

Sustainable Broadband Connectivity Model for Rural Areas of Tanzania

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Abstract

Some of the reasons for lack or limited Information and Communication Technology (ICT) infrastructures in rural areas of developing countries in general and Tanzania in particular, is high cost of establishing such infrastructures, lack of electrical energy and low ICT literacy. Public Private Peoples Partnership (PPPP) is recommended as a suitable model to implement sustainable ICT projects in rural areas. This paper surveys the availability of supporting environments for the provision of broadband rural connectivity: the surveyed environments include initiatives for ICT infrastructure development and institutional frameworks such as policies, strategies, legislations and regulations. The aim of the survey is to investigate the readiness of Tanzania to deploy PPPP model for rural connectivity implementation. Furthermore,

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the paper proposed implementation strategies in order to adapt the PPPP model for sustainable broadband rural connectivity in Tanzania.

Keywords: Broadband, Connectivity, Rural Area, PPPP, Tanzania.

JEL Classification: O10; O20; O30; O55.

1. Introduction

Rural areas are often characterized by highly sparse population consisting of low income communities, where individuals can rarely afford the costs of ICT services (Siochrú, 2005). Therefore, shared access is the model commonly used to deliver ICT services in rural areas. Implementation of the shared access ICT facilities for rural areas differs widely ranging from donor funded projects, in which the project management remains under the local community at the end of the donor funding time, franchise business model, Public-Private Partnership (PPP) and Public-Private People's Partnership (PPPP). Brief descriptions of the mentioned models are given in the forthcoming paragraphs.

A donor funded project is a project in which almost all resources required for project implementation are provided by the donor. Most of the donor funded projects are of the form of pilot projects. They often use a "top-down" implementation approach, of which at the end of the donor funding time, the local community may not have enough capacity or knowledge to manage and maintain the project. Therefore, most of the donor funded projects are usually unsustainable after the donor funding time elapsed. A franchise is a business system in which private entrepreneurs purchase the rights to open and run a similar or part of a big business. Nokia Siemens Network (NSN) village connection, n-logue's rural connectivity model and Grameens public payphone are examples of franchising models implementing ICT projects in rural areas. Characteristics of a franchising model are to push delivery and management of services closer to the end users. The NSN village connection is a solution that enables the Global System for Mobile communication (GSM) network operators to extend their network reach to accommodate remote villages, where traditional technology and commercial business models would not be profitable. The NSN village connection is implemented in partnership with local entrepreneurs, who are familiar with potential customers and who can run the local operations. In this model the entire village customer acquisition and care are handled locally, reducing overall sales and marketing expenses to the operator (franchisor). The n-logue's rural connectivity model employed a three-tier franchise model to implement a village-level kiosk. The locally owned franchises offer a variety

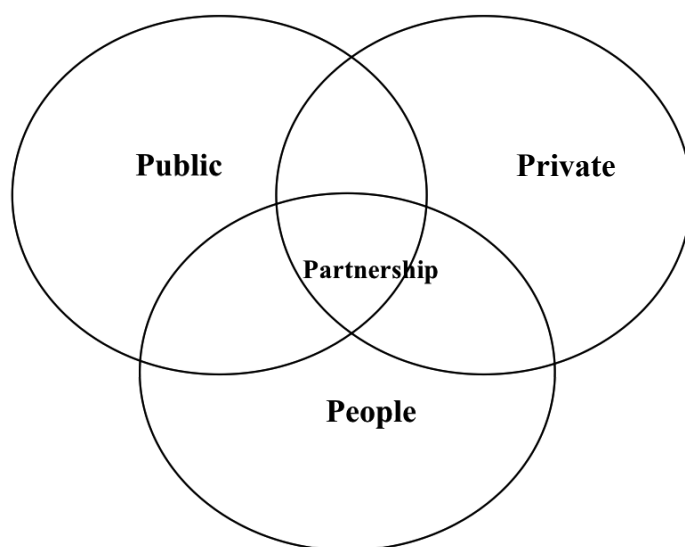
of Internet and computer-based services to the rural market. Partners of this model further developed relevant local content and services using the local language aimed at making kiosks useful to the rural society (Paul, 2004 ; Jhunjunwala *et al.*, 2004). Another example of a franchise model for rural ICT is the Grameen public payphone. The Grameen public payphone aimed at connecting rural areas of Bangladesh through the provision of public shared-access, where the entrepreneurs provide telephone services to local communities for a fee. The project is implemented by a partnership of the GSM network operator and stationary phones in the villages owned and operated by local entrepreneurs (Cohen, 2001). The franchise model is not widely deployed in implementing ICT projects due to the low level of ICT literacy and low income of the rural community. It is rare to find an entrepreneur with both the skills and financial capacity to operate ICT projects in rural areas. It is obvious that providing connectivity to rural areas is not financially viable to commercial operators. Therefore, government intervention is required for rural connectivity viability. This requirement scenario resulted into the Public-Private Partnership (PPP) model gaining popularity, especially in developing countries, in a situation when a government prioritized rural connectivity.

Public-Private Partnership is collaboration between the public sector such as the government and the private sector to implement projects. In this type of partnership, governments have been intervening by providing financial support in terms of subsidies, often from universal access funds initiatives. While PPPs have the potential to run investments in rural areas, it has been experienced that many developing countries do not have enough administrative and regulatory capacities to run PPP projects efficiently. A typical example is vandalization or poor maintenance of equipments especially those intended for ICT projects. This problem is also partly attributed to lack of beneficiary sense of ownership and inclusion (Spio-garbrah, 2010). This shortcoming was taken as an opportunity to involve beneficiaries of the project in the PPP model, which eventually lead to the Public-Private Peoples Partnership (PPPP) model, sometimes abbreviated as 4Ps.

