

Sustainable Economic Model for Rural Broadband in India

The case study of Gram Marg

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Abstract—To bridge the digital divide facing rural India, a cost-effective technology solution and a sustainable economic model based on community 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. Villagers understand that they were able to save time and money with Internet connectivity at the village. However, the network was not sustainable. Villagers suggested community networks would enable them to 'own Internet'. Hence, a Public-Private-Panchayat Partnership (4-P) model was developed. Panchayat being the local self-government at the village level, takes ownership of the network. This partnership enables the network to be owned by community for effective decision making and prioritizing 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 ROI for the Panchayat and nominal user subscription cost. It also takes into account expected futuristic 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.

Keywords—*Community Networks, optimal mix of technologies, 4-P model, impact assessment, rural connectivity, Village Level Entrepreneurs, India*

I. INTRODUCTION

One of the important factors which contributes 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 fiber, difficult terrain and scarcity of electricity makes it impossible to connect these areas.

In order to bridge this digital divide, Government of India under its BharatNet initiative [1] is building an information highway by connecting village local self-government offices called Gram Panchayats (GPs) through optical fiber. 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 kilometers away will remain unconnected. Furthermore, even if connectivity would reach the villages in India, it would be difficult to sustain itself at the village level without a sustainable economic model.

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 [2] 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 unutilized. In addition to this, the TV band has good long-distance propagation characteristics along with non-line-of-sight characteristics that enables feasible connectivity 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 [3] 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 working towards sustainability for rural settings in India. To design a sustainable model, two important criteria needs to be taken into consideration. The first is to ensure 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 demand is low to none. We suggest Community Networks (CN) 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 community network that we suggest in this paper is based on a partnership model which involves Public, Private and Panchayat. 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.

II. 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.

A. 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 2.4GHz) 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 [4]. 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. In order 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.

B. IMPACT ASSESSMENT STUDY

We studied the impact of providing Internet connectivity to the test-bed villages for a duration of one year. The 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 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 for the 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 the bandwidth and a government office (Gram Panchayat office) that housed the Internet. Two important conclusions derived at from the impact study were first, the need for a sustainable model wherein the village would own the network and second the involvement of the Panchayat (local self-government) to run the network at the village level. It was observed that involvement of community can be an important factor in developing a sustainable model. Community networks will 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 and prioritize the services that a particular village needs, depending on their regional needs. For e.g. a village where inhabitants of the village walk several km to avail banking services, would want a bank situated close by. In another case, a village with high malnutrition deaths need primary health care facilities as a priority.

III. 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 e.g. 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. In such case scenarios, the business strategy should base itself on the above-mentioned factors making it a viable business case.

Providing connectivity to remote rural areas in the last decade has been an important topic of research. Many business models have come about which have developed 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[5]

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

❑ Air Jaldi [6]

Air Jaldi is an Internet Service Provider (ISP) providing broadband to enterprises and individuals in India. They use fixed wireless access in the license exempt band (5.8GHz). They have built 10 networks in 6 different states of India. Their business model revolves around employing low cost technology and involving local youth for the operation and management of the network. Partnerships with government organizations, 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) [7]**

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.

The above-mentioned initiatives through their contributions have paved the way for newer innovations to come about. Although these initiatives have succeeded at a small scale by serving specific communities, these face challenges during their scaling up phase due to unavailability of funds, partnerships and regulatory restrictions. There is thus a need for innovative economic models, for large scale penetration of Internet in India.

IV. PUBLIC-PRIVATE-PANCHAYAT PARTNERSHIP (4-P) MODEL

This model has been developed by Gram Marg, based on user feedback from field trials and impact assessment study. In order 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 due to their demerits, such as planning and maintenance delays, inadequate monitoring, funding gaps and improper risk management, are unable to sustain themselves. The merits and demerits of this partnership are described in Fig.1. For e.g. the public-private partnership model that has been adopted by BharatNet to connect 250,000 Gram Panchayats in India. Though this initiative started in 2011 is still lagging behind in achieving its projected goals. Furthermore, the GPs that are already lit are unable to access the broadband, unviable business model being one of the important reasons.

