A Conceptual Model of Inclusive Technology for Information Access by the Rural Sector

K. Pitula and T. Radhakrishnan

Department of Computer Science and Software Engineering
Concordia University, Montreal, H3G 1M8
pitul_87@encs.concordia.ca

Abstract. In recent years, a growing number of projects seek to address the disparity in opportunities available to people in rural versus urban areas through *Information and Communication Technologies*. When introducing such technologies, there are a number of recognised barriers to their use and acceptance specific to rural areas. We define an 'inclusive technology' as a technology which overcomes the barriers in using technology that are inherent within a community in order to increase the available opportunities. We propose a conceptual model and a set of heuristic measurements for evaluating the 'inclusiveness' of a technology with respect to a given community, and illustrate our model by applying it to an actual real-world project. With this model we hope to achieve a better understanding of the problem, and develop a systematic process and framework for designing and evaluating technologies designed to overcome these disparities.

Keywords: social inclusion, information and communication technology, inclusive technology.

1 Introduction

There is a significant disparity in the opportunities available to people in rural versus urban areas throughout the world. This disparity in economic, education and health care opportunities, often referred to as the Digital Divide, has produced a "dual economy" with opportunity and wealth concentrated in the urban centres while rural communities languish [11]. New low cost technologies offer possibilities for addressing this disparity. However, experience has shown that simply providing access to technology is insufficient. What is required is access to the literacy that will allow people to make use of technology in order to engage in meaningful and gainful social activities [15]. We consider a technology that supports such use as 'inclusive'.

In this paper, through the use of a 'conceptual model' we investigate the factors involved in making a certain technology 'inclusive' with respect to some community. When determining the inclusiveness of a technology we consider the terms inclusive and exclusive as the end points of a spectrum which characterises to what extent a given community can use a specific technology to achieve its goals. Drawing on theoretical frameworks and empirical results from the fields of sociology and rural community development, we propose a conceptual model specifically to assess the

C. Stephanidis (Ed.): Universal Access in HCI, Part I, HCII 2007, LNCS 4554, pp. 243–252, 2007.

Information and Communication Technologies (ICT), and a set of heuristic measurements for evaluating a technology's 'inclusiveness'. We then illustrate our model by applying it to an actual, real-world project described in the literature.

We have several objectives for proposing such a model. In recent years, projects to provide marginalised communities with access to technology have met with mixed results. We believe that understanding why certain projects succeed while others fail would be useful in developing more suitable technologies and effective programs. Currently, there is no systematic way for characterising such projects. With our model we hope to develop a better understanding of the problem by representing the key concepts, their relationships and attributes; to provide the basis for a theoretical model that can be shared by the research community; and to develop a systematic process and framework for designing and evaluating such technologies.

2 A Conceptual Model of Inclusive Technology

Definition of Inclusive Technology. At a high level of abstraction, "social inclusion" can be defined as the extent to which an individual or community can fully participate in society and control their own destinies. In the information era, the ability to use the appropriate technology plays a critical role in this regard, and there are several recognised barriers to achieving this goal. These barriers consist of (a) access to the physical resources such as devices and infrastructure, (b) to the digital information resources such as software and content, (c) to the human resources which correspond to the skills people need to extract and apply knowledge, and (d) to the social resources which refers to the broader social context in which the technology is applied [15]. However, simply addressing these barriers does not guarantee that a technology will be adopted by its intended users. According to the *Unified Theory of Acceptance and Use of Technology* (UTAUT) model, a technology must be perceived as beneficial, easy to use, and socially endorsed, with an adequate infrastructure in place to support its use [13]. To meet these objectives the technology must be relevant to the needs of the community, it must expand on existing knowledge and skills, and it must be affordable and sustainable. To be part of a sustainable cycle, the benefits that can be derived from using a technology must balance the costs. Such a technology that fits into and is compatible with its environment is considered 'appropriate' [11]. All of these factors must be taken into account for an application of technology to be successful.

Based on the above, we define an 'inclusive technology' as a technology which empowers community members to achieve more full participation in society and control over their lives. Such a technology overcomes the barriers to using technology that are inherent within a community and enables that community and its members to make positive and meaningful changes in their lives that increase the opportunities available to them. What the specific changes are will depend upon a given community's needs and values. Thus the "inclusiveness" of a technology measures to what extent a given community can use a specific technology to achieve goals that it defines for itself.