Public-Private Peoples Partnership is defined as a strategic cooperative relationship between the public sector, private sector and the community (people) who agree to share the responsibility for achieving some specific goals (Siochrú & Girard, 2005; Spio-garbrah, 2010). The partnership emphasizes greater involvement of the communities that will eventually benefit from the outcome of the cooperative relationship. The PPPP model is based on the concept that for projects – especially in the rural areas – to be sustainable, the beneficiaries must feel a sense of ownership and inclusion (Spio-garbrah, 2010). In a PPPP, the ownership of the activity under cooperation such as a project is shared. The heart of a PPPP is therefore sharing of risks

and benefits. ICT projects that are implemented in collaboration with the community they serve are usually sustainable. This is evident in the winning projects which were selected as the most successful community-based rural ICT projects in the final report of the Commonwealth African Rural Connectivity Initiative (COMARCI). All of the selected projects were developed in partnership with the community they serve (Calindi *et al.*, 2008; Spio-garbrah, 2010). Therefore, such a selection supports the recommendation that a PPPP is a suitable formula for implementation of projects that are unlikely to be profitable in rural areas if owned and managed either by the public sector alone, the private sector alone or a combination of public and private sector partners (Spio-garbrah, 2010). The schematic diagram of the PPPP model is shown in Figure 1.

Figure 1: Schematic Diagram of Public-Private Peoples Partnership (PPPP)



The rest of this paper is organized as follows: Section 2 presents an overview on how to implement sustainable projects. Three case studies of best practices for sustainable project implementation based on PPPP model are presented in order to understand role of different actors and how collaboration/partnership takes place. Section 3 examines the readiness of Tanzania to provide broadband rural connectivity in terms of availability of ICT infrastructure and institutional frameworks (policies, legislations (Acts) and regulations) supporting rural connectivity in the country. With the existing

ICT infrastructures, institutional frameworks and experience from selected best practice projects implementation, a sustainable broadband rural connectivity model adapting the Public Private People's Partnership (PPPP or 4Ps) implementation strategy for Tanzanian context is proposed in section 4. Section 5 carries the conclusion.

2. Sustainable Implementation of ICT Project in Rural Areas

The challenging environments of rural areas result into lack or limited ICT infrastructures, especially the broadband connectivity. In addition, the common models (donor-funded, franchising and PPP) used to implement ICT-based projects in rural areas have shortcomings that lead to unsustainable ICT projects, as explained in section 1. From the literature, the Public Private Peoples Partnership (PPPP) is recommended as a sustainable model for implementation of ICT-based projects in rural areas (Spio-garbrah, 2010; Calindi *et al.*, 2008; Roman, 2009). Also, it has been noted that partnership with the community to be served is essential for the project's success and sustainability (Calindi *et al.*, 2008; Roman, 2009). However, the PPPP concept and its implementation is still in an infant stage (Spio-garbrah, 2010). Therefore, this paper aims at adapting the PPPP model and proposing its implementation strategy in the Tanzanian context with the main goal of attaining sustainable broadband connectivity in the rural areas of Tanzania. The proposed PPPP model implementation strategy for broadband connectivity in Tanzania can be generalized to other developing countries, because their respective rural areas usually pose similar characteristics with regard to ICT infrastructure development. The following three projects: rural wireless broadband networks in Peru, rural broadband connectivity project in Dominican Republic and sanitary intervention project in Nigeria, were selected as examples of best practices in implementation of the PPPP model, in order to understand the role of different actors and how collaboration/partnership takes place.

The Rural Wireless Broadband Network in Chancay-Huaral Valley District in Peru

The Chancay-Huaral Valley is a coastal district of Peru with many small farms. Farmers of Huaral were unable to capitalize on the great economic potential of their fertile land, abundant water and proximity to the nearby markets within Peru. A major challenge has been farmers' inability to adjust agricultural production to market fluctuations due to poor communications. Poor communications has also resulted into inefficient management of the river waters for irrigation (Saravia, 2005).

A rural wireless broadband network was established to make agricultural information available to farmers. The specific objectives were: (1) To train farmers in the effective use of agricultural information, (2) To develop an agricultural information system that efficiently provides information via the internet to the farmers, (3) To strengthen local capacity for obtaining, distributing and using agricultural information (Saravia, 2005). The project deployed a wireless network that connects 13 telecenters. The project has been deployed with active participation of the local farmers' association, responsible for management of water and irrigation. Technical assistance has been provided by a Non-Governmental Organization (NGO) called CEPES (the Peruvian Center of Social Studies / the Centro Peruano de Estudios Sociales). The NGO provided ICT training to young people who later took ICT jobs in the project (Saravia, 2005). A remarkable strength that provides sustainability in this project is the collaboration climate that has been created. Existing institutions in the valley pull together their forces and resources to plan and execute this project. Services offered in this project were the agricultural information via internet and Voice over Internet Protocol (VoIP). The VoIP service was not a target in the initial project planning; however, it later came up as a specific demand from project beneficiaries. This shows that the local community was pro-active in maximizing the project capabilities.

