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From Telecentres, Community Networks To Sustainable Smart Villages and Smart Islands

Case Studies

ITU

Internet Society

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Section 1: Introduction

Digital Divide

Broadband connectivity and Information and Communication Technologies (ICTs) can significantly improve progress towards all 17 United Nations Sustainable Development Goals (SDGs). Mobile and fixed-line broadband contributes to gross domestic product (GDP) growth[1]. ITU research finds that a one per cent increase in fixed or mobile broadband penetration leads to a rise in GDP of 0.08% or 0.15%, respectively[2]. However, the benefits of increased connectivity go beyond economic growth. A close relationship exists between connectivity and the human development index[3]. Mobile and fixed-line broadband contributes to ending poverty and improving food security, education, healthcare and more.

According to the ITU, there has been significant growth in access to mobile broadband in Asia and the Pacific, from 61.7 to 89.3 active mobile broadband subscriptions for every 100 inhabitants between 2017 and 2022[4]. However, many economies continue to have low rates below 50 per 100 inhabitants, including Lao PDR, Nepal, India, Pakistan, Timor-Leste, Afghanistan, Papua New Guinea, as well as several small island states such as Kiribati, Samoa, and the Solomon Islands[5]. There are persistent disparities in access to fixed-line broadband in Asia and the Pacific. Fixed-line subscriptions stand at 17.9 per 100 inhabitants in 2021, above the world average of 17.6%. However, the average is skewed by some countries in the region with exceptionally high proportions of fixed-line broadband subscriptions, such as South Korea (44.27%), Australia (35.04%), New Zealand (35.11%), Japan (36.08%), and China (37.58%). Many economies have

[1] ITU, 'Economic Impact of Broadband in LDCs, LLDCs, and SIDS: An Empirical Study'.

[2] ITU, 'Global Connectivity Report 2022', 25.

[3] ITU, 25.

[4] ITU, 'World Telecommunication/ICT Indicators Database'.

[5] ITU.

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less than five subscriptions per 100, and some have less than one[6]. Thus, while there has been some progress in closing the digital divide, the region remains the second least connected region worldwide behind Africa, with only 61% of the population using the internet, and being home to the majority of the 2.9 billion people still offline[7].

The stark differences between countries within the region, particularly in landlocked and island states, have only been exacerbated through the COVID-19 pandemic[8]. Global data shows that least developed countries and landlocked developing countries are lagging, with only 27% and 35% of the population using the internet in 2021, respectively[9]. While small island developing states worldwide have a relatively high percentage of people using the internet at 64%, the coverage gap is significantly larger than the regional average of 10% compared to under 5% throughout the region[10].

Building the infrastructure to support broadband and access to ICTs can be challenging in certain areas, mainly due to vast geographical distances, rugged terrain, and dispersed island communities. Rural and remote communities often lack internet coverage due to the high cost and low return on investment in network deployment in sparsely populated areas. Thus, combining private and public resources is crucial to bridging the digital divide and bringing internet access to underserved areas[11].

However, extending network coverage is not enough to ensure the benefits of increased broadband penetration. In addition to the coverage gap, there remains a large affordability gap that leaves many individuals, especially in the least developed countries (LDCs), landlocked developing

[6] ITU.

[7] ITU, 'Global Connectivity Report 2022', 43.

[8] Liu and Fan, 'The Digital Divide and COVID-19'; Jun, Park, and Kim, 'Digital Transformation Landscape in Asia and the Pacific'.

[9] ITU, 'Global Connectivity Report 2022', 43.

[10] ITU, 'Global Connectivity Report 2022'.

[11] ITU, 'Connecting Humanity Assessing Investment Needs of Connecting Humanity to the Internet by 2030'.

countries (LLDCs), and small island developing states (SIDS), unconnected despite living within broadband coverage. In many LDCs, LLDCs, and SIDS, the average cost of mobile packages as a percentage of GNI is significantly higher than the 2% affordability target[12]. The high cost of the internet in these countries highlights the importance of holistic connectivity initiatives that provide affordable connectivity opportunities to unconnected individuals and communities.

Challenges for Remote Islands and Villages

Limited access to broadband and digital services keeps communities from experiencing connectivity benefits in remote islands and regions. Low levels of access and coverage are due to various factors, including limited access to broadband connectivity, affordability issues, and poor digital skills. There are several dimensions to consider regarding restricted access to broadband connectivity. These include a lack of infrastructure for the delivery of digital services, limited resilience in broadband connectivity, and a need for sustainability in broadband connectivity. Further challenges include the lack of awareness, confidence and skills needed to harness the benefits of connectivity successfully.

Affordability is another critical issue regarding limited access to digital services in remote islands and villages. A lack of affordable devices, Internet services, and Wi-Fi in public places such as schools, hospitals, libraries, and offices characterises a need for more affordability. Insufficient digital skills also play a role in limiting access to digital services. A lack of training programs, education opportunities for digital literacy and skills, and community engagement for youth and women contribute to the insufficiencies in digital skills. Finally, the limited availability of digital services further undermines the extent communities can benefit from digital connectivity. There tends to be a need for more service delivery platforms, digital applications, and services that support e-commerce, education, health, finance, agriculture, fishing, and tourism.

Smart Villages and Smart Islands Initiative of the ITU

The International Telecommunication Union (ITU) has developed the Smart Villages and Smart Islands initiative to address the obstacles preventing communities in remote islands and villages from reaping the benefits of digital connectivity. This program is an evidence-based, human-rights-based, future-proof, partnership-driven, and whole-of-government approach. It has four

[12] ITU, 'Global Connectivity Report 2022'.

primary objectives: to make broadband connectivity accessible to remote islands and villages, to enhance affordability, to enhance digital skills, and to widen the range of digital services delivered.

Making broadband accessible involves establishing access to broadband networks needed for delivering digital services for all and improving the resilience of networks and connectivity. Enhancing affordability involves shared broadband connectivity and devices, a shared or common digital infrastructure, government support for universal service obligations (USO), public-private partnership models, and public WiFi in schools, hospitals, public offices, and libraries.

Enhancing digital skills is crucial to the ITU's Smart Villages and Smart Islands initiative. It involves conducting training and digital literacy programs to raise awareness within target communities, collaborating with partners to implement cross-sectoral initiatives, fostering community experts' ownership, and empowering youth, women, and persons with disabilities through targeted activities. These efforts aim to improve digital literacy and skills within remote islands and villages, ultimately allowing residents to fully utilise and benefit from digital connectivity.

Widening the range of digital services delivered involves recognising that limited access to broadband and digital services in remote islands and villages undermines the benefits of connectivity. Therefore, digital applications and services of high priority to the community are made available for socio-economic development.

Smart Villages and Smart Islands are a “holistic and inclusive approach for rural digital transformation towards achieving the SDGs in remote and underserved communities”, communities “that leverage digital connectivity, solutions and resources for its development and transformation towards attaining the SDGs”. This approach recognises that providing connectivity alone is insufficient to ensure local communities benefit from the internet. It, therefore, builds on a whole-of-government approach, multistakeholder engagement, including the participation of local communities, and citizen-centred digital services as critical ingredients that will ensure that the digital network infrastructure can deliver sustainable development of inclusive and equitable services[13].

[13] ITU, ‘Building Smart Villages: A Blueprint as Piloted in Niger’, 18.

The concept adopts a whole-of-government approach since one agency or ministry cannot solve the complex challenges of digital connectivity but can contribute its unique talents, skills and resources while reducing duplication of expenditure, operational costs, and barriers to the introduction of new services[14]. Furthermore, governments must demonstrate the political to extend meaningful connectivity to rural areas. Connectivity initiatives must provide meaningful services to the local communities to succeed, including services across various domains depending on the local circumstances, including health, banking, education, job search, entrepreneurship agriculture, crime prevention, and e-government services[15]. Lastly, a multistakeholder collaboration, including the participation of local communities in the design and implementation of Smart Villages and Smart Islands initiatives, is crucial. Smart villages and Smart Islands thus need to consider the varying needs and concerns of different sections of local communities while building strong partnerships with both private and third-sector actors to address these needs and concerns[16].

The Smart Villages and Smart Islands approach to connectivity promises a wide range of benefits over traditional methods. Individuals and organizations can conveniently utilize comprehensive services whenever and wherever necessary. These services are flexible and can be tailored to the specific requirements of citizens, groups, or institutions. The collection of these combined services is consistently enhanced to match evolving local demands. The network of collaborating organizations responsible for establishing and overseeing the intelligent community is consistently acquiring knowledge, adjusting, and personalizing their provisions. Moreover, governmental leadership embraces a holistic strategy that spans ministries and sectors to ensure integration across the board[17].

[14] ITU, 'Building Smart Villages: A Blueprint as Piloted in Niger'.

[15] ITU, 19.

[16] ITU, 'Building Smart Villages: A Blueprint as Piloted in Niger'.

[17] ITU, 4.

Learning from Telecentres

The ITU's Smart Villages and Smart Islands approach is not the first approach to address the digital divide and bring the benefits of digital connectivity to rural and remote communities. One of the earliest concepts to combat the digital divide has been telecentres, which provide valuable insights to ensure the success of Smart Islands and Villages.

While telecentres vary in size, facilities, and services according to the local context, they can be roughly defined as "strategically located facilities providing public access to ICT-based services and applications"[18]. This means that they typically provide internet access, some ICT equipment such as computers, printers, and cameras and access to the internet, a wider variety of ICT and non-ICT-related services relevant to the community, such as providing and meeting spaces[19]. Usually located within the convenient reach of community members, they provide these services at low or no cost[20]. Based on the range of services they provide; telecentres can be categorized into four different kinds: 1. micro or standalone telecentres like phone shops or ICT centres providing some basic services; 2. mini telecentres; 3. basic telecentres; and full-service centres. As technology advances, telecentres are progressing toward becoming fully equipped, versatile community hubs[21].

Telecentres originated in Sweden in the mid-1980s and experienced reasonably rapid growth in countries of the Global North, providing rural and isolated areas with telecommunications services and information technology facilities[22]. However, they have become much more common in countries of the Global South[23]. Although the prominence of telecentres has shifted to the Global

[18] Latchem and Walker, *Telecentres*, 19.

[19] Latchem and Walker, *Telecentres*; Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars'.

[20] Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars'.

[21] Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries', 114.

[22] Latchem and Walker, *Telecentres*; Thai et al., 'Factors Affecting the Sustainability of Telecentres in Developing Countries'.

[23] Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries'.

South, their primary purpose has remained the same. They continue to provide access to ICT tools and services for rural and isolated communities to empower them to meet their economic and communication needs[24]. Due to their focus on developmental goals, telecentres go beyond mere access to ICT tools. They also aim to extend the reach of public services such as education, health, and social services, provide information of general interest to the local community, and develop human capacity, thus encouraging social and economic development and helping to empower marginalised communities[25]. Their value as development instruments has led them to become prominent features of developmental policies and programs of governments and other development actors[26].

Despite their popularity, the success of telecentres has been mixed. While some have been highly successful, particularly if they could access sufficient financial support, many telecentres in developing countries were shut down after a short time[27]. Difficulties in generating the necessary funds to sustain themselves contribute to their short life span. A lack of funding is compounded by other issues such as a lack of relevant services, lack of community ownership, poor pricing structures, lack of well-trained business managers, lack of clear tariff structure, the unclear role of the overseeing agencies as well as theft of equipment[28].

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[24] Sumbwanyambe, Nel, and Clarke, 'Challenges and Proposed Solutions towards Telecentre Sustainability: A Southern Africa Case Study'; Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries', 2.

[25] Latchem and Walker, *Telecentres*; Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars'.

[26] Thai et al., 'Factors Affecting the Sustainability of Telecentres in Developing Countries'; Sumbwanyambe, Nel, and Clarke, 'Challenges and Proposed Solutions towards Telecentre Sustainability: A Southern Africa Case Study'; Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars'; Latchem and Walker, *Telecentres*.

[27] Thai et al., 'Factors Affecting the Sustainability of Telecentres in Developing Countries'; Latchem and Walker, *Telecentres*.

[28] Sumbwanyambe, Nel, and Clarke, 'Challenges and Proposed Solutions towards Telecentre Sustainability: A Southern Africa Case Study', 2 .

Learning from Community Networks

Like telecentres, community networks have emerged as part of strategies to address the digital divide that recently received more attention[29]. Although there is no standard definition of community networks, their main feature is the participation of the local community in the deployment, operation, and governance[30]. Community networks first emerged in the late 1990s, and they built on a long history of cooperation by local communities to meet their needs for communication and media infrastructure[31]. Since then, they have evolved into various technological and institutional models depending on the local circumstances. Networks range from a single shared Wi-Fi hotspot to a federation of local networks as large as a small country and potentially host a wide range of services such as locally hosted offline resources, local-only voice calls, or high-speed broadband connectivity[32].

Community networks form an alternative to large private or state networks and internet service providers[33]. As such, they address two gaps in the traditional telecommunications market, namely "the failure of commercial telecommunications operators to provide decent access to communication to people at the 'lower end of the market,' and of the governments to create suitable regulatory and other conditions"[34]. Community networks have become increasingly viable due to technological developments that make last-mile connectivity devices cheaper and easier to

[29] Gwaka, Haseki, and Yoo, 'Community Networks as Models to Address Connectivity Gaps in Underserved Communities'; Internet Society, 'Community Network Readiness Assessment Handbook'.

[30] Gwaka, Haseki, and Yoo, 'Community Networks as Models to Address Connectivity Gaps in Underserved Communities'; Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'; Micholia et al., 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions'.

[31] Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'; Micholia et al., 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions'.

[32] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; Internet Society, 'Community Network Readiness Assessment Handbook'.

[33] Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'.

[34] Internet Society, 'Community Network Readiness Assessment Handbook', 5.

operate[35]. Therefore, community networks have the potential to address the lack of last-mile connectivity and address the "needs of billions of people in developing countries who have ineffective communication services"[36].

Due to the participatory nature of community networks, they promise various benefits beyond what other forms of connectivity provide. According to Bidwell and Jensen's analysis of 16 community networks worldwide, they can foster a sense of agency, empowerment, personal connections, and inclusion in local communities. Through participation in community networks, women can benefit from community networks[37]. Community networks also bring economic benefits to local communities through the increased affordability of communications and local circulation of money by facilitating local income-generating activities[38].

Developing and sustaining community networks are not without challenges. One main issue they face is regulatory environments that do not foster their growth and replication[39]. In most countries, obtaining a spectrum licence is associated with lengthy, costly, and complicated procedures with multiple government agencies, which can be difficult for community networks to complete. Additionally, some countries have implemented application requirements such as minimum capital or collateral, which most community networks cannot provide. Most community networks are thus limited to using unlicensed spectrum such as Wi-Fi technology. However, while cheap and easy to deploy, these technologies have the drawback that they require a line-of-sight connection. This technological limitation means that towers must be closer together without obstructions such as

[35] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; Internet Society, 'Community Network Readiness Assessment Handbook'.

[36] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South', 9.

[37] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; Digital Empowerment Foundation, 'Wireless for Communities: A Case Book'; Digital Empowerment Foundation, 'Connecting Remote Communities'.

[38] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[39] Bidwell and Jensen.

hills or vegetation, making connecting very remote areas in rugged terrain more challenging. Additionally, technology that is suitable for extreme weather conditions often needs to be imported and is thus subject to high taxes, duties and custom fees increasing the cost of deployment for community networks. High cost of deployment is compounded by the fact that community networks are often limited in their sources of funding, particularly for their initial deployment[40].

Sustainability Challenges

There are many examples of impactful and sustainable telecentres and community networks, but there are also cases of them failing to deliver on their potential. A range of sustainability issues contributes to these failures. Research shows that the main challenge for telecentres and community networks is their underutilisation in rural and remote areas. A lack of awareness of users often causes underutilisation. Telecentres' services have tended to be too basic and do not generate sufficient socio-economic benefits[41]. Other issues around their organisation include a lack of financing and trained personnel[42]. Overall, an analysis of telecentres and community networks shows that providing a location with internet, infrastructure, or other technologies is insufficient. Still, it is essential to study the entire digital ecosystem. An enabling environment is vital for public uptake[43]. The sustainability challenges for community networks are mainly related to the policy and regulatory environment, challenging terrains, geography, and limited financial and human resources[44].

