Quick Response Report #85
THE POTENTIAL IMPACT OF INFORMATION TECHNOLOGY ON THE STRUCTURE OF INTERORGANIZATIONAL RELATIONSHIPS DURING CRISIS RESPONSE: THE PENNSYLVANIA FLOODS OF 1996

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Return to Hazards Center Home Page
Return to Quick Response Paper Index

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On Friday, January 19, 1996 severe flooding began in western Pennsylvania. On Saturday, January 20, the Ohio River, which is created from the Allegheny and Monongahela Rivers at the edge of downtown Pittsburgh, crested at 34.8 feet - ~9.8 feet above flood stage. Heavy snowfall followed by abnormally high temperatures caused the quick thaw of more than 30 inches of snow around the region. This, coupled with several inches of new rainfall, overwhelmed creeks, streams, and rivers with the equivalent of one month's worth of rainfall in one day. There was little warning of the coming floods. National Weather Service meteorologists did not issue flood warnings until Friday afternoon, when

the flooding of many waterways had already begun. The Flood of 1996, as it is called by the media, is the seventeenth largest flood in the region's history and the largest flood to occur in two decades.
Damage was widespread and severe. Across the state, 18 citizens died, more than 200,000 citizens were evacuated, 11,000 homes were destroyed or received major damage, and another 40,000 homes received minor damage. Approximately 2,000 businesses were destroyed or damaged. In addition, the flooding caused severe damage to state infrastructure. More than 235 bridges, 2,000 water systems, 1,400 roads, and 78 parks were damaged. On Sunday, January 21, President Clinton declared the first six counties in Pennsylvania eligible for federal disaster aid and Transportation Secretary Pena announced one million dollars in aid for the state's transportation system. By Thursday, January 25, all sixty-seven counties in the state were declared eligible for federal disaster aid. Allegheny County (the focus of this report) was declared eligible on Tuesday, January 23. The destruction included structural damage to local piers, houseboats, and recreational vehicles. Several houseboat residents were left homeless.
Allegheny County received flood damage comparable, if not greater than, many other counties around the state. The county was designated as one of fourteen counties in Pennsylvania that received additional federal assistance to repair severely damaged infrastructure. Several area water systems were unusable, and bridges damaged by runaway barges and boats were impassable. A total of 47 communities within Allegheny County reported major damage from the floods. The largest city in the county, Pittsburgh, sustained major damage to infrastructure and parks. The most noticeable damage was in downtown Pittsburgh at Point State Park (the point at which the Ohio River is formed from the Allegheny and Monongahela rivers) - where the park and fountain were completely immersed in water. Additionally, ice jams clogged the Allegheny River and increased the level of damage by displacing and redirecting runoff water.
Despite the widespread damage, many residents were unaware of the severity of the flooding. Damage, while severe, was concentrated in communities located on the shores of creeks, streams, and rivers.

Residents who did not live in or travel to these areas relied primarily on media accounts of the damage. However, there was a competing event for media attention - Pittsburgh's football team, the Steelers, were to play in the Superbowl less than one week later. In fact, when the flood occurred many members of the local media were in route to Tempe, Arizona, preparing for game coverage. Consequently, the Sunday, January 21, edition of the *Pittsburgh Post-Gazette* (two days after the largest flood in two decades) contained only two articles on the floods, but fourteen articles on the Superbowl. However, media coverage of the floods quickly gained momentum, and the Monday, January 22, edition of the *Pittsburgh Post-Gazette* contained a more balanced coverage with eighteen flood-related articles and seventeen game-related articles.

Interorganizational Analysis

The purpose of this research is to examine the structure of interorganizational relationships during the immediate post-impact response period, and to assess the impact of information technology on those relationships. Baseline data on interorganizational relationships during the immediate post-impact response to the Pennsylvania Floods of 1996 was collected. Additional information on the potential impact of information technology on those relationships was gathered. Here, the immediate post-impact response period is the first ten days after the flooding began, and information technology refers to two-way radios, cellular phones, electronic mail and bulletin boards, and on-line services such as the World Wide Web.

