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ELECTRONIC COMMUNICATIONS FOR IMPROVING DISASTER RESPONSE AND RECONSTRUCTION: LESSONS FROM THE JANUARY 2001 GUJARAT, INDIA, EARTHQUAKE

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SUMMARY

A case study of the January 26, 2001, Gujarat, India, earthquake, demonstrates that with the rapid spread of email, internet and cell phone technologies, earthquake engineers are expected to respond ever more quickly by greater numbers of people worldwide. Electronic communications that are changing notions of "home" and "experts" also provide engineers with opportunities to educate and to garner support for earthquake rescue, relief, reconstruction, and vulnerability reduction.

A January 2001 through May 2003 content analysis of internet news sources, along with the websites of governmental and nongovernmental organizations indicates that electronic communications permitted details of the Gujarat earthquake to reach officials, relief organizations, and family members more quickly than during previous Indian earthquakes. Demands for relief, damage and safety inspections, regulatory enforcement, and repair or reconstruction, also arose quickly.

Not only are engineers expected to work quickly, but the expectations are from greater numbers of people, including Gujaratis across India and Indians abroad, who stay involved with "home." Earthquake engineers could use these networks of people connected by electronic communications to disseminate information about relief distribution, earthquake-resistant repair and reconstruction, and the engineering economics of rehabilitation plans. Those with access to electronic communications do talk to those without access. Earthquake survivors are "experts" on their own experience, including observations of urban construction practices, and reconstruction quality. Family or friends outside the earthquake area may be "experts" on social and cultural contexts, and along with local residents may keep a watchful eye on relief and reconstruction, a force that engineers could galvanize for accountability in rebuilding more earthquake-resistant urban centers and rural housing.

INTRODUCTION

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Although the Friday January 26, 2001, earthquake in Gujarat, India, disrupted Republic Day celebrations and communications networks, the rapid spread of cell phones, email and internet technologies raised expectations by Indians and others around the world about how quickly earthquake engineers and government officials would respond. The earthquake, measured by the Indian Meteorology Department (IMD) using a body wave magnitude calculation, as 6.9 on the Richter scale, and measured by the United States Geological Survey (USGS) using a moment magnitude calculation as 7.7 on the Richter scale, severely affected Bhuj, Bachhau, Anjar, Rapar, Gandhidham, Ahmedabad, Rajkot, Jamnagar and Patan. According to the Government of Gujarat website 20, 086 people perished, 300,000 houses collapsed, and one million houses were damaged. Kutch District experienced a total blackout when a 220 KV line tripped Shah [1]. Although "the power supply in Ahmedabad was restored within a few minutes, it took as many as 15,000 Gujarat Electricity Board (GEB) personnel," 30 truckloads of electrical equipment, and two days to restore the power in Bhuj. Collapse of the telecom building in Bhuj destroyed equipment, while breakage of fiber-optic cables isolated Kutch from communication with the rest of Gujarat. Vatsa [2] Cell phone towers were also damaged.

RESCUE PHASE

Companies like Reliance and Cadila were conducting rescue and relief work in the field within eight hours of the earthquake. Just a phone call from the top corporate management empowered ground level staff to make key decisions in quick service to quake victims and their companies. For example, within hours of the quake, Reliance chairman Dhirubhai Ambani gave clear instructions that local units should put all of their resources into rescue work in Gujarat. This contrasted with the government officials spending the first day of the calamity assessing its dimensions while waiting for sanctions to from the top Sinha and Vidyasagar [3].

During the rescue phase, people within Gujarat, throughout India, and across the world wanted to know if their loved ones were safe or in hospitals. Those in the quake-affected areas wanted to contact family and friends to report their conditions. Shah [1] reported on a memorandum from Gujarat Chief Minister to Prime Minister Vajpayee which indicated "the only contact is through satellite phones and HAM radio operators through their wireless network," particularly in Kutch.

While trying to restore its exchange in the affected regions, a public sector telecom company, Bharat Sanchar Nigam Ltd (BSNL) on Sunday evening allowed people to use three free phone booths outside its office on the outskirts of Old Bhuj city to make long-distance calls. However, accessibility was limited by long queues of residents and military personnel, and a cut off at 11:00 hours on Monday by BSNL officials citing a lack of connectivity. BSNL also erected a satellite facility that functioned while Prime Minister Vajpayee made an aerial survey of the region, but was then delinked from the nearby headquarters [4]. All communication equipment available to the administration was used to complete the last details of Prime Minister Vajpayee's visit Mistry [5]. In short, while phones remained cut off for the fifth consecutive day on Tuesday in Bhuj, officials claimed it would require more than ten days to completely restore telecommunications to the region. A hotline connected the collector's office to the district headquarters [4].

