Signals of Change: Social Infrastructure and Community Cellular Networks in The Philippines' Last-Mile

Athena Charanne R. Presto & Josephine C. Dionisio

Abstract

This paper examines the implementation of community cellular networks (CCNs) in last-mile communities in the Philippines. As a case study, it takes the Village Base Station (VBTS) project, which aims to deliver telecommunications access to unserved barangays in Aurora province by installing CCNs. This paper explores the social infrastructure that enabled or constrained the maximum utility and sustainability of the project. Through three focus group discussions among key stakeholders in three municipalities in Aurora and document analysis of key project documents, the research reveals a mixed sentiment towards CCNs. Results show that local stakeholders acknowledge CCNs' benefits especially in disaster communication and local governance. However, stakeholders also highlight challenges, primarily financial constraints and maintenance issues. Stakeholders narrate shortcomings in the social infrastructure in the community, with suggestions for enhanced training and transparent communication to ensure CCNs' long-term viability and effectiveness. The findings offer valuable insights for similar initiatives worldwide, especially regarding the dynamics between technology and social infrastructure in developing sustainable technology.

Keywords: community cellular networks, VBTS project, social infrastructure, last mile communities, sustainable technology

Introduction

Mobile coverage throughout the world has expanded. Yet, this expansion is not universal, as countries like the Philippines still record less than 70% mobile phone penetration rate (Barela et al., 2023). Areas with connectivity gaps are referred to as 'last-mile' communities (Cherry, 2003). These communities receive little to no telecommunication service either because of distance or an insufficient number of potential subscribers to generate commercially acceptable profit. Within this context, Barela et al. (2018) emphasize the necessity of tailored technological innovations in transforming these underserved areas, including localized and community-oriented solutions beyond sole reliance on market incentives.

The Village Base Station - Connecting Communities through Mobile Networks (herein referred to as VBTS) project is one such response to technological innovations for social good. The project aims to deliver telecommunications access to unserved barangays in Aurora province, Philippines, which is done through installing community cellular networks (CCNs). Aurora was selected due to its geographic and logistical accessibility compared to other considered locations, such as Palawan, which required air travel. This accessibility made conducting regular monitoring and maintenance feasible, thereby better ensuring the project's sustainability.

CCNs differ from commercially provided networks in two ways. First, the community may have special needs that may be overlooked by commercial network coverage packages, such as more inter-network texting and cheaper inter-country call packages. More inter-networking texting packages address the communication needs of specific groups within the community, such as fisherfolks, who may rely heavily on frequent SMS texting to communicate with others within and outside their network. Meanwhile, cheaper inter-country call packages cater to families who rely on overseas remittances. Many community members may have family members working abroad, and affordable calling rates are crucial to maintaining

these familial connections without imposing significant financial burdens. Second, the maintenance of hardware and equipment is delegated to stakeholders in the communities. Stakeholders here include all entities with a vested interest in the project. At its core, the VBTS project is formed by a local group of people consisting of community members, the local state college, the local cooperative, and a telecommunications provider. CCNs are designed such that the ownership, management, and decision-making can be handled and shared by local stakeholders. CCNs are self-managed networks that form a non-elitist, open, decentralized infrastructure that the users can manage. Therefore, maintaining a properly functioning CCN entails the effective interaction of various stakeholders and institutions that support the overall social infrastructure needed to maximize the CCN.

Studying the VBTS project is crucial because it is seen to facilitate other gains beyond basic mobile telephony. Barela et al. (2016) highlight CCN's sustainable model, which not only reduces costs but also fosters local entrepreneurship, digital governance, and citizen empowerment. The project significantly enhances local governance by improving communication to enable more informed decision-making and facilitate public engagement. It also enhances disaster governance by ensuring reliable communication during emergencies, essential for effective response and coordination. Furthermore, the VBTS empowers communities by providing access to crucial information and communication tools, whether this information be economic, political, or social in nature.

But on-ground realities complicate the projected gains of the project. For one, the Philippines needs to address its infrastructure systems' social and environmental dimensions (Grabowski 2017), particularly in disaster-prone areas like Aurora province. Other social dimensions of sustainability in infrastructure projects, particularly human rights and community impacts (Treviño-Lozano 2022), are also crucial. Therefore, this paper aims to explore factors that enable or hamper social infrastructure essential in maintaining community technologies. Pillay and Mitra (2015) assert that

researching a new phenomenon, especially in an under-researched social context, is ripe with opportunities for inquiry. This paper then draws from the importance of ensuring that there is an effective social infrastructure before the introduction of, and for the maintenance of, a new type of technology. It covers various project phases, mainly the installation and maintenance of the VBTS towers. Finally, this paper is helpful for other technologies that are eyed to be deployed in the Philippines or other parts of the world, especially because CCNs form part of a new open-source and locally maintained technology.

Social infrastructure, CCNs, and the VBTS project

Social infrastructure

Social infrastructure, broadly conceived, is "the capacity and will of individuals and communities to provide or take advantage of opportunities that enhance their economic and social wellbeing" (Swanson 1996: 104). Frischmann (2012) considers social infrastructure as one of three types of infrastructure resources that offer a "wide variance of social goods" (p. 67). For this study's purposes, social goods are mobile phone connectivity through CCNs. In exploring social infrastructure, it is crucial to determine the community's needs, available resources, resources that will respond to these identified needs, institutions and organizations that support the provision of the identified needs, and a communication system between these institutions and organizations.

The enduring dimensions of social infrastructure are institutions providing both public and private resources to cater to identified needs. In this study, the community is provided with communication technology that may create an infrastructure that will be helpful for the community's development (see Huysman and Wulf 2004). The different resources are coordinated through the linkage of various institutions and a communication system among them. This information system also allows for the emergence of trust

among the involved organizations (ibid). This study thus hopes to add insights into social infrastructure design through examples of organizational collaboration in the Philippines. This is crucial because, as Bielaczyc (2006) notes, the literature does not provide a framework on how to design social infrastructure—or at least, there is no widely accepted guide in the literature for perfecting social infrastructure.

