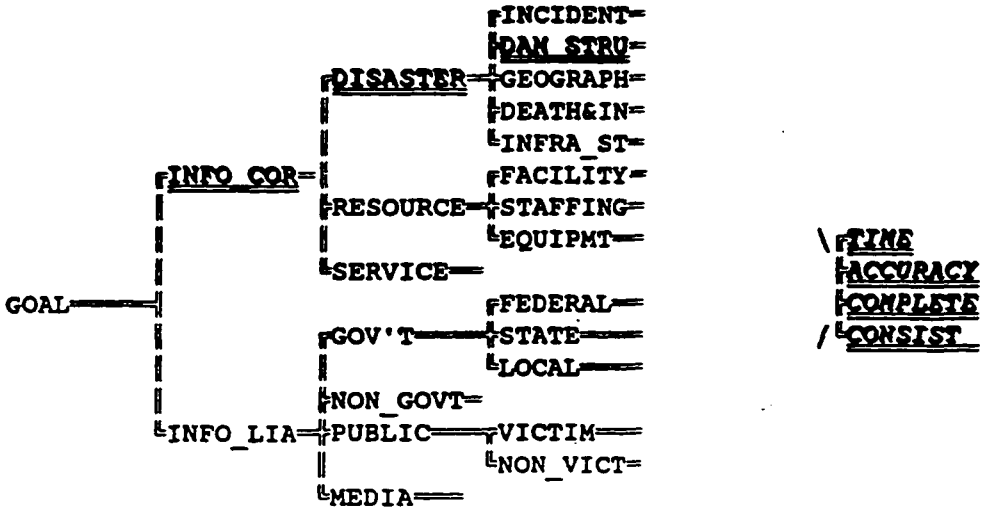
Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
TIME --- Timeliness of Information

DAM_STRU --- Damaged Structure Information
Types of Property
--- Homes, Building, Natural Resources or Fields
Seriousness of Damage
--- Major, minor or Destroyed

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
GEOGRAPH < DISASTER < INFO_COR < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

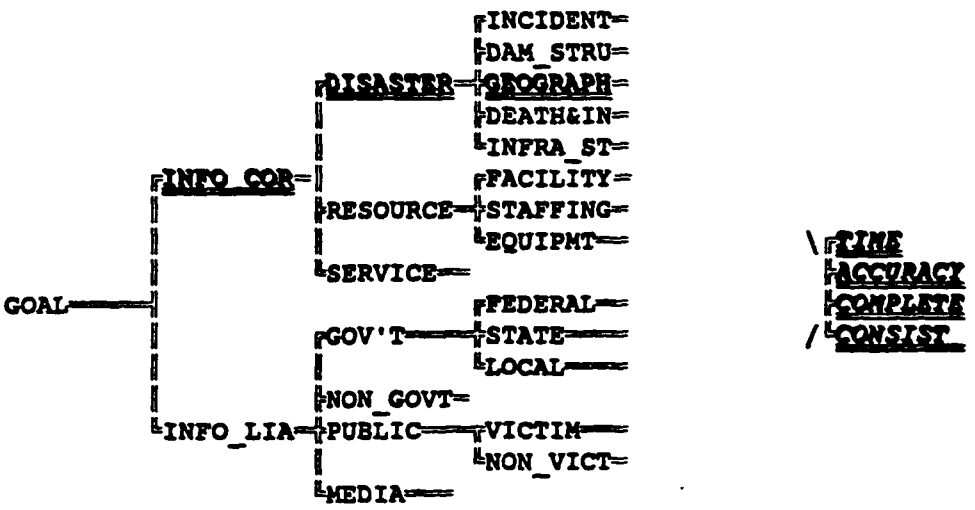
GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
TIME --- Timeliness

GEOGRAPH --- Geographical Information
Geographical Location
--- What other area might be affected by the disaster
Topographies of Affected Area

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
DEATH&IN < DISASTER < INFO_COR < GOAL
Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

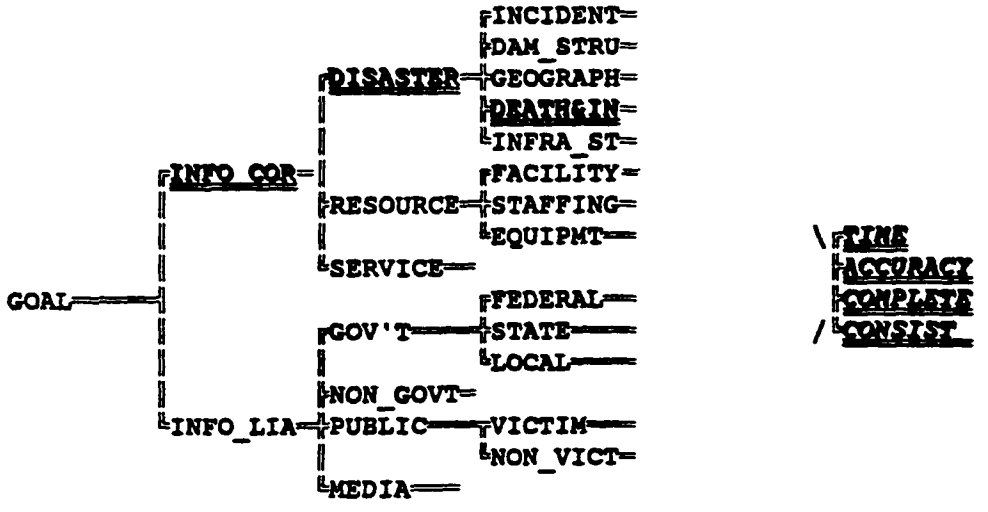
1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
TIME --- Timeliness of Information

DEATH&IN --- Death and Injury Information
Identification of Victims
--- Name, Address, SOC and Employer
Number of Death and Injuries (Major or Minor)
Special Needs (disable or elderly)
Damaged Population Demographics
--- Ethnic Group, Economic Status, Family size

Geographical Presentation od Model



Compare the relative IMPORTANCE with respect to:
INFRA_ST < DISASTER < INFO_COR < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

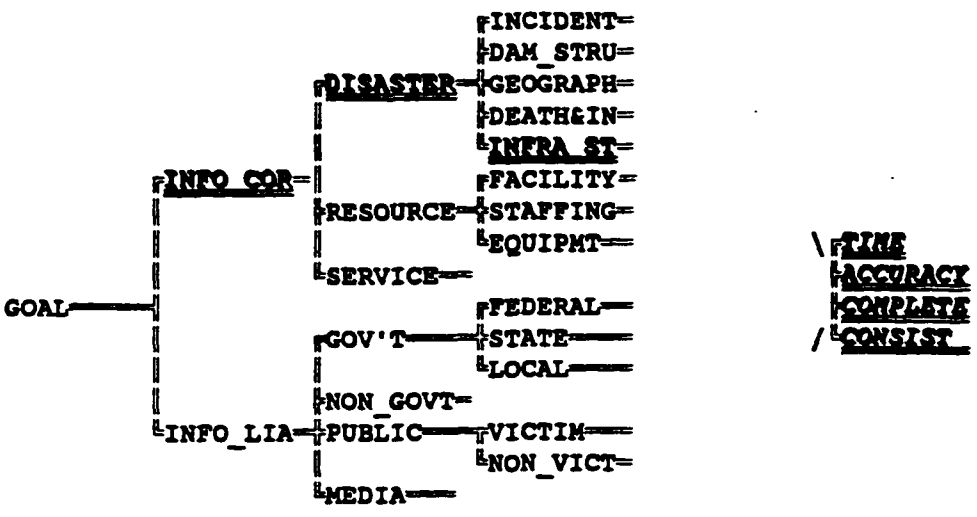
GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
TIME --- Timeliness of Information

INFRA_ST --- Infrastructure Damages
Utility Outage
Transportation Damages
--- Highways, Railroads, Airports and Sea Ports
--- Community Hubs (Shopping Center, Industrial Area)

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
RESOURCE < INFO_COR < GOAL

Circle one number per comparison below using the scale:

