Research on Community Networks: What's Old is New Again

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1. Introduction

The importance of access to communications in rural and remote communities has been recognized since the 1970's, when voice telephony was being extended via microwave and the first geostationary satellites to these regions. Criteria for access ranged from a public telephone in every village (Alaska)[1] to a telephone within an hour's walk for developing regions (the ITU's Maitland Commission[2]).

With technological evolution, the definition of "basic service" also evolved from voice service to voice plus limited data, to broadband. Technologies now include smart phones with high speed mobile networks, fiber optics, and a variety of satellites including LEOs, as well as fixed wireless networks. Also, whether by necessity or choice, some communities have built and operated networks themselves, in a variety of community-generated innovations.

During the past 50 years, a key research question has remained "What difference did it make?" How did access to these various technologies and services result in changes in economic activities, access to social services, political engagement and cultural and linguistic preservation? These questions remain important today as governments and development agencies fund expansions or upgrades of broadband infrastructure, and community networks proliferate.

This paper examines lessons from research from early evaluations to the present day, and questions that remain unanswered or minimally addressed. It also identifies factors that could enhance or reduce benefits of Internet access and broadband in previously unserved and underserved communities.

In reviewing both recent research on community broadbandand lessons from earlier research on community networks, this paper is intended to address the retrospective theme of TPRC's 50th anniversary.

2. The Historical Context

Studies on the impact of communication technologies focused almost exclusively on mass media until the 1980s. Early studies of the impact of television date from data collected in the 1950s.[3]In developing regions, researchers evaluated radio projects funded by development

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agencies such as UNESCO and the U.S. Agency for International Development (USAID). As television became available in developing regions, its educational potential was explored and evaluated in early projects in American Samoa, El Salvador, and Senegal, and eventually in many more developing countries.[4]Yet two-way or interactive communications were generally ignored, except by a few pioneering technical scholars such as Colin Cherry, who sought to understand the social and economic impacts of telecommunications in the industrialized world.[5]

During the mid-1970s, studies on interactive applications such as telemedicine and teleconferencing began to appear, many of which were funded as part of technical experiments on new communications satellites. Beginning in the late 1970s, researchers began to analyze the impact, or potential impact, of interactive telecommunications, primarily instigated by funding from the International Telecommunication Union (ITU) and the World Bank. In the following two decades, the diffusion of personal computers coupled with the introduction of online data services and the Internet led to research on their adoption and impact.[6]

The digital divide itself has evolved since the gap in access to telecommunications was first publicized more than four decades ago. In the 1980s, the ITU's Maitland Commission pointed out the gap in access to telephone services between those in developing and industrialized countries.[7] Researchers also documented lack of reliable telephone services in rural areas and low income urban areas of industrialized countries.[8] A decade later, policy makers were calling for a "Global Information Infrastructure" that would link everyone into a worldwide network, or more likely, network of networks.[9] By the turn of the century, world leaders were committing themselves to bridge "digital divides" between the industrialized and developing worlds. Now the quest is for "broadband for all."

3. Key Concepts

In designing current research on community networks, it is important to recognize that key concepts identified in earlier studies, such as from economics and diffusion theory, are still highly relevant today.

The Power of Networking

A property of information networks is that each user's welfare rises with the number of users who have access to the network. A basic principle of connectivity known as Metcalfe's Law (coined by Robert Metcalfe, one of the inventors of the Internet) is that the number of connections and thus the potential value of network increases almost as the square of its users.[10]AT&T recognized its commercial value in the early days of telephony when it expanded networks and charged moderate rates to increase the number of subscribers (while some European PTTs were limiting telephone access by serving only wealthier customers and charging high rates.) Some early email and Internet services ignored this principle when installing "walled gardens", limiting connectivity to their own members. Today, social media and the ability to

reach email users on various platforms enhance the value of connectivity for users of community networks.

Externalities

Information also has unusual properties in that it may be shared without being transferred (when I tell you something, we both know it, whereas when I give you something tangible, you now have it and I do not). Also its benefits may extend to those who have not directly participated in its acquisition, processing or dissemination. Some benefits may accrue to individuals who use the Internet, such as getting information online to solve a problem, and saving time by using online services to arrange transport or to substitute for travel. Other benefits may require more complex types of information-seeking or use by people with institutional affiliations.For example, a patient would benefit if a health worker were able to find out how to treat her rare disease by searching online. Indigenous guides would benefit if an ecotourism lodge can promote its wildlife expeditions online. These indirect benefits known as externalities while apparently obvious, are often overlooked. In doing cost-benefit evaluations of community networks, researchers must look beyond the costs of installation and the revenues from subscribers to the benefits generated for all in the community.