Crucial in analyzing social infrastructure is seeing how it is strengthened and fostered through governance. Governance is referred to in this paper as the act of managing networks, exchanging resources, and negotiating shared goals, such that the boundaries of private and public organizations become blurred and flexible (Stoker, 1998; Rhodes, 1996). Kim and Lim (2017) assert that such an endeavor does not only help in economic development, but also enables more democratic engagement as well as participation within local communities. It does not only counter social exclusion; it also forwards local empowerment. In order for social infrastructure to offer different social goods (Frischmann 2012) for different types of necessities, various stakeholders with differing mandates need to be tapped. The importance of governance strategies then lies in facilitating conversation and coordination between and among these stakeholders. Reich and Benbasat (2000) emphasize the importance of communication and planning between business and information technology (IT) infrastructure in order to seize IT capabilities and opportunities. This paper adds non-governmental and local-level organizations into the mix. Since governance strategies also bring forth negotiation of involved stakeholders' responsibilities, there is also a tendency to scapegoat and avoid accountability (Stoker, 1998). This tendency is important to note since accountability is crucial for properly maintaining CCNs. Putnam (1993) identifies trust as the driver of coordination and cooperation to arrive at mutual benefits. Overall, governance is necessarily fueled by trust fostered and maintained by benefits and goals.

Community cellular networks

CCNs fall under the broader domain of community networks (CNs), an alternative approach to standard telecom service in which communication infrastructure is built by or with local people who will use the network (Song, 2017). CCNs form part of a worldwide technological phenomenon, consistent with the ushering in of the development of digital technologies at the onset of the 4th industrial revolution. They do not have a single point of origin, as they represent a telecommunications model that has been independently developed and implemented in various regions worldwide. The CCNs examined in this paper are part of the deployments of the VBTS project. The project's towers were designed to be segmented for easier transport and assembly, keeping in mind that the target sites are located in a typhoon alley. When installed, it stands at 12 meters and is supported by six guy wires. A hinged base construction allows the whole tower to be dismantled when needed. With 10 people, it can easily be assembled or dismantled in less than one hour. The tower's wind load capacity is rated at 250 kph. To scale, the highest typhoon classification by the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) is the 'super typhoon', which corresponds to sustained winds exceeding 220 kph.

The areas tackled in this study are composed of coastal communities in the third-class municipality of Dingalan, namely, Sitio Sabang-Limbok and Sitio Market-Bacong; two coastal communities in the third-class municipality of Dilasag, namely, Sitio Dianao and Sitio Dipasaleng; and three coastal communities in the second-class municipality of San Luis, namely, Brgy. Dibut, Sitio Diotorin, and Brgy. Dikapinisan. Coastal communities often face significant risks from natural disasters and are typically underserved in national development initiatives. Flash floods and landslides are common hazards in the area, especially during heavy rainfalls influenced by the northeast monsoon. A notable recent incident was on January 6, 2023, where persistent rain caused floods and landslides, resulting in a 12-hour power outage across the province. The situation was severe in towns including San Luis, with major

roads becoming impassable (Manabat, 2023). Furthermore, the Sierra Madre mountain range isolates these sites and there is no concrete road network that connects these sites to the municipal town proper. Given these risks, the Municipal Disaster Risk Reduction and Management Office (MDRRMO) of San Luis, Aurora installed high frequency (HF) radios that primarily serve as an emergency link to reach these isolated sites. The MDRRMO HF radio network predates the arrival of VBTS towers and has been used by the local government to communicate and coordinate with its remote coastal barangays. However, the other municipalities wherein the CCNs were deployed had no prior network, unlike San Luis.

From the provincial capital of Baler, some of these sites can only be reached by boat which would take between one hour (nearest) to three hours (farthest) given good sea conditions. Prior to the arrival of the VBTS project, the sites had no existing cellular coverage and often relied on messages passed through boat folk and traders. Locals would need to travel by boat to Baler, the nearest location with cellular signal, if they need to contact someone through a phone. It should be noted, therefore, that although cellular service was first introduced to the abovementioned sites through the deployment of CCNs under the VBTS project, many of the locals already owned a cellular phone. Therefore, this paper only accounts for the introduction of cellular signals to the communities and not the introduction of mobile phones.

Community ownership

The VBTS technology allows more local control and has great potential in answering the needs of marginalized sectors in rural communities (Bidwell & Jensen, 2019), specifically women, the elderly, and Indigenous peoples' groups in sites where they are present. We see community ownership fostering a sense of agency among its users (Bidwell & Jensen, 2019). This sense of agency, for one, manifested when barangay officials in Dingalan decided to turn off the CCNs during typhoons. Turning off the satellite when connectivity is important for information dissemination was a product of deliberate and proactive

negotiation between ensuring immediate connectivity on the one hand and maintaining a technology that ensures connectivity in the long run on the other hand. It reflects a strategic decision by community leaders to balance immediate connectivity needs with the broader goal of continuous, reliable service in the face of environmental challenges.

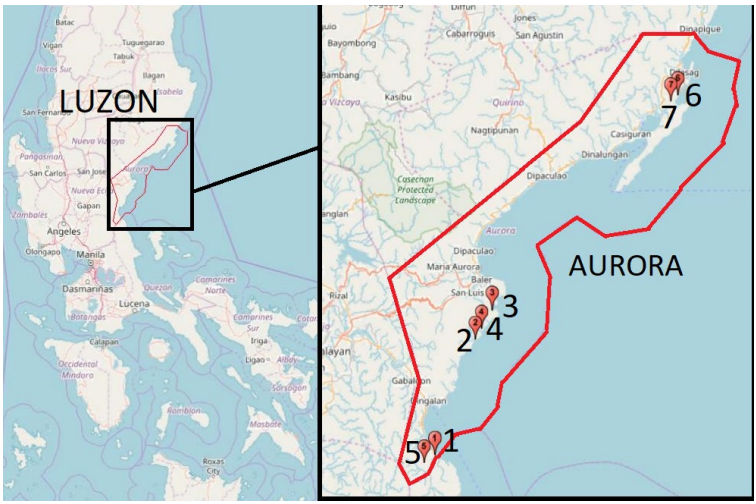

Figure 1. Map of CCN deployment sites. Shown are (1) Sabang-Limbok, Dingalan, (2), Dikapinisan, San Luis, (3) Dibut, San Luis, (4) Diotorin, San Luis, (5) Market-Bacong, Dingalan, (6) Dianao, Dilasag, and (7) Dipasaleng, Dilasag.