1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

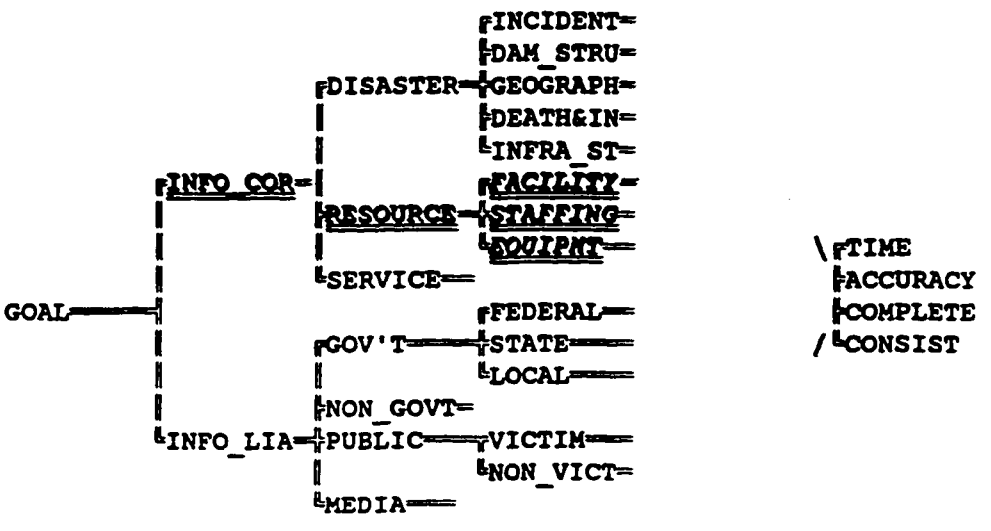
1	FACILITY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	STAFFING
2	FACILITY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	EQUIPMT
3	STAFFING	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	EQUIPMT

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

EQUIPMT --- Equipment Support(Telephone,Communication)
FACILITY --- Facility (Health,Medical and Feeding Facility) Information
INFO_COR --- Information Coordination
RESOURCE --- Resource Acquisition/Mobilization Information Coordination
STAFFING --- Staffing Acquisition/Mobilization Information

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
FACILITY < RESOURCE < INFO_COR < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

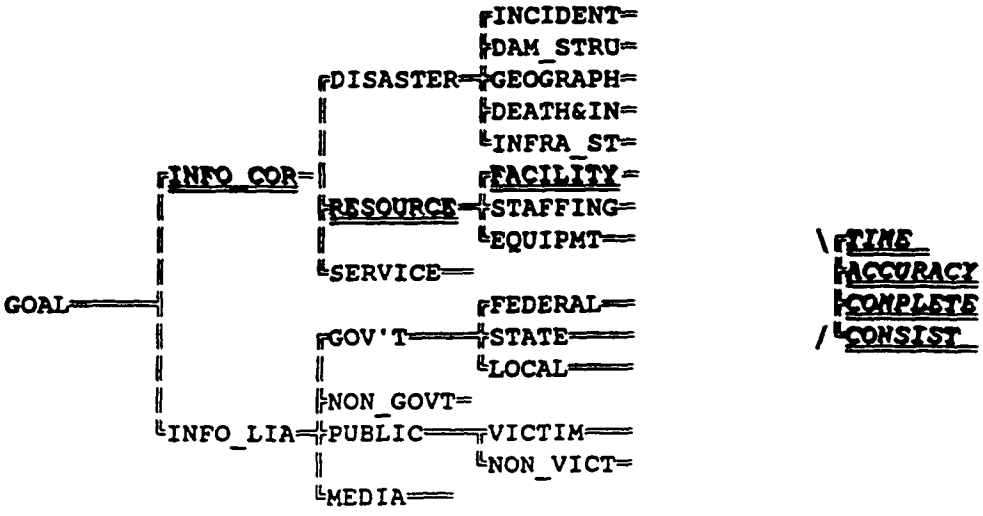
1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
FACILITY --- Facility (Health,Medical and Feeding Facility) Information
INFO_COR --- Information Coordination
RESOURCE --- Resource Acquisition/Mobilization Information Coordination
TIME --- Timeliness of Information

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
STAFFING < RESOURCE < INFO_COR < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

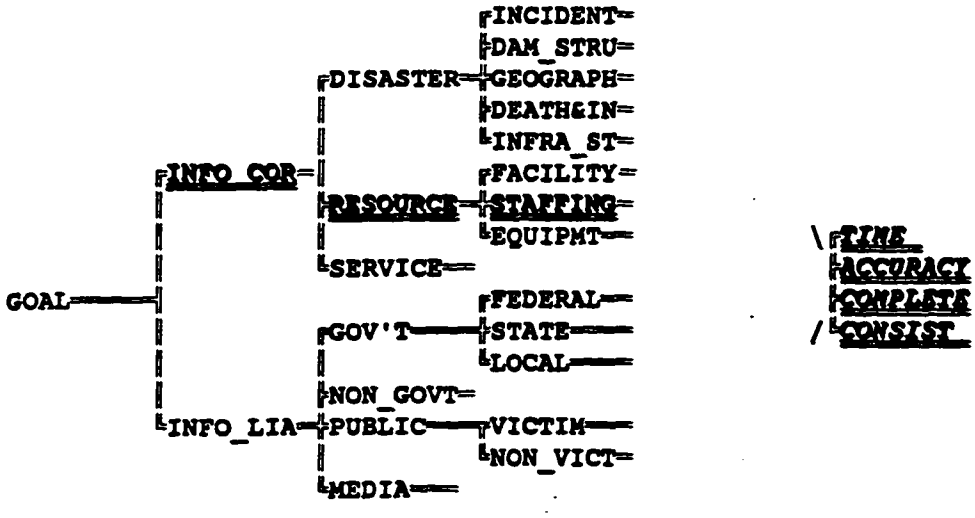
1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
INFO_COR --- Information Coordination
RESOURCE --- Resource Acquisition/Mobilization Information Coordination
STAFFING --- Staffing Acquisition Information
TIME --- Timeliness of Information

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
EQUIPMT < RESOURCE < INFO_COR < GOAL

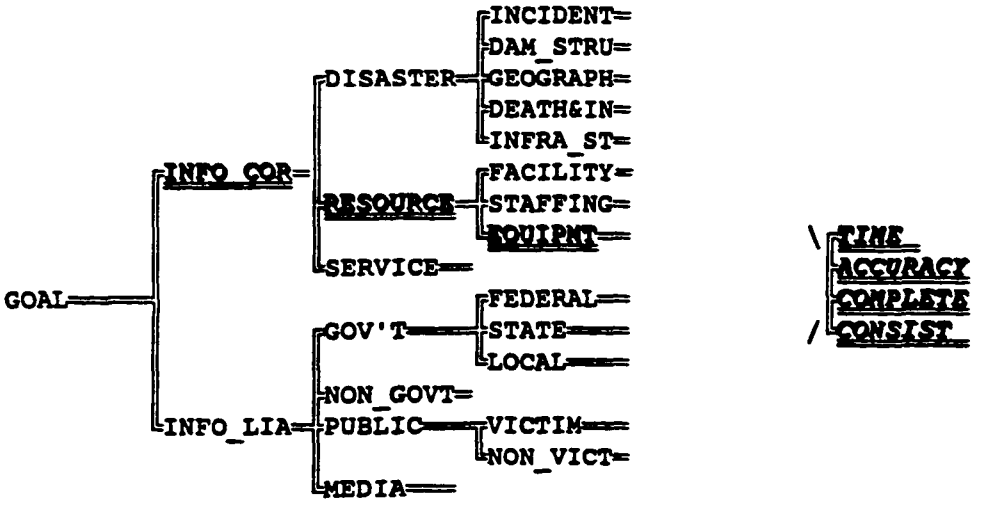
Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS
Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
EQUIPMT --- Equipment Support (Telephone,Communication) Information
INFO_COR --- Information Coordination
RESOURCE --- Resource Acquisition/Mobilization Information Coordination
TIME --- Timeliness of Information

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to: SERVICE < INFO_COR < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

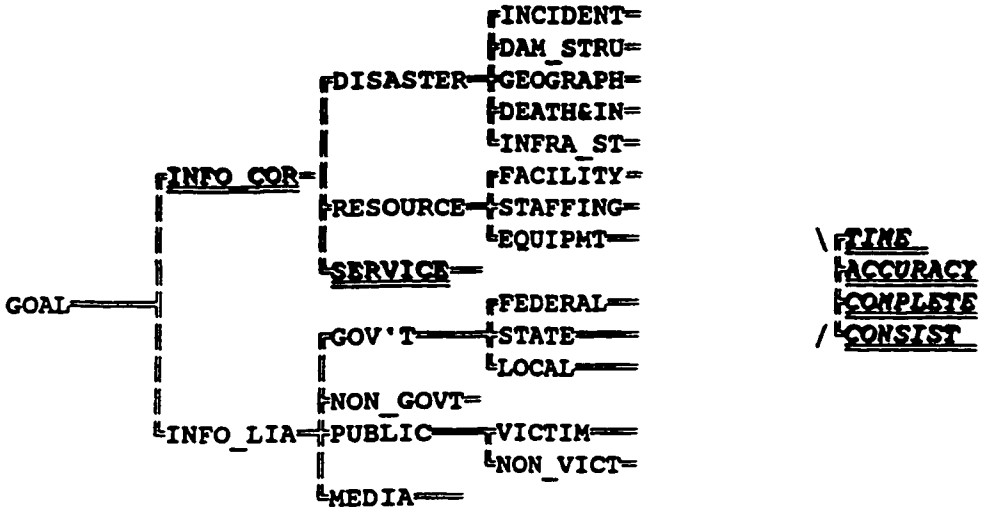
1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
SERVICE --- Service Delivery Information Coordination
TIME --- Timeliness of Information