[40] Bidwell and Jensen; Internet Society, 'Unleashing Community Networks: Innovative Licensing Approaches'; Internet Society, 'Report on the Asia-Pacific Regional Community Networks Summit 2019'; Srivastava, 'Community Networks: Regulatory Issues and Gaps–Experiences from India'.

[41] Brown and Hoque, 'Community Based Information Services: A Comparative Study between Bangladesh and Philippine Telecentres'; Sumbwanyambe, Nel, and Clarke, 'Challenges and Proposed Solutions towards Telecentre Sustainability: A Southern Africa Case Study'.

[42] Sumbwanyambe, Nel, and Clarke, 'Challenges and Proposed Solutions towards Telecentre Sustainability: A Southern Africa Case Study'.

[43] Brown and Hoque, 'Community Based Information Services: A Comparative Study between Bangladesh and Philippine Telecentres'.

[44] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

A hurdle for community network achievement of sustainability is challenging regulatory environments. Geared towards commercial ISPs, regulatory regimes often severely restrict the choices available for community networks regarding infrastructure, technology, organisational and financial models. In particular, the technological constraint to unlicensed spectrum and licencing of networks leads to increased cost and decreased reliability of internet connectivity[45].

Community networks also experience difficulties in achieving financial sustainability. One challenge to achieving financial sustainability is the high price of backhaul connectivity relative to disposable incomes in local communities due to the often rural and remote location of most community networks, especially considering that the target groups of community networks are often very price-sensitive to connectivity[46].

Report Objective

Telecentres and community networks provide valuable insights into the development of sustainable Smart Villages and Smart Islands initiative. Therefore, the ITU and the Internet Society commissioned this study to understand lessons learned and success factors emanating from present and past initiatives experiences in introducing community networks and digital services to villages and communities, considering the challenges related to the sustainability of such initiatives. Firstly, the study explores new dimensions to enhance the sustainability of community networks and

[45] Bidwell and Jensen; Internet Society, 'Report on the Asia-Pacific Regional Community Networks Summit 2019'; Srivastava, 'Community Networks: Regulatory Issues and Gaps–Experiences from India'.

[46] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; Internet Society, 'Report on the Asia-Pacific Regional Community Networks Summit 2019'; Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'.

digital services using a whole-of-government, a whole-of-society, and a multistakeholder approach. Secondly, the study provides recommendations for enhancing the sustainable delivery of the Smart Villages and Smart Islands initiative in Asia-Pacific countries, considering connectivity, affordability, digital skills, governance, awareness, and service needs.

The following section outlines a methodology used to develop the study. The third section of the study consists of a literature review of sustainability challenges and lessons learnt from community networks and telecentres. Based on the literature review, the report presents the sustainability dimensions of digital connectivity initiatives and the framework for developing case studies of community networks and telecentres. Section four presents the case studies of connectivity initiatives in the region. Each case study is structured according to the sustainability assessment framework developed based on the literature review and concludes with critical lessons learnt. The final section concludes this report with an overview of key lessons learned and recommendations for future connectivity initiatives.

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Section 2: Methodology

This report aims to provide an overview of learning from telecentres and community networks for future connectivity initiatives and develop a framework for assessing connectivity initiatives' sustainability. To achieve this goal, the research followed several steps. First, the researchers conducted a comprehensive review of the literature on community networks and telecentres. Second, based on the insights of this review, the research team developed a sustainability framework and a questionnaire for assessing connectivity initiatives' sustainability. Third, the research team identified ten case studies of telecentres and community networks in the region and applied the sustainability framework to examine each project's sustainability and key learnings for developing sustainable Smart Islands and Smart Villages. Each case study also served as means to examine the validity of the sustainability and framework and identify areas for future research. Based on the key learnings, the research team developed recommendations for future connectivity initiatives, particularly Smart Islands and Smart Villages in Asia and the Pacific.

Literature Review

The research team conducted a comprehensive literature review of telecentre and community network initiatives, specifically targeting sustainability concerns. They primarily examined academic articles, international organization reports, and NGO documents. To guarantee data reliability regardless of context, they included literature covering global initiatives with an emphasis on the Global South.

The review encompassed case studies discussing challenges and learnings from various initiatives, as well as conceptual studies that synthesized crucial factors and dimensions of connectivity initiative sustainability. To offer a more practitioner-focused perspective, they supplemented these academic studies with reports from governments and national and international development stakeholders.

Drawing on the literature, the researchers then devised a framework to assess the sustainability of connectivity initiatives. They compiled and synthesized the most cited sustainability dimensions from the literature and collected factors contributing to each dimension based on available resources.

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Selection of Case Studies

To showcase the effectiveness of the developed framework and offer recommendations for future connectivity initiatives, the researchers collected data and created various case studies. The selection of case studies aims to demonstrate the diverse range of initiatives across Asia and the Pacific, accounting for geographical differences and highlighting strengths and weaknesses in sustainability dimensions. They reviewed various connectivity initiatives in the region, ultimately selecting ten case studies from South and Southeast Asia, and the Pacific. These case studies represent the variety of the region's geography and cultures. The final selected case studies include telecentres and community networks from Vanuatu, Kiribati, India, Indonesia, Malaysia, Thailand, and Papua New Guinea.

The researchers sought to provide a balanced representation of telecentres and community networks, featuring four community network case studies: TakNet in Thailand, Wireless for Communities (W4C) in India, Ungu Community-Based LTE Network in Indonesia, and the Common Room Community Network Initiative in Indonesia. The report also includes six telecentres case studies: the Telecentre Program for Orang Asli (TPOA) in Malaysia, Gram Marg in India, Computer Laboratory and Internet Community Centre in Vanuatu, the Kinect Network Telecentre in Papua New Guinea, and Community Telecentres in Kiribati and Vanuatu.

Data Collection and Analysis

The research team formulated a set of questions to apply the framework to examine the selected case studies (see Annex 1). The questions are based on the sustainability framework and developed using existing questions found in the handbooks created by the Internet Society[47] and Micholia[48] for evaluating and constructing sustainable community networks. The existing questions were adapted, and additional questions were developed to fit the sustainability framework outlined above. The researchers utilised these questions and developed new ones to align with the sustainability framework described earlier. The researchers employed these questions to guide the data collection, develop case studies and perform analysis.

[47] 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'; 'Community Network Readiness Assessment Handbook'.

[48] 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions'.

Data collection combined desk review and primary data collection. For all the initiatives, the research team examined publicly accessible available data, including academic studies, reports from development organisations, and the initiatives' online materials. The researchers categorized and coded the obtained data based on the framework outlined in the next section. However, due to data limitations, not all dimensions presented in the framework appear in some cases. Specifically, the environmental sustainability and policy sustainability dimensions were difficult to develop based on available data. The authors acknowledge this limitation and recommend further research to address these areas.

In certain some cases, namely the Community Telecentres in Kiribati and Vanuatu and the Kinect initiatives in Papua New Guinea, primary data collection was in the form of stakeholder interviews, The developed questions and framework (refer to Annex 1) served as interview guidelines in these instances. Using the developed framework, they analysed the collected data to assess the initiatives' overall sustainability. From these insights, they gathered key learnings and synthesized them into recommendations for future connectivity initiatives.

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Section 3: A Literature Review and Connectivity Initiative Sustainability Framework

Sustainability Dimensions

The literature on the sustainability of telecentres and community literature overlaps considerably. The sustainability of a telecentre is defined as the "capacity to generate enough revenue from ICT-enabled services to ensure continued existence in the community, fulfilling the socio-economic well-being of the society"[49]. However, "both financial and social outcomes, […] are dependent on other dimensions of the ecosystem involving policy, organization and operational matters"[50]. The literature on community networks also highlights the importance of factors beyond the financial dimension of sustainability, especially considering the participatory nature of community networks[51].

The literature[52] on Telecentres thus considers the following six areas of sustainability:

- financial sustainability,
- social and cultural sustainability,
- operational/technological sustainability,
- organisation sustainability,
- policy and political sustainability, and
- environmental sustainability.

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[49] Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars', 4.

[50] Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries', 3.

[51] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[52] Sarker, 'Policy Framework towards Sustainability of Union Digital Centres in Bangladesh'; Tan et al., 'The TPOA Telecentre'; Thai et al., 'Factors Affecting the Sustainability of Telecentres in Developing Countries'; Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries'.

The Internet Society [53] distinguishes between five types of sustainability for community networks including:

- economic sustainability,
- socio and cultural sustainability,
- political and organizational sustainability,
- legal sustainability, and
- and environmental sustainability.

Social and cultural factors are crucial for ensuring the sustainability of connectivity initiatives and equal access to services and benefits within the community. The dimensions utilized in community networks and telecentres exhibit significant overlap. Both strands of literature cover the same factors in the dimensions of social or cultural sustainability and environmental sustainability. Therefore, the dimension of socio-cultural sustainability has been adapted by merging the two.

The dimensions of policy and legal sustainability within telecentres and community network literature overlap closely. The policy sustainability dimension is adopted as it incorporates legal and political support factors. The latter is clustered within the organisational dimension within community network literature. Including policy sustainability in the evaluation of sustainability of community, networks is essential as the literature consistently highlights the significant impact policy and regulations have on the sustainability of such initiatives.

The organisational sustainability dimension is adopted with a focus on governance of the initiative, excluding external political factors. The split of internal organisational factors from the external policy environment in the organisation and policy sustainability dimensions allows for a more nuanced evaluation of the initiative's sustainability.

In the literature on community networks, economic sustainability encompasses financial aspects such as financial viability and business models, as well as operational aspects like personnel, skills, service delivery, and economic outcomes for the community. However, the literature on telecentres distributes these factors between financial and operational sustainability, with the latter including technological aspects. For this study, the latter approach was chosen to enable the framework to

[53] 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'.

evaluate both dimensions separately, considering the diverse nature of the initiatives in question. This approach allows for a more thorough evaluation of technological factors in isolation, as well as other sustainability dimensions. Additionally, it highlights the importance of relevant and high-quality services for the initiative's overall adoption and sustainability, enabling the evaluation of the initiative's ability to continue delivering such services to the community.

We have thus arrived at the following areas of sustainability:

- **Financial sustainability:** the ability of the initiative to generate enough revenue to ensure its continued existence.
- **Socio-cultural sustainability:** the initiative's ability to foster social cohesion and a common identity, or at least a spirit of sharing common resources to ensure the continued participation of key actors and stakeholders.
- **Organisational sustainability:** the initiative's organisational capacity to deliver services reliably and the extent to which organisational structures are empowering the participants.
- **Operational sustainability:** the capacity of the initiative to continually offer high-quality and relevant services to the community.
- **Policy sustainability:** the broader political and policy framework and whether they enable or constrict the initiative and issues of legality, licensing, and government support.
- **Environmental sustainability:** the impact of the initiative on its environment and to what extent it disrupts local ecosystems.

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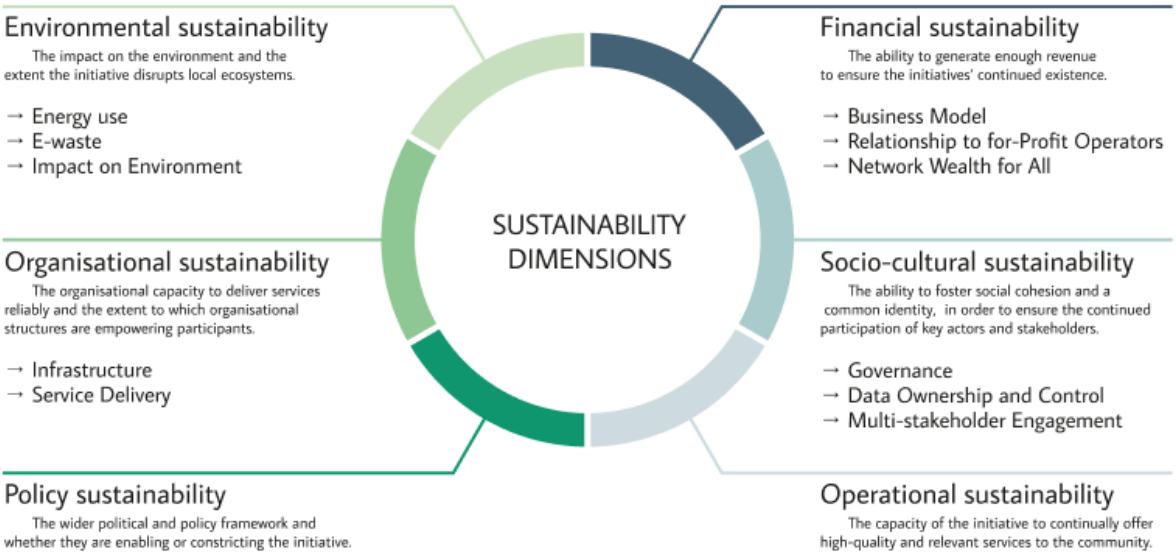

Financial Sustainability

Financial sustainability is a significant challenge for telecentres and community networks[54]. Generally, financing models can be differentiated between support from public agencies or institutions such as government agencies or development organisations, donations from other sources such as crowdfunding or one-time grants, member subscriptions, in-kind support or offering of other services[55]. The literature on community networks and telecentres highlights the importance of multiple forms of income streams, particularly the importance of self-generated income through local entrepreneurial activities[56].

[54] Thai et al., 'Factors Affecting the Sustainability of Telecentres in Developing Countries'; Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars'; Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'; Internet Society, 'Report on the Asia-Pacific Regional Community Networks Summit 2019'; Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[55] Micholia et al., 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions'; Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries'.

[56] Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries'; Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars'; Micholia et al., 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions'.

For community networks, it is challenging to gather the resources first to set up the network and establish backhaul connectivity[57]. Operating community networks is relatively low-cost, but backhaul connectivity is often more expensive than commercial operators due to the sparse population and conditions in which community networks service[58]. These factors make backhaul connectivity one of the leading financial constraints for community networks, especially considering that their target population often is particularly price-sensitive[59]. Consequently, the financial sustainability of community networks is impacted by the density of users and their income levels, usage-dependent costs (primarily upstream connectivity and, to some extent, energy), and fixed operating costs[60]. Considering these factors, community networks must gain a critical mass of users to sustain themselves long-term[61].

Community networks and other sustainability initiatives change over time as they mature and potentially adapt to changes in their context. A report by the Internet Society[62] differentiates between four key stages of community networks: starting, sustaining, growing, and maturing. During the starting phase, the key goals are to plan, get equipment, find initial customers, and seek funding. In the sustaining phase, the goal is to reach an operational break-even point and gain an understanding of their economic situation and opportunities. In the growing phase, the goal is to expand the network and reach a total break-even point. Finally, in the maturing stage, community networks need to move beyond the break-even point to reinvest profits into CapEx upgrades. Depending on the stage a community network is in, different sources of finance are appropriate. While in the beginning, the initiative should look for innovative solutions and government or other

[57] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[58] Bidwell and Jensen.

[59] Bidwell and Jensen; Digital Empowerment Foundation, 'Connecting Remote Communities'.

[60] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[61] Micholia et al., 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions'.

[62] Forster, Matranga, and Nagendra, 'Financing Mechanims for Locally Owned Internet Infrastructure'.

grants, it can move towards traditional sources of capital and move from partial cost recovery to total cost recovery[63].