Two types of data were gathered; observational and media coverage. The observational data were gathered during a five-day visit with the American Red Cross of Southwestern Pennsylvania (January 23 - January 27) four days after the initial flooding began, and during subsequent interviews with Red Cross and other response organization personnel over the weeks following the flooding.

Interview opportunities during the crisis response are limited, and

retrospective interviews and questionnaires are prone to memory biases. This is especially true given the high pressure environment of crisis response. Thus, interview data was supplemented with newspaper data. Newspaper accounts of organizational response to crises provide a good source of information regarding interorganizational relationships among response organizations. Newspaper accounts provide a more comprehensive picture of interorganizational relationships than participant observation methods.

Using media reports to build the interorganizational response network does have some limitations. Media reports contain the biases of first reporters and then editors. In order to avoid much of the biases related to this two-stage filtering process, the data gathered from these articles contains only relationships explicitly mentioned in the text. No assessments of the quality or tone (positive or negative) of those relationships are included. Another potential bias in the media is greater coverage of larger, more established organizations. These organizations might receive more press because they have dedicated media departments or personnel. However, some media analysis suggests that much of this greater coverage comes in the form of multiple organizational mentions within a single article. The coding method, which is discussed below, reduces the impact of this bias.

The *Pittsburgh Post-Gazette* published sixty-three articles regarding the floods during the first ten days of the response. The first day of flooding, January 19, is also included in the analysis. The first ten days are the immediate post-impact period. After the tenth day, media coverage severely dropped off. In order to analyze the structure of the response network, the immediate post-impact response period was divided in half. Time 1 is January 19 through January 24, and time 2 is January 25 through January 29. Dividing the response period into two sections facilitates a discussion of the evolution of the structure of the response network. Table 1 indicates the number of articles published on each day.

Methodology

Each newspaper article was analyzed separately for interorganizational relationship information. Articles were given an identification number and all relationship information was recorded using the article identification, date, the pair of organizations, and the type of relationship.

If an organization was mentioned as having a relationship with another organization, then it was recorded. However, multiple mentions of the same relationship within a single article were not recorded. This coding method reduces bias in the data resulting from journalist writing style or personal biases. Organizations were identified and grouped into categories by sector and affiliation. The sector is the primary service area of the organization. Nine sectors have been identified; including one sector called 'other' which contains a host of organizations. Three levels of affiliation were included which represent national, state, and local organizations.

Three different relationships were classified: dependency, works with, and same service. These relationship classifications are both ordered and exclusive. By ordered I mean that the level of interaction between two organizations is greatest in dependency relations and least in same service relations. Exclusivity requires that within an article, two organizations can be linked in only one way. For instance, the American Red Cross cannot both provide the same service and work with the Salvation Army within one article. The higher order relationship will be recorded. This reduces bias in the data by limiting the overstatement of relationships between organizations.

A same service link is placed between two organizations if they both appear in the same article and are both providing the same service (i.e. food distribution) but do not work together or coordinate their efforts. A works with link occurs when two organizations mentioned in the same article work together to provide a service. This relationship is distinguished from dependency relationships because it is assumed that each organization could accomplish the task without the assistance of the other organization. In other words, neither organization is dependent

upon the other. Dependency relationships encompass all types of dependencies between two organizations mentioned in the same article. The relationships include monetary, informational, manpower, and resource dependencies.

Results

Organizations representing a variety of sectors participated in the response to the floods. The interorganizational response network contained 119 organizations from ten sectors and three levels of affiliation. Table 2 lists the number of organizations by sector and level of affiliation. Sixty-six percent of response organizations had a local affiliation. In particular, the response was characterized by high local government involvement. Since the damage was widespread across the county, emergency personnel from many local governments participated in the response. Other organizations, including many businesses, played a major role in the response at both the local and national levels. Table 3 presents the percentage of organizations per sector in the response network per time period. During both time periods the network response was distributed among a range of organizational sectors. Since the bulk of the damage from the floods was to the infrastructure, government agencies dominated the response. Military/civil defense organizations such as the Army Corps of Engineers played a consistent role throughout the response managing and monitoring the flooded rivers. State and local police assisted in the evacuation of victims and securing areas. The largest problem facing the police personnel, however, were sightseers. Weather organizations such as the National Weather Service were critical during the initial days of the response, however, their role diminished once the threat of flooding subsided. Similarly, schools used as emergency shelters were of lesser importance once evacuated residents returned to their homes and started to assess damage. At this time, the role of the media grew as they provided information regarding help centers and government assistance.

