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RESEARCH ARTICLE

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Towards low-cost community networks in rural communities: The impact of context using the case study of Beitbridge, Zimbabwe

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Abstract

Most rural communities in developing countries such as Zimbabwe are underserved and/or unserved with regard to telecommunication connectivity. Governments in developing countries are also under-resourced to provide adequate digital infrastructure. Thus, community networks are increasingly seen as viable alternatives to bridge the infrastructure gap in Africa. However, new infrastructure interventions in developing countries face many challenges including complex interventions stemming from complex policies inserted into complex sociopolitical environments. The success of community networks in other African countries prompts this investigation into the potential of transferring the community network approach to Zimbabwe. The objective of this article is to frame how context impacts development of digital infrastructure. Zimbabwe's telecommunication regulatory framework is on the verge of countenancing the development of community networks, and for this reason, there is need for research to inform would-be investors, policy makers, and other stakeholders such as academia, NGOs, and communities themselves, on how the sociopolitical and economic environment impact these efforts. This is important because successful deployment of a community network may result in improved community development, eg, in food security, health, and education.

KEYWORDS

community networks, digital infrastructure, information and communication for development (ICT4D), Zimbabwe

1 | INTRODUCTION

Digital infrastructure includes "equipment; the information itself; the applications and software; the network standards and transmission codes facilitating interconnection and interoperation; and the people who create the information, develop applications and services, construct the facilities etc." (Sørensen, 2013: p. 6) and is extremely poor or simply non-existent in most rural communities of developing countries (Rey-Moreno, Blignaut, Tucker, & May, 2016; Thimm, 1993). Studies indicate that providing adequate and quality telecommunication services to rural communities is costly, largely unprofitable because of low service demand, and has limited or no real incentives for large commercial telecommunication service providers (Strover, 1999, 2001). "Thin" telecommunication infrastructure in rural communities creates disadvantages for their inhabitants who are unable to access the benefits of the services and products provided by Information and Communication Technologies (ICT) (Sekyere, Tshitiza, & Hart, 2016). This also applies to fully fledged telecommunication infrastructure that is unaffordable and therefore inaccessible (Rey-Moreno et al., 2016). All of this means the digital divide continues to widen, as do social and economic inequalities (Warschauer, 2004).

The governments of most developing countries are unable to provide rural communities with adequate resources including quality telecommunication infrastructure (Manwa, Mukeredzi, & Manwa, 2016). With private telecommunication service providers also reluctant to develop telecommunication infrastructure in rural communities (Gruber, Hätönen, & Koutroumpis, 2014), there is increasing danger that rural communities will continue to be alienated. Without sufficient and quality telecommunication infrastructure, these people will fail to catch on to the ubiquitous digital economy.

Many studies note these disparities between telecommunication infrastructure in rural and urban communities (Park, 2016; Rey-Moreno, Tucker, Cull, & Blom, 2015). Yet few provide practical solutions to address this "wicked" challenge in complex sociopolitical environments such as Zimbabwe (Takavarasha & Makumbe, 2012). We are all aware of the failure of national governments and commercial telecommunication companies to adequately provide services to the rural communities. This article takes the stance that it is incumbent upon us to look to the community networks (CNs) movement as an alternative to top-down connectivity. Community networks have amassed support and recognition for their potential to bridge the telecommunication infrastructure gaps within both urban and, more importantly for the purposes of this article's argument, rural communities in developing regions (Rey-Moreno & Graaf, 2015; Van Stam & van Oortmerssen, 2010).

Rey-Moreno and Graaf (2015) drew up a map of CN initiatives* across Africa, identifying 37 of these. The skewness of the results is concerning with 67% of the CNs being in South Africa alone. Considering Rey-Moreno and Graaf's findings, the focus of this article is solely on Zimbabwe, in which only one CN initiative currently exists, Murambinda Works! We are alarmed that CNs are not more widely spread because we know that most rural communities in Zimbabwe lack telecommunication connectivity. Notwithstanding this, the government of Zimbabwe (GoZ), through the telecommunication regulator, POTRAZ,† has made a policy move (still in early negotiation stages) towards promoting the development of CNs to bridge the telecommunication gap through a Converged Licensing Framework (CLF), which allows the roll-out of Next Generation Networks such as the low-cost CNs (POTRAZ, 2015).

While the efforts of government to promote rural CNs in Zimbabwe through the CLF are welcomed, the history of the telecommunication sector in Zimbabwe, specifically with respect to licensing, raises concerns when considering the *decade-long battle* between the GoZ and Zimbabwe's current largest telecoms company, Econet (cf Takavarasha & Makumbe, 2012). There are also recurrent conflicts with the second largest operator, Telecel (The Herald, 2015‡). It is evident that Zimbabwe is a complex environment (socially, economically, and politically), and this complexity has the potential to impact the development of the telecommunication infrastructure—especially for bottom-up CNs and inverse infrastructure (Westerveld, 2012). As such, this article aims to depict how the Zimbabwean "context" impacts the establishment of ICT for Development (ICT4D) initiatives, specifically, low-cost CNs including the transferability§ and scalability of successful ICT4D initiatives into Zimbabwe (cf Hayes & Westrup, 2012; Skogseid, Grøtte, & Strand, 2014; Walsham, Robey, & Sahay, 2007; Yeo, Hazis, Zaman, Songan, & Ab Hamid, 2011). With this understanding, the development and transferability of ICT4D initiatives such as local CNs can be accelerated. In theory, the study seeks to expand knowledge on ICT4D by engaging in critical reflexivity. In practice, this study is a "preparatory guide" for the development of low-cost CNs in rural areas such as Beitbridge¶ using the success of *Murambinda Works!* and other CNs in developing regions and with the goal to raise awareness on developments in Zimbabwe, specifically with respect to the impact of "context" on CNs development and Zimbabwe's CLF (cf Nandi et al., 2016).

2 | RELATED RESEARCH

2.1 | Telecommunication infrastructure in rural areas

Most telecommunication networks are deployed by large corporate entities with profit-driven commercial models that preclude investment in rural communities in which costs are high and demand is perceived to be relatively weak (Strover, 1999). Huge investment costs coupled with expansive and/or stringent regulatory requirements for developing a cellular network in most African countries, including Zimbabwe, restrict digital infrastructure development to precious few companies (Heimerl, Hasan, Ali, Parikh, & Brewer, 2015: p. 2). However, while telecommunication networks developments are profit-driven, there are also some investments, eg, government investments, which are undertaken for the "social good" and to promote development in general.# However, the "social-good" model may be unsustainable in the long run considering the capital and operating costs relating to digital infrastructure development and competing pressures from agendas that may be politically more attractive, such as poverty reduction and food security.