Even as officials opined about trying their best against heavy odds to restore communications, some young men went to the local satellite exchange in Bhuj and repaired limited facilities for receiving incoming calls on January 27. According to Himmat Dhamma, a 35-year old builder who played a leading role in the restoration, they had received 15,000 calls from all over the world by January 31. Callers were requested to convey messages from locals to their relatives and to pass on the three operational phone numbers. Worried locals waiting for calls from relatives praised the 24-hour service as very helpful.

Dhamma and his friends considered that providing information was the most important thing for comforting people [6].

Within two days following the quake, Shyam Telecom, Motorola, Ericsson and AT&T companies provided satellite phones and walkie-talkies enabling local people to contact their relatives Sinha [7]. According to reports from Ahmedabad, by four days after the quake, Gujarat's two cellular service providers, Celforce and AT&T had activated their network. Congestion limited the network to one-way traffic, with quake survivors able to send messages out. The Narmada Fertiliser Corporation enabled people to make calls from Kutch through a V-SAT (very small aperture terminal) link that it established [8]. Meanwhile, Gandhidham residents also stood in long queues to call relatives. Celforce resumed operations in the area by January 31, while the telecom department's efforts set up two of four telephone lines. Two telephones also operated at police stations [9].

Hundreds of relatives of people living in the earthquake-affected area arrived on special trains and buses from all over India. Many of them, like Mahesh Bhansala, who was studying engineering in Chennai, came to Gujarat after failing to contact relatives by telephone. Mahesh wanted to contact his parents in Pachchao [10].

Lessons from the rescue phase

Earthquake engineers serve on the multidisciplinary teams which create disaster management plans, so can advocate for emergency phone or internet connections for government officials to use to begin rescue and relief operations. Just one set of redundancy in the power supply and connectivity would ensure rapid official communication between governmental agencies and enable dissemination of emergency information to the public. In addition to adequate infrastructure, engineers can insist that disaster management plans provide procedures for immediate communication from the directors of governmental agencies to ground level staff. Professional engineering associations with members in both the private and public sectors can expedite transfer of the best organizational procedures and robust electronic communications infrastructure from use in the private sector to use in governmental and non-governmental organizations. Certainly, residents who see the results of rapid communication and action by private enterprises will expect at least this level of response from their elected and appointed officials.

During disaster management planning, engineers can provide the technical information for business leaders, political officials, and citizens to choose between landline phones, HAM radio, V-SAT links, cell phones, and other electronic communications technologies as their emergency communications system. Repair of the local satellite exchange to receive incoming calls in Bhuj suggests that builders, electricians, junior engineers, or computer technicians acting as responsible citizens would be able to re-establish electronic communications networks after an earthquake, especially if they are included as residents in technology choices made during disaster planning. Repairs made by citizens would increase the resources available for survivors to contact their relatives and would ease the pressure on public officials who are expected to have communications available rapidly.

Experience in the Gujarat earthquake indicates that getting messages out of the area to relatives and friends across India and the world was the most important kind of electronic communication to provide first. Whether facilities were available for incoming calls or outgoing calls, people used whatever communication network was available to convey messages out of the quake-affected area. People receiving messages outside of Gujarat willingly passed along information to others, creating cascades of communication flows. Engineers can provide for the greatest robustness and resiliency in the outgoing communication capabilities of phone, email, or internet systems, and can repair these facilities first if they find themselves in an earthquake affected area.

By providing effective communication links immediately in the aftermath of an earthquake, engineers can help avoid the congestion of non-essential persons arriving in the area. Persons who can contact their relatives do not have to visit in person. With fewer visitors to a disaster area, the burden on damaged infrastructure is decreased, and security is increased because looters are easier to sort out from those with legitimate rescue and relief purposes.

