

Extending the technology-community-management model to disaster recovery : assessing vulnerability in rural Asia

Komathi, A. L. E.; Chib, Arul

2009

Chib, A., & Komathi, A. L. E. (2009). Extending the technology-community-management model to disaster recovery : assessing vulnerability in rural Asia. International conference on information and communication technologies and development (ICTD), 328-336.

<https://hdl.handle.net/10356/101137>

<https://doi.org/10.1109/ICTD.2009.5426694>

© 2009 IEEE. Personal use of this material is permitted. Permission from IEEE must be obtained for all other uses, in any current or future media, including reprinting/republishing this material for advertising or promotional purposes, creating new collective works, for resale or redistribution to servers or lists, or reuse of any copyrighted component of this work in other works. The published version is available at: [<http://dx.doi.org/10.1109/ICTD.2009.5426694>].

Downloaded on 25 Aug 2022 01:24:05 SGT

Extending the Technology-Community-Management Model to Disaster Recovery: Assessing Vulnerability in Rural Asia

First A. Author and Second B. Author

The recent increase in natural disasters has a significant impact on the lives and livelihoods of the poor in Asia. The ubiquitous spread of information communication technologies (ICTs) in this region's rural areas, suggests the potential of technologies to enhance recovery efforts. While many ICT initiatives have been implemented to aid disaster management, from providing early warning to immediate relief, there exists a gap in the theoretical understanding of the role of technologies in disaster recovery. In this paper, we propose a conceptual framework for the implementation of ICTs in recovery operations, drawing the attention to vulnerability reducing potential of the initiatives. We review theories on disaster management and ICT use, and propose the Technology-Community-Management Vulnerability Assessment (TCMV) model for the design and implementation of ICT programs for development in rural areas. The TCMV model illustrates four vulnerabilities in disaster recovery – physiological/psychological, informational, economic, and socio-cultural, against the technology used, its management and the community involved. We validate this model using case examples from ICT deployments in post-disaster Asia, particularly India, Indonesia, Sri Lanka and China, and suggest implications for theory and practice.

I. INTRODUCTION

More than 250 million people globally are affected by natural disasters every year, and the intensity and frequency of catastrophes are steadily increasing in the last decade [1]. Asia is amongst the most affected and vulnerable regions, with disasters such as earthquakes, floods, tsunamis, cyclones, and droughts killing thousands of people each year, while millions have lost their homes, properties, livelihoods and families [2]-[4]. The increase in the proportion of people living below the poverty line, from 30 percent to 50 percent in post-tsunami Indonesia, suggests the impact of calamities on the poor, especially those living in less developed and developing Asian countries [5], [6]. These marginalized groups face the challenge of coping with, and recovering from the effects of disasters as overall development and economic growth suffer major setbacks in the aftermath [7]-[11].

The ubiquitous spread of information communication technologies (ICTs) in Asia [11], [12] offers more people access to technologies that have the potential to aid in disaster management efforts [13]-[17]. Data from the International Telecommunication Union [5] indicate a steady rise in the penetration, accessibility and use of ICTs in Asia. India, in particular, continues to be one of the fastest growing major telecom markets in the world, overtaking China in terms of mobile growth rates of 91 percent per annum since 2001. With over five hundred million internet users, Asia has a 15.3 percent internet penetration rate [18], growing from 11.8 percent in 2006 [5]. However, there exists a disparity in access to technologies in Asia where predominantly urban dwellers have more economic, educational and technological familiarity with these technologies, compared to the rural population [19]. Despite this divide in technology use, the many cases illustrating the use of ICTs in disaster management shows the potential of technology diffusion in the rural area.

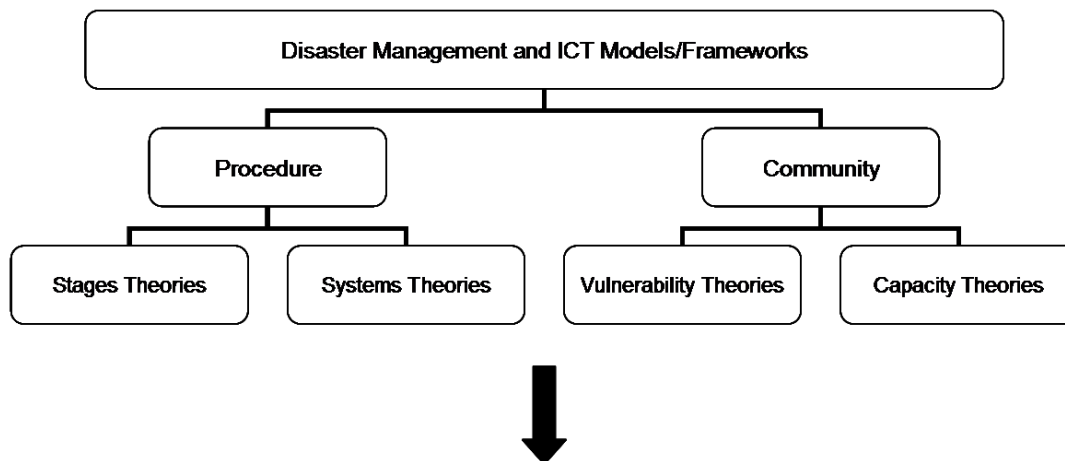
An examination of the literature suggests that ICTs are being used beyond merely facilitating early-warnings about impending disasters. The role that ICT systems, which range from older technologies, such as radio, television, and land-line telephony, to advanced modern technologies, such as Global Positioning Systems (GPS), Geographic Information System (GIS), Very Small Aperture Terminal (VSAT), and cellular phones and satellite communications, have to play at various stages of disaster management has been recognized by academics, governmental agencies, civil society groups, non-governmental organizations (NGOs), and voluntary welfare organizations in the development arena [21]-[23].