Management of the project was divided into two parts: management of the services that the project is providing and management of the equipment and the physical aspects of the network. Service management was taken care of by administrators of the thirteen communication centres, who have been trained for that. On the other hand, the CEPES technical team handled management of the equipment, configuration, maintenance and technical support. Twelve local people were trained to use the network, to identify connection errors, routine maintenance, to manage, configure and administer the network. Upon completion of their training, they were expected to take charge of network administration tasks from CEPES. There was also a plan for the project's economic sustainability. It was planned that revenue from the internet and telephone services will be used to cover costs of inter-connection with the public network and for paying technicians responsible for network maintenance and technical supports in each location.

Rural Broadband Connectivity Project in Dominican Republic

INDOTEL, the Dominican Republic communications regulatory authority launched the rural broadband connectivity project as part of the government's e-Dominicana strategy in 2007. The project objectives were to provide telephone services through public call centers and broadband internet

service through internet cafes to 508 localities throughout the country (Roman, 2009). This project also aimed at providing training to both end users and entrepreneurs in the use of the telephones and computers as well as in managing public call centres and cyber cafés. The project included a program to develop web pages with important information about each community, such as location, how to reach it, tourist attractions and products made by the local community. In order to promote entrepreneurship, the Internet access and public call centres were encouraged to be owned and managed by local entrepreneurs.

The project implementation started by establishing the status of telecommunications infrastructure in the area and consultations were made to all stakeholders in order to secure their support and involvement in the project. It was established that there were existing small entrepreneurs who use satellite and wireless technologies to install local telecenters, cyber cafes and public call centres, where the local population pay to use the services. The consultation exercise involved stakeholders such as public institutions and local entities, telecommunication operators, service providers and NGOs.

Establishing contacts with civil society agencies and NGOs was a strategic move, since most of them consider internet access as a working tool and would use it to communicate with their distant offices or staff located in rural areas. For this reason, rural broadband connectivity projects are attractive to civil society agencies and NGOs. Before launching the full scale project, the regulator did a pilot implementation in a small community to confirm whether the rural broadband connectivity project was economically and technically viable (Roman, 2009).

In the Dominican Republic, the rural broadband project was financed by using the Universal Access Funds (UAF) through tender processes supervised by the regulator. In this process, potential investors (telecommunication operator companies) are given a certain time to prepare their bids which are evaluated according to tender procedures. The company with a bid that meets all the technical specifications and asks for the least amount of subsidy from the fund is awarded the project to carry out commercial network roll out (Roman, 2009). In this case study, the regulator played a vital role in ensuring provision of rural connectivity.

Sanitary Intervention Project in Nigeria

This was a project aimed at finding a long-term solution to finance a sanitary intervention project. The mission was to promote safe sanitary and hygiene practices through hygiene education and provision of public convenience facilities that are modern, functional and well maintained (Asabia, 2009).

The target areas for provision of sanitary convenience facilities were motor parks, markets, open spaces, central business areas, commuter points and high-density areas. The model adopted to finance sanitary intervention was called public-social private partnership (Asabia, 2009). This is basically a 4Ps model where the unmentioned people's P is represented by the social component of the model. Roles and responsibilities of partnership in the sanitary intervention project were mentioned as follows (Asabia, 2009): State and local government were responsible to provide sites to locate the public convenience facilities and to provide an enabling environment for project implementation. The facilities construction costs were financed by the private sector; an NGO. The NGO took lead in engaging local community and other stakeholders located in the sites earmarked for construction of public conveniences to ensure support and ownership of the project. Community and other stakeholders were educated about basic health and hygiene requirements and the link between diseases and unsafe sanitary practices with the ultimate aim of bringing about behavioural change. To ensure project sustainability, the NGO runs and maintains the facility for an interim period of two years, after which a memorandum of understanding is signed, to enable the community or stakeholders in the target area to take over the management and ownership of the facility through a governing council comprising of key stakeholder representatives. The facilities are operated on a pay per use system. Revenue generated from usage is used to pay cleaning staff wages and to cover maintenance costs.

There are four (4) lessons that can be drawn from the projects presented as case studies of the PPPP model for project implementation. The first lesson learned is that: the presence of a governmental can make a project move fast as in the case of the Dominican Republic, where the regulator took a lead in all the steps required for a rural broadband project to take off viably. However, it is not a rule of thumb that the government/regulators are the ones to lead the PPPP initiatives, any of the partnership stakeholders can lead, especially the people (local community or local entrepreneurs), because, they are the ones who properly know their needs. This was very evident in Peru's and Nigeria's projects. Another lesson learned is the importance of local community participation in all project phases in order to deliver relevant and useful services. This aspect is more evident in the case study from Peru, where the local community was able to demand relevant services. On the other hand, all case study projects demonstrated the usefulness of nurturing project ownership by the local communities/local entrepreneurs for sustainability.

3. Readiness of Tanzania to Deploy PPPP Model for Broadband Rural Connectivity

The following section investigates the availability of supporting environments for rural connectivity, such as the availability of telecommunication infrastructures, institutional framework (policies, regulations, strategies and legislations) and initiatives for infrastructure development, which can be used to gauge readiness of Tanzania to deploy PPPP model for broadband rural connectivity.