The three types of interorganizational relationships were analyzed for each time period. Network centrality and clique analyses were performed on a total of six separate response networks. Centrality indicates the degree to which organizations have relationships with other organizations in the response network. The measure of degree centrality provides the number of relationships. Organizations with a high degree centrality are interpreted to be the most powerful organizations in the response network because these organizations can control the flow of information and resources through the network. Table 4 provides the degree centrality of the most central and common response organizations across the networks during both time periods. Blank cells indicate that the organization did not have any relationships of that type during the specified time period. Network centrality indicates the extent to which the organizations in the network are linked around a set of focal organizations. The centrality analysis investigates the structure of the network by identifying organizations in the structural center, margins, and periphery of the network. The network centrality of each network is listed at the bottom of Table 4 .

The clique analysis identifies subgroups of three or more organizations in which all organizations are connected but which are not contained in any other clique. The centrality and clique analyses together, help to identify the underlying structure of the interorganizational response network to the Pennsylvania floods.

Same Service Network

In time 1, no clearly central organizations appeared in the response network of 47 organizations. The Red Cross, National Guard, and National Weather Service were the most central organizations during time 1, but with only two relationships each, they were not significantly more central to the response than some of the other organizations. Overall, the same service network during time 1 was very decentralized and no core, margin, periphery structure could be identified. Four separate cliques were identified, which indicated that water systems provided the same assistance, and that weather organizations provided

the same information. However, no organization appeared in more than one clique - again indicating the decentralized structure of the response. The response network in time 2 differed greatly. Several of the 41 organizations were highly central in the response. These organizations, including the National Guard, firefighters, a local college and local municipalities, made up the structural core of the network. The rest or the organizations in the response were located in the margins. No clear distinction could be made between the margins and the periphery of the network. Although the same service network during time 2 became more centralized, it was still a decentralized response. Eight cliques were identified. Various media organizations played an important role in disseminating information regarding the floods to the public. Health and fire officials satisfied emergency health needs, and various organizations, including the National Guard, a local college and church, and local municipalities, provided emergency shelter for flood victims.

Works With Network

In time 1, the National Weather Service and the Red Cross were the structural center of the 50-organization response; participating in eight working relationships each. Firefighters were in the margins of the response, and all other organizations were in the periphery. Interestingly, FEMA was not central during the initial response. Even though a core structure could be identified, the overall response was still decentralized. Only two cliques were identified during time 1. The local government and police officials worked together to assist victims.

The response network in time 2 was somewhat different. The core response was larger even though the total number of organizations fell to 35. The Red Cross was again central. However, FEMA, Gov. Ridge of Pennsylvania, and the Army Corps of Engineers also became central organizations in response. All other organizations were in the periphery. Six cliques were identified. One isolated clique included the Army Corps of Engineers, National Weather Service, the *Post-Gazette*. These organizations worked together to provide information on the threat of additional flooding. The remaining integrated cliques included state and

federal government organizations that worked together to assess damage and to secure federal emergency aid.

Dependency Network

In time 1, FEMA and Gov. Ridge of Pennsylvania were the structural center of the network which contained seventeen organizations. All of the other organizations were in the periphery. Interestingly, the majority of the dependency relationships were monetary in nature. Only one clique was identified, which indicated that local and state officials depended on FEMA for monetary aid. Again, the overall response was decentralized.

In time 2, no clearly central organizations appeared in the response network of eight organizations. FEMA and Gov. Ridge still appeared as integral members of the network. However, they did not stand out as structural centers during time 2. No cliques were identified in the time 2 dependency network. Again, the overall response was decentralized.