*In a personal discussion with Rey-Moreno and Graaf, the authors probed how they defined community networks, and it emerged that CNs on the map include Mesh Networks, Village Telco, and Rural internet cafe.

†Postal and Telecommunication Regulatory Authority of Zimbabwe

‡Stories reported in The Herald Zimbabwe: March 12, 2015; April 16 and 30, 2015 (see here http://www.herald.co.zw/telecel-shut-down/)

§We prefer the term "transferability" over "replicability" because we are concerned with the transfer of models that must change depending on a local context, ie, that are not replicable as much as they are transferable.

¶The first author has established a community information centre, which can be supported by low-cost community networks. Therefore, this note is on the assumption that the CLF is approved and implemented.

#Here, development holds several definitions, but in the present study, telecommunication networks are indicators of development and also enablers of development

The redistributive function of government is charged with the development of rural areas, and often, the government institutions are resource-constrained and allocate very little resources to the development of digital infrastructure. For example, in the strategic plan for Beitbridge[‖] Rural District Council, to improve connectivity, the council had allocated USD$10 000 for this purpose (BBRDC, 2016).** Considering that the costs of establishing a cell tower are huge, this budgeted amount is too little to invest in sufficient digital infrastructure and can only be used to undertake logistics to bring players together. Therefore, with the continuing strain on the Zimbabwean economy, most rural communities will remain unconnected, and progress to connect these communities will remain at a snail's pace.

There is existing evidence to indicate how the presence of digital infrastructure can play a key role in enhancing economic development indirectly. For instance, this can happen through creating social capital (Madon, 2000; May, Dutton, & Munyakazi, 2014; Sawada, 2015), even though accurately measuring this remains a challenge (Tabassum & Yeo, 2015). Digital infrastructure allows communities to gain access to digital products and services, which can enhance economic activities of these communities. For example, access to digital infrastructure and ultimately the Internet can enable communities to engage in online trading, which has the likelihood of expanding the markets for the community products (Gwaka, 2017). Also, with Internet connectivity, communities are more likely to obtain new and relevant market and product information, which they can use in their enterprises. Even though this is the presumed case, it is critical to understand that the mere presence of digital infrastructure, products, and service does not automatically translate to improved economic participation. There is a need for efforts to learn and understand how this works, considering that most those in rural communities are characterised by illiteracy.

Therefore, considering the relative importance of telecommunication infrastructure (Malecki, 2003), there is need to develop infrastructure suitable for the conditions of rural communities. The current models of commercial telecommunication may be inappropriate, from a cost perspective, for example, for communities with households earning less than the international poverty line. Thus, low-cost alternatives are needed in resource-constrained communities. Our emphasis here is on low cost since Heimerl et al. (2015: p. 8) show that it is critical for the networks to also "… not absorb a financial loss on any part of the system."

2.2 | Low-cost community networks

Advances in technological innovations are providing opportunities to develop and deploy low-cost telecommunication networks in both rural and urban communities across the globe (Forlano, Powell, Shaffer, & Lennett, 2011). To date, there are several successes in the deployment of low-cost CNs, which have subsequently been linked to considerable socio-economic benefits within the areas in which they are developed, eg, in rural communities of Spain and Germany (Forlano, Powell, Shaffer, & Lennett, 2011). However, even though low-cost CNs have resulted in socio-economic benefits, care should be taken to construe whether there are other related causations relating to these socio-economic benefits, or if they can be attributed solely to the low-cost CN only, or if it is a combination of factors.

In Southern Africa, there are few low-cost CNs discussed in the literature. Simo-Reigadas et al. (2015) identified several: the Linknet project also called Macha Works! in Macha, Zambia, and then Peebles Valley and Zenzeleni mesh networks in South Africa. In addition to these, there is also Murambinda Works! in Zimbabwe (Rey-Moreno & Graaf, 2015). For this article, Zenzeleni and Murambinda serve as major reference points for transferability of the CNs model, where a community builds, owns, and runs its own network.

The Zenzeleni CN is an initiative led by the University of the Western Cape, and its rural wireless network runs on low-cost mesh potato devices with solar power, enabling communication at very affordable prices (Rey-Moreno et al., 2013). For example, Zenzeleni claims that voice services can be offered at a fraction of incumbent mobile network prices and that data can be offered 30 to 40 times cheaper (Tucker, 2017). Such cost reductions are good news because access to basic services in Mankosi is a challenge to most households with very low incomes. Rey-Moreno (2015) argues that since most people in developing regions live on less than $2 per day, it is important to provide communication at affordable prices. According to Rey-Moreno, a (mesh) CN like Zenzeleni can provide a "localised" fix for a market failure in the telecommunication sector in many countries. On the other hand, Bishi, Bishi, and van Stam (2016) report that Murambinda Works! project, also identified as a CN in Rey-Moreno and Graaf (2015), in collaboration with Macha Works! in Zambia, is a not for-profit operation seeking to make ICTs accessible to the rural communities. Furthermore, the operations are led by the local talent and the priority of the project is on capacity building (Rey-Moreno & Graaf, 2015).

Even though success stories of low-cost CN initiatives like Zenzeleni and Murambinda exist, many countries in Southern Africa have yet to benefit from this technological advancement. While the exact replication of this innovative technology model may be constrained by local conditions, it is worthwhile to consider how different characteristics of developing countries, eg, the economic and sociopolitical ecosystem, may impact on efforts to introduce ICT4D initiatives, including low-cost CNs.

2.3 | ICTD and context

Many ICT4D initiatives fail, and one critical aspect has been the mismatch between technology and context (Heeks, 2002; Mamba & Isabirye, 2015; Toyama, 2015). In many cases, technology designers often do not fully understand the context for which they are designing technologies,

[‖]A small town in Zimbabwe, near the border of South Africa.

**Amounts extracted from the council's budget publicly available on http://www.bbrdc.co.zw/download-category/downloads/ (Accessed December 2016)

ie, they may apply Western/Northern technologies and approaches to Southern/Eastern contexts. Even when human-centred design techniques are used, ICT4D initiatives can still fail, for the same reasons of context mismatch. Considering this, Diniz et al. (2014:16) offered "… an alternative … that users might modify not the technology, but the … context surrounding use." This interesting view has potential limitations as the adaptive capacity (what people can do, see Andrade & Doolin, 2016) of targeted users can be extremely low, eg, there are initiatives that are politicised (including telecommunication sector in Africa), and political systems in African countries are also extremely unjust. Without discrediting the work of Diniz et al, their perspective on the concept of context may lead to never-ending "feedback loops" of "things which need to be fixed apart from technologies." Such challenges therefore warrant the need to more deeply understand how context impacts and/or influences interventions in Zimbabwe like low-cost CN options. To do so, we start by providing relevant cases of Econet and Telecel before exploring low-cost and bottom-up approaches to digital development in Zimbabwe.

