Prefaces by Kathryn Brown
and Jan Dröge

Luca Belli Editor

Community Networks: the Internet by the People, for the People

Official Outcome of the UN IGF Dynamic Coalition on Community Connectivity

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CONTENT

8 Community-led Networks for Sustainable Rural Broadband in India: the Case of Gram Marg

Sarbani Banerjee Belur, Meghna Khaturia **and**
Nanditha P. Rao

Abstract

To bridge the digital divide facing rural India, a cost-effective technology solution and a sustainable economic model based on community-led networks is needed. Gram Marg Rural Broadband project at IIT Bombay, India has been working on both these aspects through field trials and test-bed deployments. It has been studied that even if the connectivity reaches rural India, without a sustainable economic model, the network would not be able to sustain itself at the village level. Our impact studies have revealed the need for community owned networks. The study reveals that villagers understood that they could save time and money with Internet connectivity at the village. However, the network was not sustainable and, for this reason, villagers suggested community-led networks would enable them to 'own Internet'. Hence, a Public-Private-Panchayat Partnership (4-P) model was developed. In this partnership model, the Panchayat, which is the local self-government structure at the village level, takes ownership of the network. The partnership enables the network to be community-led for effective decision making and giving priority to development of services based on village needs. The public-private partnership enables Internet connectivity to reach the village from where it is taken over by the Panchayat. The investment for the network is done by Panchayat at the village level. Local youth known as Village Level Entrepreneurs (VLEs) invest, maintain the network and generate revenue. The model ensures a decent and sustainable Return-on-Investment for the Panchayat and nominal user subscription cost. It also considers expected future growth in demand and related cost dynamics. Revenue generation and sharing is an important aspect which provides incentive for Internet's spread and expanse in the village.

8.1 Introduction

One of the crucial factors which can contribute to economic growth and development in rural areas is the broadband connectivity. Several activities such as banking, e-governance, e-learning, tele-health services and activities to empower villagers with e-commerce can be promoted by enabling them digitally. Internet connectivity in the village will also help in creating entrepreneurs and generate employment opportunities within the village. Social networking and entertainment are added benefits of the Internet. However, providing Internet connectivity to rural areas in India is a tough task in itself, due to several reasons. Some of the important challenges are i) lack of digital awareness, ii) unaffordability and iii) lack of Internet infrastructure. Due to villagers being digitally less aware, they are unable to appreciate the benefit of Internet and thus the Internet demand in these areas is limited. Even if there is demand, the nature of demand is dependent on their income and is sporadic. Lack of Internet infrastructure is another important challenge in these areas. The capital expenditure and operational costs of setting up a 3G/4G network is generally very high. Sparse population and low to medium subscriber density makes it impossible for them to get a return on their investment. Hence, penetration of operators in these rural areas is low to none. Other added challenges such as lack of fibre, difficult terrain and scarcity of electricity makes it impossible to connect these areas.

To bridge this digital divide, Government of India under its BharatNet initiative[284] is building an information highway by connecting village local self-government offices called Gram Panchayats (GPs) through optical fibre. This initiative, though began in the year 2012, will take a long time for completion and aims to connect only the GPs. Thus, the villages situated a few kilometres away will remain unconnected. Furthermore, even if connectivity would reach the villages in India, it would be difficult to sustain connectivity at the village level without a sustainable economic model.

284 See BharatNet Status http://www.bbnl.nic.in/index1.aspx?lsid=570&lev=2&lid=467&langid=1

In this paper, we discuss a potential solution to the above-mentioned problem. Gram Marg's Rural broadband project at the Department of Electrical Engineering, IIT Bombay[285] aims to connect the unconnected by overcoming barriers to connect rural India. In order to provide ubiquitous connectivity to these areas, a shift is required from traditional technology to a more affordable, efficient and robust technology. A wireless solution based on TV White Space has been experimentally proved to be an effective solution to connect the rural areas. In India, there is a significant amount of available spectrum in the TV band which is largely unutilised. In addition to this, the TV band has good long-distance propagation characteristics along with non-line-of-sight characteristics that make connectivity feasible in these areas. Under the auspices of the Gram Marg project, two large scale test-beds have been deployed. The first TV White Space test-bed in India[286] covering seven villages to test the feasibility of TV White Space technology was set up by Gram Marg. In the second test-bed we scaled it up to 25 villages. Unlike the first test-bed, the technology approach to connect these villages also uses point to point 5.8 GHz link in the unlicensed band. Gram Marg's aim is not only to develop technology solution for rural broadband in India, but also develop a sustainable economic model around the proposed technology for its viability.