Here, communication technologies provide access to information that is a vital form of aid in itself. Particularly in the post-disaster context, “disaster-affected people need information as much as water, food, medicine or shelter [24]” from immediate relief to long-term rehabilitation efforts. This draws the link to the potential of ICTs to be utilized in various operations following a disaster, from enabling prompt information dissemination to relief agencies and affected communities, to livelihood rebuilding initiatives in the recovery phase. The focus has been increasingly on the use of these technologies for disaster response in the mitigation

and preparedness stages [25]-[29], and limited focus has been placed on the scope of ICT in the recovery stage, particularly in rural communities.

While researchers have attempted to understand the role information communication technologies play in disaster contexts [27]-[30], there is a recognition among academics, governmental organizations and policy makers of the need for an established canon for best practice [9]. This study aims to bridge the existing theoretical gap for ICT deployment in post-disaster management, by proposing a conceptual framework to guide the design and implementation of ICT for development (ICTD) programs involving wireless technologies, specifically in disaster recovery. In this paper, we critique existing theories in disaster management and ICT to explore their application to the study's main theoretical framework of the Technology-Community-Management (TCM) model [19], [31].

Part A - Review



Part B – Proposed Framework

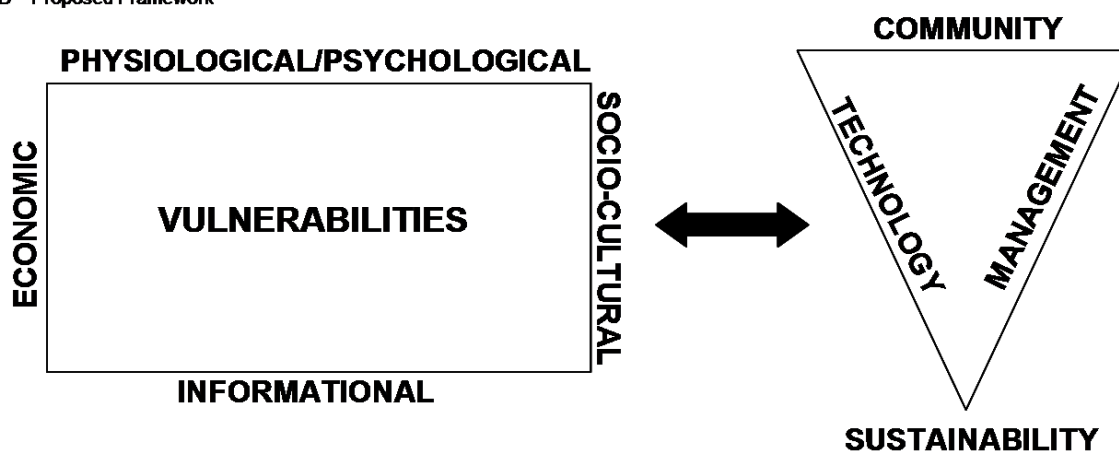


Fig. 1. Technology-Community-Management Vulnerability Assessment Framework

A. Technology-Community-Management (TCM) Model

The Technology-Community-Management model [19], [31] proposes the three key intersects of ICT characteristics - technology, management and community, which will lead to sustainable ICTD interventions. Lee and Author [31] argued that the technological design is the combination of software and hardware components, while management of a project requires an understanding of the financial requirements, establishment of key partnerships, and a regulatory environment. The focus is on the community involvement and participation for the success of programs. Community component of the TCM model were sub-divided to dimensions of information and communication needs of the community, individual to collective ownership of ICT investments and profits, and training of community users both in the use and management to technology. Here, financial and social sustainability is dependent on the replicability and scalability of projects.

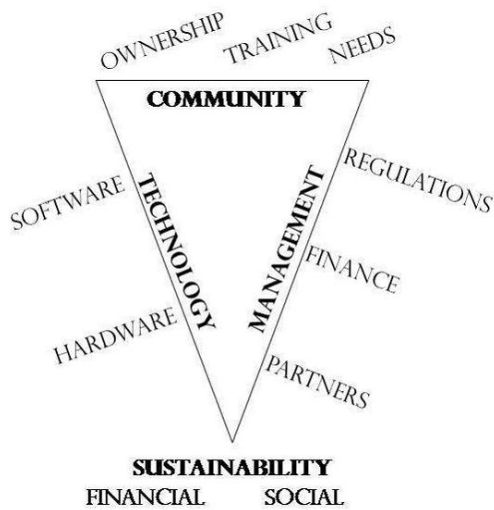


Fig. 2. Technology-Community-Management Model

The TCM model presents a comprehensive illustration of the issues surrounding ICT implementations in rural areas, condensing the key conditions affecting each T, C, and M dimension, and its value to overall sustainability for effective long-term implementations. In disaster recovery, technology and its management prompt to community's need to regain a sustainable livelihood and to acquire new skills to improve their capabilities.