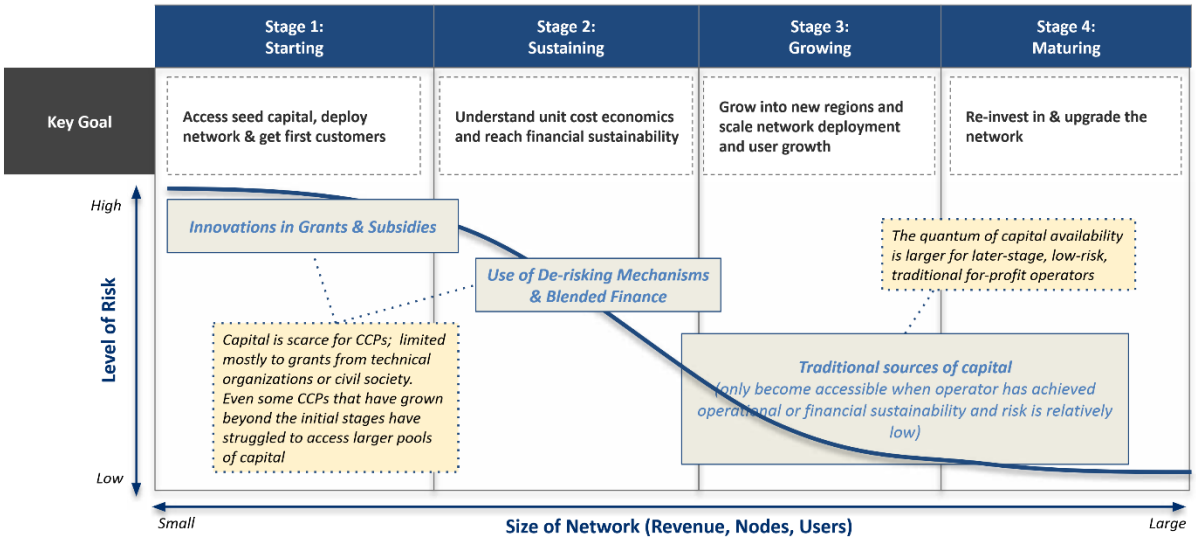

Figure 1: Extracted from: Forster, J., Matranga, B., & Nagendra, A. (2022). Financing Mechanims for Locally Owned Internet Infrastructure. Internet Society. https://www.internetsociety.org/wp-content/uploads/2022/10/Financing-Mechanisms-for-Locally-Own

Organisational Sustainability

The literature on telecentres and community networks stresses the importance of organisational factors for the sustainability of these initiatives[64]. For telecentres often run through local government agencies, factors contributing to organisational sustainability include effective management, monitoring and evaluation, and well-trained personnel[65]. Other authors highlighted the benefits of cross-sectoral cooperation in the form of PPPs. A comparison of telecentres in Bangladesh and the Philippines showed that the private sector employees were more skilled and

[63] Forster, Matranga, and Nagendra.

[64] Tan et al., 'The TPOA Telecentre'; Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars'; Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries'; Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'.

[65] Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries'.

motivated than government officials as their income was directly dependent on the telecentre's performance[66].

The literature on community networks also stresses the importance of governance and organizational structures, given the open and participatory nature of the community network models[67]. Significantly, community networks rely directly on the participation of the community and thus need to facilitate and allow for conflict resolution and participation of stakeholders, including issues such as "empowerment, active ownership of resources and data, control of one's own communication needs, […] and the rights of the network's users"[68].

One more concern that merits attention is the possible risk of free riders and misuse due to the open nature of community networks. This issue can be tackled through technological solutions like blockchain or community currencies, or by implementing organizational strategies such as incentive and punishment structures[69]. Certain challenges, like managing backhaul connectivity and administrative matters such as licensing and networking with development partners, can be particularly difficult for local communities to handle[70]. Bidwell and Jensen[71] discovered that more established and successful community networks frequently belonged to a regional or umbrella organization that assumed such responsibilities, thereby enhancing their organizational sustainability.

The findings indicate that a comprehensive multistakeholder approach is crucial for the sustainability of connectivity initiatives. Involving government and private sector actors in these

[66] Brown and Hoque, 'Community Based Information Services: A Comparative Study between Bangladesh and Philippine Telecentres'.

[67] Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'.

[68] Internet Society, 94.

[69] Micholia et al., 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions'.

[70] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[71] 13.

initiatives creates opportunities to provide a broader range of services, thereby enhancing the relevance of internet connectivity for local communities. Local connectivity initiatives can also draw upon the expertise and resources of public and private sector participants. Simultaneously, active engagement of the local community in the initiative fosters organizational sustainability by ensuring that the initiatives can continue even after the support from other stakeholders has ended.

Operational Sustainability

For the operational sustainability of telecentres and community networks, it is crucial that the underlying technology is robust and allows for the reliable offering of services. One main issue both types of initiatives face, particularly in very remote areas, is the reliability of electricity[72]. Another issue is the reliability of internet connection for community centres, particularly the backhaul connection[73]. Especially in the Asia-Pacific region, internet connection might be vulnerable to weather and climate events such as thunderstorms, making it difficult and dangerous to maintain infrastructure such as towers[74]. Offering offline and local network services can thus be very beneficial to overall sustainability, as demonstrated in the case of telecentres in Malaysia[75].

The literature on community networks highlights that government regulations are one of the main factors that limit the technological robustness of community network backhaul connections[76]. Although there are many new technologies available that should make it easy to establish connectivity for community networks, regulatory issues, import duties, and delivery charges tend

[72] Tan et al., 'The TPOA Telecentre'; Brown and Hoque, 'Community Based Information Services: A Comparative Study between Bangladesh and Philippine Telecentres'; Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[73] Tan et al., 'The TPOA Telecentre', 7 ; Srivastava, 'Community Networks: Regulatory Issues and Gaps–Experiences from India'; Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[74] Tan et al., 'The TPOA Telecentre'; Srivastava, 'Community Networks: Regulatory Issues and Gaps–Experiences from India'.

[75] Tan et al., 'The TPOA Telecentre'.

[76] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; Internet Society, 'Report on the Asia-Pacific Regional Community Networks Summit 2019'; Srivastava, 'Mapping the Regulatory Environment of Community Networks in India, Myanmar & Philippines'.

to limit community networks to using Wi-Fi spectrums[77]. Government regulations that require active and passive infrastructure sharing and reducing barriers to utilizing more sustainable and robust technologies are therefore crucial for improving the operational sustainability of community networks.

Research shows that the quality and relevance of digital services offered through telecentres is an essential factor that contributes to their success[78]. Case studies in Vietnam, Bhutan and Bangladesh show that the integration of digital government services, including e-government, significantly improves the utilization of telecentres by local communities while also increasing government commitment[79].

Furthermore, barriers for community members to use digital services must be reduced. In particular, the importance of trained staff is highlighted throughout the literature[80]. The potentially steep learning curve related to technology could inhibit local community members from using and benefiting from the services offered, thus necessitating the presence of trained staff[81]. Another factor is the reliance of some centres on volunteer staff for the operation of the centre who need to be adequately trained as the professional staff might not be always available, as seen in the case of Telecentres in Malaysia[82].

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[77] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South', 56; Internet Society, 'Report on the Asia-Pacific Regional Community Networks Summit 2019', 5; Srivastava, 'Mapping the Regulatory Environment of Community Networks in India, Myanmar & Philippines', 15.

[78] 1World Connected, 'EMPOWERING RURAL COMMUNITIES: REACHING THE UNREACHED'; Brown and Hoque, 'Community Based Information Services: A Comparative Study between Bangladesh and Philippine Telecentres'; Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries'; Tan et al., 'The TPOA Telecentre'; Thai et al., 'Factors Affecting the Sustainability of Telecentres in Developing Countries'.

[79] Brown and Hoque, 'Community Based Information Services: A Comparative Study between Bangladesh and Philippine Telecentres', 5; 1World Connected, 'EMPOWERING RURAL COMMUNITIES: REACHING THE UNREACHED', 4; Kamarudin et al., 'Factors Predicting the Adoption of E-Government Services in Telecenters in Rural Areas', 15.

[80] Tan et al., 'The TPOA Telecentre'; Brown and Hoque, 'Community Based Information Services: A Comparative Study between Bangladesh and Philippine Telecentres'; Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries'.

[81] Tan et al., 'The TPOA Telecentre', 5; Kamarudin et al., 'Factors Predicting the Adoption of E-Government Services in Telecenters in Rural Areas', 16.

[82] Tan et al., 'The TPOA Telecentre'.

These findings demonstrate the importance of going beyond providing connectivity to ensure the community benefits from the internet. This approach is reflected within the ITU Smart Villages and Smart Islands initiative which advocates for introducing digital services in different sectors such as banking, health, education, agriculture, job search and e-government services that can enhance the community's well-being[83]. Digital services have the advantage that they are accessible anytime and anywhere, are easily adapted to the local circumstances and needs, and ensure the relevance of connectivity for the local community[84]. By offering a wide range of digital services, connectivity initiatives further empower community members to become digital citizens contributing to achieving the SDGs[85].

Policy Sustainability

Political support is one of the main factors of telecentres' success, including a supportive regulatory and policy regime, a commitment to provide telecentres to rural and remote areas, and adequate staffing and financial resources[86]. Government support can and should integrate e-government services to increase digital services available at telecentres[87]. A case study of telecentres in Bangladesh highlights the importance of support, especially in the early years of the initiative. Initial support can take the forms of capacity building, digital and entrepreneurial skills development, and the building of strong organisational ties with local government administrators.

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[83] ITU, 'Building Smart Villages: A Blueprint as Piloted in Niger'.

[84] ITU.

[85] ITU.

[86] Whyte, *Assessing Community Telecentres: Guidelines for Researchers*; Thai et al., 'Factors Affecting the Sustainability of Telecentres in Developing Countries'.

[87] 1World Connected, 'EMPOWERING RURAL COMMUNITIES: REACHING THE UNREACHED'; Brown and Hoque, 'Community Based Information Services: A Comparative Study between Bangladesh and Philippine Telecentres'; Kamarudin et al., 'Factors Predicting the Adoption of E-Government Services in Telecenters in Rural Areas'; Thai et al., 'Factors Affecting the Sustainability of Telecentres in Developing Countries'.

Continued support over long periods is also essential, as it can take years for telecentres to be financially self-sustaining[88].

Community networks struggle with the fact that they are often not given sufficient recognition by national governments or the same support as for-profit operators in connecting rural and remote areas[89]. Nevertheless, the success of any community network depends directly or indirectly on public policies on local, national, and international levels[90]. Operating networks and providing network services often come with certain legal obligations. Depending on the context, this can create difficulties as many telecommunications legislations do not consider community networks. Legal ambiguity might hurt the community network as people will be reluctant to participate, and funds will be harder to access[91]. Moreover, competition and legal conflicts with telecom companies can put an entire community network project at risk. Rather, community networks should focus on fostering synergies with various stakeholders, including private sector companies[92].

Possibly the largest constraint community networks face is adverse regulatory regimes[93]. Complicated and expensive licencing regimes, limitation of bandwidth, a lack of recognition of not-for-profit network operators, illegality to compete with telecommunications operators, the high import tax of technology, and limitation on sharing public Wi-Fi hotspots all contribute to

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[88] Faroqi, Siddiquee, and Ullah, 'Sustainability of Telecentres in Developing Countries'.

[89] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South', 17.

[90] Srivastava, 'Mapping the Regulatory Environment of Community Networks in India, Myanmar & Philippines', 15 .

[91] Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities', 95; Micholia et al., 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions', 20.

[92] Micholia et al., 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions', 20.

[93] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South', 9.

constraining regulatory environment[94]. Furthermore, existing structures of governments are not geared towards community networks but towards telecommunications companies. Community networks generally do not benefit from government support for extending network coverage, such as USF[95]. Nonetheless, this challenge can be tackled by adopting innovative regulatory tools and securing essential political support from the government, as demonstrated in Papua New Guinea, which aims to enhance the environment in which community networks operate[96]. In general, this underscores the importance of a multistakeholder approach for local connectivity initiatives[97].

These findings highlight the need for a holistic approach to government involvement in connectivity initiatives. A whole of government approach to connectivity initiatives, as piloted in the smart villages project in Niger, can help to overcome these challenges[98]. Through different governmental agencies and departments working together, it is possible to streamline policy and regulations to effectively implement connectivity initiatives that ensure community benefits[99].

Socio-cultural Sustainability

Telecentres and community networks rely on the successful integration within and participation of the local community for their sustainable operation and to provide benefits to the community[100]. Since they rely on the participation of the community, they must foster a sense of belonging, social

[94] Srivastava, 'Community Networks: Regulatory Issues and Gaps–Experiences from India', 35; Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South', 16; Internet Society, 'Report on the Asia-Pacific Regional Community Networks Summit 2019', 5.

[95] Internet Society, 'Report on the Asia-Pacific Regional Community Networks Summit 2019'.

[96] Internet Society.

[97] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[98] ITU, 'Building Smart Villages: A Blueprint as Piloted in Niger'.

[99] ITU.

[100] Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars', 6; Tan et al., 'The TPOA Telecentre'; Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'; Micholia et al., 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions'.

cohesion, and trust, which should include socialization activities as well as measures that ensure equality and equity in access to the services offered[101]. Furthermore, initiatives need to foster the social capital necessary to allow the community's continued participation[102].

In aiming to foster a community spirit, it is crucial to consider geographically specific cultural and governmental frameworks[103]. Case studies of telecentres in India found that the socioeconomic status of community members impacted how often people accessed the telecentres, with people of lower economic status accessing the telecentre less. However, since the telecentres were run as commercial enterprises, nobody was excluded per se. Occupation also played a role in predicting access to the telecentres if there was an overlap between services offered and certain occupations (i.e., agricultural services). Gender dynamics were also important depending on the context (i.e., female operator, location inside a home); more males or females would be accessing the centre. Thus, it is crucial to consider the local cultural context[104].

Community networks also face challenges concerning the exclusion of certain groups due to socio-economic characteristics due to pricing and out-of-reach locations. However, it is essential to note that this is due to a lack of recognition by national policy and the consequences of challenging regulatory regimes, i.e., the negative effects of forced reliance on Wi-Fi technology[105]. Furthermore, the research found that gender issues also can lead to exclusion in community

[101] Tan et al., 'The TPOA Telecentre'; Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars'; Micholia et al., 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions'; Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'.

[102] Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities', 94; Micholia et al., 'Community Networks and Sustainability: A Survey of Perceptions, Practices, and Proposed Solutions', 20; Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars'.

[103] 1World Connected, 'EMPOWERING RURAL COMMUNITIES: REACHING THE UNREACHED', 4; Mukerji, *ICTs and Development: A Study of Telecentres in Rural India*.

[104] Mukerji, *ICTs and Development: A Study of Telecentres in Rural India*.

[105] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

networks. Gender should thus be a vital consideration in designing and operating community networks[106].

To ensure the socio-cultural sustainability of connectivity initiatives, it is, therefore, advisable to build on some of the key digital principles laid out in the blueprint for the Smart Villages initiative, including developing solutions that are locally appropriate, equitable and inclusive as well as designing with the user or citizen [107].

Environmental Sustainability

"Environmental sustainability refers to the control and appropriate level of exploitation and use of scarce natural resources"[108]. While environmental sustainability has received less attention within the telecentre literature[109], it is crucial to consider ensuring that connectivity initiatives can be a driver towards achieving the SDGs and overall sustainable rural development[110]. For telecentres and community networks, this primarily includes how location and geography influence the choice of technology for connectivity and the resulting potential detrimental effects of infrastructure construction[111].

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[106] Srivastava, 'Barefoot Women Wireless Engineers Creating Socially Viable Community Networks in India'.

[107] ITU, 'Building Smart Villages: A Blueprint as Piloted in Niger'.

[108] Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars'.

[109] Thai et al., 'Factors Affecting the Sustainability of Telecentres in Developing Countries'.

[110] ITU, 'Building Smart Villages: A Blueprint as Piloted in Niger'.

[111] Internet Society, 'Telecommunications Reclaimed: Hands-on Guide to Networking Communities'; Noor, 'A Sustainable Rural Telecentre Concept on Sustainability Pillars'.

Section 4: Case Studies

The following case studies aim to give an overview of challenges and good practices in community networks and Telecentres initiatives throughout Asia and the Pacific. The report presents four case studies of community networks: TakNet in Thailand, Wireless for Communities (W4C) in India, Ungu Community-Based LTE Network in Indonesia, and the Common Room Community Network Initiative in Indonesia. These cases were selected because they showcase the diversity of community networks in the area. TakNet in Thailand shows how adaptability and flexibility in organisational models can enhance community network sustainability. At the same time, W4C exemplifies the tremendous socioeconomic impact such initiatives can have on local communities. In contrast, Ungu Community Base LTE Network demonstrates how creative use of technology can help community networks navigate various challenges. The Common Room initiative demonstrates the potentially positive impact on indigenous communities and the spaces they inhabit.