The main objective of this paper is to propose an economic model and its implementation towards sustainability for rural settings in India. To design a sustainable model, two important criteria needs to be taken into consideration. The first thing to ensure is that, there is decent and sustainable Return-on-Investment (ROI) for the investor and secondly, a nominal user subscription cost for the end user. However, due to disparity in the demand-supply dynamics in the rural areas, developing a sustainable model becomes a challenging task in itself. On one side, the cost for setting up a network is high, whereas, on the other, the

285 See Gram Marg Website http://www.grammarg.in/

286 Kumar et al (2016).

demand is low to none. We suggest Community Networks (CNs) as a plausible solution to ensure sustainability at the village level. Community involvement will influence effective decision making and prioritising services based on the village needs. The CN model that we suggest in this paper is based on a Partnership model which involves Public sector, Private sector and the Panchayat. For this reason, this model is termed as 4-P model.

The paper is organised as follows. The first section of the paper discusses the motivation for addressing the need for sustainable model in rural broadband. In the second section we shall discuss existing economic models and their shortcomings. In the third section, we will discuss the 4-P model in detail. Finally, we will conclude the paper with recommendations and policy implications.

8.1.1 Motivation

Learnings from Gram Marg's test-beds provided insights on two important things for rural broadband project to be successful. These are i) need for a cost-effective technology and ii) need for a sustainable economic model. We will discuss this next.

8.2 Technology

The technology requirements in rural areas are quite different than those in urban areas. Hence, there is a need to develop a technology based on requirements of rural areas. The technology options for connecting rural India needs to be cost effective, easy to deploy, suitable for hilly terrain and dependent on renewable energy sources like solar and wind. In general, all rural connectivity projects deploy standard Wi-Fi technology (5.8 GHz and 2.4 GHz) in the license exempt band. While 5.8 GHz is used for backhauling Internet, 2.4 GHz is used in access points in Wi-Fi hotspots. This technology uses off the shelf devices which can be easily bought in the market. However, some of the disadvantages of this technology is that, it works in strict Line of Sight, requires large heighted towers and has a small coverage area.

Gram Marg proposes a wireless solution based on TV White Spaces (TVWS) for connecting rural India[287]. There is a significant amount of TV White Space available in the UHF band (470-590 MHz) in India with Doordarshan being the only terrestrial TV broadcaster in this band. Currently, there are no regulations for the usage of TV White Spaces in India. According to the National Frequency Allocation Plan (NFAP) 2011, fixed and mobile services can be permitted in 470-585 MHz band on case by case basis. For setting up a test-bed, there is a requirement of experimental test license to be procured before deploying the technology on ground.

TV UHF band has very good propagation characteristics which works even in NLoS (Non- Line of Sight) condition. Thereby, connecting villages that are located at far off distances from each other with sparse population. Also, the power requirements of this technology being low, makes it a perfect suit for connecting the rural areas with alternative energy sources like solar energy. It should be noted that these areas have intermittent power supply and harnessing options like solar energy and wind energy will bring down the overall cost of the network. Solar energy has been used as renewable energy source for the TV White Space test-bed. Another advantage of this technology is its ability to effectively work with towers of low height. Tower cost is a major part of the capital expenditure in setting up a network. To bring down the cost, we have fixed the height of the towers to be 9-10m in our test-bed. We have also used already existing de-functional towers to further reduce the investment cost.

Gram Marg team is also working on technology development of TVWS devices alongside testing their feasibility of implementation and deployment on ground. The TVWS device has been designed and fabricated in the Gram Marg lab. These devices are in the prototype stage, undergoing experimentation.

8.3 Impact Assessment Study

The authors of this paper studied the impact of providing Internet connectivity to the test-bed villages for a duration of one year. The

287 See Khaturia, Belur, Karandikar (2017).

study suggested that, if the villagers are digitally aware and can avail Internet to use e-Governance services in their own village, they do not mind paying for the Internet. By availing services in the village, the villagers save time and money which they would have otherwise spent visiting the block headquarters to access the e-Governance services. We also tested the villagers' readiness to pay for Internet. Given the situation that these villages had no Internet connectivity, the villagers calculated the total amount which they saved from not travelling to the block headquarters. They then back calculated a fixed amount of INR 150 (approx. 2 US dollars) monthly that they would save from not travelling and they could spend to afford Internet in their village. However, without a sustainable economic model at the village level, the Internet connectivity even though reached the villages, was not able to sustain itself in the village.

