Opportunities for Information and Communication Technology Development in remote Northern Ontario Indigenous communities in spite of COVID-19 physical restrictions

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Abstract
This article describes an opportunity to implement an Information and Communication Technology (ICT) strategy in remote Indigenous communities across Northern Ontario where access to the digital environment currently is very difficult due to the COVID-19 pandemic. Academic research in the digital environment with Indigenous communities has shown that implementation and development of ICT is a need for all communities and a right for each individual. We aim to show how the implementation and development of this ICT could be done by building on existing research on the adoption of digital technology by Indigenous communities. Our research shows that using institutional theory in the context of Indigenous self-determination and in connection with the United Nation's Sustainable Agenda 2030, the enabling of ICT infrastructure can result in positive impacts for Indigenous communities. Our article provides two tangible recommendations, that if implemented can lead Northern Ontario Indigenous communities to sustainable ICT infrastructure development. One recommendation is to leapfrog current hardware infrastructure by leveraging advances in High Altitude Platform Stations (HAPS) that provide digital access where terrestrial digital environments does not. The second recommendation is for Northern Ontario Indigenous communities to leverage the current requirements by educational institutions in Ontario to enhance experiential learning through service and community-based learning through educational partnerships. We believe that through the implementation of these recommendations, the challenges that COVID-19 has brought to physically isolated communities in Northern Ontario can be alleviated.

Introduction

In today's socioeconomic environment and as a result of physical restrictions from the COVID-19 pandemic, Indigenous communities across Canada are facing significant pressure to make their economic and social development more efficient and effective. Almost 250 remote Indigenous communities are scattered across the country dealing with challenges with energy and environmental issues, mostly located in British Columbia, Northern Ontario, Northern Quebec,

Northern Labrador, Yukon, the Northwest Territories, and Nunavut (Arriaga, Nasr & Rutherford, 2017). The inability to connect to Information Communication Technology (ICT) has a direct and significant impact on their economy and quality of life (Doong & Ho, 2012). In addition, the COVID-19 pandemic has heightened the challenges in engaging with the broader Canadian community and between communities when physical restrictions are in place.

Our goal is to present an opportunity to implement ICT by describing how remote Indigenous communities can implement hardware access and an ICT social strategy. This will lead to a tangible recommendation to couple access to ICT with knowledge transfer strategies using the lens of institutional theory. The resulting strategy will complement Canada's achievement of sustainability targets described through the United Nations 2030 Agenda.

The United Nations and its member states agreed unanimously in 2015 to promote 17 Sustainable Development Goals (SDGs) in order to provide sustainability, peace and prosperity for the planet and its citizens by the year 2030. In the context of ICT and Northern Ontario Indigenous communities, SDG #4 promoting quality education and SDG#11 promoting sustainable cities and communities are particularly salient (Sustainable Development Goals, 2019).

Years ago, Indigenous communities in Alaska faced similar challenges in ICT infrastructure. These challenges were addressed through the installation of appropriate hardware infrastructure so that Internet connectivity is now available through most of Alaska. In this paper, Alaska's scenario will be used as a comparison to Northern Ontario's current lack of ICT and infrastructure. According to the Canadian Government's Connectivity Strategy (Government of Canada, 2019), the Canadian Government launched a $305 million *Connecting Canadians* program in 2014 whose scope was to provide high-speed and reliable connection to isolated communities. Despite all these efforts, in 2019, the Government of Canada announced that a significant amount of work is still left to be done (Government of Canada, 2019).

The growth of ICT must be addressed to enhance the development and autonomy of communities. As Oliveira, Oliver and Ramalhinho (2020) state, "the way citizens interact with cities affects overall life quality" (p. 1) and that this interaction is enhanced with digital technology. The implementation and development of ICT in isolated communities would allow the quick exchange of information and necessary data between individuals, organizations and government services using digital technology. Thus, the access to ICT for a community becomes a right to a better life, to a better existence, and self-determination.

In this article, we address two related questions in the context of SDG# 4 (promoting quality education) and SDG# 11 (promoting sustainable communities). What solutions can be implemented to develop and implement an ICT infrastructure in isolated Indigenous communities in Northern Ontario? How should this infrastructure development be leveraged for the communities' benefit and social development?

