

Research Article

End-User Engagement in the Design of Communications Services: Lessons from the Rural Congo

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Abstract

End-user engagement is considered essential when designing new sociotechnical systems, but in the context of designing large-scale infrastructural systems such as communications networks, this ideal is rarely put into practice. We examine the challenges of engaging end users in the design of communications services by exploring how communities from 15 villages in the rural Congo incorporate mobile phones into their daily lives. To analyze the changes in social and cultural capital that result from mobile phone use, we apply Bourdieu's capital theory. This analysis exposes the difference in perceived value of the communication services between end users and the business owners of the infrastructure. The article concludes by suggesting new forms of partnership with end users to craft ways in which infrastructures and related organizations and practices can best cohere with local cultural views, specifics, beliefs, needs, or realities of concerned participants.

Keywords: end-user engagement, communications infrastructure, social capital, co-production, participative approach

Introduction

Communications infrastructures and mobile phone services shape the geographic, economic, and social configurations across a region (Foxon, 2011; Heeks, 2007). Research into the interconnections across the physical, social, technological, and economic structures in an environment has resulted in a growing literature that suggests infrastructures such as communications networks should be regarded as a service for end users rather than simply the means of providing a single utility (Hall, Tran, Hickford, & Nicholls, 2016; Roelich et al., 2015). Investment in infrastructures, however, is usually decided on and designed by central governments working with large corporate players; the concerns of end users are remote from this process and not usually regarded as a central concern. This article proposes new forms of partnership with end users to craft infrastructural services and related organizations and practices that cohere with end users' local cultural views, beliefs, needs, or realities.

Our research explored the perceptions of end users based in rural areas of the Democratic Republic of the Congo (shortened here to "the Congo"), a region where the recent development of communications infrastructure has provided new access to mobile phone services, which have, in turn, impacted rural villagers who

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have a tradition of growing corn and fishing. We investigated the impact of communications infrastructural development on end users in these rural communities at a micro level. Our aim was to give voice to these communities on how they perceive infrastructural development and to help them articulate their view of the services such infrastructure could provide them.

Roelich et al. (2015) argued that, as end users are the determinants of the demand for resources, it is important to include their needs when designing and implementing infrastructural systems. We offer empirical evidence for this view and analyze the microlevel changes in social and cultural capital across the villages in our study area, employing the lens of Bourdieu's (1983, 1986, 1994/1998) capital theory. We identify differences in the perceived value of the communications infrastructure between the end users in the community and the business owners and investors. Our analysis suggests a gap in perspectives of the different community, business, and investor stakeholders. We argue that addressing the challenges associated with developing infrastructural services requires an innovative approach to collaborative problem solving, requiring end users, governmental agencies, developers, and investors to co-produce plans, designs, and adaptations to services and to undertake evaluation assessments collaboratively. End users have local knowledge, social networks, and access to the cultural norms and traditional practices that are often unavailable to external stakeholders. Local communities are also the first responders in extreme events, such as El Niños or floods. This ability to respond quickly and in context places end users as the key players in achieving value from infrastructure investment. We suggest that using this resource makes economic sense and offers social benefits to local communities.

Research into information and communication technologies (ICTs) has suggested that currently little to no role is ascribed to end users (Aker & Blumenstock, 2015; Asongu & Nwachukwu, 2016, 2017; Bowman, 2010, 2015; Bowman & Bowman, 2016; Diga & May, 2016; Gagliardone & Golooba-Mutebi, 2016; May, Dutton, & Munyakazi, 2014; Ndemo, 2017; Otenyo, 2017; Sam, 2017). Additionally, researchers have tended to adopt quantitative approaches to give large-scale accounts of ICT development in the developing world, with minimal involvement of local populations or end users. As Qureshi (2015) lamented, ICT for development research

fails the poor because few researchers engage in advancing policy positions needed to make a difference, choosing instead to focus on highly specialized, largely quantitative studies . . . ICT4D researchers do not engage closely with the users of their research findings thus disconnecting findings from real-world issues. (p. 511)

Diga and May (2016) noted, "Rural areas are continuously placed at the periphery when provisions of ICT infrastructure and tools are brought to the fore" (p. 5). But rural societies constitute the largest portion of the world's population, particularly across the African continent (World Bank, 2016). Bowman (2015) undertook a study in Rwanda and wrote,

