

Barefoot women wireless engineers creating socially viable community networks in India

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ABSTRACT

‘Digital Divide’ or ‘Digital Information Barrier’ refers to the substantial asymmetry in the distribution and effective use of information and communication resources. It is widely believed that the Internet is a global information highway. By opening two-way information flows, it empowers individuals and communities, particularly creating new opportunities for individuals living in remote areas. However, this is possible only if connectivity is provided to them to access a wide range of markets, seek new opportunities, learn new skill sets, get better quality health care, become more aware of their rights and exercise them. Mobile phones and cellular technology enable people to connect with each other, thereby making Internet an integral part of economic, social and cultural lives, shaping the way people communicate with each other, bringing education into the comforts of home, creating new jobs, and providing a platform for people to raise their voices and opinions, or for sharing and receiving information.

Despite various initiatives, four billion people in the world are still unconnected and unable to benefit from key social and economic resources in our expanding digital world, according to an International Telecommunication Union (ITU) report¹. The traditional model of providing the Internet should not be necessarily considered as the most efficient one. ‘Wireless Community Networks’ or Community-based Internet Service Provider (C-ISP) are such networks whose infrastructure is developed and built by small organisations and community members by pooling their resources. These alternative models like Community Wireless networks (CWNs)² have been tested and tried in both developing and developed countries to connect the unconnected remote regions.

India-based organisation, Digital Empowerment Foundation’s (DEF) Wireless for Communities (W4C) programme is one of the community wireless networks that is trying to provide affordable, ubiquitous and democratically controlled Internet access in rural regions of the country. The network enables community economic development that can reduce poverty and encourage civic participation. One of the challenges in managing these networks in rural regions is lack of skilled community members. Moreover, in a country like India, another challenge is the migration of rural youth to urban cities for supporting their families living in villages. However, young women living in rural India are left behind to carry out traditional household chores or odd jobs.

In this paper, we define ‘new technologies’ as technologies that are a result of innovation of older technologies and aim at transforming lives. These technologies are often considered as threatening and unfamiliar; and are often viewed as ‘unacceptable’ specially for women. However, with new

¹ https://broadbandcommission.org/Documents/ITU_discussion-paper_Davos2017.pdf

² A community network starts with a local group of people who want to bring communications to their local village or town or who want to enable communications for other local services. Definition adopted by <https://www.internetsociety.org/policybriefs/spectrum/>

sustainable innovation, technology has become an empowering agent in the lives of women, especially rural women. In particular, the paper highlights how creating 'Community Women Barefoot Engineers' means that learning and knowledge are transferred and exchanged as women are empowered to act in a predominantly male-dominated field that they were previously restricted from entering.

INTRODUCTION

The emergence of a global 'information society' is driven by the continuous development of converging technologies of telecommunications, multi-media broadcasting and information technology. In just a few years, the Internet has undoubtedly turned into one of the most dynamic communication tools the world has ever seen. The flow of information that it facilitates strengthens democratic processes, stimulates economic growth and allows for cross-fertilising exchanges of knowledge and creativity in a way never seen before.

Since the time this powerful tool of development was first introduced, the Internet has undergone profound changes. The Internet has become a key instrument for social, political and economic activities in developed countries and, as broadband penetration increases across the globe, is also arguably becoming so in developing nations, too. This implies a strong dependency on both the basic infrastructure of the Internet and the applications that run on the Internet.

In today's modern industrialised era, technology has revolutionised lives in a rampant manner, bringing about far-reaching changes, impacting society and bringing about economic growth. However, in the midst of this, women still face challenges and constraints in accessing, using and utilising technologies to enhance their quality of life. Economic as well as cultural and social factors play an important role in determining how effectively women can benefit from technological advancement. As women comprise half of the world's population, the United Nations Sustainable Development Goals (SDGs) need to address each of the SDG goals through a gendered lens. This will enable us to achieve the 2030 agenda of "a better world for all".