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to: INFO_LIA < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

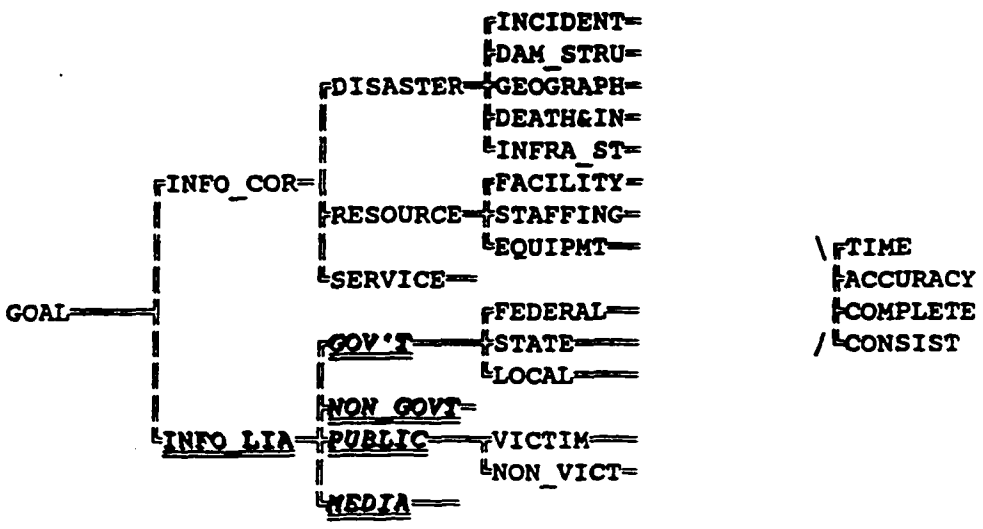
1	GOV'T	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	NON_GOVT
2	GOV'T	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	PUBLIC
3	GOV'T	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	MEDIA
4	NON_GOVT	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	PUBLIC
5	NON_GOVT	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	MEDIA
6	PUBLIC	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	MEDIA

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

GOV'T --- Coordination with Government Organization
INFO_LIA --- Information Dissemination/Liaison
MEDIA --- Coordination with Media
NON_GOVT --- Coordination with Non-Government(ARC, Salvation Army)
PUBLIC --- Coordination with Public

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to: GOV'T < INFO_LIA < GOAL

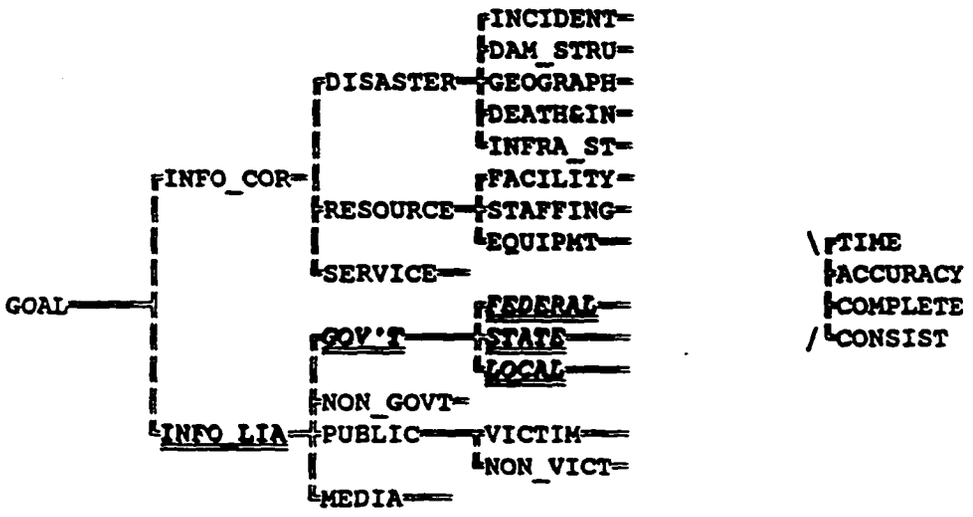
Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

1	FEDERAL	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 STATE
2	FEDERAL	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 LOCAL
3	STATE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 LOCAL

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

FEDERAL --- Federal Agencies
GOV'T --- Coordination with Government Organization
INFO_LIA --- Information Dissemination/Liaison
LOCAL --- Local Agencies
STATE --- State Agencies

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
FEDERAL < GOV'T < INFO_LIA < GOAL

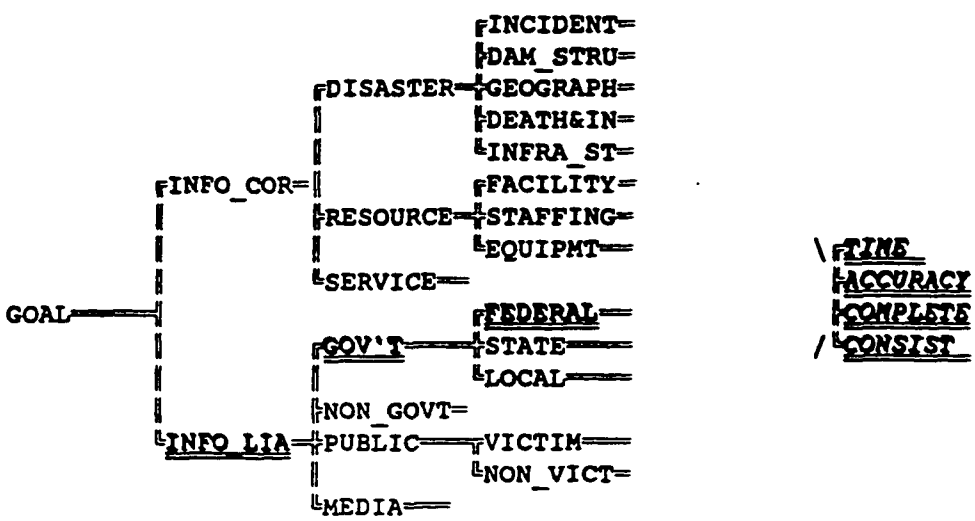
Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
FEDERAL --- Federal Agencies
GOV'T --- Coordination with Government Organization
INFO_LIA --- Information Dissemination/Liaison
TIME --- Timeliness of Information

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
STATE < GOV'T < INFO_LIA < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

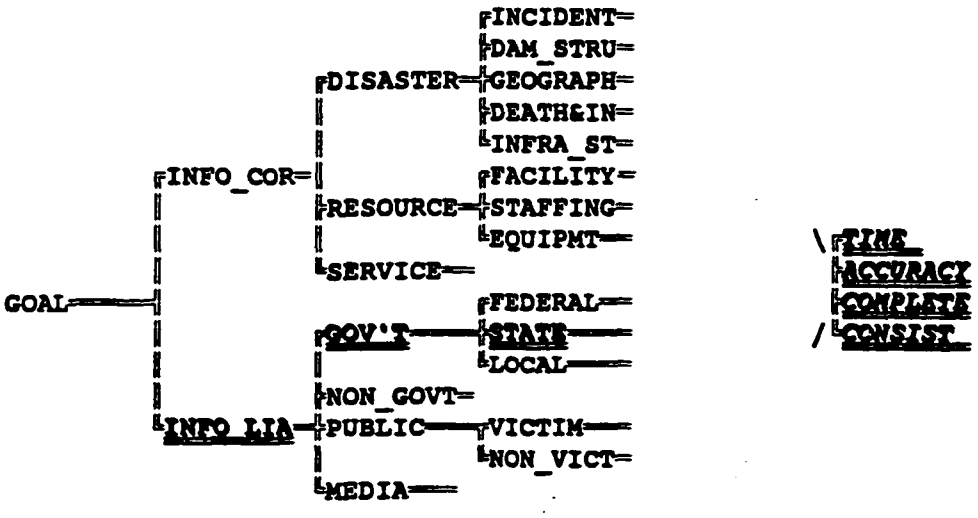
1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
GOV'T --- Coordination with Government Organization
INFO_LIA --- Information Dissemination/Liaison
STATE --- State Agencies
TIME --- Timeliness of Information