Impact of Information Technology on Network Structure

The structure of the interorganizational response to the Pennsylvania floods is clear. However, the remaining question is What was the role of information technology (IT) of that structure?. Data gathered from interviews and observations address three areas of inquiry: (1) current use of IT; (2) barriers to the use of IT for crisis response; (3) potential use and impact of IT use on network structure.

Current use of IT for interorganizational coordination varied and was nonsystematic, often relegated to the "tech group," and not used to potential due to malfunctions or misunderstandings both within and between organizations. For instance, within the Red Cross, one field disaster assessor was equipped with two beepers, one 2-way radio, one cellular phone, and one mobile phone. Another assessor had a lap-top

computer, two 2-way radios, one cellular phone, and a mobile phone; while another had only a single 2-way radio. This uneven distribution of technology was common and prohibited full usage. However, possession of the technology did not ensure use. In one case an assessor kept his cellular phone off because he mistakenly thought the weak signal indicator was a low battery indicator.

Between organizations, similar phenomenon were observed. City of Pittsburgh and Allegheny county officials used geographical information systems (GISs) to quickly identify damaged areas and to track personnel. However, the Red Cross, which had to quickly assess damage and provide that information to FEMA before FEMA could provide assistance and whose personnel interacted with county officials several times daily both face to face and via the telephone, used paper wall maps, highlighters, and push pins to identify damaged areas and to track personnel. Clearly, the response would have been aided by the sharing of GIS technology between organizations.

Barriers to IT use include both technical, organizational, and political factors. In order to use new information technologies effectively, disaster workers must understand how to operate them. From the above example, it is clear that some do not. Further, current organizational structures where new technologies are relegated to the "tech group" may prohibit widespread use of the technologies because disaster workers see the new technologies not as a tool for their use, but rather a toy for the "tech group." This phenomenon occurred for some disaster personnel at the Army Corps of Engineers. Politically, organizations must be encouraged to share technological capabilities.

Information technology could impact the structure of interorganizational response to crises. IT might promote a more centralized network structure. Given that communication channels are often destroyed or temporarily inoperable, IT might establish stronger pre-existing relationships between the employees of typical response organizations such as the Red Cross, FEMA, and Salvation Army. If these organizations develop stronger relationships, it could cause them to more heavily interact during a crisis response and centralize the structure of the response. Similarly, given that the number of organizations

participating in the response continuously fluctuates as some organizations enter, others leave, and still others transform while participating in the crisis response, the pre-existing relationships established and/or confirmed electronically might serve to make these organizations the core of the response network. Further, IT could reduce the role of smaller, more ad-hoc organizations. Currently, many network relationships are coordinated face to face. However, if on-line communication replaces this face to face interaction, smaller, peripheral organizations could find themselves out of the information loop. Alternatively, IT might promote a more decentralized network structure. Electronic communication might enable more organizations to participate in the response by providing access to key information. Further, pre-existing relationships could be established between more organizations, decentralizing the response.

Conclusions

The structure of interorganizational relationships during crisis response is defined by several factors, including response plans, sector affiliations, and informal relationships. Overall, the interorganizational response to the Pennsylvania floods was large (approximately 119 organizations responded) and decentralized. FEMA, the Red Cross, Gov. Ridge, and firefighters were the most central response units across all subnetworks. It was not possible to identify a core structure for each network.

The secondary goal of this report was to discuss the current use of information technology and the potential impact of IT on the structure of the response network. Observations suggest that currently IT used is on an ad-hoc basis both within and between organizations. It is clear that IT played a role in the structuration of the response network. However, the exact role is still unclear. This report raises competing hypotheses regarding the impact of IT on network structure. Future research will use these hypotheses to more closely analyze the impact of IT on the

structure of the response network.
Proponents claim that IT will facilitate interorganizational response, increase coordination, and reduce response time. I saw no evidence of this. Instead, IT is used in an ad-hoc fashion both within and between organizations. Although IT was present, whether it played a part in structuring the interorganizational response is unclear and is a question for future work.