The Rwandan people had little input into whether ITC is a good way to move forward for development; they also had little input into how it should be configured and where it should be distributed. They were not empowered to put forth alternative imaginaries. (p. 83)

In this article, we advocate for research and a policy that give a central role to end users in the design, implementation, and provision of communications infrastructures. The article makes three contributions. First, by exploring the microprocesses across these rural communities and analyzing how patterns of interactions and practices gave rise to social and cultural capital, we found that the literature on mobile phone adoption assumed a Western model of subscription and phone ownership that was not in evidence on the ground. This Western view of individual mobile phone ownership and subscription adoption was used by the region's mobile phone operators to make investment decisions and to model the expected returns. In practice, this approach limited engagement with the end users and so hindered realization of the economic potential and social benefits from the investment. Second, we collected examples of how local communities used mobile phones to integrate community social networks to manage information and knowledge exchange and local demand for resources, sometimes in difficult environmental conditions. The evidence demonstrated how communities influenced the social and economic wellbeing of the local population and developed new social and cultural capital by creating a more connected, joined-up approach to managing resources in challenging

END-USER ENGAGEMENT IN THE DESIGN OF COMMUNICATIONS SERVICES

conditions. Third, we suggested that a culturally appropriate, co-produced approach to designing and adapting communications services can realize greater benefits from technology investments and development of long-term resilience to serve the socioeconomic interests of end users, private investors, and governmental institutions.

The article is organized into six sections. Section 2 gives some background to the concept of “infrastructures-as-service.” This section also sets out an overview of the literature on end-user engagement in systems design and explores whether the idea of end-user involvement in infrastructural design is a reasonable expectation. Section 3 offers an overview of Bourdieu’s (1979/1984, 1994/1998) capital theory to establish the relevance in this context and sets out our research design and work in the field. Section 4 discusses the research data in the context of capital theory, and Section 5 puts forward the argument for co-production of infrastructural services with end users to better manage scarce resources. The final section summarizes the article’s contributions.

Research Context

The Congo had a population of 57 million inhabitants in 2005 and almost 75 million in 2014 (World Bank, 2015). In 2007, the International Telecommunication Union (ITU) reported the Congo had 10.5% of its population subscribing to mobile phone services, whereas sub-Saharan Africa as a whole had 18.2% (ITU, 2007). Four years earlier, in 2003, the Congo had 1.9% of mobile phone subscribers and sub-Saharan Africa had 2.8% (ITU, 2007), so usage was growing, but more slowly in the Congo than in other areas of Africa. DeMaagd (2008) observed that rapid adoption of mobile phones did not necessarily result in increased economic productivity as usage in different parts of the world can vary considerably from the “one device, one owner” model prevalent in the developed world. Mansell (2012) argued convincingly that understanding the “diffusion of devices” does not provide an insight into how mobile phones are used in context. In our research we did not examine mobile phone diffusion across the region; rather, we focused on the microlevel practices of communities in the Congo’s central and southern regions, where mobile phone access has only been available since 2007.

Infrastructure as a Service for End Users

Understanding Infrastructures as Interconnected and Complex Systems

There is growing evidence that end users of essential resources such as water, food, energy, transport, and communications have a critical role to play in managing demand, and it is the behaviors, choices, and attitudes at a local level that determine efficiency and resilience across infrastructures (Faruqui, Sergici, & Sarif, 2010; Grubler, 2010; Janssen & Jager, 2002; Steinberger, van Niel, & Bourg, 2009). Loring, Chapin, and Gerlach (2008) have promoted the idea of customers and providers co-creating value from infrastructure, but the fundamental shift from selling individual utility products to offering services has not been achieved. A transformation to a service-oriented perspective requires a more connected, “joined-up” approach to thinking about infrastructure. But to offer services, as opposed to single-utility products, requires more cooperation among designers, owners, and managers across infrastructural sectors and a better understanding of the interdependencies among infrastructures (Hall, Tran, Hickford, & Nicholls, 2016). These interdependencies are often better understood at a local level, as it is this microlevel knowledge that drives innovation and socioeconomic development, rather than large-scale intervention in a context (Grubler, 2010).