The report further showcases six case studies of telecentres: the Telecentre Program for Orang Asli (TPOA) in Malaysia, Gram Marg in India, Computer Laboratory and Internet Community Centre in Vanuatu, the Kinect Network Telecentre in Papua New Guinea, and Community Telecentres in Kiribati and Vanuatu. The TPOA demonstrates the importance of the right technical solutions for the context and integrating local communities. The Telecentre programs in Kiribati, Vanuatu, and Papua New Guinea highlight the benefits and challenges of government-initiated telecentre initiatives in remote areas. Lastly, as an experimental initiative that sits between community networks and telecentres, Gram Marg in India demonstrates that there are various models to provide sustainable connectivity in rural communities successfully. Finally, the Kinect Telecentre in Papua New Guinea reflects the importance of political commitment and community involvement.

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Community Networks

TakNet – Thailand

Country	Thailand
Implementing Partners	Internet Education and Research Laboratory (intERLab) at the Asia Institute of Technology (AIT) Net2Home (Social Enterprise) Thai Network Information Centre Foundation Local College Local technicians and bill collectors
Year Initiated	2013
Type of Initiative	Community Network
Business Model	Subscription model Donations for initial CapEx
Technology Model	Wi-Fi Mesh network

Overview

TakNet in the northwest of Thailand is a prominent community network in Thailand, significantly improving the lives of local people. It employs a model which combines external support with an entrepreneurial franchise model to bring affordable wireless internet access to a rural area around the city of Mae Sot in Tak province[112]. The Internet Education and Research Laboratory (intERLab) at the Asia Institute of Technology (AIT) in Bangkok initiated the project in 2013.

[112] APC and IDRC, 'BUILDING LAST-METRE COMMUNITY NETWORKS IN THAILAND'; Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

Financial Sustainability

When the network was initially deployed, it functioned mainly as a mechanism to share the DSL internet connection installed in multiple households. Households with an installation then shared their connection using Wi-Fi to other neighbouring households for a small fee of about 2.5 USD per month. These fees aimed to cover the internet subscription and electricity charges. The network relied on local volunteers for installation and maintenance with support from inTERlab technical staff. Additionally, some of the initial hardware was donated by various outside partners. However, this was insufficient to cover new services, expansion, or repairs[113].

In response to financial sustainability challenges, the project adopted a new business model, including subscription and organisational changes. The subscription amount was increased to approximately USD 8 for each participant, which is still about two to three times lower than a broadband subscription of commercial operators. Furthermore, households with a router installed were required to sign a contract committing not to switch off the router to maintain the network and refrain from reselling the service or using it for business purposes. A social enterprise called Net2Home was established to manage the services and network deployment of TakNet. The management of the community network service through the Net2Home social enterprise includes training local technicians and bill collectors who are paid approximately USD50 and USD30 per month, respectively[114].

Organizational Sustainability

For the project's first three years, the local communities largely governed the network and relied on volunteers for deployment and maintenance. Community members decided where to locate the new gateway and who would collect the subscription fees. However, after the model change, some of the responsibilities were shifted to the new social enterprise. Nevertheless, the network still relies strongly on local people to provide technical services. The strong involvement of local

[113] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; APC and IDRC, 'BUILDING LAST-METRE COMMUNITY NETWORKS IN THAILAND'.

[114] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; APC and IDRC, 'BUILDING LAST-METRE COMMUNITY NETWORKS IN THAILAND'.

entrepreneur technicians, and their gradual assumption of responsibility for running the network, is also seen as a vital strength of the project and in expanding the network to nearby areas[115].

Incorporating various stakeholders has been seen as a key success factor of the project[116]. The initiative relies on a solid partnership between the research and development team led by the Internet Education and Research Laboratory (intERLab) of the Asian Institute of Technology, the corporate social responsibility (CSR) programme of the Thai Network Information Center Foundation (THNICF); and the local community's participation. Furthermore, the local community college in Mae Sot has also played an important role in providing outreach and coordination support.

Operational Sustainability

TakNet's technical infrastructure, which is a component of its operational sustainability, takes the form of a mesh network in which many local routers installed in local households form a network connected to the internet through a central backhaul connection. Mesh networks are more resilient to infrastructure disturbances as one node breaking down will not impact the whole network[117]. The project is further piloting TVWS (TV White Space) technology, which could provide the community with a more efficient and affordable form of backhaul connectivity[118].

The network's operational resilience is bolstered by the deep integration of local technicians who can troubleshoot and perform maintenance services. Additionally, the network provides various other services to increase its relevance to the local community. IntERLab has installed an affordable local weather station and air pollution remote sensing device, both connected to the mesh network. A rural school wireless mesh network featuring an educational video-on-demand

[115] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; APC and IDRC, 'BUILDING LAST-METRE COMMUNITY NETWORKS IN THAILAND'.

[116] APC and IDRC, 'BUILDING LAST-METRE COMMUNITY NETWORKS IN THAILAND'; Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[117] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[118] Adisorn Lertsinsrubtavee, 'TakNet – A Community White Space Wireless Network'.

system was also deployed at Ban Mae Kued Luang School[119]. TakNet also seeks to implement incentive applications such as distributed ledger and chat applications, along with IoT, which can expand the community network to encompass agricultural services, local village manufacturing activities, and community-based waste or pollution management solutions[120].

Policy Sustainability

The local social enterprise Net2Home acts as the ISP licensee for the services. Unfortunately, local regulations only allow using unlicensed 2.4 and 5 GHz bands, which have limited transmission ranges. However, with a grant from the National Broadcasting and Telecommunication Commission, the intERLab research group tested the use of Carlson TVWS and LTE equipment for connecting rural and remote areas, having obtained special approval for research purposes from the regulator[121].

Socio-cultural Sustainability

TakNet aims to empower marginalised groups and employs gender-sensitive policies. As a result, almost 50% of inTERLab and NEt2Home team members are women, while at the community level, most of the community leaders working with the initiative are also women[122].

Key Learnings

The TakNet project in northwest Thailand demonstrates the strength of a multistakeholder approach in bringing affordable wireless internet access to a rural area. The engagement of government, local community, and academia has been crucial for the network's success. The project has also shown adaptability and resilience in changing its organizational model to fit circumstances, particularly in response to financial sustainability challenges. In addition, the project is committed to upskilling locals and aims for the integration of women in its efforts. The

[119] intERlab, 'Net2Home – IntERLab'; Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[120] APC and IDRC, 'BUILDING LAST-METRE COMMUNITY NETWORKS IN THAILAND', 6.

[121] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; APC and IDRC, 'BUILDING LAST-METRE COMMUNITY NETWORKS IN THAILAND'.

[122] APC and IDRC, 'BUILDING LAST-METRE COMMUNITY NETWORKS IN THAILAND'.

case study demonstrates strengths within the financial, organisational, and socio-cultural sustainability dimensions. Financial sustainability is achieved through changes to the subscriptions and establishing a social enterprise, Net2Home, to manage the services and network deployment. Organisational sustainability is achieved through the strong involvement of local entrepreneur technicians who gradually assume responsibility for running the network. Socio-cultural sustainability is achieved through community members deciding where to locate the new gateway. Furthermore, the engagement of and training for local technicians and bill collectors is a crucial aspect of socio-cultural sustainability. The strong multistakeholder engagement that includes academia and community involvement are key strengths supporting the expansion of the network to nearby areas.

DRAFT

Wireless for Communities (Chanderi) - India

Country	India
Stakeholders/Partners:	Internet Society Digital empowerment Foundation Barefoot engineers (local technicians)
Year Initiated:	2010
Type of Initiative	Community Network and digital resource centre
Business Model	Donor Funded
Technology Model	Wi-Fi network

Overview

Wireless for Communities (W4C) is a community network initiative from the Digital Empowerment Foundation with support from the Internet Society that was first piloted in Chanderi, a small municipality in India[123]. The pilot study was a great success, and by today, W4C has successfully used this model to deploy over 250 community networks in 68 districts in 20 states[124].

In Chanderi, average household incomes have more than doubled, mainly because of various ICT interventions. Furthermore, there is at least one digitally literate person in each weaver household, which, combined with other ICT-enabled programs, has allowed community members to establish their own enterprises. Additionally, all 13 local schools have been equipped with computer labs

[123] Digital Empowerment Foundation, 'Connecting Remote Communities'.

[124] Internet Society, 'Barefoot Wireless Engineers: Using Human Networks to Grow The Internet An Idea Expands from a Single Community to a Web of Engineers, Connecting Thousands to Opportunities', 6 .

connected to the internet. Moreover, a telemedicine facility links its Wi-Fi-enabled health centre with the next district hospital, enabling patients to consult with doctors at specific times[125].

Financial Sustainability

W4C is mainly funded by the Internet Society and receives further support from various other national and international agencies, including the national government, Cap Gemini, the Ford Foundation, the European Commission, Ericsson, Intel, Microsoft, and the Tata Trust[126].

Organizational Sustainability

One major strength of the W4C model is its "train-the-trainers" approach which enables communities to sustain and grow their own community network and helps people in other communities establish new networks. Today there are about 350 local technicians or "barefoot engineers" who help villages establish their own networks or provide training to grow networks in India and other countries[127].

Operational Sustainability

In 2014, W4C set up a digital design resource centre called 'Chanderiyaan' in Chanderi to demonstrate the benefits of connectivity and convince the local community to participate in the project. In the following years, this was extended to computer-training centres and ordinary households installing computers and internet connection[128]. The network relies mainly on unlicensed 2.4 GHz and 5.8 GHz Wi-Fi spectrum. In Chanderi, the network covers an area of 5 kilometres with 360-degree wireless signals provided by an 80 feet high antenna[129].

[125] Digital Empowerment Foundation, 'Connecting Remote Communities'.

[126] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[127] Internet Society, 'Barefoot Wireless Engineers: Using Human Networks to Grow The Internet An Idea Expands from a Single Community to a Web of Engineers, Connecting Thousands to Opportunities'.

[128] Digital Empowerment Foundation, 'Wireless for Communities: A Case Book'.

[129] Digital Empowerment Foundation.

Beyond establishing connectivity in Chanderi, W4C also introduced telehealth services and support for entrepreneurship. The latter has been particularly impactful in Chanderi, a traditional hand-weaving community. Through their programmes and the introduction of digital tools, W4C was able to empower weavers to digitally preserve traditional sari design, conduct research and create new designs, enhance production efficiency, and increase income by enabling direct communication with buyers instead of relying on intermediaries[130].

W4C relies on training local technicians or "barefoot engineers" to deploy and maintain their community networks. Thus, training was a key component of setting up the network in Chanderi, which started with ten enthusiastic local young people who were trained to install and maintain the wireless network. The initiative further developed a training course with simple, easy-to-understand guidelines and video tutorials on installing and maintaining community networks[131].

Policy Sustainability

The regulatory environment represents one of the main challenges for community networks such as W4C. The Indian regulatory regime limits the choice of technology to unlicensed spectrum and imposes other responsibilities on community networks, such as logging users' information that complicate their operation[132].

Socio-cultural Sustainability

W4C emphasizes engaging women to empower them to participate in their communities and improve their livelihoods. For example, barefoot engineer training focuses on engaging women, contributing to their empowerment and a cultural shift in communities' perception of women's role in society. The "Barefoot Women Wireless Engineers" have become role models for women and girls in their communities[133]. Furthermore, the Digital Empowerment Foundation has started

[130] Internet Society, 'Barefoot Wireless Engineers: Using Human Networks to Grow The Internet An Idea Expands from a Single Community to a Web of Engineers, Connecting Thousands to Opportunities'.

[131] Internet Society.

[132] Srivastava, 'Community Networks: Regulatory Issues and Gaps–Experiences from India'.

[133] Internet Society, 'Barefoot Wireless Engineers: Using Human Networks to Grow The Internet An Idea Expands from a Single Community to a Web of Engineers, Connecting Thousands to Opportunities'.

two programs targeting women. The Wireless Women for Entrepreneurship and Empowerment (W2E2) program was created to support women's micro-level social enterprise-based ICTs and women entrepreneurs in using Wi-Fi. While the Solar Women Wireless Engineers for Entrepreneurship and Empowerment (SW2E3) programme was developed to provide solar and wireless training to women[134].

Key Learnings

The Wireless for Communities (W4C) initiative has demonstrated the importance of implementing services that are relevant to the community, as seen in the success of the weaving program in Chanderi, India. This approach allowed the community to understand the benefits of connectivity and build buy-in before establishing the network infrastructure.

In addition to being relevant to the community, the "train-the-trainers" or "Barefoot Engineers" approach employed by the W4C initiative is crucial for organizational sustainability. This approach enables communities to sustain and grow their own community network and helps people in other communities establish new networks. By training local technicians, or "barefoot engineers", W4C has been able to build a network of skilled individuals who can deploy and maintain community networks, reducing the reliance on external support. This approach has effectively empowered the local communities to take ownership of the networks and ensure their sustainability.

The W4C initiative has strongly emphasised women's empowerment, which has contributed to its success and sociocultural sustainability. By empowering women through training, education and access to information and resources, W4C has created a more inclusive and equitable environment for the communities it serves. For example, in the traditional hand-weaving community of Chanderi, W4C has been able to empower weavers, many of whom are women, to preserve traditional sari designs digitally, research and create new designs, enhance production efficiency, and increase income by enabling direct communication with buyers, hence improving the livelihoods of many women in the community, and preserving and promoting the traditional hand-weaving industry. Additionally, the initiative has provided women with access to telehealth

[134] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

services and support for entrepreneurship, which have contributed to the overall socio-economic development of the communities. By providing women with access to information and resources, W4C has been able to break down traditional gender barriers and promote gender equality, leading to more sustainable and inclusive communities.

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Ungu Community-Based LTE Network - Indonesia

Country	Indonesia
Stakeholders/Partners	Local Missionary School ICTWatch University of Washington Airwave (Local Social Enterprise)
Year Initiated:	2016
Type of Initiative	Community LTE Network
Business Model	Operated by a local missionary school that sells sim cards and data subscriptions through further sellers
Technology Model	Data-only LTE Network Wi-Fi backhaul connection Local server

Overview

The Ungu Community Base LTE Network (CoLTE) resulted from a long-term collaboration with the University of Washington to provide a data-only LTE network to Bokondi, a remote community in the highland of Papua in Indonesia. Although the community already had an internet link before the project, the coverage was limited to the local elementary school and a few additional households. In 2016, the Indonesian NGO ICTWatch was able to convince the national telecom ministry (KOMINFO) to provide experimental licences in the mobile cellular bands to explore alternative technologies and business models[135].

[135] Bidwell and Jensen.

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Financial Sustainability

The project's initial capital expenditure was provided by a grant of 12,000 USD from APNIC/ISIF. Local operational support, and upstream internet connectivity come from a nearby social enterprise Airwaves Mission which operates as a wireless internet provider. The operating costs of the project, including upstream connectivity and operating costs, are financed through the sale of prepaid accounts and data packages. The packages are sold to local agents who resell them to the local communities at a markup of about 20%. A SIM card and initial setup, including 10MB credit, costs USD 7, and data bundles are available at 10 MB for USD 5, 100 MB for USD 15, and 1 GB for USD 25. Along with official resellers, a robust "secondary" hotspot market also emerged[136].

This financial model has proven to be sustainable, generating enough revenue to cover the equipment cost in about two years, prompting community discussion about what should be done with the excess revenue[137]. However, it was also observed that the use of the network is unequal, and the network is supported by only a handful of relatively heavy users[138].

Organisational Sustainability

The network is owned and operated by a missionary group that runs the local elementary school. They manage the day-to-day operations, including maintenance, credit sales to resellers, power management, and repairs[139]. However, the initiative is also supported by a nearby social enterprise wireless internet provider, Airwaves Mission, which supported the earlier 2G project and provided the school with connectivity[140].

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[136] Sevilla et al., 'Experiences'; Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[137] Sevilla et al., 'Experiences'; Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[138] Johnson et al., 'Whale Watching in Inland Indonesia', 2 .