However, the potential for agency and design for empowerment comes with caution. This is because a novel technology is implemented in social contexts that require new sets of implementation strategies, and may be managed by people with limited experience (Bidwell and Jensen, 2019). The project involves tower maintenance strategies unfamiliar to local stakeholders, which may lead to mismanagement or inefficiencies. Comprehensive capacity building is therefore needed to mitigate these risks. Possible repercussions will not only be shouldered by the stakeholders, but more so by the community that has jurisdiction over the VBTS towers. Accountability, then, is a necessary component that goes along with the power to make decisions, especially in novel and uncertain environments (Reich and Benbasat, 2000). These

environments in the VBTS project include remote barangays where traditional telecommunications business models do not apply due to economic and geographic constraints.

VBTS stakeholders

The VBTS project relies on stakeholder interaction and collaboration. The main project stakeholders consisted of the University of the Philippines, Aurora State College of Technology (ASCOT), the local government unit (LGU), the telecommunications (telecom) company (specifically Globe Telecom), and active cooperatives in the community.

Table 1: The key stakeholders involved in the VBTS project, with their roles, activities, and contributions. This table is useful for understanding stakeholders' collaboration with respect to the VBTS project, as will be discussed in the findings section.

Stakeholder	**Roles and Responsibilities**	**Activities and Contributions**
University of the Philippines	- Technical maintenance, research, and social enterprise activities - Coordination with ASCOT, LGUs, telecom, and cooperatives - Facilitation of agreements between LGUs and cooperatives - Capacity-building and training for community and ASCOT	- Developed training modules for social science research and operations - Conducted training sessions on UP and ASCOT campuses

Aurora State College of Technology (ASCOT)	- Partner in research and development - Participation in training modules for faculty and research staff	- Involved in negotiations and consultations for project implementation - Formalized partnership with UP through a Memorandum of Understanding (MOU)
Local Government Units (LGUs)	- Coordination of construction and maintenance activities for VBTS towers - Securing permits and land for tower installation - Support and assistance to partner cooperatives - Maintenance and security of equipment	- Implemented a maintenance system for the CCNs - Facilitated agreements with cooperatives and ensured legal compliance
Telecommunications Company (Globe Telecom)	- Provision of necessary frequency signals for the 2G system - Support in regulatory matters and provision of SIM cards and prepaid airtime	- Involved in negotiations for frequency sharing and access to cloud and Interconnect services under CSR

	- Coordination in business model formulation and implementa-tion	
Local Cooperatives	- Day-to-day management of VBTS operations and maintenance - Selling of SIM cards and cellphone load - Coordination with VBTS Team for maintenance and incident management	- Received training on technical, infrastructural, and business management aspects of VBTS - Engaged in cooperative management for social enterprises - Involved in financial and operational tasks related to VBTS, enhancing local business and technology management capabilities

Methodology

Primary data was collated through focus group discussions (FGDs) with stakeholders in May 2019 in the municipalities of Dingalan, Dilasag, and San Luis. We conducted purposive sampling to determine the participants. We sought out members of partner cooperatives in the area, concerned government officials with specific roles pertaining to the project, and sitio

and barangay leaders. The FGDs had an average duration of 66 minutes, 63 minutes being the shortest and 78 minutes being the longest. Furthermore, the FGDs had an average of seven participants—five participants in Dingalan, seven participants in Dilasag, and nine participants in San Luis. The FGDs focused on how the stakeholders communicated with each other in various phases of the project, from the installation of the VBTS tower to the maintenance of the said technology; on the challenges faced by these stakeholders at any point during the project; on what has been done to address such challenges; on the impacts of VBTS specifically on governance; and on plans for the future, especially after the VBTS tower has already been turned over to the community.

We used a semi-structured discussion guide to allow for flexibility in the discussion, especially given the exploratory nature of the study (Hesse-Biber, 2017), which tackles paucity in social infrastructure literature (Bielaczyc 2006). The recorded interviews were transcribed and coded for data processing. Key points were also noted during the FGD sessions to capture the participants' immediate reactions and insights. The transcriptions from the FGDs were analyzed using thematic analysis to identify common themes across different groups. This analysis involved coding the data and identifying patterns related to the VBTS project's effectiveness, community impact, and operational sustainability.

Supplementing the FGD data is an analysis of key documents integral to the planning, executing, and managing of the CCN installation process. This review encompassed various legal agreements and training materials that provided foundational insights into the project's operational and collaborative framework. Specific documents analyzed include:

- Memorandum of Agreement (between Globe Telecom, Inc. and a Second Party): This formal agreement outlines the collaborative relationship between Globe Telecom and the project's second party, detailing the roles, responsibilities, and expectations of both entities in deploying CCNs. The MOA is critical for understanding

the contractual obligations agreed upon by the telecom provider and the project partners, which offered insights into the regulatory, financial, and operational frameworks governing the project.

● Memorandum of Agreement between Globe Telecom, Inc. and the University of the Philippines: This MOA specifies the partnership details between Globe Telecom and UP. It highlights the mutual commitments towards the establishment and maintenance of the CCNs. Analyzing this MOA helps uncover the strategic objectives of both parties, including resource allocation, technical support, and expected outcomes, which are crucial for assessing project implementation fidelity.

● Memorandum of Agreement between UP Diliman and ASCOT: This agreement delineates the cooperative effort between UP Diliman and ASCOT in supporting the local implementation and training aspects of the VBTS. This document is key in evaluating the inter-institutional collaboration dynamics and how these impact the project's capacity-building and sustainability goals.

● Training Handouts: These materials were used during the training sessions for local stakeholders, detailing operational procedures and maintenance protocols for the CCNs. Training handouts provide a direct insight into the knowledge transfer processes and the preparedness of local operators, informing them of the project's effectiveness in building local capacity.

● Memorandum of Understanding on the Construction and Maintenance of the VBTS between UP and the Municipality of San Luis: This MOU establishes the roles and responsibilities of UP and the Municipality of San Luis concerning the construction, deployment, and ongoing maintenance of the VBTS. The MOU is pivotal in understanding the local government's involvement and the logistical and administrative support provided, which are critical for the long-term sustainability of the

infrastructure. This MOU also provides insights into the municipalities of Dingalan and Dilasag.