Literature Review

Theoretical Framework

The socio-political, economic and technological aspects of the surrounding environment influence the response and adaptability of organizations. Institutional theory has been used for more than three decades to understand and study the dynamic of these influences and how organizations in their adapting to change end up looking the same – through the process of isomorphism (DiMaggio & Powell, 1983; 1991). The concept of isomorphism explains that institutional patterns and forms of social structure are connected and become the same through coercive, mimetic, or normative reasons (DiMaggio and Powell, 1983). The relevance of institutional theory in the context of understanding the implementation and development of ICT in the remote areas in Northern Ontario and the consideration of ICT infrastructure as a right, is noteworthy as we looked at the different stages of ICT progress with Indigenous communities in Alaska and those in Northern Ontario.

Indigenous Considerations

On a global basis, the impact of COVID-19 has created social problems for remote communities due to their lack of access to reliable ICT. Mhlanga and Moloi (2020) related the challenges of the pandemic to how education was developed using remote technology in South Africa and perhaps not surprisingly, found investment in ICT helped create pockets of excellence across primary, secondary and tertiary education levels. The link between ICT infrastructure and educational excellence is made which then highlights the question of what happens to remote Indigenous communities who lack access to ICT and are thus are isolated more than normal during a pandemic situation?

According to Government of Canada resources (Statistics Canada, 2017), Ontario has the largest Indigenous population in Canada (24% or over 400,000 people). Moreover, 78 per cent of Indigenous communities identifying as First Nations communities in Ontario are in Northern

Ontario and 1 in 4 of those communities are remote and accessible only by air year-around or by ice road in the winter (Government of Canada, 2019). In an age when knowledge is digitally transmitted, people who live in the remote communities of Northern Ontario, are still very limited in their possibilities to use Internet connections for health services, school classrooms, business or other social services (Science and Economic Development Canada, 2018).

Sustainable Development Goals (SGDs)

The United Nations declared as part of their 2030 Agenda that "no one must be left behind" (Transforming our world: the 2030 Agenda for Sustainable Development, 2019). As noted earlier, SDG #4 defines quality education and SDG #11 defines sustainable cities and communities. These SDGs belong to 'The 2030 Agenda for Sustainable Development' adopted by all United Nations Member States in 2015 (Sustainable Development Goals, 2019). There are 17 SDGs and 169 targets encompassing the three dimensions of sustainable development: economic, social and environmental. The role of the SDGs is to stimulate action in areas of sustainability and social responsibility for humanity and the planet.

SDG #4 is meant to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. This SDG supports the need of accelerated actions at all government levels to facilitate important investments toward the Northern communities of Ontario and Canada. More specifically, target 4.3 proposes that by 2030, equal access to affordable and quality technical, vocational and tertiary education, including university must be ensured for all women and men. Moreover, target 4.5 proposes that by 2030, equal access to all levels of education and vocational training for Indigenous people have to be ensured. In addition, target 4.a presents the idea of building and upgrading education facilities and provide safe, inclusive and effective learning environments for all. The indicator for this goal would be the percentage of schools with access to electricity, the Internet and computers for pedagogical purposes; including implementing ICT (https://unstats.un.org/wiki/display/SDGeHandbook).

SDG #11 is also relevant as it aims to make cities and human settlements inclusive, safe, resilient and sustainable. There is a relationship between all elements of a society, organizations and communities, infrastructure and digital technologies. Target 11.a states that there should be support for positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning (Final list of proposed Sustainable Development Goal indicators, 2015).

Methodology

We performed a scoping review for peer-reviewed research on the challenges of ICT gaps with Indigenous communities using academic databases and Boolean operators followed by manual reviews of the findings. Our scoping review was guided by scoping review methodology described by Arksey and O'Malley (2005). We used the following academic databases: ABI/Inform Global, Google Scholar, and Scholars Portal (a Canadian information database provided through the Ontario Council of University Libraries). Table 1 lists the articles that were identified as relevant to our research.

Table 1. Findings from the Scoping Review		
Authors (year)	**Title**	**Journal**
Friedel, T., Archibald, J., Head, R. B., Martin, G., & Muñoz, M. (2012)	Editorial-Indigenous pedagogies: Resurgence and restoration	*Canadian Journal of Native Education,*
Hudson, H. E., Hanna, V., Hill, A., Parker, K., Sharp, S., Spiers, K., & Wark, K. (2012)	Toward universal broadband in rural Alaska	Institute of Social and Economic Research, University of Alaska
McMahon, R. (2011)	The institutional development of Indigenous broadband infrastructure in Canada and the U.S.: Two paths to "digital self-determination."	*Canadian Journal of Communication*
McMahon, R., O'Donnell, S., Smith, R., Walmark, B., Beaton, B., & Simmonds, J. (2011)	Digital divides and the "First Mile": Framing First Nations broadband development in Canada	*International Indigenous Policy Journal*
Mhlanga, D., & Moloi, T. (2020)	COVID-19 and the digital transformation of education: What are we learning on 4ir in South Africa?	*Education Sciences*