[139] Johnson et al., 'Whale Watching in Inland Indonesia'.

[140] Sevilla et al., 'Experiences'.

Operational Sustainability

The network is a pure 4G LTE network which makes the setup and operation much more straightforward than if it includes voice and SMS services. Especially given the prevalence of text and voice call services that run over the internet (i.e. WhatsApp), this makes it a viable solution for the local community. The network's base station is connected to the internet via a 50-kilometre long-distance (double-hop) Wi-Fi link to Mission Airwaves' VSAT installation in a nearby town[141].

This kind of setup of data-only LTE networks is called Community LTE and includes a local server or "network in a box", which cuts the cost of needed bandwidth by about 50% and improves reliability (local activity continues even when the upstream link goes down). In addition, to improve performance and save the expensive and limited satellite capacity, a local web cache and DNS server are also installed[142]. Local-only services facilitated through the model's local server include free local-to-local traffic and local copies of educational content such as Wikipedia and OpenStreetMap[143].

The power for the network is provided through the local microgrid, which relies on diesel generators scattered throughout the community, solar panels and a micro-hydroelectric generator connected to a battery bank for the large local private school. Choosing to rely on the local power grid over a dedicated diesel generator means that the network depended on a good relationship with the community and was only possible due to community discussion around power usage. However, it also instils a sense of ownership and an understanding of power outages, as the network will only be down if the whole community's power is out[144].

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[141] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[142] Bidwell and Jensen.

[143] Bidwell and Jensen.

[144] ISIF ASIA, 'Technical Report: Community LTE in Papua'.

Policy Sustainability

The community already had an internet connection, but it needed to be more reliable. In 2016, the Indonesian NGO ICTWatch convinced the national telecom ministry (KOMINFO) to provide experimental licences in the mobile cellular bands to explore alternative technologies and business models. This permission was granted only on the condition that the initiative would not compete with existing commercial operators. Thus, when the incumbent operator Telkomsel established a mobile base station covering that area, the local 2G community network was decommissioned. However, Telkomsel's service does not support internet connectivity, so the initiative moved to deploy the CoLTE network[145].

Socio-cultural sustainability

When implementing the project, local circumstances and culture were taken into consideration. For instance, upon the advice of all interested groups, small groups were implemented for discussions, information gathering, training and feedback to remove the troublesome issues of powerful local men dominating the public meetings. The small group approach was readily accepted, as traditional family talks are conducted similarly. Furthermore, to garner community interest and support, the local school was chosen to install the infrastructure due to its geographical and social centrality in the community despite its sub-optimal location from a technical standpoint[146].

Key Learnings

The Ungu Community-Based LTE Network in Indonesia showcases the potential for innovative solutions to address connectivity challenges in remote areas. The local mobile network technology offers operational sustainability, with a simpler setup and operation than traditional networks that include voice and SMS services. Additionally, an offline server has been implemented, allowing for data storage and access without internet connectivity, addressing the issue of unreliable internet in the region. The data-only LTE network also does not compete with the local telco, enabling the initiative to operate in the area while navigating regulatory challenges.

[145] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[146] ISIF ASIA, 'Technical Report: Community LTE in Papua'.

The project's financial sustainability is noteworthy, as the initiative generates enough revenue through prepaid accounts and data packages to cover equipment costs within two years. This model supports the local communities by providing a source of income for resellers and allowing excess revenue to be used for community development.

The initiative's organisational sustainability is achieved through partnerships and local ownership. The nearby social enterprise wireless internet provider, Airwaves Mission, provides external support and upstream internet connectivity. Meanwhile, a local missionary group owns and operates the network, managing day-to-day operations, maintenance, credit sales, power management, and repairs. This blend of external support and local ownership ensures the network's long-term sustainability, as the community is invested in its success and has the necessary skills and resources to maintain it. The Ungu Community-Based LTE Network demonstrates how innovative solutions and partnerships can provide sustainable connectivity in remote communities.

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Common Room - Indonesia

Country	Indonesia
Stakeholders/Partners:	Common Room Networks Foundation Association for Progressive Communication (APC) Kasepuhan Ciptagelar indigenous community
Year Initiated:	2018
Type of Initiative	Community Network
Business Model	APC Community Networks Learning Grant (CNLG) Sale of internet vouchers
Technology Model	Sectoral antennas and MikroTik routers are used to cast Wi-Fi connections to the backhaul internet infrastructure.

Overview

Yayasan Mitra Ruang Kolektif, or Common Room Networks Foundation, is a non-profit organisation founded in 2006 and is an open platform for creativity and innovation. It has collaborated with the Association for Progressive Communication (APC) since 2018 and has been actively engaged with the Kasepuhan Ciptagelar indigenous community since 2013. Kasepuhan Ciptagelar is an indigenous community of around 25,000 to 30,000 people living in the surrounding area of the deep forest of the Halimun-Salak Mountain National Reserve (TNGHS), and are facing increasing challenges and vulnerabilities due to rapid development. In 2018 Common Room started to develop a community network that nurtures creativity, innovation, and social entrepreneurship in the community[147].

[147] CommonRoom, 'Connecting the Unconnected'.

Financial Sustainability

The APC Community Networks Learning Grant (CNLG) initially supported the project. Continuing operation of the network is funded through the sale of internet vouchers sold and managed by the local community. In addition to financing the network development, some profit from the voucher sale is being re-invested into the maintenance and development of internet networks and infrastructure in some areas that still have no internet access[148].

The project complements commercial internet service providers with a more affordable and reliable option. Some commercial ISPs provide internet access to the Kasepuhan Ciptagelar region through 3G/4G mobile internet, but they remain unaffordable for many community members. Furthermore, the connection can be unstable when there is a power outage[149].

Organisational Sustainability

The community's residence developed and deployed the initiative with the assistance of Awinet, a local internet service provider (ISP) based in Bayah, Banten Province. Awinet was initially established as a community network actively developing local internet infrastructure. The Awinet community deployed and shared affordable internet access utilising simple network infrastructure. In 2014, the Awinet community gradually began restructuring itself into an ISP company. The initiative further builds on the cooperation of Common Room itself, the local community and APC, an international network of civil society organisations founded in 1990 dedicated to empowering and supporting people working for peace, human rights, development, and protection of the environment, through the strategic use of information and communication technologies [150].

Operational Sustainability

In the Kasepuhan Ciptagelar region, internet access has been provided by some telecommunication companies, but it is expensive and sometimes unstable. In 2018, a local ISP called Awinet started to develop a wireless broadband connection using sectoral antennas and MikroTik routers to cast Wi-Fi to the core network in the region. This infrastructure provides internet connectivity to around

[148] CommonRoom.

[149] CommonRoom.

[150] CommonRoom.

13 villages with an average of 500 users daily, with increasing demand for internet access from local community members. The local indigenous community is working together to construct the backhaul towers and establish the wireless connection, with assistance from Awinet and the Common Room team[151].

The project aims to support the economic, social and cultural empowerment of the Kasepuhan Ciptagelar indigenous community. Priority access to internet connectivity is given to schools, subsidiary health clinics, and village administration offices. Furthermore, a "mini data centre" was set up to manage local knowledge used in a participatory mapping project to identify protected forest areas. Additionally, the local community members have been trained to build and manage local internet infrastructure and can now maintain and expand the internet networks independently[152].

Sociocultural Sustainability

The development of local internet infrastructure in the region is expected to support the official state recognition of Kasepuhan Ciptagelar indigenous rights, facilitate participatory mapping activities, and support efforts to preserve and protect the tropical forest area. Before launching the project, Awinet and Ciptagelar residents conducted studies for around three months to ensure that the local community would benefit from internet access. Abah Ugi, an indigenous community leader, wished for media literacy programs for the youth, women and adults in villages and hamlets that already have access to the local internet infrastructure[153].

Environmental Sustainability

The project is expected to support participatory mapping activities facilitating protecting and conserving the tropical forest area maintained by the Kasepuhan Ciptagelar indigenous community [154].

[151] CommonRoom.

[152] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; CommonRoom, 'Connecting the Unconnected'.

[153] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; CommonRoom, 'Connecting the Unconnected'.

[154] CommonRoom, 'Connecting the Unconnected'.

Key Learnings

In the Kasepuhan Ciptagelar region, the Common Room initiative, with support from ACP and in partnership with a local ISP, provided internet connectivity to around 13 villages with an average of 500 users every day. The initiative highlights the importance of properly understanding the local context. Through intensive research and engagement with the local community prior to developing the infrastructure, the initiative was able to create a network that fits the community's needs. Priority access to internet connectivity is given to schools, subsidiary health clinics, and village administration offices. A "mini data centre" was set up to manage local knowledge used in a participatory mapping project to identify protected forest areas. The initiative is thus able to support economic, social, and cultural empowerment, as well as support the protection and conservation of the tropical forest area maintained by the Kasepuhan Ciptagelar indigenous community. The development of local internet infrastructure in the region is also expected to support the official state recognition of Kasepuhan Ciptagelar's indigenous rights.

Partnering with an ISP that started as a community network demonstrates that the right approach to community connectivity can lead to growth in opportunities. Furthermore, through engagement with the community, the initiative was able to garner support and leverages local community members for the deployment and operation of the infrastructure. The local community members have been trained to build and manage local internet infrastructure and are now able to maintain and expand the internet networks independently.

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Telecentres

The Telecentre Program for Orang Asli (TPOA) - Malaysia

Country	Malaysia
Stakeholders/Partners:	Department for Development of Orang Asli (JAKOA Net2Home (Social Enterprise) Ministry of Rural Development (KKLW) Economic Planning Unit, Prime Minister's Department (EPU) Local community steering committee
Project Period:	2013-2018
Type of Initiative	Telecentres
Business Model	Government Funded
Technology Model	Each centre is equipped with Wi-Fi and various devices Utilisation of VRMS

Overview

Through the Telecentre Program for Orang Asli (TPOA), the Department for Development of Orang Asli (JAKOA), in collaboration with the Ministry of Rural Development (KKLW), and the Economic Planning Unit, Prime Minister's Department (EPU), has brought four telecentres at remote rural sites in the states of Pahang and Kelantan, Malaysia, namely Pos Balar, Pos Gob, Pos Lenjang, and Pos Sinderut[155]. The communities where the telecentres were established consist mainly of indigenous people and are very remote and hard to access due to challenging terrain[156]. The initiative was implemented to broadly facilitate these communities' socio-economic

[155] Tan et al., 'Innovative Use of TPOA Telecentres for Covid-19 Awareness among the Orang Asli Communities'.

[156] Bala and Tan, 'Digital Inclusion of the Orang Asli of Peninsular Malaysia'.

development. The centres aim to facilitate communication and act as resource centres for new 'knowledge' and skills providing education through ICT and training for local capacity building. In addition, they aim to provide health-related information to the villagers [157].

Organisational Sustainability

The centres were designed to be fully managed and operated by the local communities. Therefore, a community advisory board was formed, and local coordinators, telecentre managers, community educators and technicians were appointed. The TPOA initiative successfully overcame some constraints due to its remote location by implementing a virtual remote management system (VRMS). The VRMS was designed to support process-based management by strengthening local telecentre caretakers' managerial skills and problem-solving capacities without on-site support from the team in UNIMAS. Furthermore, the VRMS was successful in building an interactive ecosystem between the four communities with telecentres, other indigenous communities, telecentre managers, and university researchers[158].

Operational Sustainability

The telecentres are outfitted with solar panels for electricity generation, but some centres still face issues with unreliable power. Each centre offers Wi-Fi access and is equipped with various devices tailored to different use cases. Tablet computers serve as the primary computing platform for most users, while telecentre administrators and advanced users utilize mini low-power desktop computers. For training purposes, LED TVs and ceiling-mounted projectors have been installed to display multimedia content. Moreover, a local app database portal has been redesigned to balance service usage duration and power consumption. To address challenges arising from the centres' remote locations, they rely on a self-automated virtual remote management system (VRMS). Local server contents are virtually synchronized, and telecentre caretakers experiencing any issues can receive remote assistance to resolve them[159].

[157] Bala and Tan, 6 .

[158] Bala and Tan, 'Digital Inclusion of the Orang Asli of Peninsular Malaysia'.

[159] Bala and Tan.

The establishment of the telecentres was accompanied by six socioeconomic community development programs. These programs included community training in areas such as leadership, ICT applications and usage, telecentre management, and entrepreneurship. An educational program was developed to harmonize indigenous culture with contemporary forms of knowledge. Support was provided for agro-businesses, aiming to build the capacity of smallholder farmers to understand, analyze, and effectively link to markets while developing agro-enterprises. The initiatives also focused on documenting indigenous knowledge, supporting rural and Indigenous tourism as an alternative to mainstream tourism, and implementing a health program designed to develop respectful and sensitive protocols for understanding the realities of remote community life and support e-health in Orang Asli communities through education[160].

The establishment of the telecentres together with the development programmes has led to some success stories where local communities were able to pursue business opportunities or other projects that would have been much less accessible and much costlier and difficult to obtain in the absence of the telecentres. For example, the community in Pos Sinderut was able to begin selling their own agricultural products directly without having to go through a middleman, or the community in Pos Balar which able to attain legal recognition of ownership over part of their ancestral land, which they deemed have been encroached upon by outside agencies [161].

However, the initiative had some issues retaining trained caretakers and administrators as some of the trained locals took the opportunity to move out of their villages, leveraging their new skills to pursue other opportunities[162].

Socio-cultural Sustainability

The initiative aims to foster community support and a sense of ownership of the telecentres. Therefore, the centres were culture-specific, designed and built using locally available products (sand, stones, and wood) and skills through a joint effort known as *gotong royong* between the local communities and researchers from UNIMAS. Since the communities prefer open space over

[160] Bala and Tan.

[161] Bala and Tan.

[162] Bala and Tan.

individual desks and chairs for training and learning, the internal space of the telecentres was designed accordingly. The 'open space' aligns with their community-based knowledge sharing, which allows for friendly exchanges of ideas. The participatory nature of the governance of the telecentres further increases a sense of belonging and ownership among community members. Additionally, the linkages between the communities and outside stakeholders that were built through the VRMS further strengthen local networks and capacities[163].

Key Learnings

The Telecentre Program for Orang Asli (TPOA) in Malaysia has demonstrated the importance of appropriate technology in supporting various sustainability dimensions. The virtual remote management system (VRMS) has been crucial in overcoming problems and supporting operational and organisational sustainability. The VRMS has effectively enabled process-based management, strengthened local telecentre caretakers' managerial skills, and synchronised local server contents virtually. It has further helped build an interactive ecosystem between the four communities with telecentres, other indigenous communities, telecentre managers, and university researchers.

The Telecentre Program for Orang Asli (TPOA) has successfully achieved socio-cultural sustainability by involving local communities and providing relevant services. The telecentres are managed and operated by local communities with the help of a community advisory board, local coordinators, telecentre managers, community educators and technicians. This approach has effectively empowered the communities to take ownership of the telecentres and ensure their sustainability. The provision of services such as health-related information, training for local capacity building and education through ICT has been tailored to the specific needs of the indigenous communities, making the initiative relevant and beneficial to them. The TPOA initiative has also helped in creating awareness and understanding of the local culture and customs and addressing the needs and concerns of the communities.

Based on the services provided and their impact on communities, the initiative has had several success stories, including agribusiness development, which helped to diversify income sources and improve livelihoods, and obtaining recognition of ancestral lands, which had a significant impact

[163] Bala and Tan.

on livelihoods and cultural identity. These success stories illustrate the importance of considering the local context and providing relevant services.