2.4 | Econet and Telecel cases

For years, there have been critical issues in the context of Zimbabwe pertaining the regulation of telecommunication services. Takavarasha and Makumbe (2012) provide a detailed description of the "battle" between the government and Econet. The contestation lasted close to 10 years, and eventually, Econet was awarded an operating license—marking a critical milestone in the development of telecommunication services regulation in Zimbabwe. To date, Econet remains the leading network service provider in Zimbabwe, providing mobile services and more, including smallholder farmer insurance options as well as funeral covers. A second service provider, Telecel, was also embattled with the government over license fees for many years. There were even threats of the operating license being revoked. As reported in the state-owned newspaper, The Herald (April 2015),[††] Telecel engaged the GoZ and even legal structures such as the High Court of Zimbabwe to challenge the decisions of the government. There are no licensing concerns for the third telecoms company, NetOne, as it is a parastatal. In all, based on the 2 cases provided above, it can be argued that telecommunication and licensing is much more than a legal challenge in Zimbabwe. Changes to the policies and frameworks have only been recent, eg, 3G and Voice over Internet Protocol initiatives were only ushered in 2009, as part of license framework adjustment. Even still, the licensing framework remains stifled, and as such, considering worldwide technological advances, Zimbabwe POTRAZ is considering a Converged Licensing Framework to enhance neutrality in licensing; this can create opportunities for new entrants to complement the services of the 3 existing telecoms firms (Eng Sirewu, acting director POTRAZ, cited in The Herald, April 2015).

Telecel Zimbabwe is the second largest of the 3 leading operators in Zimbabwe. The company has also faced challenges with licensing of its operations in Zimbabwe (Atwood, 2016), the key issue being related to shareholding. The 60% foreign-owned shareholding was deemed to be against the regulation promoting at least 51% local shareholding (Herald, 2015). Even though the issue of local ownership is central, Balancing Act (nd) provides a critical perspective on the Telecel case and indicated that the issue of Telecel shareholding was due to specific individuals wanting to take a stake or control in the Telecel Company. This notion is further supported in case study of Econet of Takavarasha and Makumbe (2012) when they indicate that the regulation also had "economic interests" of specific individuals.

An extract from the Telecel official Web page read,

> *Telecel Zimbabwe has been notified by the Postal and Telecommunications Regulatory Authority of Zimbabwe (POTRAZ) of the cancellation of its license to provide national cellular telecommunications services. This measure is unfair and unwarranted. Telecel has made every effort to comply with all legal and governmental requirements in Zimbabwe, and objects to this treatment in the strongest terms. Telecel and its global shareholders are taking immediate action both locally and internationally to challenge this decision. Telecel would like to assure its customers and stakeholders that it will take all possible steps to maintain the full range of its services throughout this process. We thank all our valued customers and partners for their on-going support. Your welfare is of the utmost importance and priority to us and we will continue to act in the interests of Zimbabwe and its people." (Telecel, 2015: online)*

3 | THEORETICAL FRAMEWORK

In a review of ICT4D studies, Walsham (2017) selected the Institutional Theory as one of the theories that can be applied to ICT4D research. He clarified that the Institutional Theory has been criticised by many researchers who query its relevance to the ICT4D field. However, Walsham remains convinced that the Institutional Theory can be applied to the ICT4D field specifically to address the often-overlooked critical dimensions such as power dynamics, politics, and social structures of communities in which ICTs are introduced.

The elements of this approach suggest how the establishment of CNs is regulated by institutions, and the relations (power dynamics) between these institutions can impact the process. Institutions and rules enacted by these institutions, some invisible, set conditions for action as Amenta and Ramsey (2010: p. 17) clarify that, "Institutions can be constraining, superimposing conditions of possibility for mobilization, access, and influence. Institutions limit some form of action and facilitate others." Therefore, in the context of this study, the Institutional Theory is applied to explore power dynamics of institutions (government, regulatory authorities social institutions, and telecommunication companies) and how these

[††]http://www.herald.co.zw/telecel-engages-potraz-over-compliance/

can impact the transferability of low-cost CNs. Existing studies (Takavarasha & Makumbe, 2012) show that in the set-up of Econet, institutions demonstrated influence over policies thus, could challenge Econet's application for the license. However, the granting of the license also suggested legal institutions' influence over historical institutes such as ZANU PF (which challenged Econet). Therefore, this study explores the constructs of the institutional theory in the research methodology section (which follows this section), study findings, and discussion section.

4 | METHODOLOGY

4.1 | Data collection

This study borrows the research methodology from related studies, and in line with Takavarasha and Makumbe (2012), the study adopts an interpretivist approach of a critical strand. The research areas being explored in this study (ICT, development) are *politically sensitive* issues in Zimbabwe and require caution when studying them (Takavarasha & Makumbe, 2012). To this end, the research relied on both primary and secondary data sources. Secondary data sources included policy documents (review), published documents including newspaper articles and academic journals. Primary data for the study were collected through official correspondence (eg, over 8 emails between May 2016 and November 2017) with key informants in relevant institutions such as POTRAZ to enquire about the possibilities of establishing local CNS. The official correspondence also allowed the researchers to develop insights on the current state as well future plans relating to CNs. Additional primary data were also collected between 2015 and 2017 using continuous expert discussions with experts in the CNs initiatives, ie, one expert involved in Zenzeleni Networks and another expert involved in both Macha Works! and Murambinda Works! The expert discussions enabled the researchers to develop a deeper understanding of the complexities that are encountered in the process of setting up and operating rural CNs in rural communities. Also, as part of this study, the lead author attended a 1-day training workshop on the setting up of a village telco (provided by the expert leading the Zenzeleni Network) to understand the technical complexities involved.

To ground this study in the local context, additional data for the study were obtained from ethnographic exercises conducted in the 4 villages of Ward 15 between November 2015 and December 2017 in Beitbridge. Community members were engaged through community workshops in which community challenges were discussed. The workshops were open to all community households, and 2 workshops (with villages combined) were held in the study area. From the workshops, research participants indicating knowledge and interests in the subject matter were selected for the focus group discussions. Four focus group discussions (one in each village with average of 11 participants) were conducted.