Analysis and Discussion

The FGD transcripts show that while aspects relating to the construction and operation of the VBTS towers are important and effectively performed, these were located within broader issues of community ownership, capacity constraints, and political responsibility, among others. We discuss these findings below.

Collaboration and communication concerns

Social infrastructure requires an efficient communication system among different organizations and institutions (Pillay and Mitra, 2015; Reich and Benbasat, 2000; Stoker, 1998; Rhodes, 1996). In the VBTS project, communication among different institutions enabled requirements from various components to be addressed simultaneously. Specifically, it proved beneficial in establishing ties with ASCOT, LGUs, and cooperatives, as well as paying attention to infrastructural and technical components related to land surveying, construction works, and installing VBTS towers.

The role of local governments and community leaders was emphasized as pivotal in facilitating the project's logistics. Specifically, across all the FGD transcripts, municipal employees put primacy on land as their LGU's contribution. A government employee in Dilasag even referred to it as *lupa ni Kap* (barangay captain's land), while a municipal officer in Dingalan communicated an assumption that securing land is all they have to do: *"In our case, there wasn't really any participation. We just attended the meeting. As for our office, we only know that the LGU needs to donate land. That's all."* While the local government is seen as providing crucial logistical support, this statement alone foregrounds political issues and disparities in perceived responsibilities among stakeholders.

Despite coordination among stakeholders in earlier phases of the project, results of the FGDs further show lapses in communication and stakeholder involvement in maintaining CCNs. A community leader in Dingalan lamented, "*For us, there was no participation at all. We just attended meetings. In our office, all we knew was that the LGU needed to donate land. That's it. But for the [other VBTS project] activities, we were not involved anymore.*" A government employee in the same municipality seconded: "*In the implementation part, I wasn't the one being talked to. There was no coordination with our actual office. [UP staff] talked to the [local community] without informing me. They were the ones involved there. The [local community] wouldn't tell me because they know it's office hours, [and] I wouldn't allow them to keep going to the [tower site]. I would let them if they did it on a Saturday or Sunday.*"

Stakeholders nonetheless recognized regular and effective communication as crucial. But alongside this recognition is the dismay in instances where coordination faltered, particularly shown in the Dingalan transcript, where the VBTS team had lapses in informing the local engineers during certain implementation phases. As the new Dingalan municipal engineer said, "*I did not know who the [VBTS team] were. The thing is that I was not the one [the VBTS team] talked with [in] earlier [phases], so I didn't know the project.*"

Complicating lapses in coordination and communication is how the CCNs can also fall victim to power relations between and among stakeholders. Change in political leadership entails a change in power dynamics, and the operation and accountability of the CCNs are at times used as cards in the game of politics. This political complexity then threatens the empowering potential (Bidwell and Jensen 2019) of the VBTS project. Individuals of different political leanings tended not to pass on the institutional and operational knowledge about the project. This also highlights the individual aspect of governance—that it facilitates cooperation between and among organizations and the cooperation between and among individuals forming part of the organizations. Two individuals can serve the same local government, but if they do not align politically, they can threaten the project's gains. For instance, one barangay had a new barangay captain that, as he himself

claimed, was not oriented on what the VBTS project is all about. As a barangay captain in one municipality said: "*The previous barangay captain didn't turn over anything. When I won, I didn't know what that VBTS was. Then people came to us. I think they were from UP. They were the ones who came, but the previous captain didn't tell me anything. [There was] nothing like, 'Here, this is yours now! You manage it.' There was nothing like that.*" Another government employee in this same municipality corroborated: "*Unlike before [in] the first site we had, the barangay captains were different... Now, new captains have taken over again. There hasn't been any communication between each cooperative and the new captains that have come in… It would also be good if the cooperative and the new barangay could meet.*"

It is worth noting that tensions in leadership arise, particularly when the incumbent and the elected officers are not in the same patronage network. In the example above, the previous barangay and the new barangay captain garnered the same vote, with the new barangay captain only winning by drawing sticks. Instances where a change of political leadership was smooth, moreover, were identified as possible because the incumbent and the incoming local executive belonged in the same political networks. An example is the new mayor of one of the municipalities in this study: no pressing coordination problem was identified with the change of mayorship since the new mayor is the brother of the previous one.

Social infrastructure pertains to the will and ability of community members and the community to generate and seize opportunities that enhance their well-being (Swanson 1996). Van den Hooff et al. (2004) further distinguish between eagerness and willingness in this regard. They define willingness as a positive attitude towards colleagues, characterized by a readiness to contribute when asked, but without actively volunteering information. In contrast, eagerness is defined as a proactive desire to share knowledge, even without being prompted. Eager individuals will readily offer their expertise, whether solicited or not. The transcripts show that some stakeholders go beyond willingness to actual eagerness, as starkly seen in the experience of San Luis. The fisherfolk cooperative is located in Dimanayat, which is an

hour's boat ride from the sites. Members of the cooperative went to Dimanayat amid the tedious travel. Nonetheless, they voiced their concern about safety and expenses, which puts an extra strain on their responsibility to give mobile load to CCN users. As a San Luis cooperative member illustrated, "*If we need to go to Dikapinisan, we take a motorbike… From Dikapinisan, we pass through Diotorin. From Diotorin, we go to Dibut. It's a huge expense.*" Another cooperative member expounded, "*When we went to visit them [local CCN users] in Diotorin, we swam there. We couldn't get close by any other means. That's what we went through to reach them.*"

Cooperative members still go the extra mile to give load as recognition of their citizenship responsibilities as well as their commitment to the maintenance of the technology. The need for a governance strategy that assures coordination among involved organizations is highlighted by the fact that social infrastructure in the VBTS project accounts for both willingness and eagerness. This means that for organizations to continue with their responsibilities to maintain telecommunications technology, a continuous pattern of coordination must be in place wherein organizations can negotiate responsibilities and expectations through the language of trust. Reich and Benbasat (2000) add that respecting each organization's unique contribution and challenges is also crucial. This need is manifested in cases where technology provides new choices (Ling and Donner 2009c) and new challenges.