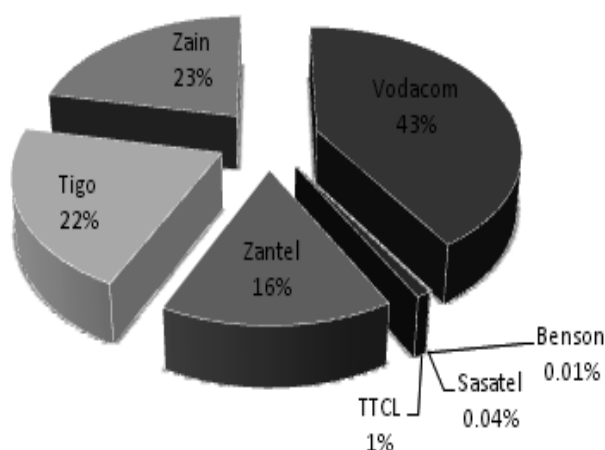
Telecommunication Infrastructures

The Tanzania Communication Regulatory Authority (TCRA) is responsible for licensing and enforcing license conditions of broadcasting, postal, and telecommunication operators, manage radio frequency spectrum and establish standards for regulated goods and services. In addition to the mentioned responsibilities, TCRA requires all operators to expand their services up to rural areas in their license obligations. By the year 2011, TCRA had licensed two wired operators, Tanzania Telecommunication Company Limited (TTCL) and Zanzibar Telecommunication Company Limited (Zantel) to provide fixed-line telecommunication services, network services and facilities throughout the country (Tanzania mainland and Zanzibar). The wireless mobile communication technology entered the Tanzanian market in 1994, when the then Mobitel Company, currently branded as Tigo, was first registered as the only privately owned wireless mobile network operator. Currently there are seven wireless mobile operators, namely Tigo, Vodacom, Zain, TTCL, Zantel, Benson and Sasatel. Their respective quarterly (Jan - March, 2011) subscription market share is shown in Figure 2.

Network coverage of fixed-line network operators is mainly up to levels of regional or district headquarters. Apart from the wired network, the wireless infrastructures are also in place from the mobile wireless cellular networks operators, which provide voice as well as broadband data and internet (multimedia) services. With wireless operators, coverage for voice services is almost countrywide while for broadband multimedia services, the coverage is in the urban areas, basically in cities. Furthermore, the TCRA which is responsible for allocating radio frequency to telecommunication networks and ICT services operators, has strategically reserved the extended GSM spectrum for operators aiming to deploy broadband network coverage in suburban and rural areas of Tanzania. So far there is an operator, called Rural NetCO, which has been allocated the extended GSM spectrum and is dedicated to extending coverage of broadband mobile wireless networks to rural areas in the country. This network is based on the third generation

(3G) Universal Mobile Telecommunication Systems (UMTS) at 900MHz frequency band. It is a shared network, in which its design strategy is to re-use existing infrastructures such as sharing network base station sites with other telecommunication operators. During the time of writing this paper, the network was still under development. Therefore, with the current status of both wired and wireless technologies, rural areas of Tanzania are still unconnected with regards to broadband network capacity.

Figure 2: Quarterly Operator's Subscriptions Market Shares (January-March, 2011)

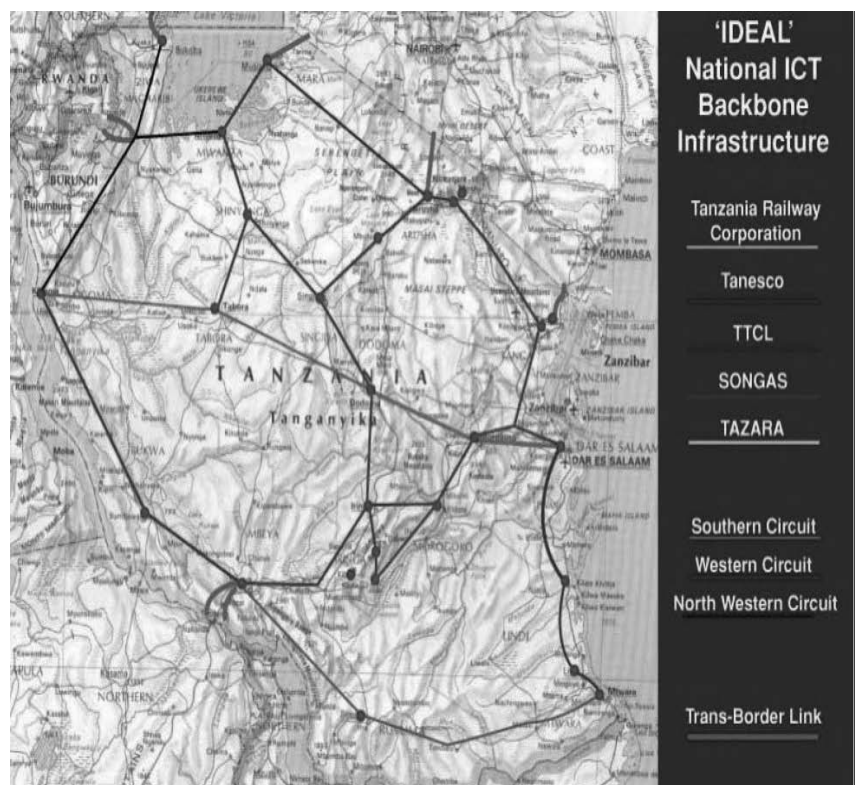


Initiatives for Broadband Infrastructure Development in Tanzania

There are efforts in Tanzania that aim to develop broadband ICT infrastructures. A typical example of such efforts is the National ICT Broadband backbone (NICTBB) infrastructure project. This is a construction of a terrestrial national-wide ICT backbone by using optic fibre cable technology to cover all regions and district headquarters in Tanzania mainland and Zanzibar. The implementation strategy of the national ICT backbone project is to use the existing networks segments from multiple utility companies such as Tanzania Electric Supply Company (TANESCO), Tanzania Railways Corporation (TRC), Songo Songo Gas Company (SONGAS), Tanzania Zambia Railways Authority (TAZARA) and Tanzania Telecommunication Company Limited (TTCL) as shown in Figure 3. The national ICT backbone aims to establish a carrier of carriers' network, which can be leased to network services or content providers. In addition, the backbone is aimed to provide cross border connectivity to the neighbouring countries: Kenya, Uganda,