GRAPHICAL PRESENTATION OF MODEL



Compare the relative PREFERENCE with respect to:
LOCAL < GOV'T < INFO_LIA < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

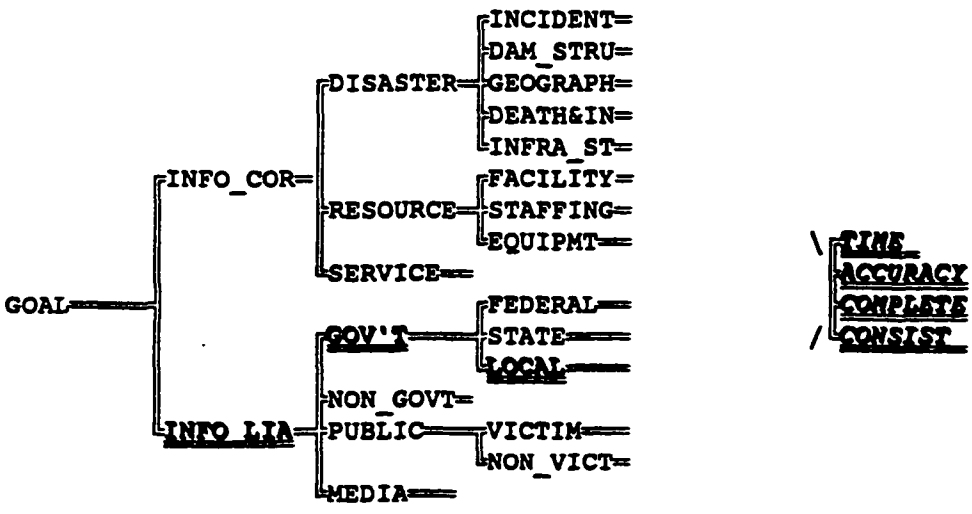
1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
GOV'T --- Coordination with Government Organization
INFO_LIA --- Information Dissemination/Liaison
LOCAL --- Local Agencies
TIME --- Timeliness of Information

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to: NON_GOVT < INFO_LIA < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

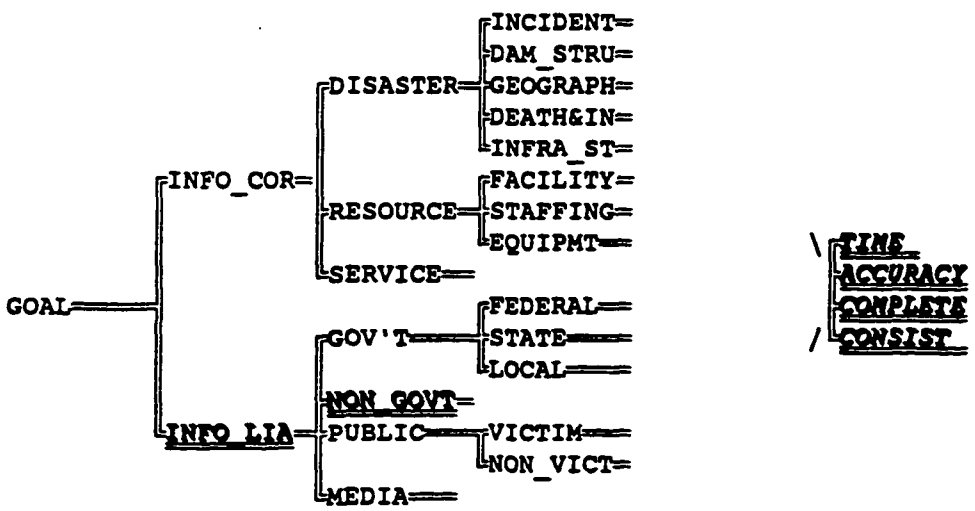
1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
INFO_LIA --- Information Dissemination/Liaison
NON_GOVT --- Coordination with Non-Government(ARC, Salvation Army)
TIME --- Timeliness of Information

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to: PUBLIC < INFO_LIA < GOAL

For each row, circle the more IMPORTANT element and indicate how many times more IMPORTANT it is in the intensity column (enter 1 for equality).

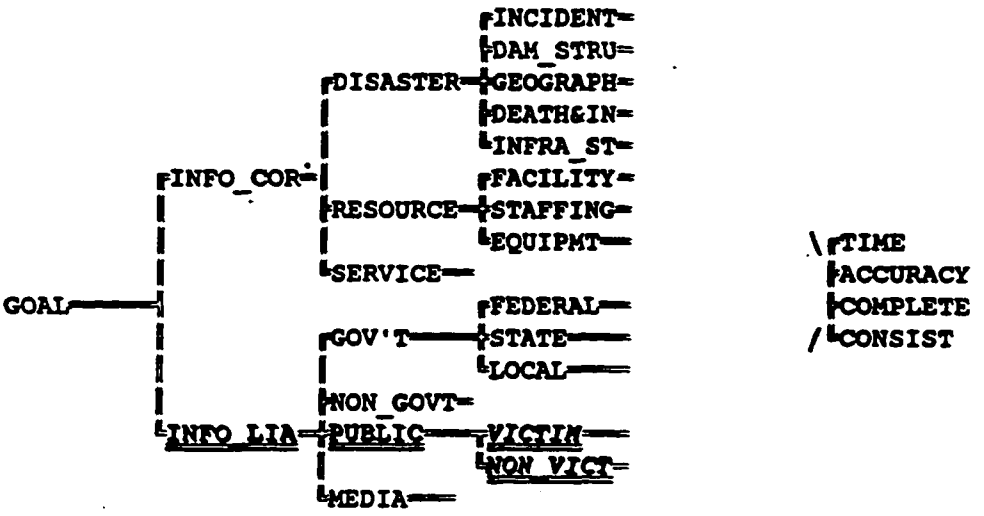
Intensity

VICTIM	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9 NON VICT

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

INFO_LIA --- Information Dissemination liaison
NON_VICT --- Non-Victim
PUBLIC --- Coordination with Public
VICTIM --- Victim of Disaster Events

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
VICTIM < PUBLIC < INFO_LIA < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

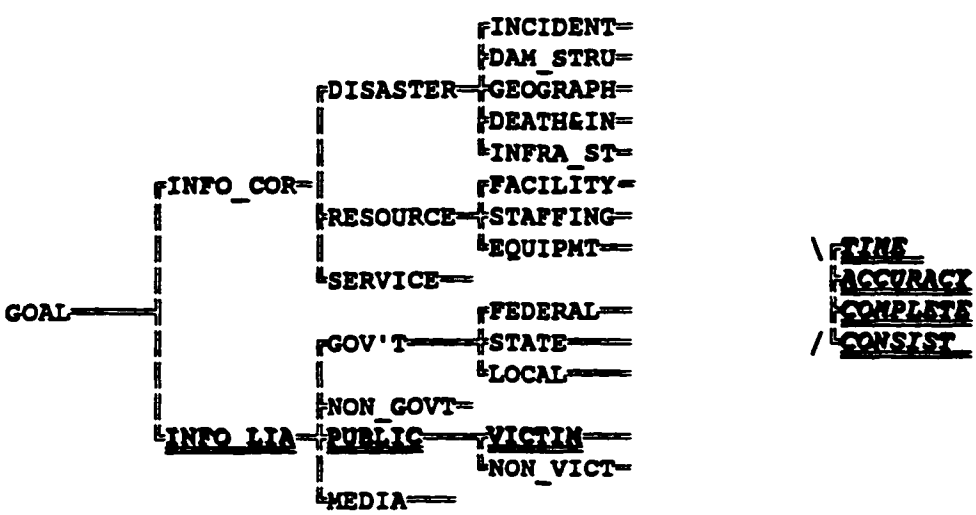
1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
INFO_LIA --- Information Dissemination/Liaison
PUBLIC --- Coordination with Public
TIME --- Timeliness of Information
VICTIM --- Victim of Disaster Events

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to:
NON_VICT < PUBLIC < INFO_LIA < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