Table 1. Flood-related articles published in the *Pittsburgh Post-Gazette* during the immediate post-impact period by day

Date	Number of Articles
January 19	1
January 20	3
January 21	2
January 22	17
January 23	10
January 24	5
January 25	6
January 26	3
January 27	4
January 28	10
January 29	2

Table 2. Organizations by sector and level of affiliation

	Affiliation			
Sector	Local	State	National	Total
Education	5	0	0	5
Government	32 10	13	55	
Health Care	3	0	0	3
Mass Care	4	0	2	6

Media	11	0	1	12
Military/CD	2	0	4	6
Religious	4	0	0	4
Volunteer	3	0	0	3
Weather	2	1	2	5
Other	13	0	7	20
Total	79	11	29	119

Table 3. Pennsylvania Floods of 1996: Percent of response network by sector.

	Time 1 (1/19 - 1/24)	**Time 2 (1/25 - 1/29)**
Education	3%	0%
Government	46%	49%
Health Care	2%	3%
Mass Care	11%	6%
Media	1%	15%
Military/CD	11%	14%
Religious	2%	2%
Volunteer	5%	2%
Weather	8%	2%
Other	11%	7%
Total	100%	100%

Table 4. Degree centrality of the most central

and common response organizations

	Time 1			Time 2		
Org	**SS**	**WW**	**DP**	**SS**	**WW**	**DP***
Army Corps of Engineers		2		1	5	
Churches				5	1	
City of Pittsburgh				5		
Coast Guard	1	3	1	1	2	
FEMA	1	3	6	4	7	2
Firefighters	1	6		6	1	
Gov. Ridge		4	5		6	3
Municipalities					7	
National Guard	2	2		6	1	
National Weather Service	2	8	2		3	
Radio Stations				5		
Red Cross	2	8		1	7	
Robert Morris College				7	1	
Salvation Army				5		
Volunteers		2		2		
Network Centrality	3.30%	13.20%	27.50%	11.20%	15.20%	28.60%

***SS=Same Service WW=Works With DP=Dependency**

Appendix I: Summary of Research Activities

during the Pennsylvania Floods of 1996

Saturday, January 20, 1996 - Tuesday, January 23, 1996
-Monitored local newscasts; visited affected areas and observed coordination efforts

Wednesday, January 24, 1996
-Visited the Red Cross of Southwestern PA emergency operations center; met EOC personnel and discussed coordination efforts and technology use; monitored local newscasts

Thursday, January 25, 1996
-Visited affected areas with Red Cross disaster assessment team; observed coordination efforts and technology use in the field; assisted in disaster assessment; interviewed Red Cross EOC personnel informally; monitored local newscasts

Friday, January 26, 1996
-Spent a portion of the day at the Red Cross EOC observing coordination efforts and technology use; visited affected areas with Red Cross disaster assessment team; observed and held informal interviews of local police, firefighters, emergency personnel, and victims; monitored local newscasts

Saturday, January 27, 1996
-Visited a Red Cross family center and talked with volunteers; visited City of Pittsburgh EOC; monitored local newscasts

February/March 1996
-Interviews with Army Corps of Engineers, Allegheny County, PEMA, and other local personnel

Appendix II: Persons Interviewed for this

report.

American Red Cross of Southwestern PA
Al Boice, Damage Assessment (Field)
Nancy Mercer, Volunteer Coordinator
Jim Merideth, Damage Assessment (EOC)
Joe Swafford, Damage Assessment (EOC)

Local City and Borough Officials
Bruno Moretti, Springdale Emergency Manager
Local police officers
Local firefighters

Allegheny County Emergency Personnel
Larry Boyle, County EOC
Steve Wilharm, County EOC

Army Corps. of Engineers
Bob Waigand, Emergency Management Division

Victims
Residents of West Elizabeth, PA
Boat owners in Sharpsburg, PA

Volunteers
Red Cross volunteers
FEMA volunteers

Return to Hazards Center Home Page
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