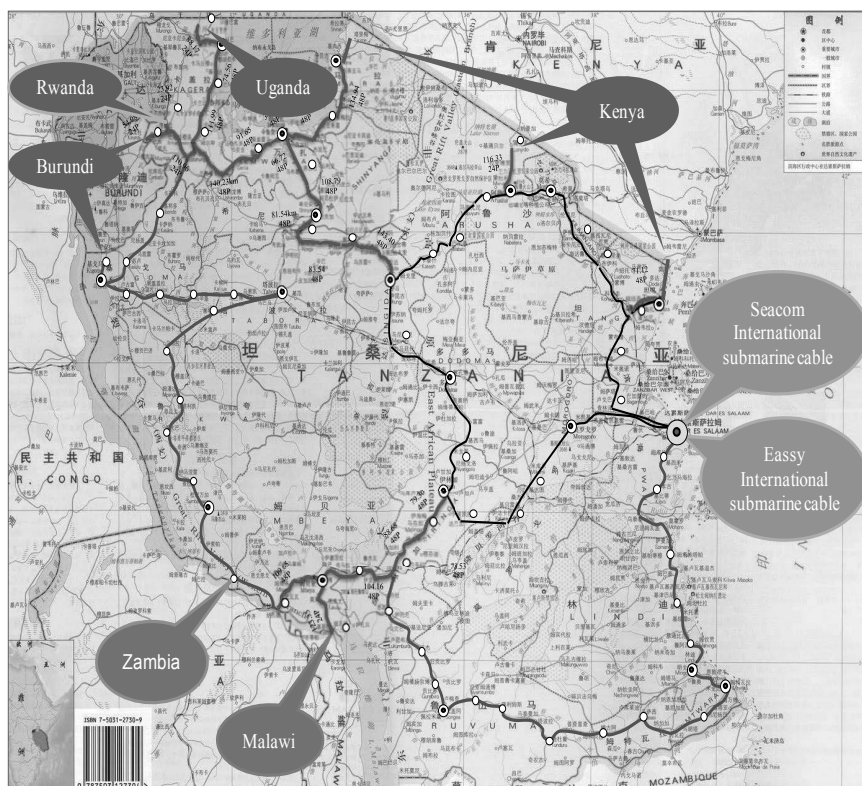
Rwanda, Burundi, Democratic republic of Congo (DRC), Zambia, Malawi and Mozambique. Phase 1 of the NICTBB project which includes utilization of the existing optic fibre cable over pylons owned by TANESCO and construction of new direct buried fibre system along routes of missing links, was completed in April, 2010.

Figure 3: The National ICT Backbone in Tanzania



Source: Pehrson & Ngwira (2006)

Tanzania is also connected to the rest of the world by using submarine cables, in addition to satellite systems. Examples of such submarine cables are the SEACOM and the Eastern Africa Submarine Cable System (EASSY) along the east African coast. The SEACOM cable was launched on 23rd July 2009 and has a capacity of 1.28Tb/s (terabits per second). EASSY has a capacity of 1.4 Tbps and was launched on 7th April, 2010. The current status (2012) of broadband infrastructure, both terrestrial (NICTBB) and submarine cables in Tanzania is shown in Figure 4.

Figure 4: Tanzania national ICT backbone and Submarine Cables

Source: Ministry of Communications, Science and Technology (MCST), Tanzania.

Institutional Frameworks

This section explores institutional frameworks such as policies, regulations, legislations and strategies which support rural connectivity in Tanzania. Existence of such frameworks is a useful tool to enforce and foster implementation of rural connectivity projects.

a. Tanzania National Development Vision 2025

The national development vision aims at a Tanzania of 2025 to be a nation imbued with five main attributes: (1) High quality livelihood (2) Peace, stability and unity (3) Good governance (4) A well educated and learning society (5) A competitive economy capable of producing sustainable growth and shared benefits. The objective of this development vision is to awaken, co-ordinate and direct people's efforts, minds and national resources to-

wards the five main attributes. Upon achievement of the five attributes, Tanzania is envisioned to be an active participant in the global competitive economy of the 21st century, which is characterized by advanced technology, high productivity, modern and efficient transport and communication infrastructure with highly skilled and innovative manpower (United Republic of Tanzania, 2000).