Take SDG 9, which focuses on industry, innovation, and infrastructure, for example. One of the ways this goal can be addressed is by improving access to innovative technology universally. Hence, we focus on better understanding this through women and new technologies alongside the role of gender in technology and innovation. The new technologies are an interesting paradigm that has not only broken various barriers and divides in society but has also created new barriers and divides as well. This is because the acceptance of new technologies meet obstacles and challenges in its adoption hindering enablement and empowerment.

The Wireless for Communities (W4C)³ project of DEF was initiated in 2010 with the aim of connecting rural and remote locations of India where mainstream internet service providers (ISPs) are unwilling to provide Internet connectivity. In the last eight years, the programme has adopted various models of engagement, ranging from the Hub-and-Spoke and Wireless on Wheels to and Internet-in-a-Box set up. These models have established 178 access nodes in 35 districts across 18 Indian states, engaging men and women equally for its installation and management. Thus, ensuring social sustainability of the wireless community networks.

³ W4C: wforc.in

POLICY CHALLENGES AND OPPORTUNITIES FOR COMMUNITY NETWORKS IN INDIA

In 2018, the global community reaffirmed the principle of ‘digital equality’⁴ – or equal access to and use of ICTs for all people. The principle is seen as critical for socioeconomic growth and for creating opportunities to achieve the Sustainable Development Goals (SDGs) by 2020. One important way to achieve digital equality is to roll out broadband to rural and other unconnected regions. However, taking connectivity to the rural regions of India has been a tough task for several reasons.

While the launch of the National Optic Fibre Network (NOFN) in 2011 aimed to connect 250,000 villages in India and the government’s 2012 National Telecom Policy⁵ called for “broadband access for all”, fixed broadband penetration in India is only 1.4%⁶. Limited infrastructure to deliver broadband—including lack of availability of backbone fibre, network towers and backhaul connectivity—beside the high cost of providing fixed-line broadband, are some of the inhibitors to roll-out broadband access. Traditional ISPs are unwilling to go to rural areas as they are uncertain about the return on their investment. This is mainly because rural areas are either not as densely populated as urban areas or they are geographically isolated. Since rural people are less aware of digital tools and their usage, service providers are also unsure if the former will be willing to pay for a service or afford the Internet plans.

Lack of digital penetration in rural areas due to these barriers further discourages already marginalised people from becoming digitally literate, leaving this rural population in a deadlocked situation where they are trapped in a vicious cycle of disconnect and information poverty.

Unfortunately, there are relatively fewer working models that provide connectivity to communities excluded from access as a result of income levels, size and geographic isolation. One of these models is the community wireless network. Realising the importance of Wi-Fi networks, the Telecom Regulatory Authority of India (TRAI) identified community wireless networks as a model to promote public access in its 2016 paper, *Consultation on Proliferation of Broadband through Public Wi-Fi Networks*⁷. Based on this paper, the Department of Telecommunications introduced the designation of Virtual Network Operator (VNO), enabling telecom service providers to utilise their networks and spectrum efficiently by sharing active and passive infrastructure to facilitate services at the resale level⁸. This has opened up opportunities for small enterprises and non-profit organisations to become small ISPs, which was difficult earlier due to regulatory challenges.

In India, there are very few social enterprises that are actively designing, deploying and setting up wireless networks specifically catering for rural communities. AirJaldi⁹ in Dharamshala, Gram Marg¹⁰ in Mumbai and DEF in Delhi are among the few organisations that are providing basic connectivity and enabling access to information for citizens outside urban areas through the models of community networks.

⁴ Commission on Science and Technology for Development. (2018). Implementing World Summit on the Information Society outcomes, 2017. unctad.org/meetings/en/SessionalDocuments/ecn162018crp2_en.pdf

⁵ [meity.gov.in/writereaddata/files/National%20Telecom%20Policy%20\(2012\)%20\(480%20KB\).pdf](http://meity.gov.in/writereaddata/files/National%20Telecom%20Policy%20(2012)%20(480%20KB).pdf)

⁶ International Telecommunication Union 2017 data.