II. REVIEW OF MODELS AND FRAMEWORKS

In this paper, we extend the TCM model to assess vulnerability in disaster recovery, and propose the TCM Vulnerability Assessment framework (See Figure 1, Part B). We categorised conceptual frameworks developed in the studies of ICT and disaster management, into two scopes of analysis – Procedure-Based and Community-Oriented theories. While procedure-based theories provide a structural understanding of methods and actions, community-oriented theories are able to elaborate on the practically relevant issues involving the community. We review the models to define the frame of reference for the proposed model (See Figure 1, Part A).

A. Procedure-Based Theories

Stages theories present frameworks in longitudinal and tier approaches. The longitudinal approach was initially adopted by the eight socio-temporal stages of disaster framework [32]-[34], which was further expanded in models, such as the six-phase disaster cycle [35], [36], [4], three stages of disaster [37], three time-dimensions of rehabilitation efforts [14], and strategic disaster management cycles [38]. These theories are useful in highlighting the types of actions and measures necessary in prior, during, and after disaster contexts. However, they fail to point out any potential barriers to the efforts implemented at each stage, particularly to ICT deployment. Furthermore, the boundaries across phases can be fuzzy, and stage-related behavior can be concurrent [39].

The most widely used six-phase disaster cycle suggests that most effective implementation of ICT in disaster management revolves around 4 main phases: mitigation, preparedness, response, and recovery. It argues that activities at each stage are unique, with emphasis on the varying information content tailored to both affected people and aid providers. The theories suggest that ICTs can be best capitalized in the recovery stage, where emphasis is on the psychological and physiological rehabilitation of affected communities. Most stages theories contend that ICT rehabilitation efforts, in the areas of physical and social rehabilitation, and health and education rehabilitation, should focus on multi-year programs. This emphasizes the need for long-term recovery efforts to ensure people regain their economic and psychological balance. It is argued that fostering of economic livelihood should be based on the principles of social inclusion and gender equity, especially those involving fishing and farming communities.

The Tier process evaluates ICT initiatives on mutually exclusive levels of impact, through which users make successive progression. The Influence-Impact Model [7] emphasized the importance of accurate, timely and complete information outflow for first and basic level impact to occur. The ICT step change table by Chetley [27] identified three levels of projects, where the informational needs of people, such as knowledge of technology, literacy level, and skill capacity of users, determine the basic, medium and high levels of ICT project. We reason that it is difficult to draw clear boundaries in such processes where users, especially those affected by disasters, possess varying, and often overlapping informational needs, and capacities to process these information.

The systems analysis groups theories such as the CARICOM structure [40] and disaster management consortium [41] identified the stakeholders involved in the decision-making and coordination of disaster operations, while the optimal disaster information flow model [40] and technical conceptual system model [42] map the roles information play in disaster management. We suggest that the systems theories can expand beyond coordination of information, and interactions by drawing attention to the action-oriented information exchanges that would highlight the combined efforts of stakeholders. Furthermore, the theories draw attention to how governments and NGOs make critical investments on ICT projects with the support of the private sector, illustrating the essential roles external bodies play in ensuring the economic livelihood of disaster affected people.

The procedure-based theories emphasize the importance of informational flow as the key factor influencing economic and psychological rehabilitation in recovery. Information disseminators employing ICTs have to be critical of the kind of information sent out to the affected people, catering to their needs, and boosting opportunities in a holistic information flow that have an impact on the livelihoods and well-being of people.

B. Community-Oriented Theories

Stages and systems theories overlooked the importance of community involvement in ICT initiatives. Particularly at the recovery stage, plans need to be understood, accepted, and implemented at the local level to be sustainable, and to achieve intended outcomes on communities in post-disaster situations [43], [44]. The paper identifies the second scope of analysis – community-oriented theories.

The Development-Disaster framework [45] provided a systematic series of ideas in the ways disasters are linked to development initiatives, while offering opportunities for vulnerability reduction. The theory highlights the importance of information in assessing vulnerabilities involved in development efforts, where the lack of, or poor access to, information could increase vulnerabilities in post-disaster situations.

The practical implications of this framework have been debated by many scholars [46]-[48]. In particular, Lavell [49] argued that the model should integrate at all six stages of disaster [4], [35], [36]. As highlighted by Pyles [50], we critique that the model should focus on community development efforts. In examining the potential of ICT interventions for development in post-disaster context, it is important to clarify what is being developed, who defines the scope of development, for whose benefits, at whose cost, for what time length, and for what purpose. The model claims that the design of development programs, should focus on decreasing community's vulnerability to disasters, and its negative consequences. Affecting people at varying magnitudes, vulnerability is defined as the "characteristics of a person or group, and their situation that influence their capacity to anticipate, cope with, resist and recover" from the impact of a disaster [51]. With insufficient capacity to cope, the poor are most vulnerable in the aftermath of disasters [8], [25].

Supplementing the Development-Disaster framework, the Capacities and Vulnerabilities Analysis [46] provided a conceptual model to give disaster managers a framework for understanding vulnerabilities of disasters, for reducing it, and to be used for designing and evaluating development projects. It illustrates that reducing vulnerabilities equate to increasing capacities of affected people at the individual, group and societal levels. It argues that communities that are well organized and cohesive can withstand or recover from disasters better than those divided by race, religion, class or caste. It contends that the individual and societal impacts on vulnerabilities would in turn determine the choice and performance of economic activities adopted in recovery.