In selecting the research participants, the study adopted the purposive sampling approach, which potentially presents a limitation of this study due to possible bias. The selected villages provided a unique case in that they use both Zimbabwean and South African networks. Also, the selected respondents (for issues on CNs, mainly legal) were selected based on their affiliations with specific institutions. All data collection techniques and processes were cleared by an institutional review board, including approval of interview and discussion instruments, including but not limited to informed consent and data protection measures. Participation in the research was voluntary and mostly those with interests in digital technologies participated.

4.2 | Data analysis

The data collected for the study were predominantly qualitative. Data sets obtained from the interviews and focus group discussions (field notes) were translated and transcribed in an iterative process of audio listening and note development. The process of developing themes involved initialisation (listening and recording research participants' accounts), grouping ideas, combining related ideas, and developing key themes. The process was repeated twice to ensure accuracy. Also, from the community-generated notes and drawings, image (diagram) analysis was also done and compared with discussions. From the analysis, 3 key issues, addressed in the results section, emerged, and these are mobile network coverage, cost, and government efforts on improving these.

5 | RESEARCH FINDINGS

5.1 | Mobile network coverage

The location of Beitbridge, at the border of South Africa and Zimbabwe—Figure 1—provided an ideal area for this study. The Beitbridge community (Zimbabwean side), like many rural communities, has extremely poor radio and mobile telecommunication network reception.

From the community engagement activities, it emerged that households within the community rely much more on the South African networks, eg, MTN, Vodacom, and Cell C than the Zimbabwean NetOne, Econet, and Telecel. Community members were requested to perform resource mapping, ie, identifying "resources" within the community including those relating to telecommunication and general infrastructure. As depicted in Figure 2, the study area does not have dedicated network base stations within its boundaries and relies on network base stations located outside the community. The closest network base station (marked in red) is located approximately 15 km away from Ward 15 at Lutumba business centre. This distance-based isolation from modern mobile telecommunications infrastructure is quite common among rural communities across Zimbabwe.

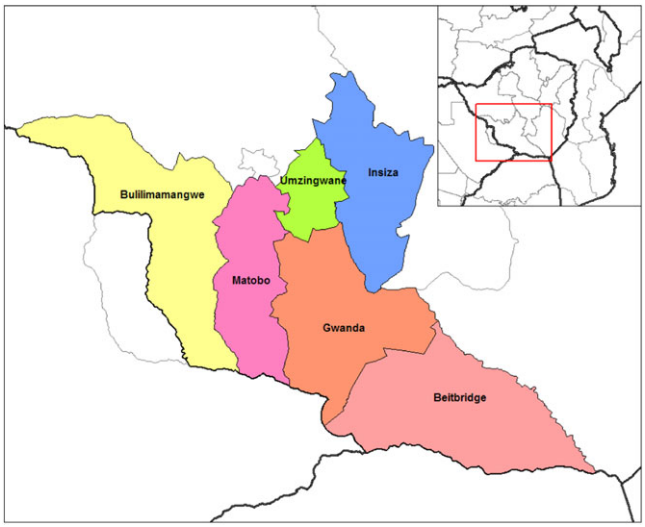


FIGURE 1 Map of Zimbabwe and the study area

FIGURE 2 Community mapping of digital infrastructure

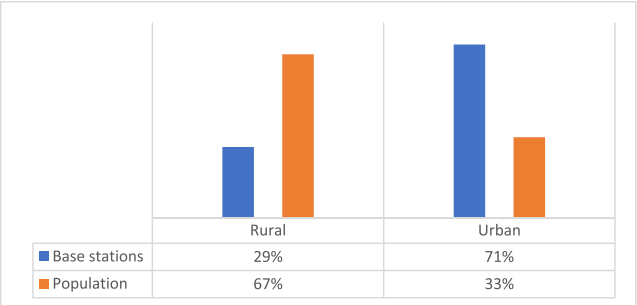


FIGURE 3 Comparison of population and base stations between rural and urban communities in Zimbabwe (Source: POTRAZ, 2015)

POTRAZ reports, as indicated in Figure 3, show that despite the rural population being 67%, this population is serviced by only 29% of the country's base stations. Inversely, the 33% located in urban areas has access to 71% of the country's base stations, and this contributes to the poor connectivity (network coverage) within rural communities.

Furthermore, most of the network base stations in rural communities only support second generation (2G) mobile GSM networks, and yet urban communities, even in Zimbabwe, are already accessing fourth generation (4G) networks, eg, LTE, with discussions about fifth generation (5G) networks underway (Hardman & Steinberger-Wilckens, 2014). It is further disconcerting that poor network coverage in Beitbridge Ward 15 also extends to radio connectivity. The lack of local connectivity has resulted in the community also relying on foreign radio stations. "Pirate

radios" as they are best known, can access foreign radio stations, eg, Voice of America—Studio 7—and avert broadcasting restrictions in Zimbabwe. Curiously, pirate radio is accessed via advanced technologies (Mabweazara, 2013).

For those community members with network coverage, it is also critical to examine the quality and cost of coverage (cf Gibson & Olivia, 2010). Because of the need to provide "cheaper" options to the rural communities, most digital service platforms are based on SMS and the use of feature phones (Karippacheril, Nikayin, De Reuver, & Bouwman, 2013). Even though this is the case, some studies, eg, Whitacre, Strover, and Gallardo (2015), are much more focused on Internet disparity between rural and urban communities. The issue of broadband is recent in most developing countries and remains almost unavailable to rural communities. For example, in Zimbabwe, broadband and Voice over Internet Protocol date back only to 2009 (POTRAZ, 2015).

Because of the above and considering the needs of the community, low-cost CNs provide a viable alternative to the problem of communication in areas such as Ward 15. The success of low-cost CNs in Southern Africa's rural communities (Rey-Moreno et al., 2016; Van Stam & van Oortmerssen, 2010) provides a motivation for the deployment of similar infrastructure in Zimbabwe. In all, if Zimbabwe, rural communities specifically, is to benefit from the emerging digital innovations, there is an urgent need to address the infrastructure "gap" and have the appropriate infrastructure in place, and low-cost rural networks provide a potential solution. It would appear, then, that low-cost CNs can therefore prove to be critical and appropriate digital infrastructure for unconnected rural communities in developing countries.