⁷ https://www.trai.gov.in/sites/default/files/Wi-Fi_consultation%20Paper_13_july_2016.pdf

⁸ Guidelines for Grant of Unified License (Virtual Network Operator). www.dot.gov.in/circulars/guidelines-grant-unified-license-virtual-network-operators

⁹ <https://airjaldi.com>

¹⁰ grammarg.in

AirJaldi started as a social, non-profit enterprise established in Dharamshala, Himachal Pradesh, to provide affordable and reliable Internet connectivity using unlicensed spectrum and wireless networks in rural communities. Gram Marg, an incubation of the Indian Institute of Technology (IIT) Mumbai, uses TV white space and now Wi-Fi to provide Internet connectivity in 13 villages of Maharashtra. DEF uses low-cost wireless technology, unlicensed spectrum bands—2.4GHz and 5.8 GHz—and line of sight to support the provision of affordable, low-cost and reliable Internet services in 38 districts of the country.

INTERNET AND ITS IMPACT

The Internet has greatly influenced the way individuals socialise, create and exploit economic opportunities and knowledge resources. A few studies have measured the impact of the Internet in an integrated manner, meaning they have examined the aspects of social, economic and knowledge enhancements that further help in understanding the phenomena constituting the impact of Internet use. Past studies have measured these impacts with two theoretical and complementary domains: social capital and social cognitive theory.

Social Capital refers to the network of near and distant social ties that individual draw upon enhancing their information base, knowledge, influence, solidarity for economic or other benefits such as improving professional status (Adler and Kwon, 2002¹¹, Coleman, 1988¹²; Dekker and Uslaner, 2001¹³; Dolfsma and Dannreuther, 2003¹⁴; Putnam, 1995¹⁵; Putnam, 2000¹⁶). These networks provide the underlying mechanism for individuals to enhance their knowledge and provide an environment for knowledge exchange (Lane and Lubatkin, 1998¹⁷; Snowden, 1998¹⁸; Wellman and Wortley, 1990¹⁹).

Since the Internet is considered a network of social exchanges, thus, it is important to take social capital consequent and Internet usage into account. On other hand, usage of Internet can lead to increase in economic capital due to enhanced opportunities for businesses or profession. Social capital can also lead to increase in knowledge that could further enhance economic or social status.

Putnam (2000) defines ‘Social Capital’ as a set of horizontal associations among community members for leveraging their existing resources embedded in the network. Social Capital is considered as an inherent part of the social network and the relationships that constitute the network Coleman (1988,

¹¹ Adler, P. S., and Kwon, S. W. (2002). Social Capital: Prospects for a New Concept, *The Academy of Management Review*, 27(1), 17-40, January, 2002.

¹² Coleman, J. S. (1990). *Foundations of Social Theory*, Cambridge, MA: Harvard University Press.

¹³ Dekker, P., and Uslaner, E. M. (2001). Introduction, *Social Capital and Participation in Everyday Life*, edited by Eric M. Uslaner, London: Routledge.

¹⁴ Dolfsma, W., and Dannreuther, C. (2003). Subjects and boundaries: Contesting social capital-based policies, *Journal of Economic Issues*, 37(2), 405-413, June, 2003.

¹⁵ Putnam, R. D. (1995). Bowling alone: America’s declining social capital, *Journal of Democracy*, 6, 65–78.

¹⁶ Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*, New York: Simon & Schuster.

¹⁷ Lane, P. J., and Lubatkin, M. (1998). Relative Absorptive Capacity and Inter-organizational Learning, *Strategic Management Journal*, 19, 461–477.

¹⁸ Snowden, D. (1998). *A framework for creating a sustainable programme*, in: S. Rock (Ed.), *Knowledge Management: A Real Business Guide*, CBI/IBM, London, 1998.

¹⁹ Wellman, B., and Wortley, S. (1990). Different strokes from different folks: community ties and social support, *American Journal of Sociology*, 96(3), 558–588

1990)²⁰. According to (Lin, 2001²²; Helliwell and Putnam, 1995²³; Knack and Keefer, 1997²⁴; Temple, 2001²⁵) Social Capital has the potential to provide growth, productivity, equality and pecuniary gains. Yang (2007)²⁶ defines Social Capital as a collective property, where individuals can draw personal benefits at different levels through the social groups or networks that each individual member can access and hence social capital can be measured at the individual level too. Nahapiet & Ghoshal (1997)²⁷ considered Social Capital as i) structural that consist of the ties and relationships embedded in the network; ii) relational consisting of factors such as trust and motivation; iii) cognitive consist of shared vision, motivation.