Inclusiveness and stakeholder engagement

Engagement varied across the sites. In San Luis, there was a stronger sense of community involvement, while in Dingalan, there were gaps in involving all relevant parties, leading to some feeling excluded from critical discussions and decisions. Participants from the partner cooperatives, barangay officials, tribe leaders from Dibut in San Luis, and municipal disaster risk reduction workers from the three case studies all agreed that the CCNs brought forth economic, social, and political benefits. All these benefits were collective stakeholder goals. The achievement of these goals can be seen as a reflection of trust (Huysman and Wulf 2004a) in the coordination among

stakeholders. The concept of social infrastructure presupposes that various organizations have different needs (Frischmann 2012) but nonetheless are bound together by their goal of seizing opportunities for well-being (Swanson 1996). Given this, it logically follows that governance can help zero in on how these specifically different needs fit into the broader collective goal of ensuring wellbeing.

Ling and Donner (2009) assert that mobile communication amplifies social relationships, helps people be productive, pursue their livelihood, distribute economic development, and form international economic linkages, especially towards overseas migrant workers. All these gains are crucial for vulnerable sectors of the population, state interventions, citizen empowerment, and information dissemination. Kim and Lim (2017) even highlight the potential for such enterprises to counter social exclusion, as economic rewards available to everyone result in the social value of equity. However, this social value is still not extensively discussed in the literature compared to its economic value (Kim and Lim 2017). The FGDs did indeed center on social value, but this social value was largely centered on safety. For example, the participants from the LGUs primarily mentioned situations of disasters, safety, and health to manifest how the CCNs have facilitated governance and wellbeing. A cooperative member in Dilasag shared, "*Even during disasters, our communication has become much faster. Unlike before when I had to ride a tricycle or a motorbike [to the CCN site] and tell [CCN users] this and that. When the signal was established, there was a significant, significant change.*" Such sentiment is also seen in the statement of a San Luis government employee: "*And now, indeed, it's a big help to us, specifically to the DRRMO [Disaster Risk Reduction and Management Office]… for disaster risk reduction, it's a big help to us now that we have communication in the coastal barangay. Before, there really was none. Especially when there are calamities, reporting is quick, warnings are given quickly, too. Or if there's something [CCN users] want to convey, they can call or text it.*"

Aside from the insight that CCNs facilitate faster reporting of possible casualties to the LGU, the CCNs are also crucial in information dissemination to the community

members. A San Luis municipal worker elaborated, "*For example, if our municipal health officer, the doctor, has announcements or messages or instructions to tell the BHWs [barangay health workers] to prepare, we can let people know. Or perhaps midwives or the doctor herself will visit for health services. Engineer [name redacted] might visit for infrastructure, whatever the projects are. There might be an inspection or a team going for a certain project. We are able to provide preliminary information to people.*"

HF radio link was the barangays' only means of communicating with the municipal government before installing CCNs. Every sitio also had its assigned announcer, exerting effort to roam houses and inform residents individually. Locals also previously depended on TV or radio for announcements on typhoon signals, but when brownouts occur and both lose power, residents are left clueless about the current situation. After the installation of CCNs, residents could now directly receive announcements and send inquiries through SMS. Text messages are easily sent out by the municipal government, informing barangay officials about the intensity of the typhoons. They, in turn, urge their constituents to immediately prepare (i.e., keep their boats safely tucked away and their roofs and houses sturdy).

It is worth noting that prior to the VBTS project, it took a couple of days before the said information could reach concerned officials. A community leader in Dilasag testified, "*We [now] have direct contact with [the residents] whenever there's an approaching typhoon. Or after it's over, the [barangay] captain acts quickly. We'll hear him reporting, 'The [number of] families who evacuated from their homes to the evacuation center were like this.' From there, we'll know how many families need immediate assistance. 'Ten houses were partially damaged or had families whose homes were flooded [for example].' It's fast. Communication and reporting are quick.*" This access is crucial in terms of governance because in responding to disasters, various organizations of differing bureaucratic positions, resources, and jurisdictions must be tapped immediately. CCNs help in the governance of disaster management, which is also an important component of social infrastructure because the use of the CCNs exemplifies how

stakeholders seize a new type of technology to forward their well-being.

Challenges and strategic learning

While communication and coordination were effectively performed in certain instances, gaps remained, particularly in inclusiveness and consistent stakeholder engagement. Certain areas reported better integration and responsiveness than others, which indicates a need for more uniform practices in stakeholder involvement to ensure all voices are heard and considered. One of the most consistent themes across the FGDs is the mismatch between community expectations and the actual services provided by VBTS. Residents had high hopes that the VBTS project would deliver connectivity comparable to major telecom providers like Globe or Smart, including expectations for similar promotions and service reliability. A Dingalan government employee shared, "*This is what I hear: It would be better to stop [using CCNs under VBTS] because there are no promos. They say it would be better to stop. We are discussing areas that are predominantly poor. And yet, [CCNs] charges are even higher there, on top of the regular load, texting, and calling of our two network providers.*"

A related concern is the financing capacity among cooperatives. A cooperative member in San Luis asserted, "*Because we are the ones financing, we can't just keep financing without anything coming back to us. We have already provided all the documents required by the telecom [company] to facilitate the agreement between the cooperative and the [telecom company]. Now, if [CCN management] is turned over to us and there is no tangible proof from the cooperative, the cooperative will discuss this, and we cannot continue financing because nothing will come back to us. Our cooperative is about collective saving. If we immediately give [service] for free, we might not be able to sustain it. So, we might still need the load we purchase, hoping at least something comes back to us.*" Such concern is crucial, especially given that mutual interest and benefits figure into the fabric of social infrastructure.