Research into infrastructures has only recently started to examine cross-sector issues, with the World Bank (2013, 2015) launching the Thirsty Energy initiative and the UN (2014) focusing attention on the Water–Food–Energy nexus to increase awareness of the interdependencies and potential conflicts across water, food, and energy resources. Hall, Tran, Hickford, and Nicholls (2016) argued that current models and methods for planning and design of infrastructural networks do not explore the interdependencies across sectors and are not well-suited to incorporating changing conditions such as the introduction of new processes or technologies.

Etzo and Collender (2010) and Mercer (2004) criticized approaches to communications infrastructure

research that fetishize communications technology. To move past this problem, we worked from a more systemic perspective of resources and systems as a connected whole. Viewing infrastructures as complex interconnected systems gives insight into the multiple layers and dynamic complexity across constituent networks. Such a view is also essential to move toward a view of “infrastructure as service” and to understand the increasing complexity and interdependence across infrastructural sectors. Communications infrastructures have an important contribution to make in achieving a more joined-up and connected approach to natural resources management, and so understanding the microlevel detail of how end users interact with and adapt communications services is essential to a successful transition toward an infrastructure-as-service model of delivery. Technologies and communication infrastructures expedite information, knowledge exchange, and decision making in complex networks and, in so doing, facilitate interconnections between physical and social systems on the ground.

Communications Infrastructure as an Integrator

The current literature on communications infrastructures focuses on how investment in these technologies and infrastructures can improve market efficiency and/or reduce transaction costs (Aker, 2010; Aker & Mbiti, 2010; Asongu, 2013; Priya & Mathiyalagan, 2012). But May, Dutton, and Munyaikazi (2014) suggested that current research, largely conducted at a macro level, is too generic to provide insight into how end users engage with communications technologies on the ground. Several authors have questioned the assumption that access to mobile phones is directly responsible for economic benefit in the developing world, and a consensus is now forming that the relationship between technology and economic development is nuanced (DeMaagd, 2008; Heeks, 2007; Rashid & Elder, 2009; Wilson, Best, & Kleine, 2005).

Governments across the developing world, however, are making investments in communications infrastructure in the expectation of transforming their economies (Dutta & Mia, 2010). Avgerou and Madon (2005) noted that such projects can lead to a digital divide, as access can be inequitably distributed across different social groups. Srivastava and Shainesh (2015) suggested that much of the research into the impact of communications infrastructures and into the digital divide has been based on a goods-centric view, where the emphasis is on provision of goods in the form of computers and mobile phones. Communications infrastructures and their associated data technologies can be applied to provide access to basic services for society’s poorest (Madon, 2005). To achieve this, it is important to understand how these end-user groups will adapt to new infrastructures and technologies. Communications infrastructures cannot replace other infrastructures such as energy, food, water, etc., but can enhance access to critical resources and support their management (Aker & Mbiti, 2010).

End-User Engagement in Service Delivery

Rethinking infrastructure as service and engaging end users first requires a shift in the approach to design practices applied in infrastructure projects. Due to the size and complexity of these infrastructural systems, design tends to be managed through structured, traditional top-down approaches, driven by quantitative metrics (Champion & Stowell, 2003). But as Jasanoff (2016) argued, “We must understand how power is delegated to technological systems” (p. 12; see also Jasanoff, 2017). Bijker (2015, 2017) also argued for an approach to designing technological systems that acknowledges social, economic, and political questions and engages with end users. Cherns (1976, 1987) laid the groundwork for engaging end users in systems design by setting out nine principles for sociotechnical design (summarized in Table 1).

In their recent overview of sociotechnical design approaches, Winter, Berente, Howison, and Butler (2014) described how research in this field assumes that design activity occurs in a reasonably homogenous organizational context. This assumption, however, does not transfer to an infrastructural design context where the resulting system will potentially impact many communities and then be adapted on the ground by a network of end users and other collaborators.

Geels (2004) and Van de Ven and Garud (1994) suggested that end users can learn new ways to amalgamate resources and create new and innovative responses to problems over time, but to achieve this end users must be embedded in the decision-making process for the service provision during the design, implementation, and use of infrastructure. To understand how such an approach to infrastructural services might work

END-USER ENGAGEMENT IN THE DESIGN OF COMMUNICATIONS SERVICES

Table 1. Nine Principles of Sociotechnical Design.