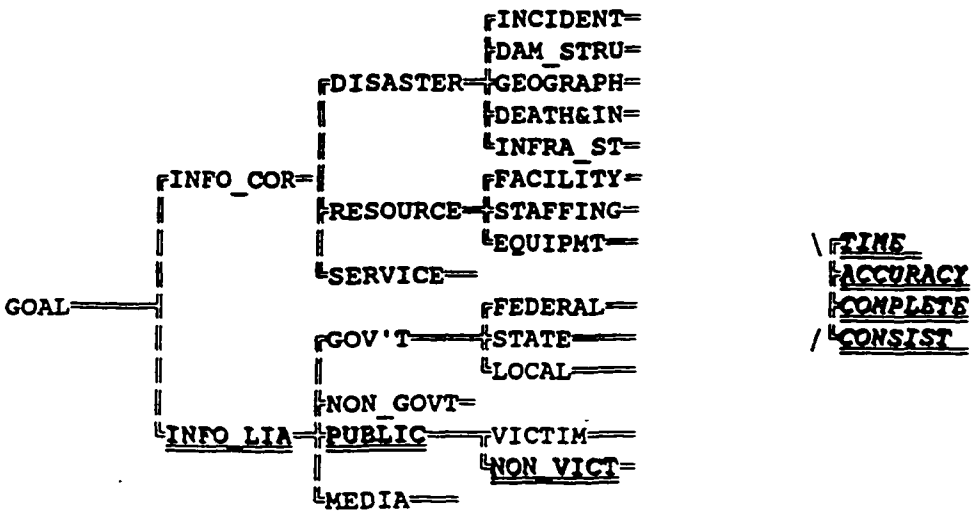
1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
INFO_LIA --- Information Dissemination/Liaison
NON_VICT --- Non-Victim
PUBLIC --- Coordination with Public
TIME --- Timeliness of Information

GRAPHICAL PRESENTATION OF MODEL



Compare the relative IMPORTANCE with respect to: MEDIA < INFO_LIA < GOAL

Circle one number per comparison below using the scale:
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

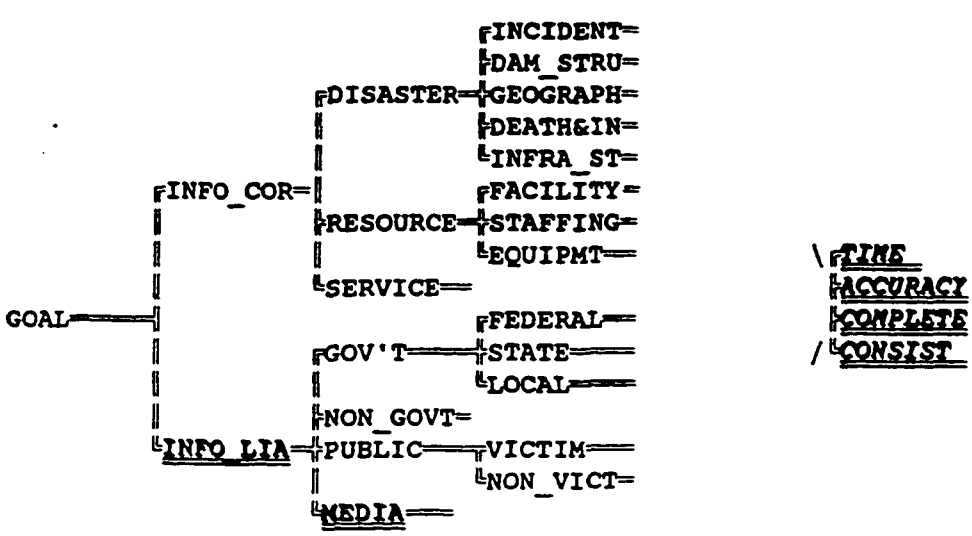
1	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	ACCURACY
2	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
3	TIME	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
4	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	COMPLETE
5	ACCURACY	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST
6	COMPLETE	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	CONSIST

GOAL: IMPACT OF INFORMATION MANAGEMENT ON DISASTER RELIEF OPERATIONS

Local Variable Definition :

ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
INFO_LIA --- Information Dissemination/Liaison
MEDIA --- Coordination with Media
TIME --- Timeliness of Information

GRAPHICAL PRESENTATION OF MODEL



Disaster Information Management
Supplementary Questionnaire

1. On the scale below, indicate how comfortable you were making comparison required in the expert questionnaire.

SCALE								
1	2	3	4	5	6	7	8	9
Very uncomfortable		Some What uncomfortable		Hard to Say		Some what Comfortable		Very comfortable

2. What is your major concern with regard to inter-organizational information management in disaster response/relief operations ?

_____

_____

_____

_____

3. What suggestions do you have for inter-organizational disaster information management to improve disaster relief operations ?

_____

_____

_____

_____

_____

_____

4. Time Spent on Survey : _____ Hour _____ Min

APPENDIX C

EXPERT CHOICE OUTPUT

EXPERT CHOICE OUTPUT
(WEIGHTS FROM EXPERT JUDGEMENT)

		Volunteers	Non_Gov't	Government
FUNCTION				
Goal	Internal Coordination	0.762	0.706	0.762
	External Information Dissemination/Liaison	0.238	0.294	0.238
Internal Coordination	Disaster Assessment	0.574	0.614	0.341
	Resource Acquisition	0.151	0.249	0.146
	Sevice Delivery	0.275	0.137	0.513
External Information Dissemination/ Liaison	Government	0.101	0.133	0.323
	Non_Government	0.497	0.104	0.122
	Public	0.213	0.292	0.104
	Media	0.189	0.470	0.451

LEVEL 3		Volunteers	Non_Gov't	Government
Disaster Assessment	Incident description	0.365	0.059	0.385
	Damage Strcture	0.123	0.258	0.235
	Geographical Location	0.184	0.099	0.097
	Death and Injuries	0.220	0.412	0.121
	Infrastructure Damages	0.108	0.171	0.163
Resource Acquisition	Facility	0.526	0.197	0.242
	Staffing	0.323	0.620	0.580
	Equipment	0.151	0.183	0.177
GOV	Federal	0.190	0.136	0.152
	State	0.328	0.261	0.297
	Local	0.482	0.602	0.551
Public	Victim	0.750	0.750	0.773
	Non Victim	0.250	0.250	0.227

Service Delivery	Timeliness	0.441	0.456	0.371
	Accuracy	0.271	0.310	0.310
	Consistency	0.147	0.121	0.160
	Completeness	0.141	0.112	0.158
Non-Government	Timeliness	0.475	0.113	0.444
	Accuracy	0.270	0.279	0.223
	Consistency	0.139	0.182	0.205
	Completeness	0.117	0.425	0.128
Media	Timeliness	0.194	0.439	0.262
	Accuracy	0.349	0.234	0.314
	Consistency	0.265	0.122	0.287
	Completeness	0.192	0.206	0.137

LEVEL 4		Volunteers	Non Gov't	Government
Incident Description	Timeliness	0.419	0.266	0.126
	Accuracy	0.262	0.456	0.419
	Consistency	0.166	0.181	0.230
	Completeness	0.153	0.098	0.225
Damaged Structure	Timeliness	0.445	0.283	0.285
	Accuracy	0.261	0.413	0.411
	Consistency	0.159	0.186	0.164
	Completeness	0.135	0.118	0.139
Geographical Location	Timeliness	0.406	0.238	0.363
	Accuracy	0.307	0.494	0.319
	Consistency	0.161	0.162	0.174
	Completeness	0.126	0.106	0.144
Death & Injuries	Timeliness	0.356	0.087	0.306
	Accuracy	0.239	0.469	0.259
	Consistency	0.216	0.255	0.227
	Completeness	0.189	0.189	0.208
Infrastrure Damages	Timeliness	0.385	0.450	0.307
	Accuracy	0.238	0.110	0.249
	Consistency	0.201	0.252	0.232
	Completeness	0.176	0.188	0.212

Facility	Timeliness	0.398	0.279	0.324
	Accuracy	0.264	0.222	0.182
	Consistency	0.190	0.353	0.349
	Completeness	0.148	0.146	0.145
Staffing	Timeliness	0.397	0.466	0.376
	Accuracy	0.264	0.163	0.359
	Consistency	0.193	0.269	0.163
	Completeness	0.146	0.102	0.101
Equipment	Timeliness	0.407	0.433	0.423
	Accuracy	0.262	0.291	0.228
	Consistency	0.183	0.145	0.174
	Completeness	0.148	0.131	0.174
Ferderal	Timeliness	0.389	0.450	0.445
	Accuracy	0.243	0.306	0.221
	Consistency	0.207	0.139	0.204
	Completeness	0.161	0.105	0.131
State	Timeliness	0.447	0.519	0.438
	Accuracy	0.243	0.276	0.222
	Consistency	0.174	0.107	0.213
	Completeness	0.136	0.099	0.127
Local	Timeliness	0.427	0.414	0.438
	Accuracy	0.262	0.196	0.222
	Consistency	0.172	0.132	0.213
	Completeness	0.139	0.258	0.127
Victim	Timeliness	0.469	0.452	0.432
	Accuracy	0.220	0.272	0.317
	Consistency	0.177	0.105	0.135
	Completeness	0.134	0.171	0.115
Non-Victim	Timeliness	0.373	0.115	0.473
	Accuracy	0.293	0.189	0.258
	Consistency	0.176	0.397	0.141
	Completeness	0.159	0.299	0.128

IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL DISTRIBUTIVE MODE
Sorted Details for Synthesis of Leaf Nodes with respect to GOAL

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
INFO_COR =0.706				
.	DISASTER =0.433			
.	.	DEATH&IN =0.178		
.	.	.	ACCURACY =0.086	
.	.	.	COMPLETE =0.045	
.	.	.	CONSIST =0.033	
.	.	.	TIME =0.014	
.	.	DAM_STRU =0.119		
.	.	.	ACCURACY =0.052	
.	.	.	TIME =0.036	
.	.	.	COMPLETE =0.019	
.	.	.	CONSIST =0.012	
.	.	INFRA_ST =0.073		
.	.	.	TIME =0.034	
.	.	.	COMPLETE =0.020	
.	.	.	CONSIST =0.013	
.	.	.	ACCURACY =0.007	
.	.	GEOGRAPH =0.039		
.	.	.	ACCURACY =0.019	
.	.	.	TIME =0.010	
.	.	.	COMPLETE =0.006	
.	.	.	CONSIST =0.004	
.	.	INCIDENT =0.024		
.	.	.	ACCURACY =0.011	
.	.	.	TIME =0.007	
.	.	.	COMPLETE =0.004	
.	.	.	CONSIST =0.002	
.	RESOURCE =0.176			
.	.	STAFFING =0.104		
.	.	.	TIME =0.047	
.	.	.	COMPLETE =0.031	
.	.	.	ACCURACY =0.017	
.	.	.	CONSIST =0.010	
.	.	FACILITY =0.037		
.	.	.	COMPLETE =0.014	
.	.	.	TIME =0.010	
.	.	.	ACCURACY =0.008	
.	.	.	CONSIST =0.005	
.	.	EQUIPMT =0.035		
.	.	.	TIME =0.015	
.	.	.	ACCURACY =0.010	
.	.	.	COMPLETE =0.005	
.	.	.	CONSIST =0.005	
.	SERVICE =0.096			
.	.	TIME =0.045		
.	.	ACCURACY =0.031		
.	.	COMPLETE =0.011		
.	.	CONSIST =0.010		
INFO_LIA =0.294				
.	MEDIA =0.137			
.	.	TIME =0.061		
.	.	ACCURACY =0.032		

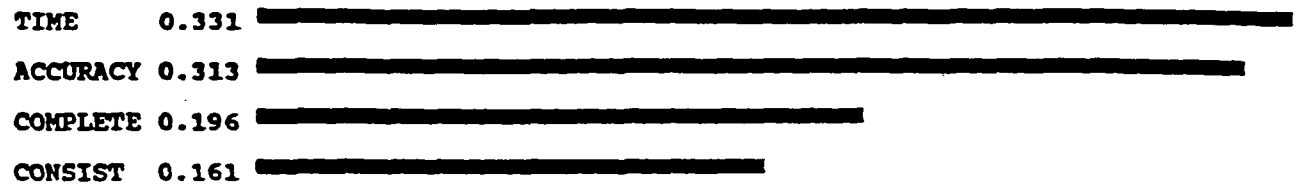
IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL
Sorted Details for Synthesis of Leaf Nodes with respect to GOAL
DISTRIBUTIVE MODE

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
.	.	CONSIST =0.029		
.	.	COMPLETE =0.015		
.	PUBLIC =0.085			
.	.	VICTIM =0.066		
.	.	.	TIME =0.029	
.	.	.	ACCURACY =0.018	
.	.	.	CONSIST =0.012	
.	.	.	COMPLETE =0.007	
.	.	NON_VICT =0.018		
.	.	.	COMPLETE =0.008	
.	.	.	CONSIST =0.005	
.	.	.	ACCURACY =0.003	
.	.	.	TIME =0.002	
.	GOV'T =0.041			
.	.	LOCAL =0.025		
.	.	.	TIME =0.010	
.	.	.	CONSIST =0.007	
.	.	.	ACCURACY =0.005	
.	.	.	COMPLETE =0.003	
.	.	STATE =0.010		
.	.	.	TIME =0.005	
.	.	.	ACCURACY =0.003	
.	.	.	COMPLETE =0.001	
.	.	.	CONSIST =0.001	
.	.	FEDERAL =0.005		
.	.	.	TIME =0.002	
.	.	.	ACCURACY =0.002	
.	.	.	COMPLETE.73E-03	
.	.	.	CONSIST .50E-03	
.	NON_GOVT =0.032			
.	.	CONSIST =0.014		
.	.	ACCURACY =0.009		
.	.	COMPLETE =0.005		
.	.	TIME =0.003		

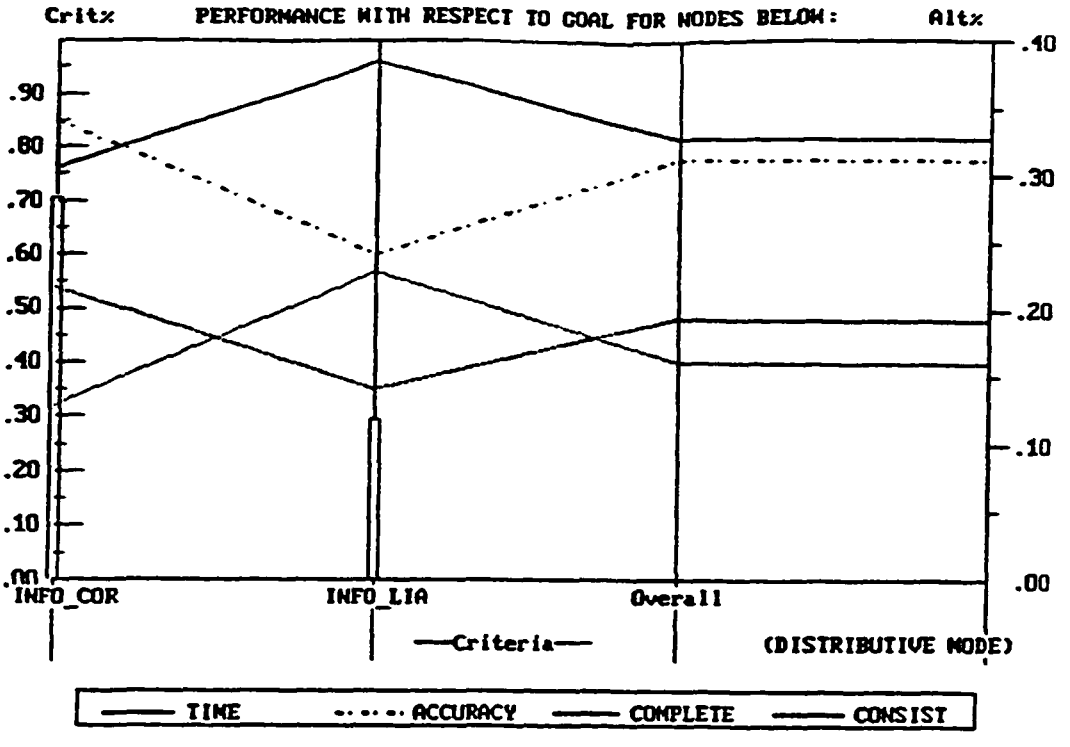
IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL

Synthesis of Leaf Nodes with respect to GOAL
DISTRIBUTIVE MODE

OVERALL INCONSISTENCY INDEX = 0.05



ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
TIME --- Timeliness of Information



IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL
Sorted Details for Synthesis of Leaf Nodes with respect to GOAL
DISTRIBUTIVE MODE