Financing concerns intersect with maintenance concerns. The FGDs highlighted concerns about the financial

sustainability of VBTS, with worries about whether the community could financially support the system once project support ended. A San Luis government employee shared, "*About allocating funds for maintenance, recently, we replaced two inverters, which were funded by the LGU. The LGU has purchased them. The spending has started. The truth is, as the former [cooperative] president said, the barangay really won't release any funds. Financially, nothing is really [available]. That's also in the MOA. It's just the LGU and the cooperative when it comes to activities at the site.*" Maintenance, therefore, is a significant challenge, compounded by reports of the towers not being adequately maintained due to a lack of local technical skills or dedicated personnel. A San Luis government employee admitted, "*The major shift came with the VBTS as it initially improved contact capabilities, but over time we noticed that fewer people were using it due to maintenance issues and lack of familiarity with its operation.*" This statement intimates the need for ongoing training and support, as suggested by a Dilasag government employee: "*The [training events] empower us through technical knowledge on how to run [CCN]. In other words, there's a turnover after the training so that we become, well, empowered and can stand on our own. We will become self-reliant to sustain it.*"

Amid concerns about training, the FGDs also show a paradox: while insights from the FGDs show that CCNs facilitated information dissemination, these CCNs are also subject to misinformation. In Dingalan ang Dilasag, participants complained that the CCNs had weakened the telecommunication signal that the communities had before the installation of CCNs. A cooperative member in Dingalan opined, "*People say that ever since the VBTS was set up here, the signal strength of our cellphones has significantly weakened.*" A community leader in Dilasag echoed this sentiment: "*Because when [CCN] was really built, I lost my signal here. Before, I had three or four bars. I could make contact but I had to hang the cellphone in a certain way. Once it's okay, I don't touch it anymore. I just start talking. But really, when [CCN] was built, the [previous telecom] signal was gone.*"

The concerns that the VBTS signal is weakening the signals of commercial telecom companies are based on a

misunderstanding—the CCNs do not directly degrade the signal quality of other networks. It is merely the presence of the VBTS that influences how phones connect to their home networks. This perceived reduction in signal quality may mean difficulties connecting with their previous telecommunications providers. Furthermore, this misconception can negatively impact the perception and use of CCNs. If users harbor negative feelings towards CCNs under the VBTS project due to this misunderstanding, they may be less likely to utilize the towers for information dissemination or other potential benefits. This hesitation could hinder the overall effectiveness and potential positive impact of VBTS in the community. This is in line with the assertion of Reich and Benbasat (2000) that failures reduce confidence in the technology and diminish risk-taking behaviors to forward that technology.

In one municipality, using boosters makes matters worse, as these boosters strengthen all the signals including those of VBTS. Since VBTS will still have the strongest signal post-boosters, mobile phones will still find it hard to connect to Smart/Globe. Community members buy these boosters online. It cost up to PHP 10,000 and eventually went down to PHP 3,000 pesos when the supply spiked. FGD participants pointed out that beyond the complaints from the users lay the fact that the design of CCNs did not take into consideration the use of boosters. A government employee in one municipality agreed, "*Perhaps previously, the booster wasn't considered in the design of the cell site. It's possible that the booster affected the signals. Maybe [VBTS team] should upgrade the system.*"

The booster situation provides a complicated yet contextual vision of the communities: when technology does not consider local practices, they may negate the technology's benefits. Nonetheless, incorporating boosters comes with a dilemma: it may defeat the purpose of the VBTS project, which is primarily to provide service to underserved areas. Designing community networks that will bow down to boosters aimed at boosting commercial networks is not part of the project's thrust. It is interesting, however, that the suggestion for this design modification came from an LGU employee. This provides a rich

context for governance analysis in two ways. First, it shows that even government workers themselves may be misinformed as to the goals of the project, and second, boosters are informally validated by the LGU although these boosters are formally prohibited. The boosters used on the site are not approved by the National Telecommunications Commission. The fact that the LGU recognizes the use of boosters provides a glimpse of how formal policy limits are negotiated on a grassroots level, especially between private households and the local government. Furthermore, signal boosters can interfere with the overall cellular network, leading to degraded service for other users not just in the immediate vicinity but potentially across a wider area. All these contexts and information do not imply failure in government per se but highlight a crucial fact: governance frameworks and policies must capture realities and negotiations on the ground.

Governance and future prospects

The reality of VBTS's service—marked by an experienced lack of signal and limited promotional offerings—led to widespread dissatisfaction and ambivalence. As a high-ranking official in one municipality lamented, "*Our initial excitement about VBTS was based on the expectation of stronger signals and more economical and practical service, especially given the dire signal situation here with Smart and Globe.*"

Despite the challenges, positive impacts were noted, such as the improvement in disaster communication and the general speed of connectivity, which facilitated quicker communication within and outside the community. This had a tangible effect on local governance and emergency management, proving the potential value of CCNs when functioning effectively. Thus, the necessity of the service in remote areas left many feeling they had no alternative but to continue using VBTS towers. It is within this context that examining governance becomes crucial.

As shown above, local leaders used the technology to enhance governance practices, such as distributing important information and coordinating disaster response efforts more

effectively. In this regard, the FGDs revolved around future planning focused on the need for sustainable practices and models to maintain the operational status of VBTS. Participants expressed a preference for future management to be handled by local entities capable of effectively integrating the technology into the community's socio-economic environment. With this, there was a strong call for partnerships with larger telecom providers to ensure technical and financial sustainability through corporate social responsibility (CSR) initiatives. As one municipality high-ranking official asked, "*Why don't we [in the municipality] tie up with Globe to use our tower powered by Globe, because this provider covers the area and it would make the service more acceptable and workable?"* CSR initiatives were believed to be essential in providing both technical support and financial viability. The distinction between eagerness and willingness is again relevant here, as the question shows that there is an initiative among local leaders to seek further partnerships to keep benefitting from the CCNs.

Other suggestions included better integration with local business practices and possibly leveraging local businesses for ongoing operations. For the future, there was a strong call for more transparent and comprehensive information dissemination about what VBTS can and cannot offer. Stakeholders suggested that promotional strategies be aligned more closely with those of larger networks to make VBTS more appealing. Additionally, the need for a more formalized and supportive transition process was emphasized. This process will ensure that local entities are fully prepared to take over operations without compromising the quality of service. As a government worker in Dilasag planned, "*Moving forward, I see that we could have an MOA with Globe so that the tower does not go to waste and is utilized. Maybe we could transfer it to isolated areas."* Thus far, it is evident that there is a desire for the project to be handed over to local entities, with partnership support to manage it effectively.