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Gram Marg - India

Country	India
Stakeholders / Partners	Local ISP Department of Electrical Engineering at the Indian Institute of Technology (IIT) Bombay Panchayat (local government) Village level entrepreneurs
Year Initiated	2012
Type of Initiative	Community Network
Business Model	1. Coupons sold by the local government 2. coupons sold by local village entrepreneurs
Technology Model	Wi-Fi network Initially tested TVWS technology but discontinued due to regulatory issues

Overview

Gram Marg is a community network in the Palghar district of Maharashtra which was initiated by the Department of Electrical Engineering at the Indian Institute of Technology (IIT) Bombay in 2012 as a test bed for different technical and institutional solutions. Utilising two different organisational models the initiative was successful in providing internet connectivity to 25 villages. The first model relied on close cooperation with the local government while the second emphasised local integration through villa entrepreneurs. While emphasising different actors both models employed a broad multistakeholder approach and made efforts to integrate local

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communities. The Gram Marg community network thus demonstrates how different approaches can lead to sustainable connectivity initiatives.[164]

Financial Sustainability

The Gram Marg project is testing two different financial models for sustainability. The area was divided into two clusters. In both clusters, the public sector was crucial in technology innovation, deploying the network and providing the capital expenditure (CAPEX) funding for setting up the network infrastructure in the villages. The first cluster of 15 villages applies a revenue model that leverages the local ISP and the Gram Panchayat office. In this model, the local ISP sells 2 Mbps bandwidth to the Gram Panchayat office, directly paying the provider. The Gram Panchayat office also pays and is responsible for the operation and maintenance of the internet service. However, as the office does not use all of the bandwidth, it sells unused bandwidth to villagers in the form of "pay as you use" daily coupons for one hour at INR 10 (USD 0.14). On average, five to 10 people use the internet at the office daily, contributing to the Gram Panchayat's monthly revenue, which plans to use the accumulated amount for development activities within the village[165].

In the second cluster of 10 villages, a Village Entrepreneur model is being employed. The government's Common Service Centre (CSC) programme Wi-Fi Coupal, purchases bandwidth from a local ISP, which it distributes to the different villages depending on the number of users in each village. In these villages, the network is maintained and operated by local village entrepreneurs (VLE) who sell bandwidth to villagers through coupons based on a fixed pricing plan. The pricing plan is set in such a way that it maximises revenue for the VLE, thus incentivising performance. Steady growth in revenue generation by the VLEs suggests that the model will perform well and also offers lucrative value for the investment made. Initial research shows that both models seem sustainable and that local villagers are using the services offered[166].

[164] Belur, 'Adressing Sustainability in Rural Connectivity: A Case Study of Gram Marg Community-Led Networks'; Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[165] Belur, 'Adressing Sustainability in Rural Connectivity: A Case Study of Gram Marg Community-Led Networks', 9 .

[166] Belur, 'Adressing Sustainability in Rural Connectivity: A Case Study of Gram Marg Community-Led Networks'.

Organizational Sustainability

The Gram Marg initiative pioneered the Public-Private-People-Panchayat Model (4P). This model is based on the introduction of the Panchayat (i.e., the village administration) in the partnership model alongside the private and public partners and a 'bottom-up' approach which has an active involvement of villagers and focuses on the local and regional connectivity needs. The anticipation of Panchayat adds value to the partnership model, as it is elected by the people of the village and represents the village administration[167]. The different partners take up different roles within the project. The Panchayat owns the network at the village level and plays a major role in determining priorities based on the digital needs of local villagers. The public sector played an important role in technology innovation, deploying the network and providing the capital expenditure funding for setting up the network infrastructure in the villages. The private sector partners are providing the bandwidth through their backhaul network. Moreover, the communities are engaged in maintaining the network and taking care of the security of the devices. Furthermore, local youth from the village community are effectively engaged through skills development and training[168].

Operational Sustainability

Initially, the Gram Marg was testing TV White Space for reaching non-line-of-sight locations, but after the trial licence was not renewed, the project had to revert to unlicensed Wi-Fi frequencies such as 5.8 GHz for middle-mile connectivity[169]. Internet access differs depending on the type of institutional model in the villages. In the first cluster of 15 villages which employs the institutional model, internet access in the form of Wi-Fi is offered at Gram Panchayat offices only. In the second cluster of villages that employ the village entrepreneur model, Wi-Fi access points are deployed at strategic locations that can be accessed in and around those locations. Overall, 60 Wi-Fi hotspots

[167] Belli and Hadzic, 'Community Networks: Towards Sustainable Funding Models'.

[168] Belur, 'Adressing Sustainability in Rural Connectivity: A Case Study of Gram Marg Community-Led Networks'.

[169] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'; Belur, 'Adressing Sustainability in Rural Connectivity: A Case Study of Gram Marg Community-Led Networks'.

have been deployed in the ten villages at the Gram Panchayat office, primary health care centres, at least one school and one community centre[170].

In addition to providing connectivity, the initiative facilitates a wide range of services through the government e-service centres at the panchayat offices. The VLEs also help community members carry out government transactions and make payments on their behalf, such as for TV and electricity bills[171].

Policy Sustainability

The initiative is well integrated with all sectors of society, including local and national governments and is aligned Indian government policies. However, Gram Marg is also limited to using unlicensed spectrum through India's regulatory environment as the experimental licence for TVWS was not renewed following the trial period[172].

Socio-cultural Sustainability

The initiative aims to build the capacity of VLE by offering training that allows them to operate the network and earn a living. IIT Bombay also partnered with Impact India to support an outreach and adult learning programme based on videos developed by Tata Trust, which are shown at the premises of Gram Panchayats and in some schools[173].

Key Learnings

The Gram Marg project in India demonstrates the importance of multistakeholder partnerships, particularly the involvement of the government, for organizational sustainability. The project pioneered the Public-Private-People-Panchayat Model (4P), which involves the involvement of the local village administration and a bottom-up approach. The project also involves partnerships with private and public sector partners. The former provides the bandwidth through their backhaul

[170] Belur, 'Adressing Sustainability in Rural Connectivity: A Case Study of Gram Marg Community-Led Networks'.

[171] Bidwell and Jensen, 'Bottom-up Connectivity Strategies: Community-Led Small-Scale Telecommunication Infrastructure Networks in the Global South'.

[172] Bidwell and Jensen.

[173] Belur, 'Adressing Sustainability in Rural Connectivity: A Case Study of Gram Marg Community-Led Networks'.

network. The latter plays a vital role in technology innovation, deploying the network and providing the capital expenditure (CAPEX) funding for setting up the network infrastructure in the villages. The involvement of different partners in the project has enabled the initiative to achieve organizational sustainability by leveraging the strengths of each partner, ensuring that local needs are met.

The initiative is testing two different financial and organisational models for sustainability in different clusters of villages. While both models have proven to be organisational and financially sustainable, the entrepreneurial model has shown promising results in revenue generation, more comprehensive internet access throughout the community, and empowerment of local villagers through their activity as entrepreneurs. The test thus demonstrates that different organisational models can be successfully employed while highlighting that more decentralised models that focus on community engagement can significantly impact the community.

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Computer Laboratory and Internet Community Centre (CLICC), Vanuatu

Country	Vanuatu
Stakeholders/ Partners	Local School administration Government
Year Initiated:	2016
Type of Initiative	School Computer Laboratory
Business Model	Levies for students and coupons for community members Initially funded by the government (2year period)
Technology MO	Data subscription from local ISP

Overview

The Computer Laboratory and Internet Community Centre (CLICC) programme was developed together with the Tablets for Schools (TFS) programme under Vanuatu's Universal Access Policy to make schools hubs for community internet access. Nineteen schools across the country were selected for the programme, which involved investments in broadband links, computer labs and networking equipment, gateway servers with educational resources and solar power for off-grid schools. Under the TFS project, investments included class sets of tablets preloaded with educational apps, charging trolleys, and training for IT teachers. Schools and local communities agreed to meet specific requirements to ensure the program's success. An important aspect was that the community had to be engaged and that the site would be open for use by the community during non-school periods[174].

Financial Sustainability

Over an initial period of 2 years, the government funded the internet service in the communities. After the end of the government support, the schools moved towards a self-financing model

[174] TRBR, 'Computer Laboratory and Internet Community Centre (Clicc) & Tablet for Students (Tfs) Program Evaluation Report.'

requesting a fee from students and other community members for the use of internet services. The levies are largely seen as affordable by both students and community members. However, it was observed that some secondary schools have levies that will lead to income beyond what would be necessary for internet subscriptions and might violate MoE regulations. The financial model has proven to be successful as most schools have renewed their internet subscription after the government subsidy ceased. However, some schools with unreliable internet services or problems with other infrastructure have opted not to renew the subscriptions. Additionally, some schools, especially primary schools, struggle to finance trained staff[175].

Organisational Sustainability

The centres are mainly governed by the school administration, although some schools operate under a community board. The successful operation of the centres often relied on finding the "right" person to manage the centre. Furthermore, the school principal's engagement and support are essential. However, in some cases, political issues such as rivalries between schools or tensions between different organisations active in the community made managing the centres more difficult. Additionally, the initiatives could benefit from increased engagement with the private and third sectors to provide more services to community members. The centres have also yet to become a hub for e-government services and could benefit from increased cooperation with the government[176].

Operational Sustainability

Several locations had trouble with the infrastructure, including internet blackouts and broken devices. Particularly the computing system was susceptible to technical problems. While some issues were due to adverse events such as cyclones, they were compounded by lacking repair procedures, conflicting arrangements with providers, and lack of skilled staff. Furthermore, some schools needed help with electricity supply despite installing solar panels. While the centres include gateway servers with local content that can be used offline, it was not accessible to

[175] TRBR.

[176] TRBR.

everyone due to difficulties logging into the server. Additionally, not all local content is relevant to the schools since they tend to focus on English and Eurocentric content[177].

Some of the schools, in particular primary and more rural schools, needed help to recruit and retain trained staff who are necessary to oversee the labs and ensure students and communities can benefit from the services offered. While the centres have proven beneficial for education, teacher preparation and administrative purposes, they still need to develop into multipurpose service centres with various services. Nevertheless, some services benefit the wider community, such as disaster warnings, communication with overseas relations, and agricultural and entrepreneurial services[178].

Policy Sustainability

As the centres are within schools, they fall under the jurisdiction of the ministry of education and, as such, do not face policy difficulties. Furthermore, the initiative is directly and indirectly addressed in the National ICT Policy, Universal Access Policy, and various educational policies[179].

Socio-Cultural Sustainability

The initiative needs to be more closely integrated into the community than intended, negatively affecting its sustainability. For instance, some communities question whether paying for an internet subscription is worth it. There are several barriers to community integration, including technical difficulties and downtime of infrastructure, lack of capacity, issues around ownership, lack of awareness of the benefits of the internet and the computer lab despite awareness talks, and lack of relevant services. Additionally, socio-economic factors such as gender and age influence facility access. Women in the community and female teachers are less likely to access and benefit from the facility. Moreover, the higher secondary students take up much of the lab's capacity to the detriment of the younger students and other community members[180].

[177] TRBR.

[178] TRBR.

[179] TRBR.

[180] TRBR.

Key Learnings

The CLICC programme has been successful in providing internet access to remote communities. The investments in broadband links, computer labs and networking equipment, gateway servers with educational resources and solar power supplies for off-grid schools have allowed for reliable internet access in these communities. Additionally, the class sets of tablets preloaded with educational apps and charging trolleys, as well as training for IT teachers, have helped to improve educational opportunities for students in these remote communities.

The centres are mainly governed by school administrations, although some schools operate under a community board. The successful operation of the centres often relied on finding the "right" person to manage the centre. Furthermore, engagement and support by the school principal have been important, but sometimes this also presented challenges.

The centres could benefit from increased engagement with the private and third sectors to provide more services to community members. Additionally, the centres have not become a hub for e-government services and could benefit from increased cooperation with the government. Overall, the initiative has proven sustainable in terms of organizational structure, but there is room for improvement in community engagement and services offered.

Although the system of levies and vouchers has proven to be financially viable, it also created room for potential misuse in violation of MoE regulations. Therefore, a system of levies should be implemented by the MoE to avoid such abuse. Despite this, the initiative has proven financially sustainable overall, as most schools have renewed their internet subscription after the initial period of government subsidy. The schools have generated enough revenue to cover the equipment cost and provide internet access to the community. The initiative has also successfully provided access to educational resources and training for IT teachers, further benefitting the students and community members. It is important to note that while there are some challenges in terms of financial sustainability, the initiative has successfully provided internet access to remote communities.

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Kinect - Papua New Guinea[181]

Country	Papua New Guinea
Stakeholders/ Partners	Kinect PNG (ISP) Local Community/Local high school Local Members of Parliament (MPs) Kacific (Satellite Service Provider) Gurant Co (Development funder)
Year Initiated	2021
Type of Initiative	Telecentre
Business Model	CapEx funded by Kacific Operation funded through the sale of internet vouchers
Technology Model	VSAT

Overview

Kinect PNG[182] is an Internet Service Provider (ISP) providing fixed wireless and satellite services to the broader PNG population. In partnership with Kacific Broadband Satellites Limited (Kacific), a satellite service provider and Gurant Co, a development funder, funds were provided to support up to 90 sites across PNG as part of the Covid-19 pandemic relief program[183]. Members of Parliament (MP) supported the establishment of 63 sites as a quick community service obligation

[181] Interviewee: CEO Kinect PNG

[182] Kinect, 'About Us'. Kinect.

[183] van Kampen and Sorhus, 'GuarantCo and PIDG Technical Assistance Support Investees Kacific Broadband Satellites Group and Acorn Holdings Limited to Respond to the COVID-19 Crisis in Asia Pacific and Kenya'.

initiative for the upcoming election. Most sites were installed in communities of approximately 150 people and above. Kacific provided the satellite infrastructure, bandwidth, a voucher system, and labour installation costs free to the site concerned, with a choice to include a polar power solution at an additional cost. Of the 90 sites established, approximately 88 sites, including all the government-established sites, have gone dormant, with only two sites still active and generating enough revenue and traffic to maintain sustainability. One of these sites is M'buke, a small island village off Manus Island, which demonstrated high community involvement[184]. Several community members financially supported the purchase of solar equipment and ensured active community involvement in operating the initiative and the sale of vouchers. In the other successful site, the local high school has been involved in the initiative and been responsible for reselling vouchers for the other successful site.

Financial Sustainability

A grant provided by Kacific covered the initial CapEx for setting up the infrastructure. The continued financial sustainability of the initiative then relies on the sale of vouchers to the community. The sites rely on for-profit operators to provide internet service and internet access vouchers. Otherwise, there are no commercial ISPs operating in these areas as the newly established VSAT terminals are often the only network infrastructure in these communities.

However, most sites have failed to become financially sustainable and continue to pay for the satellite bandwidth. The two remaining sites have managed to ensure that the community can continue to pay for the service by purchasing vouchers. The internet service provider charges for internet by volume at $US3 for 1 Gb per month. Internet bandwidth is sold to the community via vouchers priced at K2.00 for 150 Mb a day or K6 for 500 Mb a week, with the daily voucher being the most popular option. The caretaker of the solution keeps the profit as payment for selling the vouchers. Vouchers worth at least 100GB must be sold monthly to keep the solution operational. The typical revenue is K800 – 1000 per month.

In some cases, there was no initiative to ensure volunteers or support to educate the community, sell the vouchers and ensure the system's continued operation. In the two operational sites, active community members ensure that the service is maintained and sell vouchers to the community for

[184] Namun, ‘M’buke Village Sets up an Amazing Community Wi-Fi and Internet Connectivity -’.

use. Finding reliable people for the voucher selling in the MP-established locations was particularly challenging, leading to no commitment to repurchase after the stock was exhausted. Consequently, the sites started to fall into dormancy as the community could not purchase access to the internet. Where sites had active participants such as M'buke, the solution is housed and maintained by a nominated individual, the vouchers are easily obtained, and the community continues to benefit from the solution.

Organisational Sustainability

There are no formal processes of organisation provided as part of the initiative. In the case of M'buke, the community had a meeting and established some ground rules for the service's operation, providing some awareness on how it could be used. In the local high school, the general rule is that if the generator is operating, the solution can be used. Other than that, there are no formal rules. However, the community is encouraged to be involved in the initiative, mainly by selling vouchers.

Apart from early engagement by local MPs, there has been no further engagement by any other sector in this initiative. Many sites are in areas relying mainly on subsistence agriculture and some form of small handicraft industry. Some community members have asked how they can make money from the internet, but there is a lack of advice on this matter. Since the sites' failure and the lack of input from the MPs, the district government has taken over the initiative. Several district governments have set up a business arm to handle the resellers; currently, approximately 40 sites are ready to reconnect.