Conceptual Model. Our conceptual model is based on Maslow's theory whereby needs motivate human behaviour. According to this theory, human needs are organised in a hierarchy, with basic needs having to be satisfied before an individual is ready to act upon the ones above [5]. Needs can be considered a consequence of one's social environment. Based on the literature on rural development, we characterise the rural communities in which we are interested as follows [1], [10]:

- They are remote, making the cost of transportation and communications prohibitive
- The livelihoods of community members are largely based on subsistence activities
- Household incomes are low, at or below the poverty level
- They have limited or no public services and utilities such as schools, health clinics, banks, government services, electricity, phone lines, etc.
- Most community members speak primarily local languages
- Schooling is limited, leading to low reading and writing skills
- Most community members have had limited or no exposure to computer technology

According to our model, the rural environment in which a community is embedded largely shapes that community's socio-economic activity. This in turn largely determines a community's needs. A community is composed of individuals who are connected in one way or the other. Needs motivate an individual to identify goals whose achievement will result in a quantifiable or qualifiable gain, which is the motivating factor for undertaking that activity. Achieving these goals requires both knowledge and action. Acquiring that knowledge and acting upon it, both require a set of skills, resources and tools. We divide these latter into two disjoint subsets: ICT specific and *non* ICT specific. This is depicted in the Entity-Relationship diagram presented in Fig. 1.

Within this model, a sustainable cycle is achieved by selecting goals which result in a balance between social and economic benefits for individuals and the community as a whole. This cycle can be described as follows: 'needs' stimulate the discovery of relevant 'knowledge' which leads to 'actions' resulting in 'benefits'. As the community's situation improves, its 'needs' evolve creating more 'wants' stimulating the discovery of more relevant 'knowledge', and so forth. This process is illustrated in Fig. 2.

The dynamics of the group play a critical role in both goal selection and the sustainability of this cycle over time. Structure-functionalistic system theory provides a dynamic phase model for consolidating and achieving internal stability for such a social group, namely the "forming, storming, norming, and performing" model, with certain preconditions associated with each phase [8]. A full description is beyond the scope of this paper. The need for such a group to emerge from within the local community is among the basic principles for project success identified in [9], along with the need for a trusted 'space and place' where the community can explore the potential benefits and limitations of ICTs.

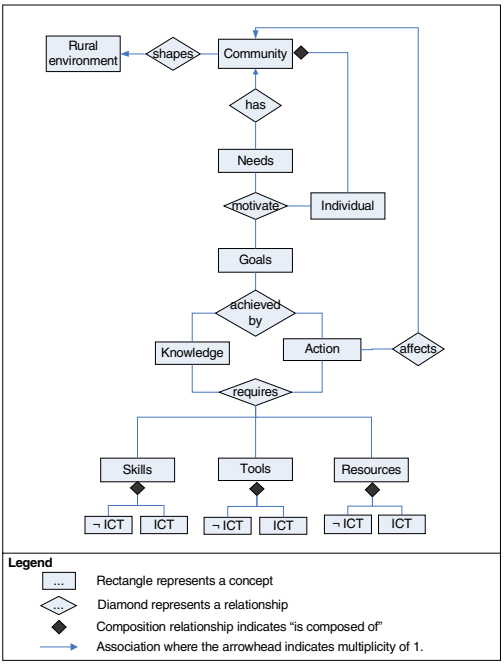

Fig. 1. ER diagram representing a conceptual model of inclusive technology

Our focus is on evaluating the ICT specific skills, resources, and tools to determine to what degree they support a community in developing the skills it needs to achieve its goals and improve its situation. Towards this end we associate certain attributes with each of the nodes in Fig.1 based on our characterisation of the rural environment and the barriers to the use and acceptance of technology described earlier. These are listed in the tables that follow.