Principle	Summary
Compatibility	Meaningful participation to ensure the design is fit for purpose
Minimal critical specification	Identify only what is essential
Variance control	Variances should not be exported across organizational boundaries
Boundary location	Boundaries should not impede knowledge sharing
Information flow	Information should be immediately available to those who must act on it
Power and authority	Those who need to act must have the power and authority to do so
Multifunctional principle	Limit the use of outside experts
Support congruence	Pay for what a person knows
Transitional organization	Train, don't test
Forth Road Bridge	Constantly renew and revise

Note: Summarized from Cherns (1987).

in practice, particularly in the developing world, there is a need for research to analyze the micro level of daily practice and engagement of end users with communications infrastructures. To structure our research, we applied Bourdieu's (1994/1998) capital theory.

Bourdieu's Capital Theory as an Analytical Lens

Bourdieu's Capital Theory

Capital theory (Bourdieu, 1983, 1979/1984, 1986, 1994/1998) can be a useful lens through which to examine the microprocesses of how communities and networks come together to solve problems and how various forms of capital (human, economic, social, cultural) support the design of new approaches and innovations (Freel, 2000; Glover, Champion, Daniels, & Boocock, 2016; Romero, 2011). Bourdieu used the concepts of field, habitus, and capital to structure the analysis of microprocesses. A *field* is regarded in capital theory as the social space people occupy; their *habitus* refers to people's habitual way of acting and thinking; the resources available to people are regarded as *capital* (Bourdieu, 1979/1984, 1986). Bourdieu (1979/1984) identified four types of capital: economic (financial, material, property wealth), cultural (knowledge, skills, qualifications), social (actual or potential access to social networks, business networks, groups with useful resources or connections), and symbolic (honor, position, prestige). Bourdieu situated his view of capital in a class struggle for resources, with those in powerful positions owning the most capital resources (Lin, 2001). Most authors agree that different forms of social capital are embedded in relationships and social structures and that investing in social capital can increase the likelihood of returns in kind (Coleman, 1988; Furstenburg, 2005; Putnam, 1993). Bourdieu went further, suggesting that the various forms of capital provide members of any particular network with "the backing of collectively-owned capital" (1994/1998, p. 51). This latter view seems directly relevant to exploring how the networks across rural communities, experiencing access to communications infrastructure for the first time, respond to the potential offered by mobile phones in their daily lives. Social and cultural capital are considered particularly important for problem solving and for a dynamic response to an issue or event (Corti & Storto, 2000; Perez & Sanchez, 2002). We applied capital theory to understand the microlevel processes associated with access to communications infrastructures across village networks in our research area in the rural Congo.

The Research Method

The aim of the research was to investigate end users' microlevel practices with communications infrastructures (through mobile phone devices) in rural communities across central and southern districts of the Congo. This region was chosen as it had experienced significant investment in communications infrastructure since 2007, with many rural communities gaining access to mobile phone networks for the first time. We adopted a participative research framework that was responsive to the communities' traditional practices. The field

researcher is native to the Congo, able to speak all three local dialects, and who, for purposes of collecting research data, spent four months living with the villagers who participated in the research. The field researcher entered fully into village life during this time, growing vegetables and contributing to the community by helping with odd jobs and joining in communal activities.

We strived to give voice to local participants and their values, so in this context we judged that coding the data would be a manipulation of and distraction from the voices expressed and the values encountered. Our choice resonated with Saldaña's (2016) position, in which he declared,

No one . . . can claim final authority on the utility of coding or the "best" way to analyze qualitative data. I must also emphasize at the very beginning that *there are times when coding the data is absolutely necessary, and times when it is most inappropriate for the study at hand.* (emphasis in original, p. 2)

Further, Miles, Huberman, and Saldaña (2014) clarified,

The ultimate power of field research lies in the researcher's emerging map of what is happening and why. So any method that will force more differentiation and integration of that map, while remaining flexible, is a good idea. (p. 93)

Since we sought to give primacy to the end users' values, per Bourdieu (1979/1984, 1986), coding as a method was unsuitable for our research. The field researcher explored how mobile phones impact the micropractices of village life to understand how the community gains value from access to the communications infrastructure. The researcher also gathered and insights into how social and cultural practices have changed. The aim was to collect empirical evidence of how the villagers crafted their social practices around the mobile phones in a way that was coherent with their local cultural views and realities. A diverse range of participants took part in this research (see Figure 1). The community's active participation was achieved, as the researcher was embedded in the field and became a member of the community through language and practice.