Operational Sustainability

The VSAT systems provided have been in operation for many years and are generally seen as highly reliable. Currently, Kinect has an uptime of 99.5% for the solutions operating. In areas with little telecom infrastructure, VSATs are the only infrastructure providing the service and access. The quality of the internet service provided is good and can support a good quality of service for internet voice and YouTube videos. Bandwidth is ample at 60 Mbps down and 5 Mbps up.

VSAT solutions are reasonably robust in extreme weather events, depending on the installation method. To the extent that any technology is future-proof, VSAT systems have been and will continue to be in operation for many years, with improvements in speed, deployment, and size. Overall, the technology and infrastructure used are fit for purpose for this environment with a Wi-

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Fi range of approximately 300-500m. Of all the units implemented, only two have been replaced due to failure.

Most sites utilise a solar system to provide power to the network infrastructure and some utilise diesel generators. The estimated capital cost of the solar system was 9000 Kina or approximately 2600 US$ for a 3kw inverter, which readily supplies the infrastructure and could drive lights or community electrical equipment. Where a solar system supplies power, there is a battery backup to support the centre after sundown. Where a generator is used, the solution can only operate if the generator has fuel and is running. Consequently, the site has an extra cost burden, with the need to pay for fuel.

Local volunteers support the infrastructure. Those doing maintenance are provided with an essential pictorial checklist and instructions on what lights mean if an issue occurs. Kinetic provides a centralised monitoring system and has visibility of all sites. Voucher sellers are trained in procuring vouchers, receipting vouchers and essential reconciliation of monies.

The primary services provided to the community are internet based. The younger community members predominantly use it for social media, whilst middle-aged community members tend to use the internet to make calls and video applications. Although there is a lack of digital literacy, the younger community members are adept at picking up how to use smartphones and providing training and assistance to those who do not yet have the skills. Improving skills, particularly beyond basic applications, would be advantageous. To date, there are no government services provided.

Environmental Sustainability

Power is a combination of solar and generators. As solar was not included in the price, the original community generator would be used if it was not procured. Overall, there is minimal impact on the environment, apart from disturbance of installation, generator noise and pollution and waste created by disposal of electronic devices.

Key Learnings

The initiative aimed to provide internet access to 90 communities, which it did achieve during the initial funding period. However, after this period, most of these sites became dormant, highlighting the importance of long-term organisational and financial sustainability planning. The initiative's goal was to become self-sustaining, but the lack of provisions for the organisation and sale of

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vouchers led to a failed shift towards other forms of funding in many of the sites. Therefore, it is crucial to implement sustainability measures from the outset of any project to prevent the same issues from arising.

The initiative further emphasises the importance of political commitment and community engagement. The lack of governance mechanisms and organisation within the initiative meant it quickly fell apart without ongoing political commitment. In contrast, the initiative thrived in areas with active community participation and engagement. Therefore, it is essential to incorporate community members and ensure their meaningful engagement when planning connectivity initiatives.

In summary, this case study highlights the importance of long-term planning for organisational and financial sustainability, as well as political commitment and community engagement. Without these elements, even the most well-intentioned initiative is at risk of failing. Therefore, from the outset, it is crucial to take a holistic approach to connectivity initiatives and consider all aspects, including governance, sustainability, and community involvement. By doing so, the initiative will have a greater chance of success and be a more effective tool for promoting digital inclusion and social development.

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Community Telecentres -Kiribati[185]

Country	Kiribati
Stakeholders/ Partners	Local School administration, Local Council, Communications Commission of Kiribati
Type of Initiative	Telecentre
Business Model	Initially funded under Kiribati's Universal Access Program (1 year) Further funding through the sale of vouchers
Technology MO	VSAT systems

Overview

The Communications Commission of Kiribati (CCK) has supported several telecentre projects under their Universal Access Programme (UAP). Currently, 12 centres are operated by the local council (four centres) or schools (eight centres). The centres are in remote islands where internet service is limited or non-existent.

Financial Sustainability

The initiative is part of the UAP under the CCK, which procures and supplies the equipment (VSAT, solar power and Wi-Fi) and operates the internet service. A grant finances the project under the UAP for the first year of service. After the initial year, the centre must be supported by the local council/schools and continue to pay for support and the internet service out of internal or earned funds. For councils, the funds would initially come to an extent from voucher sales ($1AUD for 2 hours) to the community for the internet service. An example is Kuria, which earned $AUD10,000 to support its centre. Whilst some money goes towards the internet service and support arrangements, it is still undetermined if any funds leftover are reinvested. It should be noted that there are no mobile or other telco services in this area, so the revenue may be much

[185] Information for this case study was collected through an interview with the Officer in Charge at the CCK

lower where further services are available. Sources of further funding of internet services are still unclear, but they could include an internal levy on parents or the sale of vouchers.

The services in the centres rely on commercial service providers to provide internet to them. The cost of the internet service provided is at standard market rates, deemed expensive in Kiribati. It may be possible for CCK to negotiate a lower price based on aggregating all the sites.

Organisational Sustainability

The governance of the centres varies depending on the local circumstances and is determined by local stakeholders. Council centres are controlled by the local Mayor and other councillors who decide how the centre will operate. The school centres are implemented mainly to provide services to the school, so the principal essentially determines operational decisions with the support of the Ministry of Education and advice from the school board, which also serves as a liaison to the local community. In both cases, there is no involvement of private sector or civil society organisations and limited community engagement.

Operational Sustainability

The centres are connected to the internet through satellite using VSAT systems. VSAT has been in operation for many years and is seen as very reliable. They are also resilient to extreme weather events, although the antennas can be damaged through powerful winds. New developments in satellite technology, are expected to increase the resilience of these systems to extreme weather events. The weakest part of the infrastructure is the end-user computing devices in the centres themselves. Electricity is supplied through solar cells in all centres as there is no grid electricity in any location, and this form of electricity has proven to be very reliable.

Generally, the centres mainly provide internet connectivity to the communities. They provide this service reliably with appropriate bandwidth. However, there could be further improvement in these services, particularly reducing the price of internet connectivity. The centre's operation relies heavily on working internet connection through the VSAT terminals as there are often no other forms of connectivity available that could be used as alternatives. Apart from internet connectivity only a few services are available to the communities. Some e-government services are available as Kiribati is part of the labour mobility scheme, so at a minimum, birth certificates, police checks and other services to support this scheme should be available.

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The CCK has provided training to a few staff as part of the initial funding. However, for the most part, the local councils are responsible for managing the staff necessary for running the centres. The support is contracted to the service provider for operations requiring higher skills. For schools, there is generally an IT person on staff at the school. There are no other people engaged in the operation of the centres.

Policy Sustainability

Currently, the centres are being implemented under the UAP. However, no further support is planned after the first year of initial funding. The CCK is reviewing the next round of UAP funding for more centres, and the government is investigating plans to provide more services to schools.

Socio-cultural Sustainability

The centres have limited community engagement beyond providing a space for congregation and connectivity. However, there is the potential for increased engagement of communities through training in the centres operated at local schools. There are no activities to raise awareness of online security and privacy with community members, but the CCK is considering such programs.

Key Learnings

The telecentre project under the Universal Access Programme in Kiribati has successfully provided internet connectivity to 12 remote islands with limited or no internet service. In terms of operational sustainability, the initiative highlights the potential of satellite technology, which has ensured the reliability and resilience of the system to extreme weather events. Further advances in satellite technology are expected to make satellite connectivity the preferred option to connect remote and hard-to-reach regions, particularly Pacific islands. Furthermore, solar power has provided a reliable and cost-effective source of electricity.

The project has been implemented with the support of the Communications Commission of Kiribati (CCK), which procures and supplies the necessary equipment, and operates the internet service. The project's successful launch with government funding highlights the potential for governments to kick-start local connectivity initiatives. However, the project also demonstrates that it is crucial for financial sustainability to build a source of finance that can sustain operations after government funding has expired. In the case of Kiribati, the successful initiatives have generated income for the local councils through the sale of internet vouchers, enabling them to continue supporting the centres after the first year of funding. Finally, the project highlights the

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potential for increased socio-cultural sustainability through community engagement and awareness-raising activities. While the telecentres have provided a space for congregation and connectivity, there is scope to increase community engagement through training programs and other activities.

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Telecentres under the Community Telecommunications Grants - Vanuatu[186]

Country	Vanuatu
Stakeholders/ Partners	Telecommunications, Radiocommunications and Broadcasting Regulator (TRBR), Local Committee, Local school
Year Initiated:	2018
Type of Initiative	Telecentre
Business Model	Initially funded under the Community Telecommunications Grant (3 months) Further funding through the sale of vouchers and fees for other services
Technology Model	VSAT

Overview

Starting in 2018, the Vanuatu government began to fund telecentres at schools, health centres and other community institutions. Utilising a grant under the Universal Service policy the government supplied equipment and initial funding for internet connectivity in unserved or underserved communities. On the expiration of government funding the communities then had to move towards other sources of funding such as sale of vouchers and other service fees. The initiative was successful in establishing sustainable telecentres at several locations whereas other sites failed to continue operation beyond the government funding period.

Financial Sustainability

The Telecommunications, Radiocommunications and Broadcasting Regulator (TRBR) of Vanuatu established a community grants scheme in 2018 called the Community Telecommunications Grant (CTG). The CTG came into effect as an adjunct to the Universal Access Policy (UAP) implementations and to provide support for improving coverage in under and unserved areas and

[186] The information in this case study was collected through interviews with the Universal Access and Service Co-ordinator at TRBR and the Spectrum Manager at TRBR.

fostering ICT-related projects[187]. The CTG came into effect as an adjunct to the Universal Access Policy (UAP) implementations, providing support for improving coverage in under and unserved areas and fostering ICT-related projects in communities[188]. Since 2018 the CTG grants have continued to benefit schools, health centres and the community. The grants, worth three million Vatu (approximately $USD25,000), target small-scope projects focussing on access and service in poorly connected areas[189]. The funding supplies a community or school with VSAT equipment, WiFi equipment including a voucher system, Internet service for three months, solar power system, laptops, printers, and cabling.

Project receiving grants are expected to be self-sufficient after the expiration of the grant monies. The projects, thus, must be innovative in its services. Initially, the sale of vouchers allowing timed access to the internet was the primary means of revenue raising. However, this is supplemented by other fees, such as for charging devices, printing documents, and holding events for the community. An example from one site at Erata Village, Tongariki Islands, provides an indication of the innovative fees that can be applied and the revenue able to be raised. The centre managed to raise enough to have monies available beyond the cost of operation, having achieved a level of self-sufficiency. Continued monitoring of this will provide a greater understanding of the revenue streams available and the propensity of the community to use the service. It should be noted that Erata Village is in an unserved area, so the community does not spend any income directly with the mobile operators and only uses this service.

Internet subscriptions are based on market rates and are currently VT20,000 per month (approximately $USD172). This price is on the high side for service provision for this type of service. Future alternative services may see these prices drop to more realistic levels with increased speeds. When considering affordability for the consumer, the current price for a voucher for Erata Village is VT100 ($USD0.86) for 24 hours and VT 500 ($USD4.28) for seven days with no

[187] Telecommunications, Radiocommunications & Broadcasting Regulator, Republic of Vanuatu, 'TRBR Releases Its 11th UAp Report on The Status of Implementation of the Government's UAP'.

[188] Telecommunications, Radiocommunications & Broadcasting Regulator, Republic of Vanuatu.

[189] Telecommunications, Radiocommunications & Broadcasting Regulator, Republic of Vanuatu, 'TRBR Releases Its 13th UAp Report on The Status of Implementation of the Government's UAP'.

download limits. These are in line with market rates such as Vodafone's mobile prepaid broadband rates. However, there are limitations on the download volumes across the mobile network. At another site Veni Matupavu, the voucher cost is VT50 ($USD0.43) for 2 hours, with no download limits, which compares favourably with standard mobile prepaid tariffs for data on the local mobile networks (VT50 for 300Mb and 2 hours). There is no requirement from the TRBR that any free services should be given to any group, so it is a community decision to provide services for free to various interest groups. The Erata centre does provide free internet to multiple groups, such as those with disabilities providing a level of equity for these groups.

Organisational Sustainability

The centres are owned and operated by the communities. To receive funding the grant application must be presented by the community and demonstrate how the community intends to operate the centre and provide services. Therefore, significant participation by the community is needed to win the grant, which ensures that subsequent services are operated and maintained appropriately. Furthermore, it is a requirement as part of the CRG grant that the community form a representative committee to run the centre. This committee runs, operates, and plans for the service provision of the centre. Where the centre is in a school, representatives from the school, such as the principal and teachers, must be part of the committee. Some community centres have documented their governance procedures, while others have not. Documenting governance provides a better level of accountability and performance, and it is an activity that the TRBR is considering replicating across all centres.

The TRBR can also play a role in facilitating conflict resolution. Whilst no official policies regarding conflict resolution are available, the community may initially approach the TRBR for help when traditional resolution methods fail. For example, at Venie Matupavu, several tablets went missing and were taken by an ex-teacher. The TRBR stepped in to facilitate a resolution with the identified person who took them. In another example, the TRBR is in the process to resolve a conflict among community members around the building that housed the facility.

There is no further engagement with private sector entities or other government agencies. However, other community-based initiatives might get involved in the centres in some cases. With regards to the Erata Community Internet facility, this is in the form of an existing active committee established by the community known as the Erata Development Committee. The purpose of the

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committee is to work on projects that support the welfare of the Erata people. In other cases, such community initiatives have not always proven to be a promising avenue for hosting and managing the facility.

Operational Sustainability

The centres are connected to the internet via VSAT systems. These systems have proven to be very reliable and relatively resilient to storms. However, in extreme weather conditions, the equipment can be damaged. Vodafone does provide a guide to disassembling and reassembling the VSAT dish in case of severe tropical cyclones. Whilst this is a good idea, there may be complications in realigning the VSAT to the required satellite, meaning communications can be lost for long periods. Newer solutions such as Starlink, which allows users to disassemble the antenna quickly, bring it inside during such events, and promptly reassemble it following the event, will lead to resilience improvements. Overall, the centres are highly reliant on functioning network infrastructure. Failure of any part of the infrastructure can make the centre unusable. Network services are the most critical component, with access to the Internet a requirement for operation as the centres do not offer any offline servers and are partially unusable if the internet service is down. However, this setup reduces the support overheads evident with server-based environments. In cases of solar power, a backup battery is used to support the centre after hours. When grid power is utilised, it is necessary to have a backup generator in case of power failure. The use of solar presents challenges particularly when batteries run out when they are not sufficiently recharged due to lack of sunlight or when there is maintenance to the system. Even generators to back up solar can fail when fuel has been exhausted. The cost of having a VSAT can be overshadowed by the cost of the solar power infrastructure, with associated maintenance costs, as many installations suffer from corrosion due to saltwater. Thus, power supply continues to be an issue in remote areas.

The primary purpose of the centres is to provide internet services to the communities, and overall, the quality of service concerning the internet is good, based on current performance information. No significant network downtimes have been encountered. Other services delivered to the communities include financial, educational, and health services. The educational services now delivered online are due to significant upgrades in educational systems brought about by the Covid-19 pandemic. However, there are still minimal government services. While government

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websites are available, it is often impossible to use services such as requesting birth certificates, and labour mobility services, requiring people to come to Vila to do the transactions.

However, despite the low level of services, the centres have allowed the community to use the internet and other services to communicate with friends and family. It has also allowed those engaging in seasonal employment programmes to do research and preliminary actions before committing completely. This group is pushing for improved government services so that all the preliminary checks and documentation can be done without the need and cost to travel internally until departure for their employment.

Human resources are still and will continue to be a challenge in supporting these centres. TRBR does provide some initial training and has in place several service providers that can provide further training. However, if there is little to no remuneration, people will consider alternative employment, such as the Labour Mobility schemes, to support their families. People may also move into more populated areas where they can continue to grow their skills, potentially leading to a need for constant training of people to support these centres. Trained staff is especially important as the average user has a low level of computer literacy, albeit familiar with a mobile phone and its operation. Despite low levels of digital literacy, access to the centre and the availability of services improve the general users' level of computer literacy. Nevertheless, there are still opportunities for further training to improve the general users' literacy level on all things digital.