RELIEF PHASE

In addition to contacting relatives, members of the Gujarati community throughout India mobilized relief for the quake victims in their 'desh' (homeland). For example, approximately 10,000 Gujaratis, the majority of them from Kutch, work in various trades and industries in the Jharia coalfields on the Chhotanagpur Plateau. Peresh Chauhan, eastern zone vice-president of Akhil Bharatiya Gujarati Samaj, contacted Narottam Bhai Patel, Gujarat minister for water resources and development, concerning sending a volunteer relief team immediately on February 1. The Gujarati Samaj began collecting funds in a door-to-door campaign and intended to distribute relief materials such as blankets, tents and carpets themselves. The Pradeshik Marwari Sammelan donated Rs 51,000 to the Gujarat Earthquake Relief Fund. Both the Dhanbad Nagrik Parishad and the Dhanbad district administration called meetings to expedite collection of relief funds and materials [11].

The availability of online news reports rapidly informed people around the world about the details of the earthquake in Gujarat. Some news, such as the names of collapsed multi-storey buildings, (Table 1) must have caused anxiety among family and friends of the residents.

Table 1 Online newspapers listed damaged multi-storey apartments

City	Apartment
Ahmedabad	Panch Ratna Apartments
	Skylark Apartments
	Suparna Flats
	Vimal Apartment
	Paras Apartment
	Siddhi Shila Flat
	Shraddha Apartment
	Shitalbaug Apartment
	Sharanam Apartment
	Vishram Apartment
	Ohm Apartment
	Sundaram Apartments
	Shikhar
	Sarvadarshan
	Akshar Apartment
	Purvi Apartment
	Vidwadarshan Apartment
	Mangalam Flats
	Jashodapark
	Pujal Apartment
	Shrifal Apartment
Bhuj	Ganga Yamuna
	Aradhana
	Gokul

	Mansi
	Mangalam Apartment
	Sanskar Nagar
	Jain Bhuvan
	Antriksh
Mistry [12],Chaudhary [13], [14], Mistry [15], [16]	

People who had the resources to live in multi-storey apartments are also the people with the resources and backgrounds to have relatives studying or working elsewhere in India or abroad. A long history of trade, industrialization, and export of gems and handicrafts has resulted in a larger number of educated, urban non-resident Indians (NRIs) around the world from Gujarat than from many other states Guha [17].

International organizations drew upon the generosity of people outside India, and certainly numbers of these persons are NRIs. Some appeals were specifically made to persons with ties to Gujarat. For instance, NRIs in the State of New Jersey in the United States contributed $16 million dollars, a sum larger than that given by several countries [18]. A Care India team from Delhi flew to Ahmedabad on January 27 to make an initial assessment while disaster management staff flew in from Canada. Blankets, tarpaulin sheets, lanterns, water containers and water purification tablets were distributed right away. Modern Food Industries provided ready-to-eat food for the victims. "'We do not generate resources in India,'" said Care India director Harry Sethi, "'All our financial resources are mobilized outside India.'" With help from Microsoft, medical centers were set up Pandey [19]. The Bill and Melinda Gates Foundation contributed $1 million to Care for Gujarat. Pepsico foundation contributed $500,000 for the FICCI-Care Gujarat Project [20].

Businessman Satya Narain Bansal and some other Bhuj residents wrote a letter on February 2 to the Prime Minister's Office and the central government's Crisis Management Team requesting that cranes and gas cutters be dispatched within 24 hours to clear debris in Bhuj and Anjar. Bansal, who had seventy employees in the commercial heart of Bhuj, wanted to get back to work [21]. A letter likely required more than 24 hours to reach its recipients, but email could carry direct requests from citizens to officials to make such rapid response more realistic.

The number of large and small industrial units like Bansal's and the number of migrant workers from other states in India create a continuous demand on postal services in Gujarat even under normal conditions. As people tried to return to some of their usual activities, demand for postal services increased. Hybrid mail service which combines electronic and traditional mail services was provided free of charge in the earthquake affected areas in early February [22].

Lessons from the relief phase

Knowing that people with ties to a homeland will likely want to assist earthquake victims, engineers can plan for the arrival of materials and funds from places where numbers of community members have settled. People with ties to the community will generally send culturally and climatically appropriate relief materials. Engineers can make the best use of these items by having distribution procedures worked out in a disaster management plan.

As more and more voluntary organizations make online appeals for funds to assist earthquake victims, engineers can expect that increasing numbers of people will want to know how relief funds are being used and financial accounts are kept. Engineers can use internet technology, as well as the usual hard copy, to disseminate disaster management plans before calamities strike and to document ongoing relief activities. Engineers can advocate that the organizations for which they work or consult publish on the internet their chartered accountants' reports of the use of donor funds for earthquake relief activities.