Most of the interviews took place at common meeting places such as a village plaza or market, and a few interviews with village elders took place during home visits. Only chiefs and elders could be seen alone. Interviews were often interrupted by the needs of children or other family members, so the length of the interviews varied.

This area of the Congo has experienced recent violent unrest spilling over from the events in neighboring Rwanda, and during the fieldwork there was growing unrest in Burundi. This political situation impacted the way interviews could be conducted. During the unrest in nearby Rwanda there had been an influx of migrants to this area of the Congo, and in some areas of the Congo lists of names had been circulated of people who were taken away and imprisoned, tortured, or executed (*The Economist*, 2016). For this reason, inquiring about someone's background and history was deemed socially unacceptable.

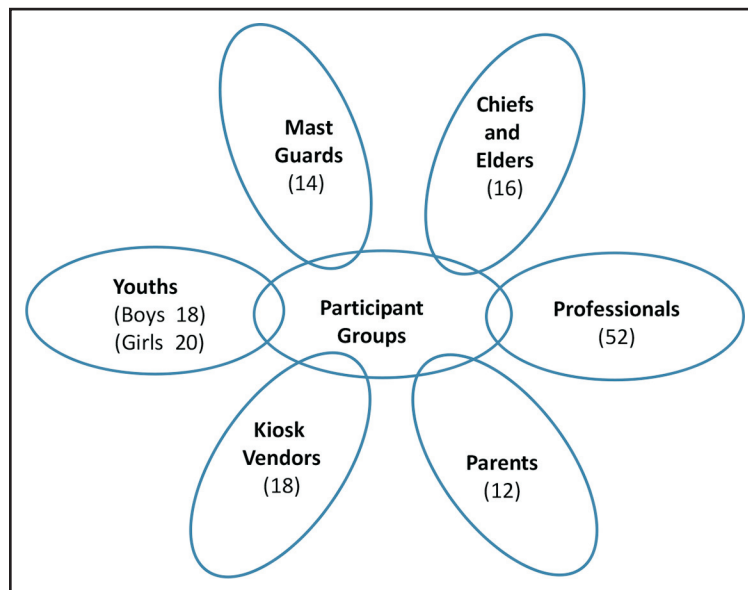


Figure 1. Participants in the Field Work.

Notes: Professionals included midwives, artists, craftsmen and -women, builders, traders, teachers, and storytellers. Numbers in parentheses denote number of participants in the group.

No interviewee was counted twice.

END-USER ENGAGEMENT IN THE DESIGN OF COMMUNICATIONS SERVICES

Chiefs and elders limited what details could be recorded; taping or filming interviews was forbidden. With the chiefs' permission and the community's knowledge, a field notebook was used by the field researcher to take notes and write down quotations in which participants were identified according to their group or profession. It is important to state that to ensure participants were comfortable with the research process, the field notes were often written up after the interview or meeting to act as an aide-mémoire for the field researcher; hence, few direct quotations were recorded. Participants from 15 villages took part in the research, and the conversations and interviews were conducted by the field researcher in one of the three official dialects of the Congo—Lingala, Swahili, and Ciluba—depending on the interviewee's preferred dialect.

By being flexible in the way the research was undertaken, a detailed picture emerged of how mobile phones were used in and incorporated into daily life. By living with the villagers for four months, the field researcher could check his understanding and witness the activities mentioned in the interviews. More traditional research approaches would have alienated participants, and no data would have been collected. The aim of this research was to gain a deep understanding of how end users interacted with the communications infrastructure, and we argue that the research approach was sensitive to the concerns of the participating communities and of sufficient rigor to offer useful insight. The experience of undertaking this research resulted in learning that is also valuable in framing approaches to engage end users in the infrastructure design. This is discussed in the article's last section.

The qualitative data collected for this research was mainly in the form of interview notes and field observations recorded in a series of field notebooks. The interview notes were recorded in the language in which they took place and then translated into English and reviewed thoroughly. Themes from the data were identified through constant comparison and thematic analysis to identify concepts, which were linked back to the data (Glaser, 1996). The aim of our research was to allow the community to speak for itself; hence, we did not suggest universal prescriptions about mobile phone devices in other developing countries. Rather, we identified some "lessons learned" that applied to the rural Congo and could be used beyond "the setting for the specific case" (Yin, 2014, p. 40).