The narration presented in this section reflect some constructs of the institutional theory in various ways. Firstly, the lack of network coverage in rural communities (compared with urban communities) reflects the nature and/or influence of institutions located within a specific context, in this study, rural communities. For instance, telecommunication companies perceive various institutions located in urban communities as the prime consumers with major influence on the business of the telecommunication companies and as such make efforts to deliver the service. The institutions in urban communities also exert pressure on telecommunication companies and government to deliver quality services; thus, government and the private sector are able to deliver in urban communities than rural communities. Conversely, institutions within rural communities have limited influence and therefore are deprived of the connectivity among many other necessities.

5.2 | Telecommunication service cost

Telecommunication services and products are central to the development process of rural communities, and yet, for many rural households who have some form of connectivity, no matter how weak, the relative costs of that connectivity prohibit them from accessing and using these services and products. Rey-Moreno (2015) and Rey-Moreno et al. (2016) found that households are using up to 22% of their income to recharge airtime. This is due to resellers adding markup to rural customers who cannot afford to go to the nearest city to top-up airtime at normal rates, eg, pay 8 ZAR for a 5 ZAR top-up (Tucker, 2017). This egregious situation is just as disturbing in Beitbridge ward 15 where resellers sell South African airtime vouchers at an excessive profit, eg, to buy airtime voucher for USD $1 (approximately 14 ZAR), one must pay ZAR 22.

Incredibly, the need to communicate pressures rural households to allocate an excessive percentage of income to purchase recharge vouchers (for voice, data, and SMS) and presents a sizeable market for innovations (Kuriyan, Nafus, & Mainwaring, 2012). For instance, during the research period, households were selling unshelled baobab fruits harvest at $0.12/kg; thus, for a sack, they received approximately $3. On average, an individual sold 5 sacks and thus obtained just below $20. Of this, an individual would buy a recharge voucher of $1, representing 5% of income. The top-up would allow one to make a call for less than 4 minutes or buy a WhatsApp bundle for a week. The current pricing models for most telecommunication service providers are considered expensive by most community members in rural communities as one respondent indicated that,

> *Mobile phones are helpful to my family in many ways. They have improved communication and sending or receiving money (through mobile money services) but the main concern is that our expenditure on airtime is high. However, we use different techniques to ensure we get the most from our recharge e.g. calling at night when rates are cheaper or only calling when there is need, otherwise, we can use WhatsApp to send text or record voice message."*

As reflected above, trends in telecommunication indicate that there is an increase in the use of over-the-top (OTT) services such as WhatsApp. The general cost of these services is significantly lower than normal services. For instance, in Zimbabwe, total revenue for telcos dropped by at least 12% because of OTT (POTRAZ, 2015). Even though OTT services are cheaper, most elderly individuals in rural communities still prefer traditional texting and calling. Most OTT services are delivered in the form of apps that require smartphones, which many in rural communities cannot afford. Further to the above, OTT services require broadband connectivity. In Zimbabwe, like most developing countries, the prices for data bundles are extremely high (Gambanga, 2016). As many Zimbabwean took to the social media to voice out their frustrations against the government, there was a notable increase in the costs of data bundles in Zimbabwe, and some data promotions by network service providers were scrapped. Also, there were sudden increases in data prices reaching up to USD $50 for only 2GB (Shezi, 2016). Therefore, from an institutional theory perspective, achieving low-cost communication, eg, through OTT service, is technically possible, but institutional power dynamics (eg, between Internet service providers and OTT service providers) complicate the process. However, government can also enforce regulations on the pricing of data to ensure usability of OTT services, but all these processes require striking a balance on institutional needs.

6 | GOVERNMENT EFFORTS ON LOW-COST COMMUNITY NETWORKS

The development of critical infrastructure such as telecommunication services is normally a decision that requires the approval of regulatory authorities (Rey-Moreno et al., 2015). In the case of Zimbabwe and like many other countries, the development of telecommunication services requires an individual or organisation to obtain a license to build and operate such infrastructure. In Zimbabwe, POTRAZ is the responsible organisation regulating the licensing of telecommunication services. Because of the complex sociopolitical environment in Zimbabwe, the telecommunication industry is viewed by many as "hostile," "politically driven," and "prohibitive" to new entrants as well as being equally challenging to the existing operators (cf Takavarasha & Makumbe, 2012). Specifically, the experiences of the 2 non-parastatal players in the telecommunication industry over the years are a testament to this. Econet faced a hostile challenge in acquiring the initial operating license—and the matter was only resolved in the high courts of the country. On the other hand, Telecel also faced challenges with regard to licensing.

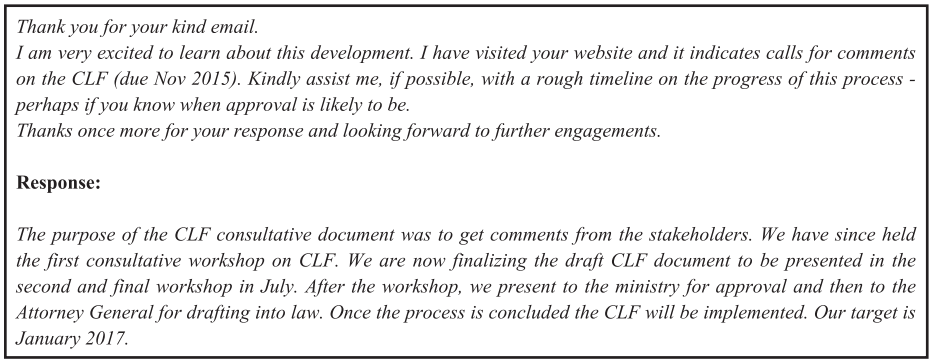
Zimbabwe has a considerable population, which remains unconnected. This is not unique to Zimbabwe considering that other studies even acknowledge connectivity gaps even in some developed countries, eg, Philip, Townsend, Roberts, and Beel (2015) provide a detailed indication of unconnected populations in developed countries. However, in other countries such as South Africa, regulatory frameworks have been developed to accommodate newer technologies on which various projects on telecommunication services are rolled out. Critical to this study is the regulatory framework promoting low-cost telecommunication service in rural communities. Following many other success stories on low-cost CNs, POTRAZ is in the process of amending the regulations, which will enable it to issue licenses for CNs development (see email correspondence, Figure 4). Considering the extensive studies indicating the hostility of Zimbabwean sociopolitical environmental towards telecommunication development, it is essential to acknowledge efforts in the right direction but also maintain "skepticism" due to the recent revocation of the community radio licenses.