The two important players in the three villages that we studied were a private telecom operator who provided bandwidth and a government office (Gram Panchayat office) that "housed" the Internet, providing access points. Two important conclusions derived from the impact study were, first, the need for a sustainable model wherein the village would own the network and, second, the benefits of involving the Panchayat (local self-government) to run the network at the village level. It was observed that involvement of the community can be an important factor in developing a sustainable model. CNs can motivate villagers to have an ownership of the network, thus enabling maintenance of the network at the village level. Also, the community acts in coalition to decide what are the services that a particular village needs and should be prioritised, depending on their local needs. For example, a village where inhabitants walk several km to avail banking services, would need e-banking services as a priority. In another case, a village with high malnutrition deaths need primary health care facilities as a priority.

8.4 Existing Economic Models

Customer base and Return-on-Investment are the two driving factors leading to success of traditional business models of Internet connectivity. It is obvious but natural that these two factors are available in urban areas and not in the rural areas. Hence, to motivate operators to reach rural areas, there has to be innovation both in technology as well as business strategy. However, it should be noted that a single business strategy will not be suitable for all rural scenarios. We should take into account the sentiments and needs of the people in these areas while developing a business model. For instance, in certain locations there could be a resistance to adoption of Internet due to harmful effects of radiation, while in other locations, lack of digital awareness is the reason for no demand for Internet.

Providing connectivity to remote rural areas in the last decade has been an important topic of research. Many business models have been proposed in India, offering unique approaches to overcome the challenges in connecting rural areas. Some of the models will be discussed here along with their merits and demerits.

ITC eChoupal[288]

Launched in the year 2000, this is one of the oldest and largest initiative to bring about Internet based interventions in rural India. This initiative is unique and innovative, as it contributed substantially to the rural economy by co-creating rural markets with the help of local communities. Due to farms being fragmented, farmers took resort to the 'middle man' for selling and buying farm produce. ITC's eChoupal Internet intervention helped in overcoming this challenge by setting up 6450 kiosks in 40,000 villages and reaching out to 400,000 farmers. Farmers could enhance their farm productivity and hence could get higher farm gate prices for their produce. Connectivity was provided to the farmers through phone lines or Very Small Aperture Terminal (VSAT). This initiative though helpful for the farmers, could not sustain itself for a long duration due to policy issues, export bans, subsidies and slow amendment to Agricultural Produce Market Committee (APMC) Act. This being an Internet intervention for rural farmers, the bandwidth requirement was only meant to cater a single service. Another reason why the project stopped

288 Bowonder, Gupta, Singh ([s.d.]).

scaling itself was due to its inability to effectively combine other services along with farm applications to serve the communities based on their needs.

Air Jaldi[289]

Air Jaldi is an Internet Service Provider (ISP) providing broadband to enterprises and individuals in India. Air Jaldi uses fixed wireless access in the license exempt band (5.8GHz) and has built 10 networks in 6 different states of India. Air Jaldi's business model revolves around employing low cost technology and involving local youth for the operation and management of the network. Partnerships with government organisations, Ford Foundation, Facebook and Microsoft have played a major role in Air Jaldi's success. As the networks set up by Air Jaldi are dependent on existing infrastructure, their outreach is limited to only those areas where infrastructure is available. Though it is a successful initiative, adherence to local needs and dependency on external funding can act as a bottleneck in its scalability.

Wireless for Community Network (W4C)[290]

Wireless for community network (W4C) is an initiative of Digital Empowerment Foundation (DEF) and Internet Society (ISOC). W4C was launched in 2010 with the aim to connect rural areas where communities are well established such as tribal areas. In order to connect these communities, W4C employs low cost Wi-Fi equipment in the license exempt band (2.4 and 5.8 GHz) to set up their network. This initiative uses a bottom-up approach wherein community is an important stakeholder in the operation and management of the network. W4C has set up networks in tribal communities such as Baran and Tilonia in Rajasthan, Guna and Shivpuri in Madhya Pradesh and Agariyas in Rann of Kutch, Gujarat.

Through their contributions, the above-mentioned initiatives have paved the way for new innovations to come about. Although these

289 See https://airjaldi.com/
290 See http://wforc.in/

initiatives have succeeded at a small scale, by serving specific communities, it is important to note that they face challenges during their scaling up phase, due to unavailability of funds, partnerships and regulatory restrictions. Thus, it can be argued that there is a need for innovative economic models, for large-scale penetration of Internet in India.