According to (Beugelsdijk and Smulders, 2003²⁸; Lancee, 2010²⁹; Leonard, 2004³⁰; Ryan, 2011³¹) 'Structural Capital' usefully bridges networks, creating economic capital by supporting employment and enhancing income. Structural Capital components usually refer to the interaction between actors. As interactions with others allow individuals to leverage their social characteristics, Social Capital may be linked to Economic Capital (Glaeser, et al, 2002³²).

Social Capital can be converted to other kinds of capital as the social network may be leveraged for economic gains and knowledge enhancements (Adler and Kwon, 2002³³). On other hand, both knowledge and economic capital could lead to development or enhancement of Social Capital. Increased productivity and innovation, value chain re-composition, access to public services and information, reduction in transport time, timely access to education and health services are major economic impact of the Internet. It has enabled growth in scope of earning and included behavioural changes with respect to new ways of earning more by increasing scope of doing business, increasing customer/subscriber base, enhancing product portfolio, enhancing employment opportunities. Social

²⁰ Coleman, J. S. (1988). Social capital in the creation of human capital, *American Journal of Sociology*, 94(Supplement), S95-S120.

²¹ Coleman, J. S. (1990). *Foundations of Social Theory*, Cambridge, MA: Harvard University Press.

²² Lin, N. (2001). *Social capital: A theory of social structure and action*, Cambridge, UK: Cambridge University Press.

²³ Helliwell, J. F., and Putnam, R. D. (1995). Economic Growth and Social Capital in Italy, *Eastern Economic Journal*, 21(3), 295-307

²⁴ Knack, S., and Keefer, P. (1997). Does Social Capital Have an Economic Payoff? A Cross-Country Investigation, *The Quarterly Journal of Economics*, 112(4), 1251-1288.

²⁵ Temple, J. (2001). Growth Effects of Education and Social Capital in the OECD Countries, *OECD Economic Studies*, No. 33, 2001/II 57.

²⁶ Yang, K. (2007). Individual social capital and its measurement in social surveys, *Survey Research Methods*, 1(1), 19-27.

²⁷ Nahapiet, J., and Ghoshal, S. (1998). Social Capital, Intellectual Capital, and the Organizational Advantage, *The Academy of Management Review*, 23(2), 242-266.

²⁸ Beugelsdijk, S., and Smulders, S. (2003) Bridging and Bonding Social Capital: which type is good for economic growth? 43rd Congress of the European Regional Science Association: "Peripheries, Centres, and Spatial Development in the New Europe", 27th - 30th August 2003, Jyväskylä, Finland.

²⁹ Lancee, B. (2010). The Economic Returns of Immigrants' Bonding and Bridging Social Capital: The Case of the Netherlands, *International Migration Review*, 44(1).

³⁰ Leonard, M. (2004). Bonding and Bridging Social Capital: Reflections from Belfast, *Madeleine, Sociology*, 38(5), 927-944

³¹ Ryan, L. (2011). Migrants' social networks and weak ties: accessing resources and constructing relationships post-migration, *The Sociological Review*, 59(4), 707-724

³² Glaeser, E. L., Laibson, D., and Sacerdote, B. (2002). An economic approach to social capital. *The Economic Journal*, 112(483), F437-F458

³³ Adler, P. S., and Kwon, S. W. (2002). Social Capital: Prospects for a New Concept, *The Academy of Management Review*, 27(1), 17-40, January, 2002.

Capital is associated with job prospects, career compensation and resource exchange (Hsu and Hung, 2013³⁴).