Authors (year)	Title	Journal
Mignone, J., & Henley, H. (2009)	Impact of information and communication technology on social capital in aboriginal communities in Canada	*Journal of Information, Information Technology*
Mignone, J., O'Neil, J., Ross, W., & Brown, J. (2008)	Information and communication technology in aboriginal communities in Canada: Increasing aboriginal social capital	Faculty of Human Ecology, University of Manitoba
O'Donnell, S., Beaton, B., McMahon, R., Hudson, H. E., Williams, D., & Whiteduck, T. (2016, June)	Digital technology adoption in remote and northern Indigenous communities in Canada	University of Calgary
Simon, J., Burton, K., Lockhart, E., & O'Donnell, S. (2014)	Post-secondary distance education in a contemporary colonial context: Experiences of students in a rural First Nation in Canada	*The International Review of Research in Open and Distributed Learning*

Discussion of Findings

We found a significant gap in the literature around access to ICT in remote Indigenous communities in Canada and particularly for Northern Ontario where the need is apparent. Mignone et al. (2008) and Mignone and Henley (2009) describe the impact of ICT on social life of Indigenous communities in Canada and bring a deep understanding of the technological environment of information and communication for Indigenous communities in Canada including Northern Ontario. Mignone et al. (2008) discuss the K-Net Case of Ontario which was brought to life under the stewardship of the Keewaytinook Okimanak (KO) Tribal council located in Northwestern Ontario. The K-Net case is one where a variety of terrestrial and wireless links that effectively connected a number of Indigenous communities to each other and the wider world was still not enough to cover the rest of the remote communities of the Northern Ontario. The article shows that although the K-Net case is a successful story for certain communities, there are still communities with no access to the Internet. Almost half of the Northern Ontario communities only

have a dial-up connection. Mignone et al. (2008) state that the utilization of ICT provides "greater access to essential services such as education, training, and health care and many increased community capacities, ultimately strengthening communities" (p. 33).

Thus, life facilitated by Internet connectivity would support continuing education, higher education, economic development and self-determination and autonomy. O'Donnell et al. (2016) finds that appropriate ICT infrastructure can encourage more companies to do business in the area, increased job opportunities, additional Telehealth stations, culture continuity, non-expensive videoconferences, social services as banking, shopping and socializing and leisure aspects of a community. In this way, the access to the information and communication technology becomes a tool that enables the autonomy and self-determination of communities.

Similarly as the findings by Mignone et al. (2008), the work of O'Donnell and colleagues (2016) highlights the importance of implementation of ICT as this has the potential to bring "transformative change to all communities but particularly to communities in remote and Northern regions" (p.4). In addition, the article identifies factor levels that influence digital adoption. Their recommendation was to develop and support digital capacity in community organizations as one of the main thrusts of policy and programs to increase the adoption of digital technologies (2016). According to the findings by O'Donnell et al. (2016), Indigenous community members have demonstrated their eagerness and ability to use digital technologies when they are affordable, accessible and meet their needs.

As a result, the implementation and development of ICT and its access turns to be a right for every household and community member of the remoted Indigenous communities of Northern Ontario as it offers opportunities to the ones with access. Furthermore, the article affirms that when the local and regional language is supported by communication tools, "the people tend to embrace these technologies, identifying innovative and unique strategies for their adoption" (O'Donnell et al., 2016, p. 29). This is another argument which needs to be considered when the implementation and development of ICT must be evaluated. Due to the remoteness of the communities "telecommunications firms are slow, and in many cases unwilling, to extend their broadband networks to Northern and remote communities without significant government investment" (O'Donnell et al., 2016, p. 30). As a conclusion, the report suggests that significant new investments by government partners need to be done in order to sustain, build, upgrade and

maintain broadband in infrastructure in Northern and remote Indigenous communities of Ontario and across Canada.

McMahon, O'Donnell, Smith, Walmark, and Beaton (2011) focus on the challenges of establishing Internet infrastructure in the 'first' mile and that this challenge has to be addressed for the specific needs of First Nations in Canada. McMahon (2011), recognizes that there are national and institutional differences between these strategies for Indigenous populations in the United States and Canada that requires a certain number of contingencies that are particular to the Indigenous community. However, we believe that it still important to recognize the impact of ICT infrastructure improvements with Indigenous communities outside of Canada.