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
INFO_COR =0.762				
.	SERVICE =0.391			
.	.	TIME =0.145		
.	.	ACCURACY =0.121		
.	.	COMPLETE =0.063		
.	.	CONSIST =0.062		
.	DISASTER =0.260			
.	.	INCIDENT =0.100		
.	.	.	ACCURACY =0.042	
.	.	.	COMPLETE =0.023	
.	.	.	CONSIST =0.022	
.	.	.	TIME =0.013	
.	.	DAM_STRU =0.061		
.	.	.	ACCURACY =0.025	
.	.	.	TIME =0.017	
.	.	.	COMPLETE =0.010	
.	.	.	CONSIST =0.008	
.	.	INFRA_ST =0.042		
.	.	.	TIME =0.013	
.	.	.	ACCURACY =0.011	
.	.	.	COMPLETE =0.010	
.	.	.	CONSIST =0.009	
.	.	DEATH&IN =0.031		
.	.	.	TIME =0.010	
.	.	.	ACCURACY =0.008	
.	.	.	COMPLETE =0.007	
.	.	.	CONSIST =0.007	
.	.	GEOGRAPH =0.025		
.	.	.	TIME =0.009	
.	.	.	ACCURACY =0.008	
.	.	.	COMPLETE =0.004	
.	.	.	CONSIST =0.004	
.	RESOURCE =0.111			
.	.	STAFFING =0.065		
.	.	.	TIME =0.024	
.	.	.	ACCURACY =0.023	
.	.	.	COMPLETE =0.011	
.	.	.	CONSIST =0.007	
.	.	FACILITY =0.027		
.	.	.	COMPLETE =0.009	
.	.	.	TIME =0.009	
.	.	.	ACCURACY =0.005	
.	.	.	CONSIST =0.004	
.	.	EQUIPMT =0.020		
.	.	.	TIME =0.008	
.	.	.	ACCURACY =0.005	
.	.	.	COMPLETE =0.003	
.	.	.	CONSIST =0.003	
INFO_LIA =0.238				
.	MEDIA =0.107			
.	.	ACCURACY =0.034		
.	.	COMPLETE =0.031		

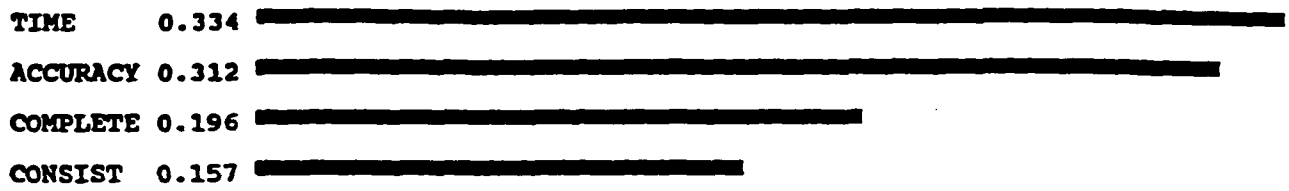
IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL
Sorted Details for Synthesis of Leaf Nodes with respect to GOAL
DISTRIBUTIVE MODE

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
.	.	TIME =0.028		
.	.	CONSIST =0.015		
.	GOV'T =0.077			
.	.	LOCAL =0.042		
.	.	.	TIME =0.019	
.	.	.	ACCURACY =0.009	
.	.	.	COMPLETE =0.009	
.	.	.	CONSIST =0.006	
.	.	STATE =0.023		
.	.	.	TIME =0.010	
.	.	.	ACCURACY =0.005	
.	.	.	COMPLETE =0.005	
.	.	.	CONSIST =0.003	
.	.	FEDERAL =0.012		
.	.	.	TIME =0.005	
.	.	.	ACCURACY =0.003	
.	.	.	COMPLETE =0.002	
.	.	.	CONSIST =0.002	
.	NON_GOVT =0.029			
.	.	TIME =0.013		
.	.	ACCURACY =0.006		
.	.	COMPLETE =0.006		
.	.	CONSIST =0.004		
.	PUBLIC =0.025			
.	.	VICTIM =0.019		
.	.	.	TIME =0.008	
.	.	.	ACCURACY =0.006	
.	.	.	COMPLETE =0.003	
.	.	.	CONSIST =0.002	
.	.	NON_VICT =0.006		
.	.	.	TIME =0.003	
.	.	.	ACCURACY =0.001	
.	.	.	COMPLETE.79E-03	
.	.	.	CONSIST .72E-03	

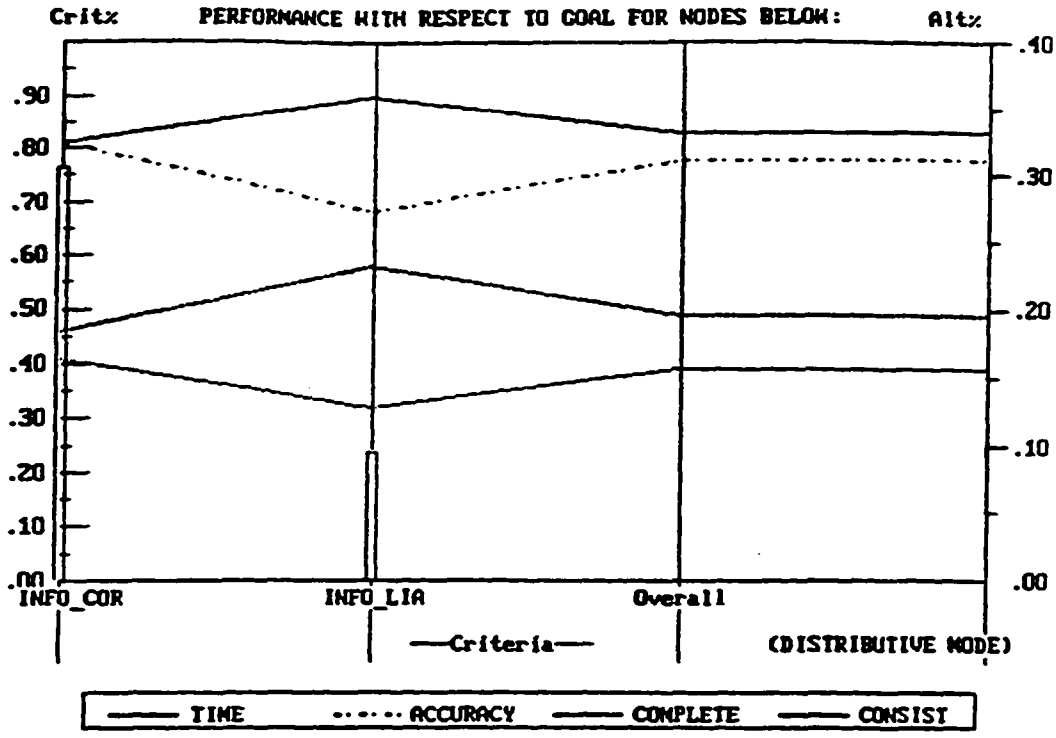
IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL

Synthesis of Leaf Nodes with respect to GOAL
DISTRIBUTIVE MODE

OVERALL INCONSISTENCY INDEX = 0.05



ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
TIME --- Timeliness of Information



IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL
Sorted Details for Synthesis of Leaf Nodes with respect to GOAL
DISTRIBUTIVE MODE

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
INFO_COR =0.762				
.	DISASTER =0.437			
.	.	INCIDENT =0.160		
.	.	.	TIME =0.067	
.	.	.	ACCURACY =0.042	
.	.	.	COMPLETE =0.027	
.	.	.	CONSIST =0.024	
.	.	DEATH&IN =0.096		
.	.	.	TIME =0.034	
.	.	.	ACCURACY =0.023	
.	.	.	COMPLETE =0.021	
.	.	.	CONSIST =0.018	
.	.	GEOGRAPH =0.080		
.	.	.	TIME =0.033	
.	.	.	ACCURACY =0.025	
.	.	.	COMPLETE =0.013	
.	.	.	CONSIST =0.010	
.	.	DAM_STRU =0.054		
.	.	.	TIME =0.024	
.	.	.	ACCURACY =0.014	
.	.	.	COMPLETE =0.009	
.	.	.	CONSIST =0.007	
.	.	INFRA_ST =0.047		
.	.	.	TIME =0.018	
.	.	.	ACCURACY =0.011	
.	.	.	COMPLETE =0.009	
.	.	.	CONSIST =0.008	
.	SERVICE =0.210			
.	.	TIME =0.093		
.	.	ACCURACY =0.057		
.	.	COMPLETE =0.031		
.	.	CONSIST =0.029		
.	RESOURCE =0.115			
.	.	FACILITY =0.061		
.	.	.	TIME =0.024	
.	.	.	ACCURACY =0.016	
.	.	.	COMPLETE =0.012	
.	.	.	CONSIST =0.009	
.	.	STAFFING =0.037		
.	.	.	TIME =0.015	
.	.	.	ACCURACY =0.010	
.	.	.	COMPLETE =0.007	
.	.	.	CONSIST =0.005	
.	.	EQUIPMT =0.017		
.	.	.	TIME =0.007	
.	.	.	ACCURACY =0.005	
.	.	.	COMPLETE =0.003	
.	.	.	CONSIST =0.003	
INFO_LIA =0.238				
.	NON_GOVT =0.118			
.	.	TIME =0.056		
.	.	ACCURACY =0.032		