WIRELESS COMMUNITY NETWORKS AND WOMEN'S ENTREPRENEURSHIP

Wireless community networks – or community networks – are bottom-up network models defined by various academicians and institutions as networks owned and managed by communities. Community networks are also defined by some as “crowdsourced networks” that are structured as free, open and neutral; they are built by a community and managed and operated as a common resource³⁵. Elkin-Koren³⁶ offers a more technical definition of community networks as distributed network architectures in which users can implement a physically decentralised network through the decentralisation of hardware. According to the European Commission, community networks are a “private initiative by the local residents of the community using a so-called bottom-up approach.” In general, community networks offer an alternative and complementary approach to the traditional commercial model where internet connectivity is sold to the user.

DEF was founded in 2002 to connect unreached and underserved regions of India in an effort to bring them out of the digital darkness and empower them with access to information. With a firm belief that access to information and community engagement can reduce information poverty in communities, it became essential for DEF to support first-mile connectivity solutions and to develop digital literacy to understand why and how relevant information can improve socio-economic conditions of people living in underdeveloped contexts.

In 2010, DEF and the Internet Society (ISOC) initiated the W4C project to help provide Internet connectivity in regions where traditional ISPs were unwilling to operate. The first pilot project was started in a handloom community in Chanderi, Madhya Pradesh, with the aim of providing the community with information about weaving, allowing them to produce their own content, facilitating access to tools to archive their designs digitally, and connecting them to a wider global customer market. Gradually the project transformed into the first community network project in India established in a weavers' community. Using low-cost, line-of-sight wireless technology, and the unlicensed 2.4 GHz and 5.8 GHz spectrum bands, W4C now creates community-owned and community-operated wireless networks.

The W4C programme has four main components: 1) train the community members on using wireless networks and its components to create ‘barefoot network engineers’; 2) use open source practices, low-cost technology and frugal methods³⁷ to set up community wireless networks (such as using line of sight to find the tallest building for setting up the antennas); 3) create a platform to develop local content using the wireless network; and 4) improve the socioeconomic lives of community members.

³⁴ Hsu, J. S. C., and Hung, Y. W. (2013). Exploring the interaction effects of social capital, *Information & Management*, 50(7), 415–430

³⁵ Baig, R., Roca, R., Freitag, F., & Navarro, L. (2015). guifi.net, a crowdsourced network infrastructure held in common. *Computer Networks*, 90, 150-165. <https://doi.org/10.1016/j.comnet.2015.07.009>

³⁶ Elkin-Koren, N. (2006). Making Technology Visible: Liability of Internet Service Providers for Peer-to-Peer Traffic. *New York University Journal of Legislation and Public Policy*, 9. <https://ssrn.com/abstract=924316>

³⁷ https://en.wikipedia.org/wiki/Frugal_innovation

Along with establishing the wireless networks, DEF also creates physical resource centres as information hubs known as Community Information Resource Centres (CIRCs) to provide digital literacy training to community members. These centres stand on the principle of DEF's AHEAD Agenda³⁸, which stands for:

- A – building *awareness* on social rights and services through online avenues, and on laws and issues such as the Right to Information Act and women's empowerment.
- H – *health*, such as tele-health services to connect primary health centres to district hospitals and enable local communities to access health-related information through the internet.
- E – *education* for young people who have not completed their schooling, and access to online learning materials.
- A – *activating* entrepreneurship by enabling community members, particularly women, to set up e-commerce sites and businesses.
- D – *delivery* of governance services and enhancing state transparency and accountability.

In eight years, the W4C programme has over 178 access points, connecting more than 4,000 people; and the user numbers are growing. Most of these networks are located in tribal and telecom dark areas, where people have never seen a computer before and experienced the Internet.

The success of the sustainability of these networks rests on two key aspects. The first is establishing, managing and operating the network and the second is creating and managing the content. It was through its on ground experiences that DEF realised that most community networks it set up were managed by young men from the local community, who often migrated to cities later to find better livelihood opportunities, leaving the network management role behind. Service providers from urban areas, too, are not the most keen to travel to rural areas for troubleshoot and there is often a lag between raising a complaint and its redressal, given lack of human resources within the local community to provide immediate support. The down time also affected the sustainability of the networks. That is when DEF realised the need to engage local women in managing and operating the networks. And so, DEF dived into the space of training and enabling local rural women to become wireless barefoot engineers and wireless women entrepreneurs. Since then, engagement of women has been a priority for DEF's W4C programme, subsequently leading to a two-fold impact: 1) creating a network of women barefoot engineers who can manage the network and produce locally relevant content; and 2) improve the presence of women in the male-dominated telecom and wireless sector.