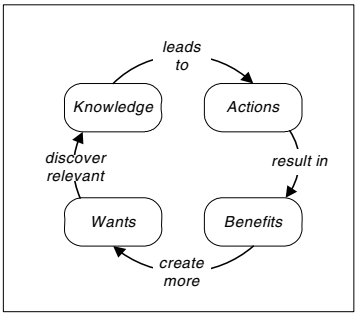

Fig. 2. Sustainable cycle

Table 1. Attributes of the environment and community

Rural environment	**Community**
– population density – transportation and communications – distances to other communities and urban centres – climatic conditions affecting technology	– cost of transportation and communications – availability and cost of electricity, phone lines, high-speed internet connections – current economic and social activities – organisations (political, community, social, non-governmental, private sector) – services (schools, health, banking, government, etc.) – sources of funding
Individual	
– household income – livelihood – reading and writing skills – languages – computer skills	
Need	**Goal**
– determined by the community and the individual	– defined by the community and the individual to fulfill a need

Table 2. Attributes of the ICT tools, resources and skills

ICT tools	**ICT resources**	**ICT skills**
– device – I/O and peripherals – power sources – connectivity – parts, maintenance & upgrades	– content – applications – training – peer support – maintenance and updates – consultation	– operate ICT tools – access and create content – run applications – technical and administrative support

Heuristic Measurements for Evaluating the Inclusiveness of a Technology. We have developed a set of heuristic measurements for evaluating the inclusiveness of a technology with respect to a given community. A detailed description is provided in [7]. Below we list the key questions that we use our model to answer with respect to the ICT tools, resources and skills. For each of the 7 questions, we assign a value of null, low, medium or high, resulting in a vector of 7 elements. We are currently investigating how to combine the vector elements into a single overall measurement, and how to combine the evaluations from multiple experts.

- *Is it feasible within the community's environment?* This measures how practical it is to satisfy or adapt a technology's requirements in terms of tools, resources, and skills to the prevailing conditions and constraints within a given community.
- *Is it affordable to the community?* This measures the cost/benefit of the technology with respect to the community. Here, we only consider those costs for which the

community is responsible, either on an individual basis or as a group, in terms of acquiring, operating, maintaining, using and otherwise benefiting from the technology.

- *Is it usable by the community?* This measures both the standard usability metrics as documented in the literature [12], and physical accessibility with respect to the community. Accessibility looks at whether access is restricted or open to a critical mass of people in the community, including groups that might otherwise be marginalised for political, economic or social reasons.
- *Is it relevant to the community's goals?* This measures how appropriate or significant the technology is to the community, given the community's needs and goals.
- *Is it trustworthy?* This measures the level of trust the community can place in the technology. In other words, it measures if the community can rely on the tools, can trust the resources and can have confidence in the skills.
- *Does it improve the community?* This measures to what extent the technology contributes to a positive and measurable outcome in line with the goals that the community has defined for itself.
- *Does it advance the knowledge available within the community?* This measures to what extent the technology adds to the body of knowledge that will enable the community and its members to act in the future.

3 The K-Net Services Project

K-Net is a community network that provides broadband access to 60 First Nation communities across the provinces of Ontario and Quebec in Canada. Launched in the mid-90's, it has been the subject of many well documented studies and it is considered a new model for delivering telecom services to remote, rural areas [2], [3], [4], [6], [14]. The communities served are remote, small and in sparsely populated areas, with limited or no road access. Although most people speak English, Oji-Cree and Cree are the primary languages. For decades these communities experienced high unemployment, high suicide rates, and low school completion rates. In addition, most communities lacked basic health and school services, obliging members to fly great distances for medical treatment and schooling. In 1994, a council of Northern Chiefs in partnership with the government launched a regional broadband network called K-Net Services with the goal of promoting "economic development, social capital and civic participation". In the words of one of the founders, "if the internet is the information highway of the future, then our youth should be the drivers and not passengers".

K-Net has a decentralised structure. K-Net Services negotiates with the different service providers to provide broadband services to the communities at wholesale prices. In turn each community owns, manages and maintains its own local network, buying services from K-Net according to community priorities, and offering them locally at an affordable price. Each community covers its connection costs by aggregating demand from band offices, schools, constabulary, nursing stations, businesses and subsidised on-line services along with individual use. A "champion"

from the community represents local interests and is locally accountable. Champions are responsible for engaging the community in planning potential ICT projects and facilitating support for projects at all levels in the community, government and with potential partners.