Empirical Findings and Discussion

Our findings are grouped around three key themes taken from Bourdieu's (1979/1984) capital theory: social capital, cultural capital, and *amplification effect*, where new value is created by combining different sources of capital. We also explored the data for evidence that symbolic capital was important to creating value from the communications infrastructure. Bourdieu referred to *symbolic capital* as accumulated prestige or honor. In this research, symbolic capital could be regarded as being held by village chiefs and elders. We found that these individuals held positions of honor in their communities because of their age, experience, and knowledge. Respected community members or volunteers often acted as keepers of the mobile phones in the social networks, but holding the phone for others to use did not add to the keepers' symbolic capital. Rather, they kept the phone because of their symbolic position. For this reason, we focused our discussion on social and cultural capital and the combinations of capital that created value from the communications infrastructure.

Social Capital

Bourdieu (1979/1984) defined *social capital* as networks and connections that could be accessed to offer resources and introductions. As part of this research we explored the social networks across the research area and how mobile phone access had changed the reach and range of these networks to the communities' benefit. One of the most important aspects of these community networks was the approach to mobile phone ownership found in this region of the Congo. We found that mobile phones were usually regarded as being owned by a community or network, rather than a single individual. A senior member of the community, often a matriarch/grandmother, acted as a "keeper" and lent the phone to whoever needed it. Mobile phones were used by community members who needed the phone for specific purposes such as to plan a visit to the city or to arrange a family gathering. Most people in the region where this research was conducted did not own a personal phone, but could, if needed, access a phone through their family or community network.

To explore mobile phone use and to understand how mobile phone ownership operated in the community

networks, interviewees were asked to tell the interviewer about how and when they obtained access to a mobile phone and in what context. Many interviewees, from across the participant groups, had first used a mobile phone device on some type of significant occasion such as a trip to the city or the death of a relative. They had been lent a phone for the time needed to cover the event. For example, a person had borrowed a phone to arrange a funeral gathering in one of the villages and to help villagers contact people living in the city. Other examples of significant occasions included lending the mobile phone to call a midwife for an expectant mother or to arrange for visits from friends and relatives in other villages or locations. Most of the phones were owned on a pay-as-you-go basis, that is, the person who borrowed it was responsible for topping up the credit on the phone after they had finished using it. Charging the phone was often a communal responsibility, as charging could only take place in locations with access to a power supply. This meant the activity would be undertaken by someone within the network who was going to a location where charging could take place. After a caller had finished with a mobile phone, it would be returned to the keeper, ready for the next person who needed it.

Mobile phones were also used to access information to facilitate certain activities. For example, communal trips to the market to swap goods and services would be arranged, and the prices for goods at other markets could be checked to ensure fair pricing. Mobile phones would also be used to report on the health of vulnerable community members and to coordinate odd jobs and repairs to village huts or equipment. In these situations the mobile phones supported access to people with professional knowledge such as nurses, so symptoms could be checked. This communal use of mobile phones aligned with the region's traditional structures and practices, where communication networks facilitated village and communal activities. Jasanoff (2016) observed that "a more immediate result of technological advancement . . . is fragmentation and loss of community, in short, the weakening of the social ties that make human lives meaningful" (p. 6). Perhaps one reason for this finding is the strong communal culture found in this region.

The best explanation of the communal culture prevalent in this region of the Congo is through the concept of *Ntu* (Tshiamalenga, 1975, 1985), taken from Bantu languages, meaning life, existence, being, etc. The concept of *Ntu* rose to prominence in the 1990s under the Zulu (South African) term *Ubuntu*, broadly referring to *communalism*, a term used by President Nelson Mandela (Kimilike, 2008; Kithaka, 2015; Oppenheim, 2012). The idea conveyed is that of the rapport of a person with self, others, things, and the wider community. A Zulu proverb says, "*Umuntu ngumuntu ngabantu*" [A person becomes a person through and with (the help of) others] (Esongi, 2011, p. 26). Or as a Ciluba (Congo) proverb states, "*Buena muntu budi ndambu ndambu*" (Humanity lies in sharing the little a person has) (Kalamba, 2013, p. 30). These traditional practices of sharing and joint ownership across a community impact the ways mobile phones are used across groups. For example, one mobile phone could be used, charged, topped up, repaired, etc., by a person's neighbor, uncle, friend, sister, husband, grandma, etc. The mobile phone is shared across a chain of relationships and uses, extending the social capital for all individuals in the network.