Policy Sustainability

The centres are established under the UAP under the leadership of the TRBR. Apart from this, there is no other government involvement in these projects, including no e-government services. However, a CTG grant application may require a community centre to establish itself under Vanuatu laws to ensure appropriate governance.

Socio-cultural Sustainability

Each community is relatively small and closely knit, which is typical in Vanuatu. The ability to develop a proposal for the grant and subsequent service shows some form of solidarity and trust in the people leading the initiative. Furthermore, within small and remote communities, these centres can provide a meeting place where people can come together to discuss issues or socially engage. An example of social engagement was the recent World Cup, where the Eratas centre

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provided the facilities for the community to come together and watch the event in comfortable surroundings. Additionally, the community centre is a centralised place where the community can access telecommunications services and obtain training in various online and ICT matters. Notably, the TRBR has provided ICT literacy training to centres in the past, and the expectation would be that this would continue. Furthermore, these communities may also be given a combination of government initiatives concerning cybersecurity and financial literacy and TRBR initiatives in online safety and other matters. In all cases, improving knowledge of the community on ICT services allows the community to engage better and improve overall.

Environmental Sustainability

Most sites have no grid electricity infrastructure; therefore, all power is solar generated. Some localities are on the grid and have power generated by hydro (for example, Brenwai in Malekula). Where centres are located on the grid, power is predominantly provided by diesel generators. All locations utilise generator backup if batteries fail. There are currently no policies or initiatives regarding e-waste in Vanuatu. However, the TRBR is looking into developing an e-waste guide as, to date, e-waste is disposed of together with general waste, leading to possible environmental damage. The issue will be the cost associated with shipping waste offshore for recycling; however, any revenue generated by the programme offsets this cost.

Overall, the initiatives have minimal environmental impact apart from building construction. Construction has been done in specific locations to improve accessibility, service provision and future extensions to other local sites. Furthermore, there is little impact on the environment regarding VSAT infrastructure, which is a very small structure but requires a concrete plinth to be constructed to support them. Depending on the pointing angle, clearing vegetation is unnecessary as the VSAT infrastructure location is already cleared.

Key Learnings

The Community Telecommunications Grant (CTG) in Vanuatu provides community infrastructure to improve access to information and communication technology (ICT)-related projects in under and unserved areas. The implementation of the CTG in Vanuatu shows how the government can support connectivity initiatives by taking on the initial capital expenditure that is often difficult for local communities to invest. The initiative further demonstrates that it is possible to become financially self-sufficient if the appropriate framework is in place.

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The project further demonstrates that community engagement in the initiative can be achieved if the right framework is adapted. Applying for the funds ensures that they have to band together and show sufficient commitment and community organisation. However, to further build on this community engagement and fully benefit from the establishment of the telecentres, the initiative should include services and training beyond connectivity.

The telecentres in this case study demonstrate the promises of VSAT technology to connect remote and hard-to-reach areas such as pacific islands. While the initial investment is quite high, the VSAT terminals are very robust and can withstand extreme weather conditions. This technical arrangement also provides a reliable and high-bandwidth internet connection with minimal environmental impact. Similarly, solar panels have proven to be a reliable and environmentally friendly solution for power generation in the context of these connectivity initiatives.

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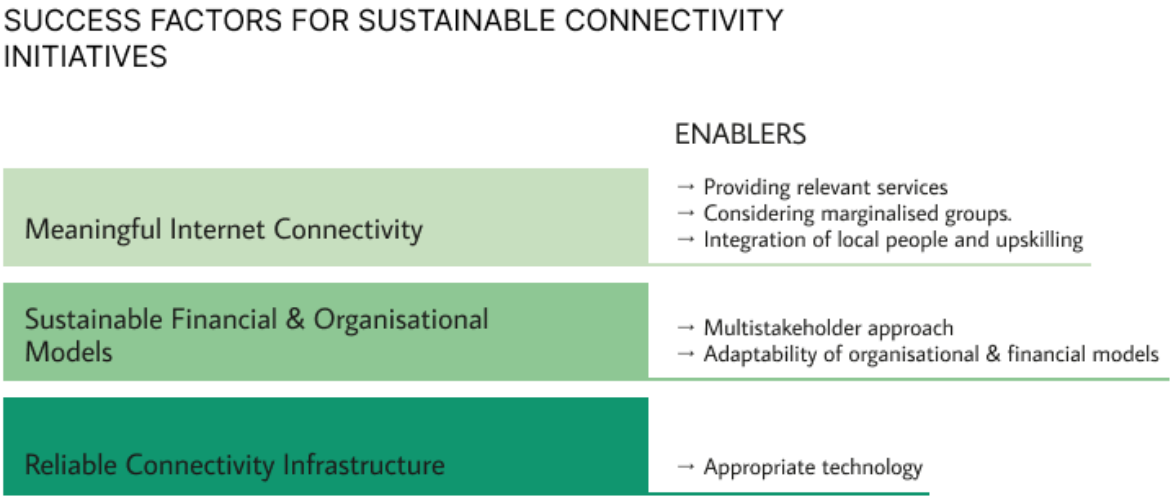
Section 5: Conclusion

Summary of Key Learnings



Multistakeholder Approach

The analysis of the case studies underscores the significance of a broad coalition for the sustainability of connectivity initiatives. Local government engagement and support, as exemplified by the Gram Marg project in India, can greatly contribute to organizational sustainability. Incorporating the private sector can establish backhaul connectivity sustainably and increase operational sustainability. Private sector involvement can also take the form of social enterprises, such as TakNet in Thailand or the Ungu CoLTE network. Academic institutions, as seen in many of the projects examined, can also support connectivity initiatives. Effective relationships between various stakeholders are crucial for a multistakeholder approach to succeed. Overcoming barriers related to the remoteness of target communities, as illustrated by the TPOA initiative in Malaysia, can be achieved by using appropriate technology.

Integration of local people and upskilling

All the case studies have shown that successful engagement with local community members is beneficial to both the community and the project's sustainability. Unsuccessful engagement, on the other hand, will lead to underutilisation of the services offered and ultimately to sustainability challenges, as could be observed in the CLICC project. Establishing an initial presence in the community that demonstrates the benefits of connectivity, such as the digital resource centre in

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the W4C initiative in India, can be beneficial to engage the local community effectively. Furthermore, training the local community to operate, maintain and extend the networks is crucial to successful community engagement, as demonstrated by the TakNet in Thailand and W4C in India. The Barefoot Engineers in the W4C project shows the great potential of this approach. Finally, the GramMarg initiative shows that while connectivity initiatives can potentially be sustainable without a great extent of community involvement, as demonstrated in their institutional model, the project will be more beneficial to the community if they are engaged, as shown in their Village Entrepreneur model.

The Adaptability of organisational models

To effectively bring connectivity to underserved communities in Asia and the Pacific, it is important to adopt a flexible approach that considers the varied contexts of each country and environment. The case studies highlighted above demonstrate that there is no one-size-fits-all solution to connectivity challenges. Instead, sustainability can be achieved through creativity, and flexibility in the deployment of technological, organisational, and financial solutions. There can include multiple approaches with different advantages and disadvantages for the same location, as shown by the GramMarg initiative. TakNet also demonstrates the importance of adapting to changing circumstances and growing networks to increase sustainability. In contrast, the Ungu CoLTE initiative showcases the potential for innovative technical solutions, such as establishing a data-only mobile network to increase operational sustainability while navigating regulatory challenges. By being open to flexible and creative solutions, connectivity initiatives can better serve the needs of underserved communities and promote digital inclusion and social development.

Appropriate technology

The case studies reveal that while regulatory conditions can pose limitations, appropriate technological solutions can enable sustainability across various dimensions beyond operational sustainability. For instance, the implementation of a virtual remote management system (VRMS) in the TPOA initiative in Malaysia has been crucial in enabling organisational sustainability through building an interactive ecosystem between the four communities with telecentres, other indigenous communities, telecentre managers, and university researchers. Similarly, the creative solution of the CoLTE network in the Ungu community in Indonesia has allowed the project to offer better services, thus increasing operational sustainability while addressing regulatory concerns. Another important consideration must be value for money of the connectivity

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infrastructure. In particular, the chosen technology must provide internet services that are affordable for the community or it risks continued operation as demonstrated at the Kinect Network in Papua New Guinea. Thus, the right technological solution can support various sustainability dimensions and contribute to the success of connectivity initiatives in different contexts.

Importance of relevant services

Local relevance is a crucial aspect of sustainability for connectivity initiatives, as demonstrated by is the project's relevance to local communities. Throughout the case studies. Services that are tailored to the needs of local communities play a significant role in determining both operational and socio-cultural sustainability. The case of W4C is a prime example of how connectivity can be used to empower local livelihoods. In the village of Chanderi, connectivity with relevant services led to a doubling of the average household income. However, the benefits of appropriate services go beyond the economic sphere. In the TPOA program, services have been customized to the specific needs of indigenous communities. This tailoring of services has made the initiative relevant and beneficial, ultimately allowing communities to gain recognition of ancestral land through engagement with the community telecentres.

Consider vulnerable groups

The success of connectivity initiatives relies on considering the needs of marginalized groups, along with overall cultural sensitivity, to ensure benefits for the whole community. The W4C initiative is a successful example of this, as it prioritized empowering women through their connectivity initiative, leading to improved livelihoods for many women in the community. This emphasis on gender equality was pivotal to the overall socio-cultural sustainability of the initiative.

Recommendations for Smart Villages and Smart Islands

Employ a multistakeholder approach

The literature and case studies illustrate the value of a multistakeholder approach in achieving various dimensions of sustainability for connectivity initiatives. Therefore, it is recommended that such initiatives adopt a broad multistakeholder approach in their operations, involving both local and national government actors. Government actors can provide resources and ensure the legal and political legitimacy of the initiative while also integrating government services to make the initiative more relevant to local communities. Partnerships with the private sector can also be

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beneficial, with their contribution in deploying or operating the infrastructure, providing funding or expertise, and offering other services that are relevant to the community. In addition, civil society organisations such as NGOs, social enterprises, or academia can support the initiative's sustainability.

Ensure local community participation

The participation of the local community is crucial for the sustainability of connectivity initiatives. Without their involvement, most projects are likely to fail. Therefore, the community should be engaged from the outset to ensure that the project serves their needs. Relevance to the community is essential and needs assessment should be conducted to ensure that the initiative addresses their needs. Sustainable connectivity initiatives should also offer services beyond connectivity to remain relevant to the community. Additionally, the community should be viewed as an asset for the deployment and operation of the project. Thus, initiatives should include training for local community members and involve them in maintenance and operation tasks. In the long term, sustainable connectivity initiatives should aim to be financially self-sufficient and require as little external support as possible.

Consider the local context

Sustainable connectivity initiatives can employ various operational and organizational models, depending on the local context. The technology, business model, or form of organization should be carefully selected to ensure the success and sustainability of the initiative. While innovative technologies can contribute to sustainability, they need to be well-matched to the local context to avoid failure. Factors such as weather conditions, maintenance requirements, local skills and external support, and existing infrastructure need to be considered. Moreover, the right form of organization should encourage ownership by the local community, and the organizational and business model should reflect the local cultural and political context and the attitudes of the community towards the project. Therefore, before designing any sustainable connectivity initiative, a thorough assessment of the local context and conditions should be carried out.

Increase availability of data

To evaluate the sustainability of a connectivity initiative, it is crucial to have access to relevant data. However, this report has revealed that many initiatives fail to collect or publish data on their operations and impact. Therefore, it is recommended that connectivity initiatives should prioritize

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impact reporting to ensure the effectiveness and continued success of their projects. Additionally, further research is necessary to validate the findings of this report. In both future research and reporting of initiatives, all sustainability dimensions should be taken into account. It is important to recognize that the dimensions discussed in this report are interconnected, and a comprehensive evaluation of an initiative's overall sustainability requires consideration of all these dimensions.

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Annexe 1: Case Study Guiding Questions

Financial Sustainability

Resources:

- To which extent does the initiative manage to survive economically, i.e., to afford the necessary hardware and labour necessary for the continuous operation?
- To which extent can the initiative ensure that it has enough resources, supporters, workers, volunteers, and users?

Business Model

- What is the business model of the initiative?
- To which extent does the initiative rely on internal funding sources?
- To which extent does the initiative rely on external funding sources? How regular are they?
- Are there possibilities for the initiative to obtain public or municipal funding or to cooperate with municipalities, public institutions or the state in providing access and services?
- To which extent does the initiative rely on a single individual or a small group of actors to provide the necessary resources (time, skills, money)?

Relationship with for-Profit Operators

- To which extent does the initiative rely on a commercial provider? What is the nature of this provider (e.g., for-profit vs social enterprise or local vs nonlocal)?
- To which extent does the model of network provision face competition from commercial for-profit telcos based on the quality of signal/provision, lower cost and/or better network maintenance?

Network wealth for all:

- To which extent does the initiative provide gratis/cheap/affordable network and Internet access for all and services?
- If subscriptions are used, are they affordable?
- To what extent are there different pricing schemes, such as for residential users, small enterprises, bigger firms, and public institutions (e.g., schools)?

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Organizational Sustainability

Governance

- How is the initiative governed? How does it decide on which rules, standards, licences, etc., are adopted?
- To what extent does the initiative allow and encourage the participation of community members in governance processes?
- To what extent are there mechanisms in place for conflict resolution and for proceedings in the case of the violation of community rules?

Data ownership and control:

- What are the policies and practices in place to protect the data privacy of the community?
- Does the initiative provide capacity and awareness building of the community around issues of online safety and privacy?

Multistakeholder engagement

- To what extent are stakeholders from various sectors part of the initiative?
- To what extent is the initiative controlled by the community? Is the initiative collectively controlled by its members as a commons?
- To what extent is the initiative controlled by the local/municipal authorities?
- To what extent is the initiative controlled by private corporate interests?
- Is the initiative part of large regional networks or organizations?

Operational Sustainability

Infrastructure

- How robust is the network infrastructure used for service delivery?
- To what extent does the Initiative rely on a single infrastructure, or to what extent is service delivery dependent on functioning network infrastructure?
- How reliable is the electricity supply, and what type of electricity supply is used?
- How resilient is the infrastructure to adverse events such as extreme weather?
- Is the technology used "future-proof"
- Is the technology used suitable for the purpose of the network?

Service Delivery

- How reliant is the initiative on the internet?

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- To what extent does the initiative have the capacity to deliver good quality services?
- Is there enough trained staff?
- Are the services offered high quality and relevant for the local populations?
- Are government services involved?
- What technological skills are required of the average user to benefit from the initiative?
- To what extent are the community needs served by the initiative?
- To what extent are the needs of local businesses served by the initiative?

Policy Sustainability

- To what extent is the local/regional/national government involved/supportive?
- To what extent are e-government services part of the initiative?
- Is the initiative recognised/supported by relevant policies?
- What is the legal framework of the initiative?
- Is the initiative legally incorporated in a form that supports its primary functions?
- Is the initiative engaged in a dialogue with policymakers and/or advocacy?

Socio-cultural Sustainability

- How closely knit is the community? To what extent are trust and solidarity present, and how are they manifested?
- To which extent does the initiative provide mechanisms for learning, education, training, communication, conversations, community engagement, strong democracy, participation, cooperation, and well-being? In what ways?
- To which degree is the initiative able to foster a culture of togetherness and conviviality that brings together people? In what ways?
- Are those who work professionally for the maintenance of the network fairly remunerated for their labour so they can lead decent lives?
- To which extent are the needs of diverse individuals (e.g., by gender, age, nationality) and groups in the community served by the initiative?

Environmental Sustainability

Energy use

- To what extent does the initiative rely on relatively environmentally friendly energy sources (wind, solar, tidal, wave, geothermal, biomass and waste energy)?

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E-waste

- To what extent does the initiative have policies and practices in place to reduce the amount of e-waste through repairing, recycling, and use of sustainable hardware?

Impact on Environment

- To what extent does the initiative's infrastructure impact the environment?

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