Urban dwellers, business owners, or small industrialists who have the resources to occupy multi-storeyed buildings, and who are likely to agitate for official accountability, are also likely to have the education and resources to use websites. Consequently, engineers can use internet technology to meet some of the demands made of them, and to enlist residents to take actions to help themselves and their communities or neighborhoods.

To help collect timely information about the type and amount of relief materials needed in various locations, engineers can establish email addresses, as well as phone hot lines, for residents and staff to submit reports or requests. The rapidity of email, and the ability to organize and archive electronic information, could be used to coordinate and distribute relief materials. Technology may help overcome the perennial criticism of unevenness and delay in delivery of relief materials.

As earthquake engineers assess earthquake damage, enumerate collapsed buildings, and inspect buildings for repair, retrofitting, or demolition, they can make their findings known on websites that would serve several purposes. As data accumulate, both residents and government officials will see direct evidence that damage and safety inspections are proceeding as they expect. Residents can use the information to make their own knowledgeable choices about investing in repairs or retrofitting, moving households or businesses to other locations, returning with confidence to safe structures, or filing lawsuits against negligent builders or construction regulators. Government officials can use the data to seek arrest warrants or levy fines against violators of building codes, or to distribute funds and materials for retrofitting and repair.

Given that access to electronic communication will remain uneven, especially after earthquakes, even as overall accessibility increases exponentially, engineers can consider hybrid solutions, similar to hybrid mail, which use electronic and radio or paper communications to disseminate information during relief operations. For instance, instructions for water purification, or where to sign up for governmental programs may need to be disseminated on posters in public buildings, but could also be put on a website. A website could contain necessary information in numerous languages.

RECONSTRUCTION PHASE

Immediately after the Gujarat earthquake, engineers from across India began lending their expertise to reconstruction. On Tuesday January 30 four teams of structural engineers representing the Hyderabad chapter of the Association of Consulting Civil Engineers (ACCE) began visiting the worst-affected areas in batches to assist local professionals in assessing building damage and advising people about the safety of their structures. The association's secretary, P. Suryaprakash, said there was a need for stringent mechanisms to ensure proper engineering practices in the construction industry [23].

In the wake of the Gujarat earthquake, professionals, political leaders, and citizens noted that earthquake-resistant construction and disaster preparedness needed much more attention to avoid future losses. Andhra Pradesh Chief Minister N. Chandrababu Naidu recommended that the central and state governments take initiative in developing quake-resistant buildings in cooperation with Japan, which has expertise in the technology [24]. Dr. V. Thiruvengadam, head of the department of building engineering, School of Planning and Architecture, warned that until local authorities in Delhi and other quake-prone cities monitor builders and architects, building designs and construction won't conform to norms established by the Indian Bureau of Standards Ghosh [25]. On February 3, Karnataka Chief Minister Krishna charged a special group of experts, including some from the Indian Institute of Science, with periodically monitoring seismic activity in the state to be as prepared as possible [26] Dilip Chaware [27] reported that no steps had been taken yet to tighten laxity in implementing building codes in Maharashtra

despite a government survey after the Latur earthquake which found 78% of houses in the state would suffer major damage in another large quake. Although norms were hardly followed earlier, municipal commissioner G. R. Aloria issued a circular in the first week of February asking all Vadodara Municipal Corporation administrators to only permit construction of buildings with certificates from registered structural engineers or architects [28]. On February 7, the Cuttack Development Authority (CDA) appealed to people to avoid flats built illegally in the city and listed 23 multi-storeyed buildings that were not safe for human habitation. The questionable condition of nearly 75 high-rise buildings in Bhubaneswar may challenge Orissa urban development minister Samir Dey's promise to follow the example of Union urban development minister Jagmohan to demolish all illegal buildings Satapathy [29]. To answer questions posed by anxious prospective buyers, Harpal Singh, managing director of Shipra Estates, sought suggestions from IIT-Delhi (Indian Institute of Technology) and inserted advertisements in national newspapers highlighting all of the quake-resistant features of three 20-storey residential high rises being built in Ghaziabad Kumar [30].