Cultural Capital

Cultural capital (Bourdieu, 1979/1984) arises from holding educational qualifications, having valuable skills, or possessing cultural objects viewed as having inherent value. The community relies extensively on family/community skills and knowledge. Chiefs, storytellers, and senior members of the community tell stories of how problems had been solved and how members of the present community had developed their skills and expertise, particularly if the story featured humor or peril. Chiefs and storytellers also told stories to increase awareness and knowledge across the community. This knowledge could be applied by younger and other community members without direct experience of the narrated events. In one actual example, an area flooded, making travel dangerous. In this instance a younger community member remembered a story of a similar flood and used a mobile phone to communicate to nearby villages the extent of the flooding and to remind them which paths had been safe in a previous flood.

Across these rural communities there were many examples of older, more experienced villagers passing on knowledge and skills (cultural capital) to the next generation, as might be expected. Collaborative problem solving was also apparent, and mobile phones extended the number of circumstances where advice could be

END-USER ENGAGEMENT IN THE DESIGN OF COMMUNICATIONS SERVICES

sought. They also extended the network of people who might be contacted to obtain advice. This can be seen most directly in the way phones were used to take pictures and record text, creating a portable library of information and shared memories. These information stores facilitated better problem solving in some circumstances. For example, if one family or farmer had a problem with crops, a mobile phone could be used to take a photo of the stricken crops and either message or show the photo to someone with more experience to diagnose the issue and suggest a solution. These sorts of activities extended the reach of problem-solving networks and facilitated new and timely social interactions to improve the community's wellbeing.

Within this research context, mobile phones were observed to improve the speed of access to knowledge as well as the quality of advice given in certain circumstances. The phone facilitated contact with people who would otherwise be a half-day or entire day's walk from the problem situation. This access to social and cultural capital (Bourdieu, 1979/1984) was a prerequisite to successful problem solving.

The Amplification Effect

The focus on microlevel impacts and interactions between end users and communications infrastructure, and the use of Bourdieu's (1979/1984) capital theory as a lens through which to analyze the changes in social and cultural capital across these villages, demonstrated that improved problem solving was one of the most valued aspects of access to a communications infrastructure. For example, sharing pictures of problems with crops or of damage to a hut allowed a family to connect with the needed help more quickly than before. By sharing news of the weather, the state of a road, where to fish, or whether someone who lived remotely had sufficient supplies through the mobile phone network, communities were able to organize a swifter, more connected and joined-up response to needs and opportunities. Cultural capital, that is, access to skills and knowledge, was extended via the communications network, which resulted in improved problem solving and innovation.

To date, ICT research undertaken in developing regions of Africa has overwhelmingly focused on the capital investment, economic benefits (Asongu & Nwachukwu, 2016, 2017; Diga, 2013), and usability issues arising from technological features. Diga (2013) criticized these approaches, arguing that "the key assumption underlying this work—that the poor could be moved out of poverty simply by providing them with ICT and information access and usage—was a limited one" (p. 127). This view was confirmed by Sam (2017), when from his work exploring mobile phone use with the poorest residents of Sierra Leone, he commented, "it is not strongly evident that the use of mobile phones completely emancipates them from socio-economic and political exclusion" (p. 359). Our work provides additional evidence for the views of Kolko, Putnam, Rose, and Johnson (2011), who argued that the "distance between technology design teams and end users" (p. 575) was part of the problem. In this article we followed Bourdieu's (1986) lead: that capital should not be reduced to a materialistic or monetary agenda. While the issues of economic benefit and technology features were important, the application of Bourdieu's (1986) capital theory provided an additional and necessary perspective.

Interviews were conducted with many groups during the field research (Figure 1), which exposed stark differences in the ways the villagers (the end users of the communications infrastructure) perceived the value of the services offered by mobile phones and of the business models of the communication infrastructure investors and mobile phone companies. One group of stakeholders perceived problems with the way the community was given access to the communications infrastructure: kiosk vendors. This group sells mobile phones and prepaid cards from kiosks, or huts, or market stalls to the villagers. The majority view of the villagers could be summarized as concern for the lack of equity between the people selling prepaid cards in the city and those selling the cards from kiosks or stalls in rural areas. One kiosk vendor commented that a great deal of investment into selling mobile devices had occurred in the city, but that he had received no help or investment from the mobile phone companies to grow his business: "As a kiosk vendor I could use a table or the back of a container to put out my merchandise" (Kiosk Vendor VIII).