8.5 Public-Private-Panchayat Partnership (4-P) Model

The Public-Private-Panchayat Partnership (4-P) model has been developed by Gram Marg, based on user feedback from field trials and impact assessment study. To take broadband connectivity to the rural areas of India, partnerships have always been the prescribed method. The most relevant of these partnerships have been the Public-Private partnerships (3-P model). However, these partnerships are frequently unable to sustain themselves, due to their demerits, such as planning and maintenance delays, inadequate monitoring, funding gaps and improper risk management. The merits and demerits of Public-Private partnerships are described in Fig.1. An example of the inefficiency of the 3-P model is offered by BharatNet to connect 250,000 Gram Panchayats in India. Although this initiative started in 2011 is still lagging behind in achieving its projected goals. Furthermore, the GPs that are already "connected" are unable to access the broadband, unviable business model being one of the important reasons.

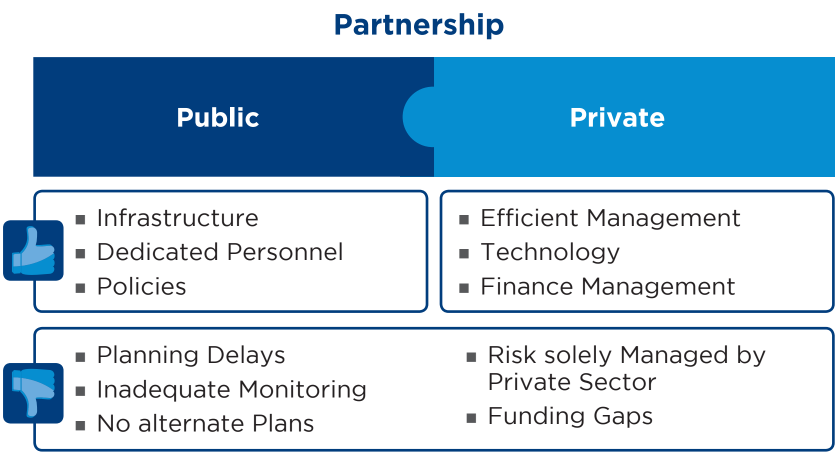

Figure 1. Public Private Partnership

A classic feature that is commonly found in partnership models studied so far is the adoption of a top-down approach. In this approach, the involvement of local people for whom the network is being set up and he consideration of the local needs are not taken into account. For example, in rural areas which suffer from maternal, child and infant deaths, the connectivity services should be oriented towards better healthcare facilities.

In order to build a network that can cater to local and regional needs, we follow a bottom-up approach and propose a sustainable economic model based on CNs. Unlike, some of the existing CNs in India, which are based on established communities such as tribes, or communities of individuals sharing specific occupation, or caste *etc.*, the type of CN analysed here is different as it relies on and forms communities based on usage and adoption of Internet, thus bridging existing gaps, by default. This proposed model is based on a Public-Private-Panchayat Partnership (4-P) as illustrated in Fig. 2. Notably, in this model:

- The Panchayat holds the responsibility of maintaining the network at the village level by appointing Village Level Entrepreneurs (VLEs). The Panchayat also plays a major role in defining priorities for the local digital needs of the villagers.
- The Private partnership plays a vital role regarding technology innovation and setting up of the network.
- The Public partnership is important for the viability gap funding and making suitable policy recommendations to the government.

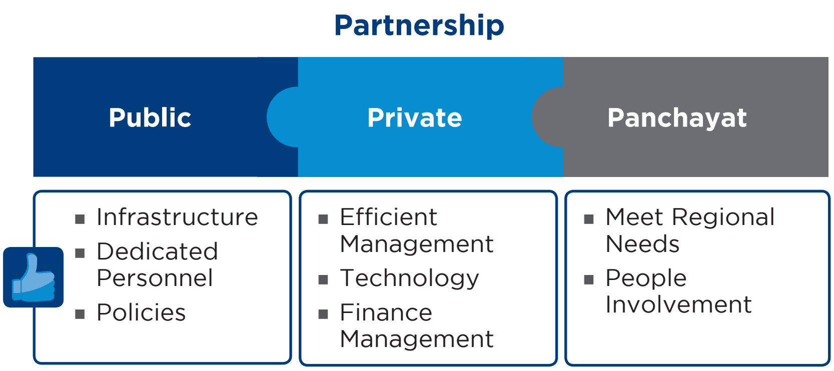

Figure 2. 4-P Model

8.5.1 Conceptualising Viability of 4-P Model

Analysing cost dynamics is very important for conceptualising the viability of the 4-P model. Two important cost indicators that are taken into account for deploying a network are Capital Expenditure (CAPEX) and Operational Expenditure (OPEX). In order to bring down the total cost of the network, innovation in technology plays an important role. Moreover, dependency on single technology for network growth and expansion may not be feasible in the rural settings of India. Hence, it is proposed that existing technologies and innovation be optimally mixed to form a true game changer for the Indian rural connectivity scenario. This will enable large outreach and will prove to be a very cost-effective solution when scaled up.