The Pressure and Release Model and Access Model [52] argued that distribution of power in a society is affected by the demographic, political and economic processes within the social structures. This emphasises the socio-cultural impact on technology adoption and use, which is critical in determining the equal access and use of ICTs with a community.

The Access Model [52], which defines access as the ability of an individual, group or community to use resources to secure a livelihood, argued that people with access to information, equipment, and social networks are less vulnerable and able to recover more quickly. It suggests that access to resources is influenced by the social relations of class, gender, ethnicity, and age, affecting people's relative resilience to disasters.

The Sustainable Livelihoods approach [53] considers economic vulnerability as part of the context in which livelihoods are shaped. The theory argues that the resources and livelihood assets that poor people have access to and use affect how they create a livelihood for themselves and their households. This is influenced by

the technologies, people's skills, knowledge and capacity, health, access to information, sources of income, and their networks of social support. The Sustainable Livelihoods approach is not a blueprint for rural development, rather an analytical framework which guides the thinking behind development planning and intervention, with the potential to incorporate cultural aspects. As critiqued by Ellis [54], the framework needs to acknowledge that access to economic enhancing assets and activities is influenced by socio-cultural determinants such as gender, class, and religion.

On the whole, vulnerability theories can be used to analyse the role ICT can play in recovery efforts aimed at reducing vulnerabilities of the rural poor by increasing capacities and focusing on livelihood enhancing development efforts. The theories bring together the discussion that socio-cultural, informational and psychological recovery of people have a significant impact on their economic vulnerability.

The ICT Skills and Discretionary Slack framework [60] highlights the importance of capacity building in vulnerability reduction by proposing a correlation between level of ICT skills, and availability of time. It fails to account for the fact that the factors of skill and time are affected by both psychological and physiological determinants of users. This would affect the adoption, use, continuation and termination of ICT deployments. For instance, the level of ICT skills can be affected by physiological components such as the availability of ICT, the access to the technology, the cost and limitations to use. Similarly, discretionary time available could be affected by conditions such as the amount of training sessions offered, and cultural, gender-based and social restrictions. The psychological component affecting ICT skill level could include the individual literacy levels, attitudes towards ICT adoption, and overall willingness to learn. This theory is useful in highlighting that information processing capacity and access to information is dependent on the socio-cultural determinants as well as the individual's mental state to absorb and use the information.

III. TECHNOLOGY-COMMUNITY-MANAGEMENT VULNERABILITY ASSESSMENT MODEL

We identify four dimensions of vulnerabilities influencing the rural poor, (1) Physiological/Psychological Vulnerability, (2) Informational Vulnerability, (3) Economic Vulnerability, and (4) Socio-cultural Vulnerability, and argue that effectively designed ICT for development (ICTD) programs have the potential to reduce the magnitude of these vulnerabilities in disaster recovery. We extend the TCM model, and propose the Technology-Community-Management Vulnerability Assessment (TCMV) model (See Figure 1, Part B). The proposed model states that physiological and psychological enrichment, information optimization, economic resuscitation, and socio-cultural reconciliation can be achieved when paralleled with ICT interventions aimed at recovery.

It is crucial to first examine and assess the scale of each dimension of vulnerability in order to critically determine the roles technology, community, and management focused ICT initiatives can play in improving the lives of marginalized communities. We suggest that technology programs implemented encompassing objectives to reduce existing vulnerabilities, distinctive to each disaster affected community, will foster sustainable development beyond disaster recovery.

IV. RESEARCH FOCUS

In this paper, we propose the Technology-Community-Management Vulnerability Assessment (TCMV) model to guide the design and implementation of ICT for development (ICTD) initiatives in disaster recovery, and validate the model using ICTD cases in disaster-affected communities in Asia. Specifically, we examine cases from disaster affected rural areas in India, Indonesia, Sri Lanka and China. To do so, we look beyond the individual characteristics of technological design, management perspective and community participation, and examine their relationship with the four key dimensions of vulnerability.

V. METHODOLOGY

The Asian rural ICTD cases used to highlight the TCMV model were gathered from both primary and secondary sources during the period of April 2005 to August 2008. The fieldwork was conducted in Banda Aceh, Indonesia, and Tamil Nadu, India from July 2005 to February 2006, included semi-structured interviews with representatives from relief agencies and non-governmental organizations, and members of affected communities. These interviews were complemented with first-hand data collected by one author, based as a research consultant at the Asia Tsunami Response Team of World Vision to record and evaluate the ICT strategies and plans of World Vision, with the permission of this international non-governmental organization.

Supplementary data were gathered from case illustrations [54]-[59]. In these reports, information on post-disaster ICT projects were collected using a combination of quantitative and qualitative research methods, particularly in-depth interviews, participant observations, documentary analysis and surveys. While some cases demonstrated the use of ICTs, such as GIS, Internet, radio, and multimedia technologies to purely disseminate disaster-related information to people, we note that cases selected for this study focused on initiatives that involved community-level participation and use of technologies, thus targeting beyond passive reception of information.

VI. PHYSIOLOGICAL/PSYCHOLOGICAL VULNERABILITY

The physiological and psychological vulnerabilities are micro-level dimensions involving the physical and mental well-being of affected persons, or a specific community. It is the extent to which people are susceptible to post-catastrophic emotional stress and trauma, as well as their access to depleted health infrastructure and resources. This highly cognitive variable influences people's outlook on life, beliefs, and motivations to persevere in regaining their normal lives.