Another kiosk vendor suggested:

I sell the prepaid cards and I am on my own. Mobile phone carriers don't even know where I live, whether I have a house, where I sleep. The tiny leftovers of credits, if there are any left, of course, are your profit or salary, I would say. (Kiosk Vendor XVII)

The differential treatment between urban and rural communities expressed in these comments was perceived as contrary to the local Utu culture. The communities involved in this research found value from mobile phones in the way the phones could support and extend the Utu culture, their way of living with each other. In contrast, the mobile phone companies gained profit through the increased sale of individual phone contracts (Gough, 2005). This was reflected in the increased investment in city areas, as more contracts could be sold in an urban environment. This supported the findings of Kolko, Putnam, Rose, and Johnson (2011), who highlighted an increasing gap between technology designers and end users. It raises the question of how mobile phone companies can adopt more sustainable and ethically appropriate practices when investing in developing countries.

We suggest that to achieve full realization of the potential benefits from investments in infrastructures and to support and promote connections and services across utilities and across urban and rural communities, there is a need for a more holistic view of how value is created in developing countries. The lessons from this field work suggest that end user engagement in the design of services would be a start, but moving toward a situation where end users are actively engaged across the design, planning, implementation, and evaluation of regional infrastructures would offer a more effective route to understanding how multi-utility services could significantly increase community wellbeing and resilience and could promote innovative new approaches to sustainable resource management.

The Co-Production of Infrastructural Services

We suggest that to achieve the full benefits of infrastructure investment on a sustainable, long-term basis and to move from a “product” to a “service” mentality, end users must be fully engaged in the design and implementation of services. This requires end users to be co-producers throughout service design, implementation, and evaluation. End users have a unique role to play in facilitating knowledge and information exchange in their region. In the developing world in particular, the manner in which information and knowledge are spread is situated in the microlevel social practices, routines, and traditions of the end user community.

Co-production is the idea that end users are engaged with professional providers in the decision-making processes for public goods and services. The idea was initially developed by Ostrom and colleagues in the 1970s (see Ostrom, 1990 for an overview). Since then, the range of applications and contexts where co-production has been regarded as legitimate and valuable has grown. Fledderus, Brandsen, and Honingh (2014) noted that co-production arises from a belief that citizens can “no longer be treated as passive clients or consumers, but as (potentially) active co-producers of the services they receive” (p. 425). Co-production is often seen as a radical reinterpretation of the relationship between users and providers of services (Bovaid, 2007). Several authors suggest that working within this approach has also been shown to produce outcomes that are trusted, more valued, and more likely to be transforming (Alford, 2002; Boyle & Harris, 2009; Considine & Lewis, 2003).

We suggest that *co-production* in the context of providing infrastructural services can be defined thusly: The processes whereby infrastructural services are designed, planned, implemented, managed, adapted, and evaluated by infrastructural service providers working together with end-users as equal partners.

This definition places end users as equal players in the design, delivery, and evaluation of infrastructure. Our research also demonstrates that applying such a participative approach requires appropriate methods and means of engagement with different communities. This work was undertaken in a manner that was ethically appropriate for the communities in this area of the Congo by a researcher familiar with region’s languages and practices and so gave voice to these villagers.

Conclusion

In this research, we focused on how communities in the rural Congo integrated mobile phones into their lives and across their social networks at a micro level. We explored whether access to new communications infrastructure and technology changed the ways in which these communities responded to events and how the end users perceived the value of mobile phones in enabling the community’s social and economic wellbeing.

END-USER ENGAGEMENT IN THE DESIGN OF COMMUNICATIONS SERVICES

Reimagining infrastructure-as-a-service will require end users to frame services, with co-production being a means of managing scarce resources in ways that better cohere with the local cultural views, specifics, needs, or realities of concerned end users.

In this study we foregrounded the experiences and views from our research context in the Congo through a culturally appropriate research method. In so doing, this research highlights the need to reconceptualize how we assess what impacts large infrastructural projects might have on the social and cultural structures and networks in a region. We intend to focus future research on these issues to understand how to effectively engage end users in the co-production of infrastructure services for future sustainability. ■

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END-USER ENGAGEMENT IN THE DESIGN OF COMMUNICATIONS SERVICES

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