The CLF alluded to suggests various classes of licenses, but the relevant class for CNs described in the CLF is presented in Table 2.

The national efforts to improve digital infrastructure are also being translated at provincial and district levels. During an interview with the Acting Chief Executive Officer of Beitbridge Rural District Council, BBRDC, it emerged that,

> *… BBRDC is aware of the importance of ICTs and has therefore developed a strategy to use ICTs in their work. To date, the council is connected to the internet and it is waiting for the rest of the stakeholders to be online and to conduct transactions online. However, infrastructural development is a key challenge. (Acting CEO of BBRDC, 2016)*

Further to these sentiments, the council has embedded within its strategic plan the concerns of connectivity and/or digital infrastructure. The local authorities are making efforts to improve "coverage" and/or "connectivity" of the individuals within the rural communities of Beitbridge. To this end, the council's strategic objective 7.4.5 reads, "Increase coverage of cellular phone network and utilization of modern state-of-the-art communication devices by 2015" (Beitbridge RDC, 2011).



Thank you for your kind email.
I am very excited to learn about this development. I have visited your website and it indicates calls for comments on the CLF (due Nov 2015). Kindly assist me, if possible, with a rough timeline on the progress of this process - perhaps if you know when approval is likely to be.
Thanks once more for your response and looking forward to further engagements.

Response:

The purpose of the CLF consultative document was to get comments from the stakeholders. We have since held the first consultative workshop on CLF. We are now finalizing the draft CLF document to be presented in the second and final workshop in July. After the workshop, we present to the ministry for approval and then to the Attorney General for drafting into law. Once the process is concluded the CLF will be implemented. Our target is January 2017.

FIGURE 4 Email correspondence with a POTRAZ official

TABLE 2 Category B license in the proposed CLF of Zimbabwe

Characteristic: Proposed Class/Category	Category B
Jurisdiction	National, local (provinces; municipalities, districts, wards, villages etc)
Services	Allows the provision of end-user telecommunication services including value added services such as virtual network operation (mobile, broadband, etc), value added service provision (eg, SMS aggregation, SMS gateway operation, pay phone services, Internet telephone (VoIP), messaging services, tracking services, etc
Application fees	USD250/5 years
Operating fees	2% of Adjusted annual gross turnover

Source: POTRAZ (2015).

7 | DISCUSSION: TOWARDS LOW-COST COMMUNITY NETWORKS IN RURAL COMMUNITIES

There is no doubt that most rural communities in developing countries including Zimbabwe remain unserved and/or underserved in relation to digital infrastructure. Without being overly techno-deterministic (see Toyama, 2015), the successes of digital initiatives such as M-PESA in Kenya are quite encouraging and provide a glimpse of the potential of digital technologies to improve societal well-being when appropriated correctly by end users in developing regions. However, there is unfortunately a plethora of examples for unintended, and even negative, consequences of technology appropriation (Heeks, 2002; Toyama, 2015). The optimism on the potential of technologies has led most governments, Zimbabwean government included, to move towards policy and regulation reforms to create an enabling environment for technology appropriation (Heimerl et al., 2015: p. 16). Thus, states as institutions are also realising the need to conform to international trends.

Mills (2012) addresses many key issues affecting the development of African countries. One key theme central to Mills' discussion revolves around the fact that African leaders are consistently making poor policy choices leading to extensive poverty across the continent. Referring to African leaders' approaches to policy choices, Mills (2012) argues that "… they do not make such choices because they lack examples of successful development to observe … but these are seldom adopted and applied." These sentiments are evident in several developing countries. Governments have developed several attractive and feasible blueprints, white papers, and working documents on development that are seldom applied. Regarding digital infrastructure in Zimbabwe, the recent decision to suspend licensing of community radios is a testament to Mills' observations. Because of this and of historical events, questions therefore arise that, even though the government, through POTRAZ, has decided to undertake a critical framework, the CLF, what opportunities and efforts are there to appropriate to ensure that the CLF becomes a success. However, for this study, the main consideration was the potential of transferring models such as the Murambinda Works! and Zenzeleni CN, which has been established in rural areas like Beitbridge.

In addition to the proposed licensing framework changes, one key opportunity available to ensure the success of the CNs is the proposed infrastructure sharing initiative. In the draft document developed by POTRAZ, it is argued that infrastructure sharing has massive benefits to the various network service providers. In support of this initiative, Simo-Reigadas et al. (2015) further indicate that sharing infrastructure of rural CNs with and between operators has potential benefits including but not limited to the generation of revenue, which can be used to maintain the system. Even though this may be the case, the development of infrastructure is a commercial exercise, which is designed to bring in business and profits (or return on investment) to the operators. As such, Simo-Reigadas et al. (2015) call for an analysis of the economic appeal of community networks to operators. In Zimbabwe, Econet, the leading service provider, has been rejecting infrastructure sharing citing huge investments it had made on infrastructure from which other competitors could profit from without making investments.

Furthermore, there are also initiatives by governments to improve access to ICT. The Zimbabwean government has embarked on initiatives to provide computer equipment to institutions such as schools and clinics. Also, there are community information centres that are being developed under the initiative to promote Science, Technology, Engineering, and Mathematics (STEM). Apart from the initiatives by government, there is considerable growth in demand for digital services and products rural population. The declining cost of technological artefacts such as mobile phones is further promoting adoption and use of digital service and products.

In the preceding sections of this article and in other studies (eg, Takavarasha & Makumbe, 2012), it has been argued that politics affect ICT4D initiatives in Zimbabwe. However, in November 2017, Zimbabwe's political landscape transformed with the resignation of former president Robert Mugabe. During his reign, the political autocracy within Zimbabwe created a hostile environment for telecommunication operators. However, there is now a transition in government although it remains to be seen how this impacts the telecommunications industry. It is the study's submission that the changing political landscape in Zimbabwe can redefine the existing practices, eg, the new government has issued official calls for external investors in different sectors including telecommunication.

With all these opportunities, the authors of this study have also started practical work to develop a community information centre in the study area. The centre will provide training on and access to ICTs. Following this stage, a community committee spearheading the CN will be established and engagements with appropriate authorities (regulatory institutions) will continue. In all this, further lessons will emerge from the models that inspired this work, which are Zenzeleni networks and Murambinda Works!