For example, in comparison to Northern Ontario, the American state of Alaska, a state with a high Indigenous population, also faced a significant infrastructure deficit that acted as an obstacle to economic growth in the region. In the late 1970s, connectivity was limited only to cities or large towns. Communities with 25 permanent residents would only have telephone service primarily by satellite (Hudson et al., 2012). However, in Alaska the government instituted a project that implemented ICT infrastructure to the region. This project, named the TERRA project, required significant hardware investments. Studying the present implications of TERRA project in Alaska, gives us an understanding or a model of how ICT could be implemented and developed in the remote Northern Ontario communities.

Hudson et al. (2012) through their research for the Institute of Social and Economic Research of Alaska Anchorage University, described several impacts and benefits to Alaska after access to ICT was enabled through the TERRA project in 2010. The TERRA project succeeded in extending broadband service to 65 communities on the Southwest part of Alaska using connection to the Internet by 'satellite backhaul'. Also, wireless connections were enabled residences to the local community substation, and from the substation to a satellite. Microwave towers were constructed and according to Hudson et al. (2012), most of the communities now have cellular service.

Resulting from this investment in infrastructure, the Internet is now used for banking and reservation services, online shopping, mobile broadband, the tourism industry, seafood processing industry, and educational institutions. In fact, Alaska is a pioneer in telemedicine with 248 sites connected to the AFHCAN network that links village clinics to regional hospitals, in an efficient, effective, equitable and reachable way through the TERRA – Southwest project. The project was

funded by a combination of grants and loans from the Rural Utilities Services (RVS) and federal funding from the National Telecommunications and information Administration (NTIA). The ICT was enabled through the installation of a combination of optical fiber networks and terrestrial microwave. The scope of the TERRA project is to connect 84 communities over 45,000 people to high-speed broadband by the end of 2017 (Handyside, 2017).

Recommendations

The following recommendations integrate our review of the relevant SDGs, and Indigenous considerations from our findings in the context of institutional isomorphism. As exemplified by the example of ICT development in Alaska and the K-Net case in Northern Ontario, we suggest that establishing an ICT infrastructure will lead to community developments along SDG#4 and SDG#11.

Infrastructure Recommendations

When considering the possible recommendations for the development of ICT infrastructure for remote areas, specific considerations need to be addressed. The criteria for choosing and finding infrastructure recommendations is based on reviewing the examples shown by the Alaskan TERRA project, the Northern Ontario K-Net case and considering costs, accessibility and community involvement. Although satellite connections and traditional cabling (including fiber optic) can be considered, a new technology of using High Altitude Platform Stations (HAPS) could be attractive. We describe two infrastructure choices:

1. Establishing a satellite connection consists on adapting the TERRA project from Alaska to the remote areas in Northern Ontario. A plan of action and past results are available from the details of the TERRA project. The case for Northern Ontario is very similar to the situation that Alaska experienced years ago. Thus, this method consists of having antennas installed which then would connect to an already existing satellite. This method does deliver high and efficient high Internet speed thus make any of the upcoming ICT social strategies possible to implement. Although it is clear that there is significant cost to establishing the ground-based satellites and microwave towers.

2. A new way of providing wireless connection to anyone regardless of their geographical location has been recently developed and is known as HAPS with Google launching Internet Balloons in a program known as 'Project Loon'. These HAPS systems are making

a quick impact on enhancing communication in remote regions worldwide. This technology can be placed anywhere around the world; deserts, oceans, mountains, forests, cities and even the most remote areas. As the HAPS systems constantly remain in the sky, digital waves are being sent over a specific area, thus providing quick, fast, reliable and secure Internet connection. This method launches balloons up to an altitude of 18-25 km where they travel in geosynchronous orbit in order to provide data (Kapri, & Singh, 2016). This option is also very cheap compared to the other possibilities as this requires an investment around 40k per balloon for an operation lifetime of 5 years (Burr, 2017). For example, on July 8, 2020, it was announced that Kenya's remote areas now have 4G LTE reliable connection expanding over 50 000 square kilometres by using 35 balloons. Since only 28% percent of Africa's population has Internet access, this method has proven to be a big opportunity that will help them to close this gap (Feleke, 2020).