The use of technology can aid in alleviating the emotional distress of psychologically vulnerable communities. Children and youth are particularly prone to trauma from disasters, faced with the challenge of coping with the loss of their families and friends. In post-tsunami India, low cost computers at child-friendly spaces exposed children to games while introducing them to basic computing. Computer usage at these spaces helped ease traumatized children back into the routine of play [55]. Similarly, playing multimedia games on educational multimedia play-stations, provided by World Vision as part of its rehabilitation efforts, effectively reduced the stress level of children suffering from post-traumatic events caused by the tsunami.

The well-being of community is greatly enhanced by ICT projects designed with an in-depth understanding of community needs. Mobile communications has been identified as a potential means of improving health services, where comparatively increasing maternal and child mortality were worsened in post-tsunami Banda Aceh, Indonesia. The use of mobile phones by rural midwives offered low cost means of improving the handling of complicated obstetrical cases, and lowering rates of pre-natal and maternal mortality. By facilitating communication between midwives and obstetricians, mobile phone usage improved rural midwives' skills, and ultimately aided in the reduction of pre-natal and maternal mortality. In the coastal regions of Tamil Nadu, India, where many fishermen lost their lives and livelihood assets to tsunami, 200 GPS navigation tools were deployed in 12 fishing villages with the objective of helping fishermen overcome fear of the sea in order to regain livelihoods. This electronic device assists the fishermen as a compass in deep sea by showing distance and travel directions, thereby assisting the fishermen to navigate easily at sea, with more time efficiency. Besides increasing their confidence to fish, the psychological health of fishermen was improved when the saved time was spent interacting with family and friends [55].

VII. INFORMATIONAL VULNERABILITY

The informational vulnerability deals with the access to and availability of information within affected communities. The destruction of informational resources, ranging from personal documents, books and critical data, to opinion leaders and professional experts, affects the capabilities of people who are dependent on these sources of information. The informational vulnerability among rural people is further augmented by the low literacy levels and lack of relevant technological skills, necessary to overcome barriers to post-disaster development.

In post-disaster villages, technology enhanced capabilities of fishermen and farmers in obtaining updated information. Traditionally, local fishermen faced exploitation due to the lack of access to updated market prices. Middlemen capitalized on this factor to gain high profits by usurping much of the value-added to the basic product. With the establishment of telecenters and use of mobile phones in rural villages, fishermen have taken to obtaining market prices from fish wholesale markets in the region, allowing them to negotiate

better prices for their catch. The Govi Gnana system project was established with the aim of reducing rural farmers' exposure to price volatility by providing updated crop information about trading prices. It enabled farmers, traders, and buyers and sellers of agricultural produce to view live transaction prices at various trade stalls in their own markets as well as prices in other areas of the country, which were made accessible at telecenter terminals and kiosks, and broadcasted via the telephone and internet [58]. Thus, up-to-date information via the use of communication technologies reduced the information differential, and provided better economic resources to rural fisher-folk and farmers. In addition, a Short Message Service (SMS) system allowing midwives to upload critical health information to a database technology, improved midwifery access to maternal health data as well as enabling the rural midwife to consult senior nurses and doctors using mobile phones.

The effects of poor informational infrastructure can be devastating on the available educational resources in affected areas. In addition to the destruction and damage of scholastic infrastructure, the impact on human capital, in terms of the loss of teachers and parents largely reduce the informational capacity in resource-starved communities. For children, ICTs are a source of learning opportunities that help in building critical technological skills. To familiarize students with technology, World Vision in India equipped two schools in affected-villages with computers, providing practical computer lessons integrated with the school curriculum. In addition to computer oriented skills, children spent time with interactive programs learning Tamil, English, and other academic subjects.

Offering trainings to aid greater adoption of technology can make a significant difference to the information accessibility of rural people. In drought-hit Yellow Sheep River, China, the "Town and Talent Project" equipped the village's E-commerce center with 25 computers to provide information and computer usage to local farmers. Since its initialization in 2000, the project has organized 24 Internet courses for farmers to equip them with relevant computer skills for better retrieval and usage of agricultural information (Zhao, 2008). A Community Multimedia-Education Center in Jayagiri, Indonesia promoted community radio and multimedia as educational tools to encourage people-centered development in disaster recovery. The series of trainings, offered to build the capacity of center managers and volunteers running the community radio and programmes, aimed at improving their technological skills to strengthen information content of programmes (UNESCO, 2008).

Finally, informational capacity building is greatly enhanced by community management of technology in recovery efforts. The collective-ownership of facilities can promote the dissemination and sharing of information within communities. The "Town and Talent Project" in Yellow Sheep River, China introduced 22 computers, and one computerised classroom with 11 computers and internet connection to enrich educational resources in the town's school. Collaborating with a local company, two teachers received computer trainings to subsequently help the school set up its own network, and connect to the Internet. These teachers were the central information providers on computer usage to both fellow teachers and children [56]. The Nanasala telecenter project was managed by individual entrepreneurs within the community to provide internet access to rural villages in Sri Lanka [57]. The initiative exposed rural people to internet, computer, and telephone technologies with free training sessions to gain knowledge of technology use and online retrieval of information on new agriculture practices and techniques, and information on a variety of health issues.