8 | CONCLUSION

The findings of this study indicate that the Zimbabwean complex sociopolitical environment has significantly contributed to the poor state ICTs, including infrastructure development in rural communities (Takavarasha & Makumbe, 2012). Using the institutional lens, the study found that the regulatory authority, POTRAZ, has been at odds with many institutions (including key players) such as Econet and Telecel over licensing. Takavarasha and Makumbe (2012) had their own conclusions, which pointed at the polarity between politics and development (influence over policy) as a key issue over licensing. Also, in both cases of Econet and Telecel, there have been issues of economic interest by "influential people" considering that Telecoms are very brisk business ventures (cf Mills, 2012). However, this needs to be further ascertained in the case of low-cost CNs. The reason for this, as indicated in Rey-Moreno et al. (2015), is that, CNs often struggle to even sustain themselves and are rather done for development purposes more than economic returns.

The contradiction between intention and reality in Zimbabwe is worrying. Even if the intention is there to improve the digital infrastructure (see, for example, the strategic planning documents such as the CLF document), the issue of who gets the approval or is better positioned to build and operate CNs or related infrastructure (cf Wong, Luo, Zhang, & Rozelle, 2013), under what circumstances/conditions and in what ways decisions are made, is a major concern and often unclear. Drawing major lessons from the recent call to suspend community radio licensing, it is evident that even when frameworks are in place, an indicator of intention, the reality often tells a different story (Radioworld, 2016).

This research study draws critical conclusions that can be applied to practice and theory. In practice, there is potential and need for low-cost CNs in communities such as Beitbridge. These CNs can also be achieved through the CLF. However, the study has also revealed that the development of low-cost CNs is not purely technical but also relies on institutional dynamics that need to be understood. The challenge therefore is to comprehend the institutional dynamics that can potentially impact the development of CNs. In doing so, critical perspectives need to be applied to consider, mutation of institutions, invisibility of institutions among many complexities of institutions.

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REFERENCES

Amenta, E., & Ramsey, K. M. (2010). Institutional theory. In *Handbook of politics* (pp. 15-39). Springer, New York, NY.

Andrade, A. D., & Doolin, B. (2016). Information and communication technology and the social inclusion of refugees. *MIS Quarterly*, *40*(2), 405–416.

Atwood, A. (2016). Zimbabwe's unstable infrastructure. Retrieved September 21, 2016 from http://spheres-journal.org/zimbabwes-unstable-infrastructure/

Beitbridge Rural District Council (BBRDC) (2016). *Beitbridge Rural District Council budget* 2016. Retrieved December 08, 2016 from http://www.bbrdc.co.zw/downloads/downloads/

Bishi, J., Bishi, S., & van Stam, G. (2016, August). ICT Training in rural Zimbabwe: The case of Murambinda Works. In *1st Institute of Lifelong Learning and Development Studies International Research Conference*, *Chinhoyi University of Technology* (pp. 2–5).

Diniz, E. H., Bailey, D. E., & Sholler, D. (2014). Achieving ICT4D project success by altering context, not technology. *Information Technologies & International Development*, *10*(4). pp-15

Forlano, L., Powell, A., Shaffer, G., & Lennett, B. (2011). From the digital divide to digital excellence: Global best practices for municipal and community wireless networks.

Gambanga, N. (2016). Zimbabwe has the third most expensive mobile data in Africa - Techzim. Retrieved September 24, 2016 from http://www.techzim.co.zw/2016/09/zimbabwe-third-expensive-mobile-data-prices-africa/#.V-aOTPl97IU

Gibson, J., & Olivia, S. (2010). The effect of infrastructure access and quality on non-farm enterprises in rural Indonesia. *World Development*, *38*(5), 717–726.

Gruber, H., Hätönen, J., & Koutroumpis, P. (2014). Broadband access in the EU: An assessment of future economic benefits. *Telecommunications Policy*, *38*(11), 1046–1058.

Gwaka, L. T. (2017). Digital technologies and sustainable livestock systems in rural communities. *The Electronic Journal of Information Systems in Developing Countries*, *81*(1), 1–24.

Hardman, S., & Steinberger-Wilckens, R. (2014). Mobile phone infrastructure development: Lessons for the development of a hydrogen infrastructure. *International Journal of Hydrogen Energy*, *39*(16), 8185–8193.

Hayes, N., & Westrup, C. (2012). Context and the processes of ICT for development. *Information and Organization*, *22*(1), 23–36.

Heeks, R. (2002). Information systems and developing countries: Failure, success, and local improvisations. *The Information Society*, *18*(2), 101–112.

Heimerl, K., Hasan, S., Ali, K., Parikh, T. and Brewer, E. (2015). A longitudinal study of local, sustainable, small-scale cellular networks. *Information Technologies & International Development*, *11*(1), pp-1.

Karippacheril, T. G., Nikayin, F., De Reuver, M., & Bouwman, H. (2013). Serving the poor: Multisided mobile service platforms, openness, competition, collaboration and the struggle for leadership. *Telecommunications Policy*, *37*(1), 24–34.

Kuriyan, R., Nafus, D., & Mainwaring, S. (2012). Consumption, technology, and development: The "Poor" as "Consumer". *Information Technologies & International Development*, *8*(1), pp-1.

Mabweazara, H. M. (2013). 'Pirate' radio, convergence and reception in Zimbabwe. *Telematics and Informatics*, *30*(3), 232–241.

Madon, S. (2000). The Internet and socio-economic development: Exploring the interaction. *Information Technology & People*, *13*(2), 85–101.

Malecki, E. J. (2003). Digital development in rural areas: Potentials and pitfalls. *Journal of Rural Studies*, *19*(2), 201–214.

Mamba, M. S. N., & Isabirye, N. (2015). A framework to guide development through ICTs in rural areas in South Africa. *Information Technology for Development*, *21*(1), 135–150.

Manwa, L., Mukeredzi, T. G., & Manwa, L. (2016). Rural school teaching in Zimbabwe: Mentoring experiences of beginning primary school teachers. *Australian and International Journal of Rural Education*, *26*(2), 62.

May, J., Dutton, V., & Munyakazi, L. (2014). Information and communication technologies as a pathway from poverty: Evidence from East Africa. *ICT Pathways to Poverty Reduction: Empirical Evidence from East and Southern Africa*, 33–52.

Mills, G. (2012). *Why Africa is poor: And what Africans can do about it*. UK: Penguin.

Nandi, S., Thota, S., Nag, A., Divyasukhananda, S., Goswami, P., Aravindakshan, A., … Mukherjee, B. (2016). Computing for rural empowerment: Enabled by last-mile telecommunications. *IEEE Communications Magazine*, *54*(6), 102–109.

Park, S. (2016). Digital inequalities in rural Australia: A double jeopardy of remoteness and social exclusion. *Journal of Rural Studies*.