Insights from Gram Marg test-beds suggests that it is important to exploit the benefits of various technologies to bring down the overall cost. For instance, in locations where tower infrastructure is already available, Wi-Fi (5.8 GHz) is a more suitable option. Whereas, in locations devoid of any infrastructure, TVWS is much more feasible due to its dependency on low heighted towers, less power consumption making it a cost-effective solution for rural broadband.

Revenue generation and revenue sharing is also an important aspect that contributes to sustainability of the 4-P model where a large part of the revenue goes to the VLE, which in turn motivates them for extending the network inside the village. In the proposed 4-P model, this aspect is brought about by the involvement of local youth in the village known as Village Level Entrepreneur (VLE). VLEs invest and maintains the network as well as generates revenue by selling bandwidth to the villagers. VLEs are also instrumental in taking the eGovernance services to the end users and in turn generates employability for themselves, thus making the model sustainable. The revenue generated is also shared between the partners depending upon their contribution in the partnership.

The authors of this paper believe that all the aspects mentioned above, if carefully taken into account, can lead to a positive Return-on-Investment (ROI) or cost benefit for the investor. This suggests that the model will perform well on field and is also a lucrative value for the investment made.

8.6 Policy Recommendations

We suggest the following policy recommendations to ameliorate the rural connectivity scenario in India.

- CNs are allowed to operate in India but there are no specific policies that support these networks. We suggest that CNs should be promoted and encouraged by the government.
- Different marketing strategies can be adopted by local ISPs such as advertising, branding of products, subsidies, discounts *etc*. This would enable innovation and competition leading to better quality of services in rural areas. Such provisions should be taken into account while designing the policies for CNs.
- CNs should always be decentralised as they will enable locally created and locally relevant content to be circulated in the villages for better acceptance of Internet.
- To scale the CNs, funding should come through funding agencies like Universal Service Obligation Funds.
- As suggested above, usage of TVWS is crucial in making the network cost-effective in comparison to other technologies. However, there are no regulations in India for the usage of TVWS for rural broadband. We suggest that TVWS spectrum should be lightly licensed in semi-rural areas. In remote areas where there is no penetration of ISPs, this band should be license-exempt.

8.7 Conclusions and Future Work

In this paper, we address two questions that are very pertinent to the longevity of broadband in rural areas of India. The first is related to why sustainability of rural broadband in India is necessary and the second is how rural broadband can perpetuate itself in these areas where the demand-supply dynamics is so uneven.

Hence, we propose a sustainable economic model termed as 4-P model, developed by Gram Marg and based on the utilisation of CNs as a solution. The 4-P model suggests partnership between Public, Private and Panchayat. The model is based on insights and findings from Gram Marg test-beds and adopts a bottom-up approach. Before elaborating the 4-P model, existing partnership models have been reviewed and various approaches to overcome the challenges in serving rural India have been studied. In the 4-P model, the Panchayat is at the crux of the model, enabling local participation and regional needs being met. Village youth are appointed as Village Level Entrepreneurs (VLEs) who invest, maintain and operate the network in the village. They are also responsible for expanding the network in the village. Importantly, cost is an significant aspect of this model. In order to cater to rural needs, the model has to be based on cost-effective technology solutions that can bring down the cost of setting up the network substantially. Hence, it is proposed that an optimal mix of technologies along with innovation can be utilised as a game changer for rural connectivity scenario in India. Through revenue generation and sharing, the model would be able to sustain itself in the rural areas. This paper also discusses the need for policy formulation for developing CNs in India. This body of policy is currently not present in India, although CNs and their development in India would be crucial for rural connectivity to reach remote rural areas.

Currently, the 4-P model is at its validation phase on the field in Gram Marg's 25 villages live test-bed at Palghar, Maharashtra. As part of the validation, we expect to perform extensive cost benefit analysis to quantify sustainability of Internet, cost effectiveness of technologies, revenue generation by VLEs and calculation of Return-on-Investment. The success of the model will be measured through a set of success indicators. Both qualitative and quantitative data would be collected from the network set up at the live test-bed. The data will be related to demand, quality and affordability by which the sustainable economic model can be tested for its viability.

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