Overall, we see that the effectiveness of the VBTS project significantly depended on efficient communication among institutions, vital for coordinating project components such as land surveying, construction, and tower installation. However,

lapses in communication, especially during maintenance phases and political transitions, undermined the project's continuity and highlighted the detrimental effects of political dynamics on operations. Engagement levels also varied across different sites: some experienced strong community involvement while others felt sidelined from crucial decision-making, despite the project bringing recognized social, economic, and political benefits aimed at enhancing community well-being. Furthermore, the project grappled with financial sustainability and discrepancies between expected and actual service levels, often perceived as inferior to major telecom providers. These challenges were compounded by misunderstandings about the technology's impact on existing telecom signals, which affected community acceptance. Despite these issues, the project notably improved disaster communication and overall connectivity— a gain that in itself reinforces the need for future enhancements. This includes forming partnerships with larger telecom providers for better financial and technical sustainability, integrating the technology more thoroughly into the community's socio-economic framework, and ensuring a transparent, supportive transition to local management.

Conclusion

The VBTS project reinforces the concept that effective social infrastructure needs to be contextually grounded and sensitive to the specific requirements of the technology and the community it serves. Consistent with Bielaczyc (2006), this paper maintains that there is not one definite way to design social infrastructure. The stakeholders making up the project and the community's social infrastructure are not definite and fixed. With that as a caveat, we provide three general recommendations. Firstly, enhanced training and capacity building are crucial to address technical maintenance challenges and empower local stakeholders. While UP and ASCOT provided training programs for maintenance officers, these training programs would benefit from outrightly tackling turnover and continuity challenges. Secondly, future plans should focus on transitioning management to community-based

entities. This approach can align the operation of projects like VBTS with local economic and social practices to ensure the project's sustainability comes from a greater sense of community and local ownership. Thirdly, stakeholder communication and engagement are vital and should consider potential disappointments and disillusionment arising from contextual challenges. Employing regular and transparent communication strategies should manage expectations and keep all stakeholders informed about the project's progress and potential limitations. Together, these steps would elevate the effectiveness and sustainability of initiatives like the VBTS. We note that it is essential to focus on building robust communication strategies, especially critical in the aftermath of the COVID-19 pandemic. The pandemic has exposed the vital role of communication technology in maintaining social and economic functions when traditional interaction mechanisms are disrupted.

The VBTS installations democratize access to communication technology, which significantly reduces the hierarchical barriers that traditionally limit access to information and communication channels. In areas where VBTS has been implemented, community members gained direct and equal access to telecommunication services, which disrupted the conventional flow of information that typically privileges certain groups over others. This leveling of the communication landscape allows individuals to engage more actively and independently, as well as reduce reliance on intermediaries who previously controlled information dissemination. Moreover, VBTS projects considerably shorten the communication process by providing immediate access to telecommunication services. This is especially critical in emergency situations where the speed of communication can affect the community's ability to respond effectively. Faster communication facilitates quicker dissemination of warnings and coordination of responses. This enhances community resilience against disasters and enables more efficient exchanges of information that support opportunities.

The results show, nonetheless, that projects like VBTS are not all smooth sailing. The CCNs were not absolutely positively welcomed and maximized in the community. The sentiment towards VBTS was mixed, with acknowledgments of its benefits tempered by frustration over its shortcomings. This mixed reception shows the necessity of foregrounding the project with realistic negotiations of expectations and capabilities. These negotiations are key to maintaining technological development (Reich and Benbasat, 2000). The FGDs clearly indicated a need for adjustments in expectations, service provision, and stakeholder training to bridge the gap between what VBTS promises and what it delivers. Ultimately, this paper illustrates the VBTS project as a pivotal example of how specific technologies can necessitate and strengthen social infrastructure within their target communities. The experiences documented here underline that such technological implementations do not fit a universal model; rather, they require tailored approaches based on each community's unique social, economic, and environmental contexts. Finally, this paper contributes to understanding how localized and community-oriented technological solutions can signal a positive change in terms of connectivity and socio-economic development in remote areas, thus offering a model adaptable to similar contexts in a post-COVID-19 world.

References

Barela, M. C., Blanco, M. S., Martinez, P., Purisima, M. C., Heimer, K., Podolsky, M., Brewer, E., & Festin, C. A. (2016). Towards Building a Community Cellular Network in the Philippines: Initial Site Survey Observations. *Proceedings of the Eighth International Conference on Information and Communication Technologies and Development*, 1–4. https://doi.org/10.1145/2909609.2909639

Barela, M. C., Cunanan, M. T., Festin, C. A., Heimerl, K., Jang, E., Johnson, M. W., Martinez, P., & Vistal, R. V. (2023). Connecting Communities Through Mobile Networks: A Case Study of Implementing Community Cellular Networks in the Philippines. In T. Madon, A. J. Gadgil, R. Anderson, L. Casaburi, K. Lee, & A. Rezaee (Eds.), *Introduction to Development Engineering: A Framework with Applications from the Field* (pp. 567–587). Springer International Publishing. https://doi.org/10.1007/978-3-030-86065-3_21

Barela, M. C., Dionisio, J., Heimer, K., Sapitula, M., & Festin, C. A. (2018). *Connecting communities through mobile networks: The Vbts-CoCoMoNets project* (Global Information Society Watch, pp. 209–213). https://giswatch.org/en/country-report/infrastructure/philippines#:~:text=%5B1%5D%20The%20Village%20Base%20Station,of%20California%2C%20Davis%2C%20and%20Aurora

Bidwell, N. J., & Jensen, M. (2019). *Bottom-up connectivity strategies: Community-led small-scale telecommunication infrastructure networks in the global south* (APC-201906-CIPP-R-EN-DIGITAL-299). Association of Progressive Communications.

Bielaczyc, K. (2006). Designing Social Infrastructure: Critical Issues in Creating Learning Environments With Technology. *Journal of the Learning Sciences*, *15*(3), 301–329. https://doi.org/10.1207/s15327809jls1503_1

Cherry, S. M. (2003). The wireless last mile. *IEEE Spectrum*, *40*(9), 18–22. https://doi.org/10.1109/MSPEC.2003.1228003

de Moraes, T. M. M., de Lima Viveiros, H. A., Jacintho, F. F., Camargo, G. M., Adami, J. F., & Dias, R. A. (2020). The use of technology for the growth of the sustainability concept inside community. *IEEE Global Humanitarian Technology Conference*.