VIII. ECONOMIC VULNERABILITY

The economic vulnerability is triggered by the loss of livelihood activities and equipment to financially support households and sustain economic growth in rural villages. From the destruction of houses, fishing boats and nets, and crops, to the loss of breadwinners and savings, the economic impact of disasters pose a significant problem to recovery in Asian rural communities. The destruction to the physical infrastructure, in terms of the breakdown of telephone wiring and electricity supply, amplifies the economic burden for overall development in villages.

ICTs have the potential to empower communities to regain economic stability in the disaster aftermath. The use of GPS systems and fish-finders to aid fishing practices, technology use has proven to have positive impacts on livelihood improvements and income generation in Indian fishermen communities. The fishermen reported an increase in fish caught, which in turn increased livelihoods from 20% to 50%, while a fifth reported a doubling of income [55]. Knowledge centers in India focused on providing income-generation tools for village Self Help Groups by providing access to information services. World Vision India Tsunami Response Team formed more than 600 Self Help Groups imparting various livelihood skills including computer, and entrepreneurship skills. Computer trainings, including introduction to business software skills, were provided to young adults and school graduates to improve their job prospects in the technologically-savvy Indian workforce.

IX. SOCIO-CULTURAL VULNERABILITY

The socio-cultural vulnerability of communities is determined by the social structure and values of society that define human relationships in communities. These hierarchies affect access to resources and assets, and decision-making power of people, established by gender, age, race, religion, caste, and class egalitarianism within communities.

Community pressures are seen most directly in the existing networks of power within the social system. The traditional power of the higher castes (social power), the middlemen (economic power), and males (gender power) limits the opportunities available to those groups with less power, which could work in the favour of the haves, and often further marginalize the have-nots. Tactfully designed ICT initiatives have the potential to champion the cause of development without widening existing social inequalities. To guard against this, the M. S. Swaminathan Research Foundation, an Indian NGO, has established knowledge centers in Dalit (lower caste) villages, while World Vision trained women Self Help Groups to take ownership of the ICT projects within their communities. Furthermore, telecenters in most village claimed no gender or age restrictions on access, with no separate timings for female users, or lower castes, allowing a co-mingling of different sections of society [55].

In some situations, the socio-cultural issues surrounding communities may indirectly affect people's perceptions on their capacity to use technologies. In rural China where computers were introduced in the classrooms, elder teachers were reluctant to take on computer usage due to the fear of not being able to learn and effectively adopt computer skills, predominantly possessed by younger users. In order to help staff overcome this technophobia, two training courses were designed to cater to these teachers, who then effectively grasped basic E-literacy for employment in daily teaching and learning [56]. In another case, Indonesian midwives initially perceived the ICT-based health practice as a monitoring system; rather than a tool to assist their work. This negative perception, triggered by existing class structures within the medical field, could have encouraged them to revert to the prior, more inefficient, paper-based system for reporting maternal health. One method being employed to motivate rural midwife use of the mobile phone health solution was to develop a JAVA-based applet that functions with scroll and select functionality, rather than using traditional text-based SMS, which was criticised as being too cumbersome to operate. Constructive responses to the suggestions and feedback of midwives gave them of the credibility of the initiative, which subsequently encouraged the use of ICT beyond existing class barriers between rural midwives and hospital-based doctors.

X. DISCUSSION AND CONCLUSION

A critical examination of Asian cases reveals that the deployment of ICTs in disaster recovery needs to look beyond the technology, its management and the community involved, and to take into careful consideration the vulnerabilities impacting the social sustainability of development efforts. The study extends the theoretical literature on disaster management and ICT, by addressing a gap in research on the best practices for ICT deployment in disaster recovery. We propose the Technology-Community-Management Vulnerability Assessment model to specifically guide the planning and execution of programs, identifying four key vulnerability dimensions. Contributing to the study on ICTD, the paper illustrates the issues and characteristics of each component of vulnerability, and analyses its relevance to practical real life cases. Thereby the proposed model is relevant to practitioners to aid design of ICT initiatives aimed at bringing about social changes with well-executed recovery operations.

As opposed to proposing a conjectural framework with clearly defined boundaries, the study discusses the inter-relationships of vulnerabilities and ICT characteristics by recognising real world complexities, in terms of barriers to implementation and considerations for long-term program success. The argument leads back to assessing the criteria for sustainable recovery initiatives, where results of the case analyses indicate that physiological and psychological vulnerability, informational vulnerability, economic vulnerability, and socio-cultural vulnerability are not mutually exclusive variables. ICTs focusing on economic livelihood building can impact the psychological well-being of users, while programs to enhance information flow can positively affect the livelihood capacity of communities.

The study provides a holistic understanding of ICT design by looking at the internal process of community, including the needs, ownership, and training, against external impacts of technology and management. In rural communities, educational and technological familiarity constrain the attractiveness, and hence the optimal usage of the ICT solutions. The management of rural initiatives, largely lead by village leadership councils, could lead to criticisms on privileged access to technologies, in turn affecting the socio-cultural balance within society. Furthermore, the emphasis on education in post-disaster societies, often placed on basic primary education, could ignore the needs of adolescents and youth, raising issues of age discrimination to technology access.

The study was restricted to conducting semi-structured interviews, instead of holding focus group discussion to obtain more in-depth information gathering, due to low accessibility to fieldwork data in post-disaster situations. Future research should examine how the TCMV model could expand beyond disaster recovery to apply in general ICTD project design. In the scope of disaster recovery, study can be done targeting specific vulnerability dimensions to examine the implications for technology, management and community in the whole.