Infomediaries

The concept of the "infomediary" was introduced in the early days of community access when the Internet was primarily available at a community location, e.g. telecenter, community center, library, or school. It refers to a digitally skilled person such as a teacher, librarian, volunteer, or tech savvy teenager. Today, such infomediaries may also help new users with limited formal education or digital experience to navigate online, find the information they need, and avoid spam or fake news.

The Early Adopter

Some people may be more likely to use online services sooner than others, for example, those with more education and those with clearly defined information needs. An artist who wants to stay in her community may generate income from selling her artwork online. A local business can take advantage online resources for payroll and taxes. A handyman may expand his business by finding how-to videos and schematics online.[11]Therefore, it is important to collect demographic information about users, and if possible, collect more than one wave of field data to analyze changes in adoption over time.

Chain of Inference

Policy makers and project funders often look for immediate benefits of connectivity to justify their investments. Access to timely information about prices and markets for local products may generate more income, and students with access to the Internet may be more likely

to qualify for jobs or training for future employment. But much of the impact is likely to take longer and be much more indirect.

It is therefore important to understand the "chain of inference" that is, connections between use of community networks and eventual social or economic benefits. For example, adults earning high school diplomas may result in more local people being employed in the community. Access to videoconferencing for social contact with distant families and for continuing education may result in reduced turnover among outsiders employed in the community. Online meetings and working groups among local governments may result in increased applications for development funding and resulting investments and jobs in the community. This chain of inference must be made explicit to trace any causal connection between provision of the facilities and outcomes that may extend beyond the timeframe of short-term evaluations.

4. Connectivity: Necessary but not Sufficient

Access to the Internet can contribute significantly to community development, but investment in connectivity alone is not likely to be sufficient for benefits to be achieved. Thus community networking may be seen as a complement to other infrastructure such as transportation and electrification. Effectively managed operations may also benefit more from online access. For example, a well-managed organization such as a Tribal government or tourism enterprise will likely derive more benefits from online services than a poorly managed or understaffed operation.

To summarize, access to the Internet and other information technologies is generally a necessary but not sufficient condition for economic development.[12] Other factors may facilitate or hinder the impact of connectivity:

- **Context:** It is important to understand the social, cultural, and economic context. For example, if transportation is infrequent or very expensive, local people may not be able to benefit significantly from online ordering, or from selling their wares online. Unreliable electric power may make it difficult to charge digital devices or to go online.
    - **Content:** Those who speak primarily local or regional languages may not benefit from online content in major languages such as English, French or Spanish. As noted above, "infomediaries" can help to find and interpret useful content, but its true potential will be realized only if content is both relevant and understandable.
- **Capacity:** Effective use of the Internet requires digital literacy– skills in finding information, using popular software, and assessing the quality and veracity of information from various sources.

5. Challenges that could impact Effectiveness

With a renewed emphasis on infrastructure funding, there has been little attention to other factors that could enhance or reduce the benefits of connectivity for previously unserved or underserved communities. Among these are:

- Sustainability
- Engagement
- Digital skills

Sustainability

Perhaps sustainability has received the least attention in evaluation of benefits of connectivity. In the 1970s, experiments and pilot projects were funded by Canada and the U.S., primarily using capacity on experimental and early operational satellites (ATS-1, ATS-3, ATS-6, CTS, and Anik B).[13] Yet even when positive outcomes were found in evaluations, most projects died with the end of experimental funding. In the 1980s and 1990s, international development organizations funded various models of telecenters for community access to the Internet and other digital services. Again, many did not survive.

In some cases, their demise resulted from upgrades in technology, making them obsolete. Commercial telephone service replaced two-way radios. People began to access text and some other services on mobile phones. Yet in other cases, advances in technology did not result in scaling the successful experimental applications. The most common problem was lack of a sustainable business model which typically had not been included in project planning or in evaluation.

As in earlier eras, funders, whether government administrations or development agencies, tend to provide funds only for equipment and installation (Capex). They typically do not provide ongoing operating support (Opex). The U.S. is an exception, with various funds available to subsidize service to high cost and low income customers.[14] However, community networks need to be certified as Eligible Telecommunications Carriers (ETCs), usually by state regulators, and their managers may need help in obtaining certification.

Planning for sustainability generally requires figuring out how to cover costs (in funds and time) of ongoing operations such as charges for connections to a middle mile network and operations and maintenance of the local equipment or network. If connections were initially provided for free would users be willing to pay, or is some other source of funds available? If volunteers had installed and maintained equipment, could these functions be turned into jobs?