The initial service offering based on extensive consultation in the communities focused on telehealth and high school education. Since then a wide range of training and capacity building programs have been developed and delivered. Current services include video conferencing, telephony, VOIP, web and email services, and e-learning applications as well as internet access for First Nation schools. Telehealth services in local nursing stations remain the most used and generate the most revenue, while VOIP provides 40% savings over standard long distance. There are currently over 38,000 email accounts and 18,000 group and hosting sites, with free registration for First Nations and members of remote communities. In addition to broad band services, K-Net also provides technical training for local network managers and technicians, on-line support and a toll free help desk. It also runs workshops for youth on web page development and content management, and hosts various community and cultural web sites and discussion forums.

4 Applying Our Model to the K-Net Project

The characterisation provided here is based on [4] which summarises an extensive archive of publicly available information on the K-Net project.

Table 3. Attributes of the environment and community

Rural environment
– Sparse population dispersed in small communities across a large geographic area. – Great distances between communities and to urban centres. – Transportation primarily by air with limited or no road access. – Prior to K-Net, communications between communities and with the rest of the world limited to community radio and public satellite television delivered by local cable. – Northern climate characterised by extreme cold in winter, high temperatures in summer.
Community
– Transportation and communications prohibitively expensive. – Electricity provided through local hydro projects or by gas-powered generator is expensive – Prior to KNet, many communities had no or one public telephone, no high speed connectivity; some dial-up connectivity in schools while very remote communities exchanged floppies. – High unemployment rates, with temporary and seasonal employment in government services, forestry and mining, supplemented by traditional economic activities that are given precedence – Communities have a tradition of sharing knowledge, pooling resources and working together – Most communities have a band office, primary school, constabulary, and nursing station. Children must leave their community to pursue higher schooling. For medical treatment and support, patients must fly to larger centres. – Government funding for access to essential services (health, education) and a variety of incentive programs to fund telecommunications access and promote economic development

Table 3. (*Continued*)

Individual	
– low household incomes – temporary and seasonal employment supplemented by traditional activities – limited reading and writing skills in English – primarily Oji-Cree and Cree with some spoken English – prior to the launch of the project little or no exposure to computer technology	
Needs	**Goal**
– health services – education – employment – social capital – civic participation	– telehealth services – high school and other education services – training programs – affordable communication between communities

Table 4. Attributes of the ICT tools, resources and skills

ICT tools
– standard devices, I/O and peripherals flown in from larger centres – powered by locally produced electricity – terrestrial, wireless and satellite connectivity within and between communities, and to external world – parts flown in from larger centres, maintenance & upgrades provided locally by a distributed network of trained community technicians. On-line help and a help desk also available.
ICT resources
– content designed for and by the communities – applications selected by and developed for the communities according to local priorities – training provided by K-Net services supported by government programmes – peer support within the K-Net community, from an emerging cross-Canada aboriginal network, and international network – maintenance and updates provided locally by a distributed network of community technicians – consultation with K-Net services, with other K-Net communities, with academia via a research institute launched by the tribal council
ICT skills
– training programmes to develop skills locally to operate ICT tools, access and create content, run applications, provide technical and administrative support

Answers to key questions. From the information available in the literature, we obtain the following answers to our questions. Based on these answers, we conclude that the technology is highly inclusive.

Feasible. The technology is highly feasible within the community's environment as the equipment and infrastructure are standard technologies, the digital resources are designed for and made available to the communities, and training and workshops are provided.

Affordable. The technology is highly affordable as by pooling resources, aggregating demand, and facilitating contact with funding sources, the services, resources, and training can be provided at an affordable price.

Usable. The technology is highly usable. Training of local management and technicians ensures that the required skills are available locally. Access to the tools is not restricted. Services are designed for and chosen by the communities.

Relevant. Communities select services according to their priorities. Resources are designed based on consultation with the communities and by community members themselves. Training addresses local needs.

Trustworthy. The network and tools are well supported through training programs and assistance. Local management and accountability provide a basis for trust while training provides a basis for confidence in the skills.