In 2017, DEF designed and developed Zero Connect, a solar-powered Internet-in-a-box solution with antenna. The box is a plug-and-play configurable networking solution for deploying a wireless network for people in predefined small-range coverage areas. It is solar enabled and the size of a suitcase, and is fixed with a trolley mechanism for easy mobility. The lightweight unit (7 kg) is made of aluminium and is divided into four sections to hold the tripod and hotspot printer (to print receipts for internet vouchers); the charger controller; the batteries; and the router, antenna (5.8 GHz and 2.4 GHz) and other equipment. A solar panel on the top of the box is fitted for the purpose of charging the batteries. The batteries can provide power for six to eight hours. The unit has the power to connect as many as 200 individuals at a time within a radius

³⁸ Srivastava, R. (2016). A Network by the Community and for the Community. In L. Belli, Community Connectivity: Building the Internet from Scratch. Annual Report of the UN IGF Dynamic Coalition on Community Connectivity. bibliotecadigital.fgv.br/dspace/handle/10438/17528

of 500 metres to 5 km. To make this solar-enabled box, we will be using low-cost wireless technology such as Mikro-Tik routers and omni-directional antennas, and using both 5.8 GHz and 2.4 GHz unlicensed spectrum to provide the connectivity.

The prototype model was implemented in Anantapur district in Andhra Pradesh. Presently, DEF is scaling these Zero Connect boxes in other wireless locations. In early 2019, DEF also initiated the Solar Women Wireless Engineers for Entrepreneurship and Empowerment (SW2E3) programme to provide solar and wireless training to women. It aims to create a network of women wireless engineers who cannot only set up and deploy the Zero Connect box, but are also able to operate and manage the wireless network, thus providing them with a holistic training for education, livelihood and social opportunities.

TRAINING THE FIRST WOMAN BAREFOOT ENGINEER

In 2014, Kainat Ansari became the first woman appointed by DEF to set up a wireless network. Following three months of rigorous training that explained the basics of wireless technology through practical hands-on approach rather than a theoretical one—in Guna, Madhya Pradesh, Kainath was initially engaged in the day-to-day management of the Community Information Resource Centre.³⁹ Soon after, she had started managing the wireless network—including configuring devices and setting client access levels—as well as interacting with community members on their technological needs and advising them with relevant and timely solutions. Her tasks also included live network set-up, DVR configuration, point-to-point configuration and even troubleshooting at the server or client level. Since then, Kainat has helped DEF set up other wireless networks in Aron village of Madhya Pradesh and Saidanpur village of Uttar Pradesh.

Kainat's role in the community as a self-sustainable woman in the community who could serve community technological solutions influenced other girls in Guna to be inspired to enter the male-dominated telecom and Internet world. Fauzia was one of them. She often visited the Community Information Resource Centre in Guna to watch YouTube videos, for both education and entertainment purposes, where she chanced a conversation with Kainat. Encouraged and inspired, Fauzia followed Kainat's footsteps and joined the wireless networking training programme in Guna. Today, Fauzia is an expert at making PCB circuit boards, climb network towers, configuring TP-Link router, and troubleshooting at the client level⁴⁰.

EMPOWERMENT THROUGH DIGITAL LITERACY

The prequel to the Solar Women Wireless Engineers for Entrepreneurship and Empowerment (SW2E3) programme of DEF was the Wireless Women for Entrepreneurship and Empowerment (W2E2) project. A project under the umbrella of W4C, initiated in partnership with ISOC in 2014⁴¹, it aimed to help women engaged in grassroots-level businesses to leverage digital tools and technologies to give a boost to their respective business. The programme focussed on training women in how to use and leverage a laptop, a digital camera, a printer-scanner and the Internet. Since then, the programme has digitally enabled and empowered several women.