b. National ICT Policy

In 2002, Tanzania set off a multi-stakeholder ICT policy development initiative that led to the development of a national ICT policy and its adoption by the Government in 2003. The policy is currently (2011) under review for improvement. The policy articulates ten focus areas drawn from the aspirations of Tanzania's Vision 2025. One of the focus areas is the ICT infrastructure, with an objective of establishing mechanisms that will result in least cost access to bandwidth for institutions or individuals in Tanzania. The National ICT Policy stipulates that, "Tanzania should have a universally accessible broadband infrastructure and ICT solutions that enhance sustainable socio-economic development and accelerate poverty reduction nationwide" (Ministry of Communications and Transport, 2003). To achieve this objective, the Government is committed to support, through incentives and directives, bona fide institutions actively involved in the development and application of ICT infrastructure and services (Ministry of Communication and Transport, 2003). Another focus area of ICT policy is the universal access, where the Government is committed to reduce the ICT access gap between the rural and the urban areas by activating the universal communications access fund, offering special incentives to investors in rural ICT provisions, supporting the construction of rural telecentres and involving local government authorities in ICT utilization and promotion (Ministry of Communications and Transport, 2003). As part of the implementation of the national ICT policy, Tanzania embarked on an initiative for development of an open national ICT backbone network in 2005.

c. The National Strategy for Growth and Reduction of Poverty (NSGRP)

Introduced in 2005, this strategy which is popularly known as MKUKUTA in Swahili, was revised in 2010 into MKUKUTA II. Among other objectives, the strategy aims to promote the use of PPP model for developing and operating ICT infrastructures. It also looks for efforts to support increased access and application of ICT which will eventually increase productivity in government, business, education and Small To Medium Enterprises (SMEs) development (NSGRP, 2005; NSGRP II, 2010).

d. National Rural Development Strategy (RDS)

The strategy came into existence in the year 2001 with the aim to promote introduction of ICT in rural areas through developing telecentres. The telecentres are responsible for providing ICT services such as voice, fax, e-mail, internet access, distance education, telemedicine, news distribution, access to information on market and weather conditions (RDS, 2001).

e. Universal Communications Service Act 2006

The Act established a fund responsible for promoting ICTs in rural and underserved urban areas by subsidizing operators investing in rural areas (UCS-Act Tz, 2006; Pehrson & Ngwira, 2006). The fund receives contributions from TCRA, development partners and telecommunication operators who contribute 0.3% from their annual growth turn over.

f. Converged Regulatory and Licensing Regime

In 2005, TCRA introduced a converged licensing framework, which is a technology- and service - neutral framework. The converged framework ensures efficient utilization of network resources, in such a way that an individual network can be used to provide a broad range of ICT services, which will eventually lead to address market and technological developments. The converged licensing regime allows leasing of excess capacity of communications infrastructures owned by utility companies in order to provide communication services to customers. Moreover, it provides a framework for all communication service providers to build a nationwide backhaul and interconnect with each other.

In 2005, Tanzania prepared different communication regulations which in one way or another support provision of broadband connectivity. Regulations relevant to broadband connectivity are the Tanzania communication regulations for: broadband services, quality of service, access and facilities, radio communication and frequency spectrum, and interconnection.

Table 1: ICT Initiatives for Education

Initiative (projects)	Description
Tanzania beyond Tomorrow	An e-learning initiative launched by MoEVT in partnership with technology companies (Accenture, Intel, Microsoft and Cisco) and NGOs (NetHope, AMREF, World Vision) aims at integrating ICT in the teaching and learning processes.
TanSSe-L (CoICT-UDSM)	The project is under the College of Information and Communication Technology (CoICT), University of Dar es Salaam. It aims at providing e-learning services to rural secondary schools. It has three pillars: interactive learning management system, e-learning contents for self learning and connectivity solution.
The e-School Forum	Nine task forces were formed, focusing on key areas for ICT in secondary education (1) ICT infrastructure development (2) technical resources, (3) student management (4) content and curriculum development (5) e-learning (6) sensitization (7) human resources (8) programme co-ordination and (9) funding. At the time of writing this paper, the e-School programme proposal was still under review by the MoEVT.
Science, Technology and Higher Education Program (STHEP).	It is a programme under the MoEVT and the Ministry of Communication Science and Technology (MCST) that aims at improving development of human capital in the areas of science and technology and to create a knowledge based economy. This program focuses on National Research and Education Network (NREN), Education Management Information system (EMIS), e-Library and e-Learning.
Zain, Build a Nation project	670 schools in Tanzania have benefited with textbooks or educational tools such as computers provided by the then Zain, now Airtel mobile network operator.
Bridge IT project	The project is implemented under the management of International Youth Foundation. It is about the use of mobile phones to teach Maths and Science in class 5 and 6. It is operational in 150 primary schools. Development of course materials is done by Pearson Foundation, hosting of the course materials is by Vodacom. Delivery of the course materials is through Nokia phones to television sets in the classrooms. Contents assist teachers in the classrooms.

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Table 1 continued

Initiative (projects)	Description
Computer for Schools Project	Barclays bank and Digital Links International company formed a partnership to spur the growth of ICT in schools across three countries in East Africa (Tanzania, Uganda, and Kenya). The project sets a target to place 10,000 computers in approximately 500 schools. The implementation strategy is through collaborative partnerships with organizations in each country. For Tanzania, the project is implemented by Tanzania Education Authority (TEA), Tanzania Commission of Science and Technology (COSTECH), and Mkombozi centre for street children.
Distance Learning Education Services (DILES) (IICD Supported)	The project develops teaching and learning materials for secondary schools. These resources are available online (http://www.diles.or.tz).

g. ICT for Education Projects

In Tanzania, there are number of pilot projects aimed at integrating ICT in the education system. The projects are currently challenged by lack of connectivity to make them more beneficial. Therefore, most of the existing ICT for education initiatives aim at providing computers to schools, and sometimes training to teachers and students. The existing projects on ICT for education are formed under different collaboration models; the most common model being a Public-Private Partnership (PPP), which is a collaboration between the Ministry of Education and Vocational Training (MoEVT) with technology companies. Another model is the donor funded model, where the efforts are from either the private or public sector to support schools by providing computers or capacity building through training. Table 1 provides a brief description of indicative sample projects. The list is not exhaustive.