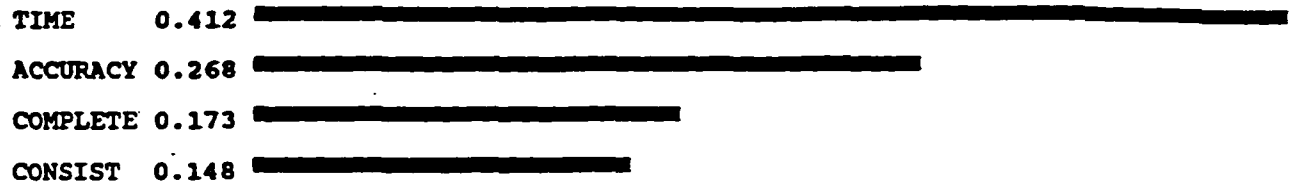
IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL
Sorted Details for Synthesis of Leaf Nodes with respect to GOAL
DISTRIBUTIVE MODE

LEVEL 1	LEVEL 2		LEVEL 3		LEVEL 4		LEVEL 5
.	.		COMPLETE	=0.016			
.	.		CONSIST	=0.014			
.	PUBLIC	=0.051					
.	.		VICTIM	=0.038			
.	.		.		TIME	=0.018	
.	.		.		ACCURACY	=0.008	
.	.		.		COMPLETE	=0.007	
.	.		.		CONSIST	=0.005	
.	.		NON_VICT	=0.013			
.	.		.		TIME	=0.005	
.	.		.		ACCURACY	=0.004	
.	.		.		COMPLETE	=0.002	
.	.		.		CONSIST	=0.002	
.	MEDIA	=0.045					
.	.		ACCURACY	=0.016			
.	.		COMPLETE	=0.012			
.	.		TIME	=0.009			
.	.		CONSIST	=0.009			
.	GOV'T	=0.024					
.	.		LOCAL	=0.012			
.	.		.		TIME	=0.005	
.	.		.		ACCURACY	=0.003	
.	.		.		COMPLETE	=0.002	
.	.		.		CONSIST	=0.002	
.	.		STATE	=0.008			
.	.		.		TIME	=0.004	
.	.		.		ACCURACY	=0.002	
.	.		.		COMPLETE	=0.001	
.	.		.		CONSIST	=0.001	
.	.		FEDERAL	=0.005			
.	.		.		TIME	=0.002	
.	.		.		ACCURACY	=0.001	
.	.		.		COMPLETE	.94E-03	
.	.		.		CONSIST	.73E-03	

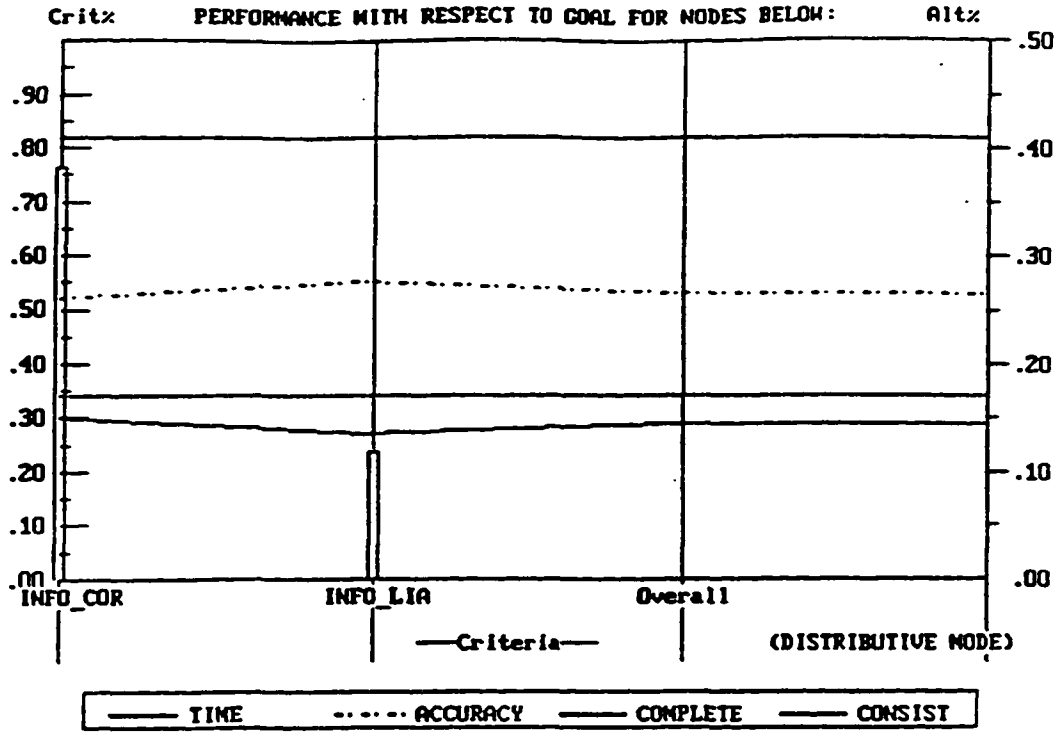
IMPACT OF INTER-ORGANIZATIONAL INFORMATION MANAGEMENT ON INITIAL

Synthesis of Leaf Nodes with respect to GOAL
DISTRIBUTIVE MODE

OVERALL INCONSISTENCY INDEX = 0.02



ACCURACY --- Accuracy of Information
COMPLETE --- Completeness of Information
CONSIST --- Consistency of Information
TIME --- Timeliness of Information



APPENDIX D

LIST OF ABBREVIATION

LIST OF ABBREVIATION

ARC	American Red Cross
CAR	Congressional Affairs Representative
CARD	Collaborating Agencies Responding to Disasters
CDRG	Catastrophic Disaster Response Group
CFR	Code of Federal Regulations
CLO	Congressional Liaison Officer
COE	Corps Of Engineers
CRO	Congressional Relations Officer
CRC	Crisis Response Cell
DAC	Disaster Assistance Center
DCO	Defense Coordinating Officer
DFO	Disaster Field Office
DHHS	Department of Health and Human Services
DHUD	Department of Housing and Urban Development
DLA	Defense Logistics Agency
DMAT	Disaster Medical Assistance Team
DOC	Department of Commerce
DOD	Department of Defense
DOS	Department of State
DOT	Department of Transportation
DSR	Damage Survey Report
DWI	Disaster Welfare Inquiry
EC	Emergency Coordinator
EICC	Emergency Information and Coordination Center
EMS	Emergency Medical Services
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
ERT	Emergency Response Team

ESF	Emergency Support Function
EST	Emergency Support Team
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FCO	Federal Coordinating Officer
FECC	Federal Emergency Communications Coordinator
FEMA	Federal Emergency Management Agency
FESC	Federal Emergency Support Coordinator
FRCM	FEMA Regional Communications Manager
FRERP	Federal Radiological Emergency Response Plan
FTS	Federal Telecommunications System
GAO	General Accounting Office
GIS	Geographical Information System
GSA	General Services Administration
ICS	Incident Command System
JCS	Joint Chiefs of Staff
JIC	Joint Information Center
JTRB	Joint Telecommunications Resource Board
NCC	National Coordinating Center
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NCS	National Communications System
NCSP	National Communications Support Plan
NEIS	National Earthquake Information Service
NGO	Non-Government Organizations
NICC	National Interagency Coordination Center
NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
NRT	National Response Team
NTSP	National Telecommunications Support Plan

OES	Office of Emergency Service
OFA	Other Federal Agency
OFDA	Office of U.S. Foreign Disaster Assistance
OJCS	Office of the Joint Chiefs of Staff, (DOD)
OSC	On-scene Coordinator
OSHA	Occupational Safety and Health Administration
PA	Public Affairs
PAO	Public Affairs Officer
PHS	Public Health Service (HHS)
PIO	Public Information Officer
P.L.	Public Law
RD	Regional Director
REC	Regional Emergency Coordinator
ROC	Regional Operations Center
RRT	Regional Response Team
SAR	Search and Rescue
SCO	State Coordinating Officer
SLPS	State and Local Programs and Support Directorate (FEMA)
SOP	Standard Operating Procedure
TREAS	Department of Treasury
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
USPHS	U.S. Public Health Service
USPS	U.S. Postal Service

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