³⁹ in Interview with Kainat Ansari

⁴⁰ Interview with Fauzia.

⁴¹ wforc.in/w2e2-2

Bidyawati Mehar, a girl from Barpali village in Odisha, had completed her school but the financial conditions of her rural weaver household did not allow her to pursue further education. Barpali, famous for its hand-woven ikat⁴² sarees, is home to about 20,000 handloom weavers. Bidya was among the first women to become digitally literate in the village, and was also one of the fastest learning student at the local Community Information Resource Centre. Weavers in Bidya's village lacked knowledge about new designs, business practices and modern technologies. Most of the designs made by the weavers had not been set to paper but restricted to memory. This restricted experimentation and innovation in designs. Being a digitally literate weaver gave Bidya opportunities to introduce various digital interventions into the weaving process. From looking up the Internet for market trends and using advanced CAD/CAM software to using Photoshop for product branding and social media for eCommerce, Bidya was mobilising a team of young men and women to adopt digital tools and further train scores of youth from her community in digital literacy and design⁴³. In 2017, Bidya's efforts were recognised by the Internet Society's 25 Under 25⁴⁴ award. She was one of the 25 individuals from around the world, all under the age of 25, who were recognised for their efforts at connecting their communities with the opportunities the Internet has to offer. The award ceremony was held in Los Angeles, United States, on 18 September 2017.

Bidya says, *"Today, I'm the only woman digital weaver in our cluster. People who criticised me earlier for delaying marriage and choosing this occupation, now call me 'Lady Master Weaver' with respect*⁴⁵.

The engagement with women has created new opportunities for rural women who want to learn technical skills but do not get the opportunity due to a lack of projects, programmes or institutions that offer training, or because they face social and patriarchal challenges that exist in the society. As part of W4C, over 30 rural women have been transformed into barefoot wireless engineers. These women barefoot engineers act as influencers of others and motivate them by showing how this sort of training can improve their livelihoods.

CONCLUSIONS

Community networks are recognised as a catalyst for development, especially for women, who have fewer opportunities to access digital tools compared to men. But when the opportunity is given to them, women have shown to manage wireless networks effectively and efficiently – just how they manage their homes. These barefoot women wireless engineers, who can barely read and write, have demystified technology and transferred the control, management, and ownership of the technologies to the community.

Engaging in experiential learning and using the technology in a way that improves lives and skills have changed the definition of "literacy" and what it means to "be educated". This approach has enabled rural women to impart their skills to others in a sort of multiplier effect. Engaging women has not only given them an opportunity to learn about technology, but also enabled them to find a comfortable place in an area mainly dominated by men, besides earning a source of livelihood. This is a small effort that helps bridge the gender divide in the telecom sector. In the last three years, it has led DEF to engage more women in the wireless sector, as they not only make the network economically sustainable but also make it socially viable.

⁴² <https://en.wikipedia.org/wiki/Ikat>

⁴³ One or two weavers also received training to maintain the wireless network.

⁴⁴ <https://www.internetsociety.org/25th/25-under-25>

⁴⁵ Interview with Bidyawati Mehar

Over the years, the W4C programme has adopted various kinds of models as interventions, depending upon the needs of the community and the social environment. One thing that was common in all models was the need to capitalise on the social and human value already present in the community, and transforming this into a socially sustainable wireless network model.

Based on the approach of DEF, a few action points that should be included in programmes for socially sustainable community networks are:

- **Increase Gender Sensitivity:** Community networks should be designed in a more gender-sensitive and gender-inclusive manner. For example, it should be made mandatory that at least 50 per cent of the people participating in activities of managing and operating the networks should be females. Further, efforts have to be made to create a conducive environment for women to engage with the community as well, both socially and economically.
- **Promote different models of community networks:** Presently most of the community network models in India are only talking about leveraging technology and innovation, but there is a need to sustain these networks socially and economically by making the networks contextually relevant to indigenous communities. Stakeholders should promote and support community network models that do this.
- **Make funds available:** Universal service funds and other funding mechanisms should be made available to increase participation in community networks.

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