Improvement. Communities can select services according to their priorities. The resources and training provided address local community needs.

Advances to knowledge. Communities can select services according to their priorities. Resources are provided with the intent to increase the available knowledge. Training increases the knowledge available to the community.

5 Conclusion

In recent years, a growing number of projects have attempted to address the disparity in opportunities available to people in urban versus under-developed rural areas of the world using ICTs. Some of these projects have been highly successful while others have failed. Although it would be highly useful to apply the experience gained to other projects, the lack of a systematic way for characterising and evaluating these projects makes this difficult. In this paper, we propose a conceptual model that lays out the key factors involved in making a technology inclusive with respect to some community, and a set of heuristic measurements for evaluating that technology's inclusiveness, and we illustrate their use by applying them to a real-world project. By putting forward this model we hope to lay down the foundation for a theoretical framework for designing such applications of technology. With our set of measurements we hope to achieve a systematic way for characterising and evaluating these applications. Our future work includes validating our model and the set of measurements against a larger set of existing projects to ensure that they are complete and minimal, and investigating how this model can be used in the design and development of new projects intended for bridging the Digital Divide.

References

1. Ashley, Caroline, Maxwell, Simon.: Rethinking Rural Development. In: Overseas Development Institute (ODI) briefing paper, reprinted in Current Issues in Rural Development, Swedish University of Agricultural Sciences, (March 2003) (2002)
2. Beaton, B.: The K-Net story: community ICT development work In: The Journal of Community Informatics (2004), 1(1) (2004)

3. Canadian Research Alliance For Community Innovation And Networking, K-Net Case Study Profile. (2005) (Retrieved November 20, 2006), http://www3.fis.utoronto.ca/research/iprp/cracin/research/K-Net%20Case 20study%20Profile_2005.pdf
4. Fiser, A., Clement, A., Walmark, B.: The K-Net Development Process: A Model for First Nations Broadband Community Networks. CRACIN Working Paper No. 2006-12. Toronto: Canadian Research Alliance for Community Innovation and Networking (2006)
5. Huitt, W.: Maslow's hierarchy of needs. Educational Psychology Interactive. Valdosta, GA: Valdosta State University. (2004) (Retrieved from July 24, 2006), http://chiron.valdosta.edu/whuitt/col/regsys/maslow.html
6. Longford, Graham.: Community Networking and Civic Participation in Canada: A Background Paper. CRACIN report prepared for The Department of Canadian Heritage. (2005) (Retrieved from November 20, 2006), http://www3.fis.utoronto.ca/research/iprp/cracin/publications/pdfs/wips/CRACIN_CNCP_webversion.pdf
7. Pitula, Kristina, Radhakrishnan, T.: A set of heuristic measurements for evaluating the inclusiveness of a technology. In: review (2007)
8. Pieper, Michael.: Sociological Issues in HCI Design. In: User Interfaces for All – Concepts, Methods, and Tools. Constantine Stephanidis, Lawrence Erlbaum Associates, Mahwah (2001)
9. Ramirez, R.: A model for rural and remote information and communication technologies: a Canadian exploration. Telecommunications Policy No. 25, 315–330 (2001)
10. Reimer, Bill.: Rural and Urban: Differences and Common Ground. In: Harry, H., Hiller (eds.) Urban Canada: Sociological Perspectives, Oxford University Press, New York (2005)
11. Schumaker, E.F.: Small is Beautiful. Economics as if people mattered ... 25 years later with commentaries, Hartley and Marks (1999)
12. Stone, D., Jarret, C., Woodruffe, M., Minocha, S.: User Interface Design and Evaluation. Interactive Technologies. Morgan Kaufmann, San Francisco (2005)
13. Venkatesh, Viswanath, Morris, Michael, G., Davis, Gordon, B., Davis, Fred, D.: User Acceptance Of Information Technology: Toward A Unified View. MIS Quarterly 27(3), 425–478 (2003)
14. Walmark, B., O'Donnell, S., Beaton, B.: Research on ICT with Aboriginal Communities: Report from RICTA, National Research Council Canada (2005)
15. Warschauer, M.: Technology and Social Inclusion. MIT Press, Cambridge (2003)