There is no doubt that calamities have tremendous negative impact on the rural poor, but the rapid proliferation of ICTs in Asia holds potential to bring about positive recovery to the lives and state of those affected. We believe ICTs have the power to increase the capacities of communities, in turn reducing the vulnerabilities that arise in post-disaster context. With effective design and implementation of ICT programs, rural communities can witness long-term social sustainability of recovery efforts.

REFERENCES

- [1] Department for International Development, 2007. [Online] Available: <http://www.dfid.gov.uk/news/files/disasters-day.asp> [Accessed: Aug. 15, 2008]
- [2] Centre for Research on the Epidemiology of Disasters, *Emergency Events Database*, 2007. [Online] Available <http://www.emdat.be/> [Accessed: Aug. 15, 2008]
- [3] LIRNEasia, "Using ICT for effective disaster management," unpublished.
- [4] D. Stauffacher, and S. Hattotuwa, "ICT for disaster management in least developed countries and small islands in the Asia Pacific region," 2006. [Online] Available: <http://stdev.unctad.org/unsystem/cstd/escap8.doc> [Accessed: Aug. 15, 2008]
- [5] International Telecommunication Union, *ICT Statistics Database*, 2008. [Online] Available: <http://www.itu.int/ITU-D/ICTEYE/Indicators/Indicators.aspx> [Accessed: Aug. 15, 2008]
- [6] Asian Disaster Preparedness Center, "Making MDGs disaster proof United Nations millennium campaign & Asian disaster preparedness center," unpublished.
- [7] A. F. Gorp, "ICT as an enabler for humanitarian relief? An assessment of communication and information flow in inter-organizational context," presented at the 55th Annual Conf. of the Int. Communication Association 2005.
- [8] B. K. Paul, "Disaster relief efforts: an update," in *Progress in development studies*, vol. 6, pp. 211–223, 2006.
- [9] L. Tschoegl, R. Below, and D. G. Sapir, (2006, March). "An analytical review of selected data sets on natural disasters and impacts," *Centre for Research on the Epidemiology of Disaster*. [Online] Available: <http://www.emdat.be/Documents/Publications/TschoeglDataSetsReview.pdf> [Accessed: Aug. 15, 2008]
- [10] United Nations Center for Human Settlements, "Sustainable human settlements in an urbanising world, including issues related to land policies and mitigation of natural disasters," unpublished.
- [11] United Nations Development Program, "Information and Communication Technologies for Development," [Online] Available: <http://www.sdn.undp.org/it4dev/> [Accessed: Aug. 15, 2008]
- [12] International Telecommunication Union, "ICT and telecommunications in the least developed countries," 2007. unpublished.
- [13] N. Gunawardene and F. Noronha, "Communicating Disasters," in *An Asia Pacific Resource Book*. Bangkok: UNDP Regional Centre.
- [14] i4d. (2005, January) Tsunami. [Online] Available: www.i4donline.net/archive/archive.htm [Accessed: Aug. 15, 2008]
- [15] C. Kassianides and E. Lavan, "Using ICT for effective disaster management," unpublished.
- [16] C. Wategama, "ICT in Disaster Management," 2007. [Online] Available: <http://www.apdip.net/apdipenote/16.pdf> [Accessed: Aug. 15, 2008]
- [17] R. Iannella, K. Robinson, O. Pekka, and R. Koski, "Towards a framework for crisis information management systems," unpublished.
- [18] Internet World Statistics, "Usage and population statistics," 2008. [Online] Available: <http://www.internetworldstats.com/asia.htm> [Accessed: Aug. 15, 2008]
- [19] Author and J. Zhao, "Sustainability of ICT interventions: Lessons from rural projects in China and India," in *Communicating for Social Impact: Engaging Communication Theory, Research, and Pedagogy*, L. Harter & M. J. Dutta, Ed. ICA 2008 Conference Theme Book. Hampton Press.
- [20] C. K. Prahalad, *The fortune at the bottom of the pyramid. Eradicating poverty through profits*. Wharton School Publishing, 2005.