Frischmann, B. M. (2012). *Infrastructure: The Social Value of Shared Resources*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199895656.001.0001

Grabowski, Z. J., Matsler, A. M., Thiel, C., McPhillips, L., Hum, R., Bradshaw, A., Miller, T., & Redman, C. (2017). Infrastructures as socio-eco-technical systems: Five considerations for interdisciplinary dialogue. *Journal of Infrastructure Systems*, *23*(4), Article 02517002. https://doi.org/10.1061/(ASCE)IS.1943-555X.0000383

Hesse-Biber, S. N. (2016). *The Practice of Qualitative Research* (Third). SAGE Publications, Inc. https://us.sagepub.com/en-us/nam/the-practice-of-qualitative-research/book240120

Huysman, M., & Wulf, V. (2004). Social Capital and Information Technology: Current Debates and Research. In M. Huysman & V. Wulf (Eds.), *Social Capital and Information Technology* (pp. 1–16). The MIT Press. https://doi.org/10.7551/mitpress/6289.003.0002

Jarvenpaa, S. L., & Lang, K. R. (2005). Managing the Paradoxes of Mobile Technology. *Information Systems Management*, *22*(4), 7–23. https://doi.org/10.1201/1078.10580530/45520.22.4.20050901/90026.2

Kim, D., & Lim, U. (2017). Social Enterprise as a Catalyst for Sustainable Local and Regional Development. *Sustainability*, *9*(8), 1427. https://doi.org/10.3390/su9081427

Lehmann, A., Zschieschang, E., Traverso, M. *et al*. Social aspects for sustainability assessment of technologies—challenges for social life cycle assessment (SLCA). *Int J Life Cycle Assess* **18**, 1581–1592 (2013). https://doi.org/10.1007/s11367-013-0594-0

Ling, R., & Donner, J. (2013). *Mobile Communication*. Polity Press. https://books.google.com.ph/books?id=4X0QAAAAQBAJ

Magpantay, J. (1998). *Beyond 2000: Assessments of the Economy and Policy Recommendations- Social Sector dealing with Technology Policy*.

Manabat, J. (2023). Heavy rain brings floods, landslides to Aurora. *Rappler*. https://www.rappler.com/philippines/luzon/heavy-rain-floods-landslides-aurora-january-2023/

Manalili, A. G. (1990). *Sama-samang pagpaplano at pamamahala ng mga proyektong pangkaunlaran: Tungo sa kaunlarang mula sa tao, para sa tao*. Kapatiran-Kaunlaran Foundation. https://books.google.com.ph/books?id=goSfGwAACAAJ

Pillay, P., & Mitra, J. (2015). Socialising Entrepreneurship: An Activist Approach. *Journal of Entrepreneurship and Innovation in Emerging Economies*, *1*(1), 79–98. https://doi.org/10.1177/2393957514555050

Preface. (2020). *IOP Conference Series: Materials Science and Engineering*.

Putnam, R. D. (1993). *The Prosperous Community: Social Capital and Public Life*. https://api.semanticscholar.org/CorpusID:153485206

Reich, B. H., & Benbasat, I. (2000). Factors That Influence the Social Dimension of Alignment between Business and Information Technology Objectives. *MIS Quarterly*, *24*(1), 81. https://doi.org/10.2307/3250980

Rhodes, R. A. W. (1996). The New Governance: Governing without Government. *Political Studies*, *44*(4), 652–667. https://doi.org/10.1111/j.1467-9248.1996.tb01747.x

Song, S. (2017). *Policy Brief: Spectrum Approaches for Community Networks*. Internet Society. https://www.internetsociety.org/wp-content/uploads/2017/10/Spectrum-Approaches-for-Community-Networks_20171010.pdf

Stoker, G. (2018). Governance as theory: Five propositions. *International Social Science Journal*, *68*(227–228), 15–24. https://doi.org/10.1111/issj.12189

Swanson, L. E. (1996). Social infrastructure and economic development. In T. D. Rowley, D. W. Sears, G. L. Nelson, J. N. Reid, & M. J. Yetley (Eds.), *Rural development research: A foundation for policy*. (pp. 103–122). Greenwood Press Inc.

Syrjänen, A.-L., & Kuutti, K. (2004). Trust, Acceptance, and Alignment: The Role of IT in Redirecting a Community. In M. Huysman & V. Wulf (Eds.), *Social Capital and Information Technology* (pp. 21–52). The MIT Press. https://doi.org/10.7551/mitpress/6289.003.0004

Treviño-Lozano, L. (2022). Framing Social Sustainability in Infrastructure Theory and Practice: A Review of Two Road Projects in Mexico from a Business and Human Rights Lens. *Sustainability*, *14*(4), 2369. https://doi.org/10.3390/su14042369

Van Den Hooff, B., De Ridder, J., & Aukema, E. (2004). Exploring the Eagerness to Share Knowledge: The Role of Social Capital and ICT in Knowledge Sharing. In M. Huysman & V. Wulf (Eds.), *Social Capital and Information Technology* (pp. 163–186). The MIT Press. https://doi.org/10.7551/mitpress/6289.003.0010

ATHENA CHARANNE "ASH" R. PRESTO is a Senior Lecturer at the Department of Sociology of the University of the Philippines Diliman. She obtained her Master in Public Policy from the National University of Singapore and her Bachelor in Sociology from the University of the Philippines Diliman. Her policy consultancy work focuses on social policy, particularly gender and development.

Associate Professor **JOSEPHINE C. DIONISIO** is a faculty member and former Chair of the Department of Sociology, College of Social Sciences and Philosophy (CSSP), University of the Philippines Diliman, where she earned her Bachelor of Arts and Master of Arts Degrees in Sociology. Jo teaches undergraduate classes in social psychology, environmental sociology, and foundational social science courses. Her teaching is enriched by her continuous engagement in collaborative interdisciplinary research, which includes research on how to pursue a more inclusive model of rural industrialization and development. Before joining the academe, Jo worked in a development NGO, where she developed the passion and commitment to pursue social justice, which continues to be her main motivation in teaching, research, and public service. In addition to teaching and doing research, Jo has also held various administrative positions in UP. Jo is an active member of the International Sociological Association and several of ISA's Research Committees including RC 23 (Sociology of Science and Technology) and RC 24 (Environment and Society), where she currently serves as Member of the Board of Directors.