ICT Social Strategies

When implementing ICT social strategies in remote and Indigenous areas across Northern Ontario or in any other remote region, a robust infrastructure providing Internet access is needed in order to be able to offer these services. Upon, getting a stable Internet connection, then the development of ICT social strategy can be initiated. An important part of fighting social isolation and building up independence and self-determination is through education (Friedel et al., 2012). Online service-learning is a successful strategy for developing the capacity and knowledge of students, therefore enhancing the student experience and making higher education available to anyone despite their location or background (La Lopa, 2012). The following suggestions address the common goal of the SDGs specifically SDG #4, institutional theory and Indigenous considerations.

1. Since there would already be an existent Internet infrastructure, one recommendation is to provide online education related to ICT infrastructure to the Indigenous communities across remote places in Northern Ontario. This online training can be delivered as online courses, where specific individuals are hired to remotely teach people how to work with ICT. The curriculum would be designed to approach the communities and encourage them to take part in taking control of their own ICT development and use.

2. Another recommendation is to implement a service-learning experience that could blend community students with institutions of higher education. This recommendation consists of

connecting students from the remote communities with students in urban centres to allow learning to happen on both sides, to empower Indigenous students in a learning process that also benefits their community, and to increase awareness of Indigenous conditions with students in urban areas. The students under the remote supervision of a faculty from the educational institution would work with the Indigenous student and their Northern Ontario remote community to apply their studies in an experiential and service-oriented manner. In terms of the students, this would not only be a great experience but also a unique way of learning and understanding the real world instead of just lecture notes (Simon, Burton, Lockhart, & O'Donnell, 2014). The remote communities would benefit from the service learning as they would then be less socially isolated, empowered to develop their community, and take part in increasing the knowledge of their Indigenous traditions among students.

Preferred Recommendations

In order to make an impact and to enhance sustainability, changes in both infrastructure and ICT social strategies must be made.

Our preferred recommendation for the infrastructure is the HAPS Option. 'Project Loon' is a new innovation with long term plans of expanding. It provides reliable, fast and secure Internet worldwide. At the same time, it is a sustainable and economically viable option with long term opportunities for further development as well. This option promotes the most community engagement and control over its ICT infrastructure.

Looking at ICT social strategies, we believe that community expertise about their ICT infrastructure is important along with the opportunity for service learning with and by the Indigenous communities. These strategies will result in greater engagement between urban and rural areas with remote Indigenous communities, enhanced student experiential opportunities, remote area sustainability, educational institution promotion and development, and many other reasons including the prominent one of working around COVID-19 physical restrictions. Also, this recommendation promotes different principles of the service-learning both towards the university students but with the remote community as well. Therefore, with the implementation of the above recommendations, connectivity and sustainability are expected to be help the community.

Limitations

There are a few limitations in this research including the limited available secondary data regarding ICT and Indigenous communities in Northern Ontario. In addition, Indigenous traditions, conditions, and technological accessibility may be different in different global settings. If trying to compare the remote areas from Canada with other regions from different countries a different approach would be needed since culture and main language would not necessarily have similarities.

Three future research areas can be explored: 1) primary research including interviews with these remote communities, so that the feedback of the citizens can be understood and taken under consideration when installing an ICT infrastructure project; 2) a policy paper regarding the suggested alternatives to see how to encourage external investment in ICT infrastructure and community development; 3) research towards developing regulations and standards so that the approach to both ICT infrastructure and community development can be institutionalized and controlled by the Indigenous communities.

Conclusion

In conclusion, the core of this article is about the infrastructure and ICT development in remote Northern Ontario regions. It is based on following two questions as mentioned before: How to develop and implement ICT in isolated communities? Could ICT infrastructure be considered a right?

Regarding the first question, by taking under consideration the preferred recommendations, developing the Internet infrastructure for remote communities in Northern Ontario using HAPS can be implemented. In order to develop ICT social strategies, a service-learning program offered by a post-secondary institution will provide the necessary resources in order to enhance community and individual knowledge mobilization. Institutionally, using the principles of isomorphism, it is possible that Indigenous communities in Northern Ontario embrace not just the examples of the K-Net Case but also the examples of Alaskan remote communities and how they were empowered as a result of their access to ICT.

Considering the question of whether or not ICT could be considered a right and analyzing it with the SDGs and institutional theory, the final conclusion is that the UN declaration that "No one must be left behind" " (Transforming our world: the 2030 Agenda for Sustainable

Development, 2019) should not be ignored. In the context of the SDGs, specifically SDG# 4 and SDG#11, every citizen should have access to quality educational and sustainable cities as well. No matter their geographical location or culture, a person should be able to choose whether he or she would like to be able to use technology towards their own benefit.

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