The ICT for education initiatives summarized in Table 1, illustrates that Tanzania has a number of ICT for education initiatives running concurrently. Many of these initiatives are pilot projects that are not well documented with no clear strategic plan for their implementation and there is no centralized coordination. The missing coordination and strategy for implementation to the many ICT for education initiatives implies that opportunities to combine, or associate related projects are missed, hence duplication, lack of experience sharing, and a potential for ineffective use of resources and opportunities is inevitable. Tanzania is currently (2011-2012) preparing a

National School Connectivity Plan (NSCP) under the Ministry of communication, science and technology in collaboration with International Telecommunication Union (ITU). The NSCP aims at providing an ICT broadband infrastructure master plan to facilitate implementation of broadband connectivity solution for primary and secondary schools as well as to tertiary education. Among other targets, the NSCP intends to address the lack of coordination and absence of a single ICT for education implementation strategy.

This section presented the existence of telecommunication infrastructures, institutional frameworks and initiatives for broadband connectivity in the country and ICT for education projects. Collectively, all these efforts demonstrate readiness of Tanzania to provide rural connectivity. The following section proposes implementation strategies in order to build sustainable broadband rural connectivity in Tanzania.

4. The Proposed Model for Provision of Sustainable Broadband Rural Connectivity

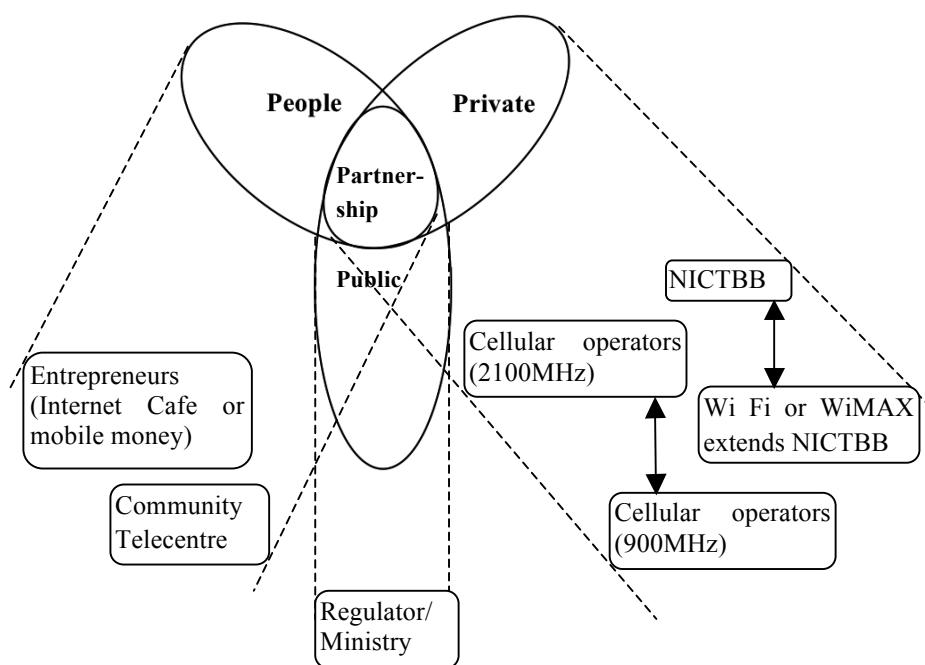
Availability of broadband infrastructures, institutional frameworks, ICT for education projects and the governmental will are the potential enabling tools for PPPP implementation in Tanzania. Having the tools and knowledge from the best practice projects implemented based on PPPP model, a sustainable model for broadband rural connectivity suitable for the Tanzanian context is proposed as shown in Figure 5. Roles of the different actors in the model are explained in the forthcoming sections.

Public Sector

The public sector can be made up of the communication regulatory authority and/or the Ministry responsible for communications, science and technology. The main roles of the public sector are:

- To create and enforce enabling policy and regulatory frameworks for PPPP.
- To train the local community in basic computer literacy, Internet use as well as services and applications delivered by broadband networks.
- To enforce as well as contribute the subsidy funding for universal communications access fund to private sectors in order to facilitate ICT infrastructure and service deployment to rural areas.
- To encourage the private sector to rollout commercial networks in rural areas.
- To coordinate formation of the PPPP.