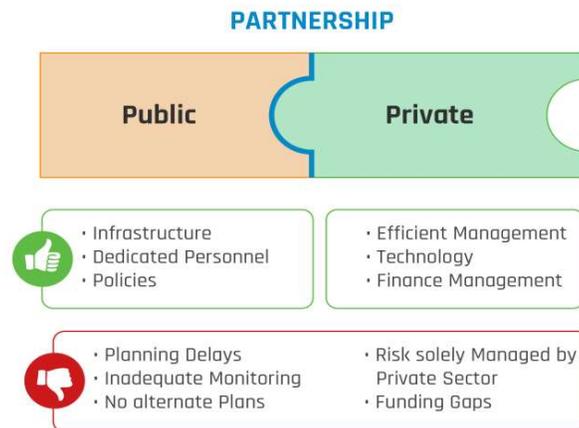


Figure 1. Public Private Partnership

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 their regional needs are not taken into account. For example, in rural areas which suffer from maternal, child and infant deaths, the 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 Community Networks. Unlike, existing community networks in India, which are based on established communities such as tribes, communities based on specific occupation, caste etc. Our community network is different as it forms communities based on usage and adoption of Internet thus bridging existing digital gap. This proposed model is based on a Public-Private-Panchayat Partnership (4-P) as shown in Fig. 2. In this model

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

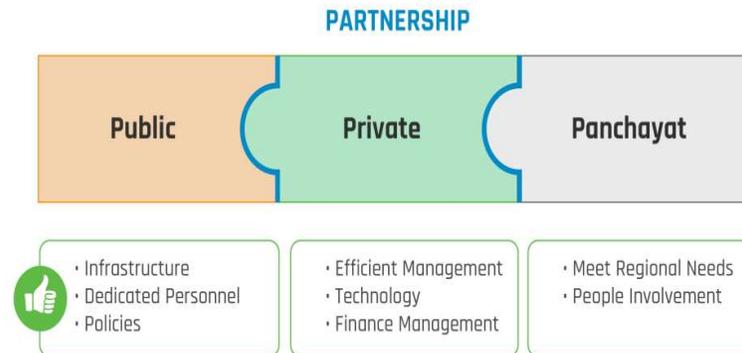


Figure 2. 4-P Model

A. CONCEPTUALIZING VIABILITY OF 4-P MODEL

Analyzing cost dynamics is very important for conceptualizing 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 an optimal mix of technologies along with innovation can be a game changer for rural connectivity scenario in India. 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 so as to bring down the overall cost. For e.g. 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.

We believe that all the aspects if 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.

V. POLICY RECOMMENDATIONS

We suggest the following policy recommendations so as to aid the rural connectivity scenario in India.

- Community networks are allowed to operate in India but there are no specific policies that support these networks. We suggest that community networks 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 community networks.
- Community networks should be decentralized as it will enable locally created and locally relevant content to be circulated in the village for better acceptance of Internet.
- Initial funding can come through funding agencies like USOF so as to scale the community networks.
- 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 license-exempt.

VI. 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 based on community networks as a plausible solution developed by Gram Marg. 4-P suggests public, private and panchayat partnership. The model is based on insights and findings from Gram Marg test-beds and adopts a bottom-up approach. Existing partnership models are reviewed and unique approaches to overcome the challenges in serving rural India are studied. In the 4-P model, 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. Cost is an important aspect of this model. In order to cater to rural needs, it has to be a cost effective technology solution 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 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 about the need for policy formulation for developing community networks in India which is currently not present in India. Thus community networks and their development in India would be crucial for rural connectivity to reach remote rural areas.

Currently this 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. These would be related to demand, quality and affordability by which the sustainable economic model can be tested for its viability.

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