Some projects did manage to continue their services after initial pilot funding. Indigenous network Kuh-Ke-Nah Network (KNet) in northern Ontario (Canada) contracted with government education and health agencies to deliver distance education and connectivity for telemedicine. The mayor of Tombouctou (Timbuktu) decided to pay operating costs of a telecenter installed with Canadian funding by mandating a surcharge on plane tickets to and from the town. As some residents began to obtain their own laptops, the telecenter also became an ISP that charged for use. Some other African telecenters offered photocopying and desktop publishing of items such as invitations, notices and posters.

Sustainability remains a problem with some contemporary community networks, which tend to be run by volunteers with other jobs and responsibilities. The result may be delays in trouble-shooting or restoring service. Also, access is often initially free on these networks, making it difficult to then charge community users.

Engagement

Engagement with the community has been emphasized for both community network planning and field research on community networks. An early example involved a participatory approach to installing two-way radios in remote Canadian Indigenous communities, where regional leaders were consulted on identifying priority communities for the pilot project. Also, to participate, communities had to provide a space for the radio, poles for the antennas, and a person to be trained to operate the radios.[15]

The participatory approach to rural communications was more common in media projects such as community radio and early community TV using portable video recorders. In contrast, extension of telecommunications services typically has been done by carriers sending outside technicians to install wiring or satellite terminals.

While engagement has been promoted for installation and evaluation of community Internet services, criteria may be vague or ignored. A community network project in the Asia/Pacific arbitrarily selected villages for satellite terminals matched with others without connectivity, sent in evaluators, and then removed facilities where the service was underutilized. It did not try to engage leaders in site selection or suggestions about where to move equipment to other villages that had expressed interest in participating in the project.[16]

In Canada, the Canadian Radio-television and Telecommunications Commission (CRTC) has required carriers requesting support from its Broadband Fund to consult with communities it intends to serve. Original CRTC guidelines stated that applicants should show that they "attempted to consult" with communities. Such a requirement could be fulfilled by a letter never received or a telephone call never answered. Further, an example of acceptable consultation was

a "market study" that could be done using available information (e.g., population, average income, public institutions, local businesses) without any interaction with the community.[17]

In contrast, the Federal Communications Commission (FCC)now requires a *Tribal Government Engagement Obligation* from carriers receiving subsidies to provide services on Tribal lands (although not elsewhere). These carriers must demonstrate that they have coordinated with the Tribal government and provide a report documenting their compliance. The FCC has determined that, at a minimum, the annual Tribal engagement obligation for ETCs must include (1) needs assessment and deployment planning; (2) feasibility and sustainability planning; (3) marketing services in a culturally sensitive manner; (4) rights-of-way processes, land-use permitting, facilities siting, environmental and cultural preservation and review processes; and (5) compliance with Tribal business and licensing requirements.[18]

However, Indigenous connectivity advocates point out the limitations of this process. According to a subject interviewed by McMahon, although regulations require carriers to meet with Tribes, consultation is typically limited to a letter sent to a generic email box of the Tribal government (which may or may not have access to telecommunications expertise). After 60 days, the carrier can check the box stating that it did consult with Tribes; as one interviewee put it: "Less than one percent [of carriers] are truly doing consultation . . . it's a very small number of people who are actually doing consultation." Another person noted that many Tribal communities are learning that funding for connectivity in their communities has been secured by external providers who may not have engaged with (or even informed) them about their plans.[19] Research is needed to document to what extent required consultations were actually carried out.

Digital Skills

Effective utilization of new services may require a digital literacy strategy to ensure that residents understand how to use online services and to handle issues such as fake content and threats to privacy. For example, McMahon et al. (2018 and 2014) describe training of Indigenous residents to access community networks in Canada's North.[20]

Digital skills can also include installation, operation and maintenance of community networks. Indigenous participants in Canadian regulatory proceedings have urged that commercial recipients of federal broadband funding be required to hire and train local residents to install and maintain their equipment.[21] To date, no such requirements have been imposed.

However, Indigenous networks such as KNet in northern Ontario have trained Indigenous staff at their headquarters and in the communities they serve. Also, the Internet Society (ISOC) has hosted annual Indigenous Connectivity Summits in North America since 2017 that include workshops to train people to install and maintain community networks.[22]

6. Planning Community Network Evaluation

Need for Economic Analysis

Macro level studies on broadband attempt to address economic impacts, but leave many questions unanswered. Bertschek et al. conclude from their review of studies on economic impact of broadband that "…almost all adoption-related broadband studies find positive effects on economic outcomes whereas this finding is clearly less evident in availability-related broadband studies."[23] Without knowing whether and how people used the Internet, we cannot conclude that the usage made a difference – in whether they adopted new farming techniques, or found jobs, or got better prices for their products. And it is unclear in the macro studies whether the relationship between Internet use and income is correlational or causal. Does use of the Internet lead to higher income? Or does higher income enable people to pay for digital devices and online services? Or both?