Philip, L. J., Townsend, L., Roberts, E., & Beel, D. (2015). The rural digital economy. *Scottish Geographical Journal*, *131*(3–4), 143–147.

Postal and Telecommunications Regulatory Authority of Zimbabwe (POTRAZ) (2015). Converged licensing consultation paper. Retrieved January 18, 2018 from http://www.potraz.gov.zw/images/documents/CONSULTATION_PAPER_CONVERGED_LICENSING_FRAMEWORK_2015.pdf

Radioworld (2016). ZACRAS responds to suspension of radio station licensing. Retrieved September 19, 2016 from http://www.radioworld.com/article/zacras-responds-to-suspension-of-radio-station-licensing/279290#sthash.EWCAXmUs.dpuf

Rey-Moreno, C. (2015). Community Telco: An acceptable solution for providing affordable communications in rural areas of South Africa. OMM Press.

Rey-Moreno, C., Blignaut, R., Tucker, W. D., & May, J. (2016). An in-depth study of the ICT ecosystem in a South African rural community: Unveiling expenditure and communication patterns. *Information Technology for Development*, *22*(sup1), 101–120.

Rey-Moreno, C., & Graaf, M. (2015). Map of the community network initiatives in Africa.

Rey-Moreno, C., Tucker, W. D., Bidwell, N. J., Roro, Z., Siya, M. J., & Simo-Reigadas, J. (2013). Experiences, challenges and lessons from rolling out a rural WiFi mesh network. In *3rd Annual Symposium on Computing for Development (ACM DEV)* (p. Article 11, 10 pages). Bangalore, India: ACM. https://doi.org/10.1145/2442882.2442897

Rey-Moreno, C., Tucker, W.D., Cull, D., & Blom, R. (2015, May). Making a community network legal within the South African regulatory framework. In *Proceedings of the Seventh International Conference on Information and Communication Technologies and Development* (p. 57). ACM.

Sawada, Y. (2015). The impacts of infrastructure in development: A selective survey. ADBI Working Paper, Tokyo, Japan.

Sekyere, E., Tshitiza, O., & Hart, T. (2016). Levering m-governance innovations for active citizenship engagement. Retrieved March 21, 2018 from http://www.hsrc.ac.za/uploads/pageContent/7504/HSRC%20Policy%20Brief%2018%20-%20Levering%20m-governance_PRESS.pdf

Shezi, L. (2016). Zimbabwe data prices hiked by up to 500% to curb social media activism and Dissent Retrieved September 24, 2016 from http://mg.co.za/article/2016-08-05-zimbabwe-data-price-hiked-up-by-up-to-500-to-curb-social-media-activism-and-dissent

Simo-Reigadas, J., Municio, E., Morgado, E., Castro, E. M., Martinez, A., Solorzano, L. F., & Prieto-Egido, I. (2015). Sharing low-cost wireless infrastructures with telecommunications operators to bring 3G services to rural communities. *Computer Networks*, *93*, 245–259.

Skogseid, I., Grøtte, I. P., & Strand, G. L. (2014). Understanding broadband infrastructure development in remote and rural communities—A staged and reflexive approach. *The Journal of Community Informatics*, *10*(2).

Sørensen, C. (2013). Digital platform and-infrastructure innovation. In H. Higashikuni (Ed.), *Mobile strategy challenges (In Japanese)*. Tokyo: *Nikkan Kogyo Shimbun Ltd*.

Strover, S. (1999). Rural Internet connectivity. *27th Annual Telecommunications Policy Research Conference*. Retrieved March 22, 2018 from https://moody.utexas.edu/sites/default/files/rural_internet_connectivity_1999.pdf

Strover, S. (2001). Rural internet connectivity. *Telecommunications Policy*, *25*(5), 331–347.

Tabassum, G., & Yeo, A.W. (2015, May). Measurement of tangible and intangible impacts of telecentres on rural communities. In *Proceedings of the Seventh International Conference on Information and Communication Technologies and Development* (p. 61). ACM.

Takavarasha, S., & Makumbe, J. (2012). The effect of politics on ICT4D: A case of Econet wireless's struggle for a license in Zimbabwe. *International Journal of E-Politics (IJEP)*, *3*(3), 40–60.

Telecel (2015). Telecel press statement on licence cancellation. Retrieved February 22, 2017 from http://www.telecel.co.zw/about-us/press-releases/250-telecel-press-statement-on-licence-cancellation

Thimm, H. U. (1993). Linkages of rural infrastructure to food security. Regional Food Security and Rural Infrastructure, 2.

Toyama, K. (2015). *Geek heresy: Rescuing social change from the cult of technology*. PublicAffairs.

Tucker, B. (2017, November 18). How a rural community built South Africa's first ISP owned and run by a cooperative. The Conversation Africa.x

Van Stam, G., & van Oortmerssen, G. (2010). Macha works! Paper presented at WebSci10: Extending the frontiers of society on-line, April 26-27th, 2010, Raleigh, NC: US. Retrieved March 22, 2018 from https://drive.google.com/file/d/0B_AoSsevFs-uMGhGTDQtZ1B0Z1k/edit

Walsham, G. (2017). ICT4D research: reflections on history and future agenda. *Information Technology for Development*, *23*(1), 18–41.

Walsham, G., Robey, D., & Sahay, S. (2007). Foreword: Special issue on information systems in developing countries. *MIS Quarterly*, *31*, 317–326.

Warschauer, M. (2004). *Technology and social inclusion: Rethinking the digital divide*. MIT press.

Westerveld, R. (2012). Inverse telecommunications: The future for rural areas in developing countries? In T. M. Egyedi, & D. C. Mehos (Eds.), *Inverse Infrastructures: Disrupting networks from below (pp. 187–207)*. Edward Elgar Publishing Ltd.

Whitacre, B., Strover, S., & Gallardo, R. (2015). How much does broadband infrastructure matter? Decomposing the metro–non-metro adoption gap with the help of the National Broadband Map. *Government Information Quarterly*, *32*(3), 261–269.

Wong, H. L., Luo, R., Zhang, L., & Rozelle, S. (2013). Providing quality infrastructure in rural villages: The case of rural roads in China. *Journal of Development Economics*, *103*, 262–274.

Yeo, A. W., Hazis, F. S., Zaman, T., Songan, P., & Ab Hamid, K. (2011). Telecentre replication initiative in Borneo, Malaysia: the CoERI experience. *The Electronic Journal of Information Systems in Developing Countries*, *50*.

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