- [21] H. E. Hudson, "Universal access to the new information infrastructure," in *The handbook of new media: Social shaping and consequences of ICTs*, L. A. Lievrouw and S. Livingstone, Eds. London: Sage, pp. 369-384.
- [22] United Nations Conference on Trade and Development, *Information and Communication: Technology development indices*. New York: United States, 2003.
- [23] S. Yodmani and D. Hollister, "Disasters and Communication Technology: Perspectives from Asia," presented at the Second Tampere Conf. on Disaster Communications, Tampere, May 28-30, 2001.
- [24] The International Federation of Red Cross and Red Crescent Societies, "World Disasters Report: Focus in information on disaster," p. 2, 2005. [Online] Available: <http://www.ifrc.org/publicat/wdr2005/index.asp> [Accessed: Aug. 15, 2008]
- [25] M. I. Ahmed and E. C. Lentz, "Enhancing the Livelihoods of the Rural Poor: The Role of Information and Communication Technology," 2007. unpublished.
- [26] Bangladesh NGOs Network for Radio and Communication, "Bangladesh meet focuses on empowering poor through ICTs," 2006. [Online] Available: <http://www.bnnrc.net/> [Accessed: Aug. 15, 2008]
- [27] A. Chetley, *Improving health, connecting people: The role of ICTs in the health sector of developing countries*. InfoDev Task Manager: J. Dubow, 2006.
- [28] T. Eisensee and D. Stromberg, "Disaster relief," *The Quarterly Journal of Economics*, vol. 122, no.4, pp.693-728, May 2007.
- [29] O. Takizawa, "Using ICT in Disaster Mitigation," 2004. unpublished.
- [30] A. Hovanesian and A. Cox, "ICT for tsunami recovery: Best practices and lessons learned," 2007. unpublished.
- [31] S. Lee and Author, "Wireless initiatives for connecting rural areas: Developing a framework," in *Participation and media production. Critical reflections on content creation*, N. Carpentier and B. D. Cleen, Ed. ICA 2007 Conference Theme Book. Newcastle, UK: Cambridge Scholars Publishing.
- [32] J.W. Powell, *An Introduction to the Natural History of Disaster*. University of Maryland: Disaster Research Project, 1954.
- [33] R.R. Dynes, *Organized Behavior in Disaster*. Heath, 1970.
- [34] L. Palen and S. B. Liu, "Citizen communications in crisis: Anticipating a future of ICT-supported public participation," 2007. unpublished.
- [35] L. Buzna, L. Issacharoff, K. Peters, V. Rosato, and D. Helbing, "How can future ICT enhance disaster relief and recovery," 2007. unpublished.
- [36] Caribbean Information and Communications Technology Community, "Facilitating Effective Disaster Management in the Caribbean," 2004. unpublished.
- [37] D. Basu, "A compendium of learnings from engagements in Afghanistan, Iraq, Liberia, Iran, Sudan, Guatemala, Indonesia, Sri Lanka, Pakistan, Lebanon," 2006. unpublished.
- [38] U. Sastrokusumo, "ICT for countermeasures and strategies against emergencies and disaster crisis: A suggestion to build Asia-Pacific pilot project," 2006. unpublished.
- [39] L. Palen, S. Vieweg, J. Sutton, S.B. Liu, and A. Hughes, "Crisis informatics: Studying crisis in a networked world," presented at the Third International Conf. on e-Social Science, Michigan, Oct. 7-9, 2007.
- [40] The Caribbean ICT Virtual Community and Guyana DevNet, "Facilitating effective disaster management in the Caribbean," 2004. unpublished.
- [41] B.R. Balachandran and A. Haer, "Corporate involvement in disaster management: A conceptual framework," 2004. unpublished.
- [42] Y. S. Alghtani and S. Al-Zahrani, "A conceptual framework for information network system to exchange information to control accidents in Saudi Arabia," unpublished.
- [43] Associated Programme on Flood Management, "Social aspects and stakeholder involvement in integrated flood management," 2006. unpublished.
- [44] Earthquakes and Megacities Initiative, "Disaster risk reduction in metropolitan regions through the cluster cities project," 2005. unpublished.
- [45] F. Cuny, *Disasters and Development*. Oxford University Press: Oxford, 1983.
- [46] M. Anderson and P. Woodrow, *Rising from the Ashes: Development Strategies at Times of Disaster*. Westview Press: Colorado, 1989.
- [47] A. Kreimer and M. Munasinghe, *Managing Natural Disasters and the Environment*. The World Bank, Washington, D.C., 1991.
- [48] A. Kreimer and M. Zador, *Colloquium on Disasters, Sustainability and Development: A Look at the 90s*. The World Bank: Washington, 1989.

- [49] A. Lavell, "The impact of disasters on development gains: Clarity or controversy Latin American social science faculty and the network for the social study of disaster prevention in Latin America," presented at the International Decade for Natural Disaster Reduction Programme Forum, Geneva, Jul. 5-9, 1999.
- [50] L. Pyles, "Community organizing for post-disaster social development," *International Social Work*, vol. 50, no. 3, pp. 321-333, 2007.
- [51] B. Wisner, B. Wisner, P. M. Blaikie, T. Cannon and I. Davis, *At risk: Natural hazards, people's vulnerability and disasters*. London: Routledge, 2003.
- [52] P. M. Blaikie, T. Cannon, I. Davis, B. Wisner, *At risk: Natural hazards, people's vulnerability and disasters*. London: Routledge, 1994.
- [53] C. Ashley and D. Carney, *Sustainable livelihoods: lessons from early experience*. London: Department for International Development, 1999.
- [54] F. Ellis, *Rural livelihoods and diversity in developing countries*. Oxford University Press: Oxford, 2000.
- [55] Center for Media Studies, *Evaluating ICT-4D project of World Vision India*. World Vision India, 2007.
- [56] J. Zhao, *The Internet and rural development in China: The socio-structural paradigm*. Peter Lang AG: Bern, 2008)
- [57] F. J. Proenza, "ICTA Nanasala Program: Field Visit Report," 2005. unpublished.
- [58] InfoDev, "Enhancing the livelihoods of the rural poor through ICT," 2008. unpublished.
- [59] United Nations Educational, Scientific and Cultural Organization, "UNESCO Develops Community Multimedia Centre for Education in Jayagiri, Bandung, Indonesia," 2008. [Online] Available: <http://www.unesco.or.id/activities/comm/icts/423.php> [Accessed: Aug. 15, 2008]
- [60] T. Newholm, K. Keeling, P. Mcgoldrick, L. Macaulay, and J. Doherty, "The digital divide and the theory of optimal slack," *New Media and Society*, vol. 110, no. 2, pp. 295-319, 2008.