Costs, Benefits and Sustainability

Evaluation research should include questions and analysis designed to understand what economic benefits may be derived directly or indirectly from use of a community network. Is there evidence of new jobs, economic activities, markets, savings in time or money? Are there intermediate changes such as learning new skills or exploring new techniques learned online that could be inferred to result in economic impact in the future?

Researchers should also look for evidence of Internet usage that could lead to longer-term impact, such as students doing research online for school, adults taking courses online to finish high school or for continuing education, people using online services to look for jobs or information relevant to their work as farmers, trades people, entrepreneurs, and parents, etc.

Also, what can be learned about the demographic profiles of users, including early adopters? Is adoption widespread, or are there barriers such as cost, skills, or cultural norms? Is there evidence that the network can be sustainable such as significant adoption, plans to cover operating expenses, technical training to operate and maintain facilities?

The evaluation should also be designed to identify any barriers that could impede longer-term impacts, for example, lack of funds to continue the project, unaffordable usage charges, new competing providers, lack of local jobs for newly trained workers, etc.

Sector-Specific Research

As Wilbur Schramm[24] pointed out more than 50 years ago, a motivated student can learn from anything – a teacher, a book, a film strip, and so on. Today we can augment that list to

include videos, notes on a computer, interactive games, and group learning online (audio conferencing and videoconferencing). Early distance learning evaluations pointed out that dropout rates were high, and that interactive support such as in person or online tutorials) could result in significantly higher completion rates of correspondence courses. Research on Internet usage and impacts during the COVID pandemic is just beginning to become available. Anecdotal reports in the media suggest that many students fell behind because of lack of motivation, technical problems, distractions at home, poor teachers' skills, or some combination of these. Yet we need a better understanding of how or under what conditions online instruction CAN become effective, to build on earlier research.

Community and rural broadband evaluations to date tend to focus on general residential usage. While dedicated studies of online education during the pandemic are likely to shed more light on effectiveness and results, including questions in residential surveys could also help to increase our understanding. Questions could include whether anyone in the household has studied online, then questions on demographics (age, level of education, etc.), online classes (level, for credit or not, etc.) and whether the course was completed or not, and if not, reasons for dropping out (difficulty, lack of support, technical problems, work or other priorities, etc.) This information would contribute to research both about online education and about potential impacts of community networks.

Concerning telemedicine, we learned in the 1970s that regular voice communication between a health aide in an Alaskan village and a regional doctor could result significant improvement in diagnosis and treatment of village patients, and a shared audio circuit could enable the health aides to learn from these consultations (Hudson and Parker, 1973)[25]. Today, both audio and videoconferencing are used in rural Alaskan health care, and x-rays and other tests can be analysed by distant specialists.

The COVID pandemic accelerated the adoption of telemedicine and telehealth, more than 40 years after these early experiments. The reasons for delay were primarily not technology but institutional barriers. Would insurers pay for telemedicine? What about legal liability? And would health care providers be willing to "see" patients remotely? These issues were pointed out by Maxine Rockoff of the National Center for Health Services Research in 1975 where her analysis of disincentives was discounted by NASA and Canadian technologists who worked on experimental satellite projects.[26]

Community network studies can increase our understanding of online health services by asking residents if they have ever had telehealth consultations (interaction with a health care practitioner from their home), and if so, how recently, and whether they were satisfied, and/or had problems with using telehealth. This research would also contribute to understanding of the

potential benefits of community networks, as well as savings in time and/or money from travel substitution.

7. Conclusion

Since the early days of community networks, we have learned about the benefits of connectivity, but many research questions remain unanswered. Today, in the era of broadband connectivity, we still need to learn more about how and under what conditions use of community networks can contribute to social, economic, and cultural development:

For example:

- Can short term outcomes contribute to long term benefits?
- What do we know about the demographics of users for various applications?
- What do we know about early adopters and laggards, and do profiles of adopters change over time?
- Under what conditions is connectivity necessary but not sufficient to achieve socio-economic benefits?
- What conditions are necessary for community networks to be sustainable?
- How should externalities or indirect benefits be assessed?
- How can community members be involved in planning and evaluation of community networks?
- How can digital skills be incorporated in network implementation – both in user skills and in installation and operation of community networks?

A better understanding of these issues is important not only for researchers but also for policy makers and funders in the broadband era where governments, development agencies, and private industry are investing in infrastructure to extend access to broadband to rural, remote and Indigenous communities.

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