Figure 5: The PPPP Model of Rural Broadband Connectivity in Tanzania

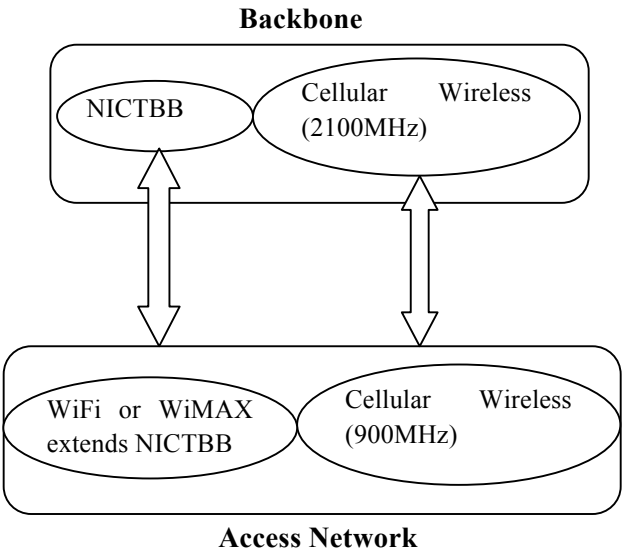


Private Sector

The private sector in this context is proposed to have two (2) tiers; the upper tier also known as the backbone tier and the lower tier known as the access network tier. The architecture of the private sector in the Tanzanian PPPP model is shown in Figure 6. The upper tier (backbone tier) is composed of cellular mobile operators. These are the operators that have wide coverage in the urban areas, but their networks are not extended to reach rural areas, due to the high cost associated with network roll out and maintenance in rural areas. Another candidate for the backbone tier is an operator managing the NICTBB infrastructure. The objective of the backbone tier is to provide local and international connections to the access network tier, which is made up of operators who have infrastructures in rural areas. The access network tier is responsible to provide broadband network capacity in the rural areas. In this context, the access network tier can be made up of Wireless Fidelity (WiFi) or Worldwide Interoperability for Microwave Access (WiMAX) wireless operators extending the coverage of the NICTBB. The access

network tier can as well be made up of a wireless cellular mobile operator of 3G broadband access network at 900MHz frequency band to extend coverage of the existing 3G at 2100MHz broadband mobile wireless network.

Figure 6: Two Tiers of Private Sector in the PPP Model for rural connectivity in Tanzania



Different roles of the two tiers are as follows:

Backbone Tier

- Provide local and international connections to the access network tier
- Develop and offer value added services
- Create environment for franchise business model with access network tier
- Train the access network operators for potential business opportunities
- Train the local community in basic computer literacy, Internet use as well as services and applications delivered by broadband networks.

Access Network Tier

- Roll out the commercial broadband access network infrastructure
- Develop and offer value added services
- Create environment for franchise business model with local entrepreneurs

- Train local entrepreneurs for potential business opportunities
- Train the local community in basic computer literacy, Internet use as well as services and applications delivered by broadband networks.

People's Sector

The people or local community can be the local government or management responsible for a shared local ICT facility such as telecentres. Another potential local partners to represent the people's part are the existing entrepreneurs in rural communities who are already providing some forms of telecommunication services such as internet cafes or mobile money transfer to others within the community. The PPPP model can benefit from the ICT-based local entrepreneurs from their ICT literacy and experiences. Roles of the people's part in the partnership can be:

- Make in-kind contribution to set - up network, for example provide land, labour and site security.
- Train the local community in computers and Internet use.
- Strive for participation and local ownership of the rural broadband connectivity, which will lead to sustainability and service relevance.
- Demand and maximize use of the value added services.

Sustainability aspects of the proposed PPPP model for broadband rural connectivity in Tanzania are considered into two aspects: financial and the partnership (stakeholders working together) sustainability. In addition to the subsidies offered by the public sector and revenue collected from the main intended service to be offered, other value added services relevant to the local community can contribute to the rural connectivity project's financial sustainability. Providing need-driven services that are affordable to the local community, which also inspire social-economic development at the community level will generate revenue that in turn contribute to the financial sustainability of the project.

The training component appears to be a role for all actors in the proposed PPPP model due to the fact that capacity building to the local community is essential to ensure sustainability of the project. People in the community have to understand the usefulness and potential of broadband Internet as well as of the services and applications that it can deliver. If the local community feels empowered by the broadband rural connectivity projects, they will participate more actively in seeking ways to keep it running. Capacity building by formal training is not the only ingredient for sustainability. Awareness creation to the community about services to be provided by the broadband network and how to access and use them can

also add to the sustainability of the rural broadband connectivity. Therefore, it is necessary for the people to be trained to become customers of the service and thereby ensure the project's sustainability. Training for potential business opportunities between backbone tier, access network tier and local entrepreneurs is essential in order to foster business partnership climate. In order to enhance sustainability, the partnership should strive to nurture local community inclusion, involvement and ownership throughout all the implementation phases of rural broadband connectivity projects.

Participatory action research is a practical approach which involves all participants affected by the issue under study (Rydhagen, 2002). Active participation of actors, which can be brought about by the participatory approach, strengthens partnership and trust among the stakeholders. Due to the requirement of PPPP model to maintain the strategic partnership in all phases and throughout the project, the participatory approach is recommended in the process of nurturing partnerships, because it can build a climate where rural communities feel a sense of inclusion and ownership. Furthermore, having the existing policies, legislations, strategies and regulatory framework supporting rural connectivity will protect, promote and support its development and existence, hence its sustainability.

5. Conclusion

This paper has identified the availability of supporting and enabling tools such as broadband connectivity, Integration of ICT in the educational system, governmental will and institutional frameworks, favourable for adopting PPPP model for rural broadband connectivity in Tanzania. By having such tools and the supporting environments, a PPPP model for sustainable rural broadband connectivity implementation in Tanzania has been proposed. The Government of Tanzania through its Ministry of Communication, Science and Technology in collaboration with International Telecommunication Union (ITU) are formulating the national school connectivity plan (NSCP). The objective of the NSCP is to develop a nation-wide master plan for providing broadband connectivity to all schools in Tanzania. The PPPP model for rural broadband connectivity proposed in this paper can be a very useful input to the NSCP.

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