Some groups like the Calcutta Municipal Corporation (CMC) sent engineers to Bhuj and Ahmedabad for on-the-spot experience in relief and rescue operations. Within two weeks after the Gujarat earthquake, the Kolkata civic authorities convened a meeting with state and central government agencies to discuss precautionary anti-earthquake measures. The CMC building department indicated that their number of structural engineers would have to increase to strengthen inspection of earthquake-resistant measures in multi-storey buildings under construction [31].

Although reconstruction spans a longer period of time than rescue or relief, rapid telephone communications played an important role, and some of those phone calls originated outside of the quake-affected area. Former US president Bill Clinton phoned Prime Minister Vajpayee on the morning of Friday February 2 to ask if he could help the quake victims. "'I told him,'" Vajpayee said, "'that he could ask the many Indians now settled in the US to adopt some of the affected villages'" [32].

By February 6, urban dwellers again had access to cyber cafes and phones, but their usage evidenced fear among the population. In Ahmedabad, Vikram's cyber café closed at 9:30 pm or later, before the quake and although overflowing at 7:00 pm after the quake was empty by 8:00 pm because people wanted to be with their families after dusk. Word spreads quickly by phone if a larger than usual aftershock empties a commercial complex or if someone believes a crack in their wall has grown larger Jha [33]. Meenu Dhingra of Noida, whose doctor husband did relief work in Bhuj said that his phone calls describing the destruction made her want to move from the fourth floor flat to the ground floor Kumar [30].

Amidst the ongoing news of the Gujarat earthquake, Jyoti Kamal [34] reported that Chandigarh was set to be the first fully wired city in South Asia. Lucent Technologies, Spectra Net, RPG Cables Limited, Hathway, Bharti Broadband Networks Limited, Zee Interactive Multimedia and Power Grid are all adding to networks and bandwidth for future networked houses, interactive TV, broadcast TV, interactive shopping, TV downloads and tele-education, online business, and ultra high speed data access. With its business and industrial vibrancy, metropolitan areas and the entirety of Gujarat cannot be far behind Chandigarh in the explosion of bandwidth availability. Earthquake engineers can take advantage of the increasing wired technologies to educate people about quake-resistant construction, to collect and process data from in-situ instruments, and for coordinating groups of citizens monitoring construction or retrofitting of buildings.

The possibility of innovative use of electronic communications for improving disaster response and reconstruction came to the Ahmedabad Municipal Corporation (AMC) in the 2001-2002 budget year with an e-governance project undertaken by Reliance. The corporation installed 100 computer terminals at various points in the city and connected them with optical fiber cables to the AMC control room [35].

Lessons from the reconstruction phase

In the reconstruction phase, engineers could employ electronic communications to help people help themselves as much as possible. Again, websites could provide numerical and pictorial information showing the progress being made by governmental and voluntary organizations in demolishing unsafe structures, relocating and reconstructing housing, and rebuilding infrastructure. Tele-education could benefit even the illiterate. With information, citizens can decide what actions they need to take to spur officials and agencies to greater action, or to express thanks and recommend responsible organizations or business operators to others for quality construction.

Increasing numbers of cell phones have digital photography capabilities. Engineers could use this technology themselves or train residents how to document every step of retrofitting or construction processes. A record for inspectors and regulators to use is important because inspectors cannot be at a particular site continuously.

Engineers can arrange for phone numbers and email addresses for residents to use to ask questions or report questionable or exemplary activities by builders. For instance, someone who is hiring a structural engineer or architect needs a way to confirm certification or licensure of a professional. By responding quickly to citizens' reports, inspectors can detect construction flaws before they are hidden, and can assure corrections without exorbitant costs. For example, requiring the rebuilding of three tiers of bricks in a wall because of weak mortar is less expensive than rebuilding the entire wall if the error is discovered very late.

With educational materials such as retrofitting instructions or illustrations of earthquake-resistant construction on websites, residents with family and friends near and far can activate these networks to understand construction technicalities. Even if residents are not engineers themselves, they likely know people in their networks who can assist them in making decisions about where to rent, buy or build housing, and assist them in overseeing any construction work done for them. The use of cyber cafes in Ahmedabad and the explosion of wired technologies in South Asia suggest that it is reasonable for engineers to expect that people will use electronic communications more and more in the future. Engineers can capitalize on the increasing use of electronic communication to improve earthquake disaster response and reconstruction.

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