Exploring the Critical Success Factors for Adopting Wireless Broadband Services in Developing Countries

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Abstract— Wireless Broadband Networks are high-speed wireless internet access and data networks. They can leverage other technologies or networks that are already in place. The advent of smart phones and other mobile handsets requires wider broadband penetration in developing countries, which would enhance the rapid adoption of the mobile phones and quickly close the digital divide. The purpose of this research is to analyze the success factors of some selected countries bring out the challenges and advice government and policy maker on how to enhance Broadband technology in developing countries. The framework of the study looked at the factors that make the pulling and pushing in the broadband environment after investing on infrastructure to bring out the output of connectivity and economic growth. The analyses of broadband technologies, a case study of three countries; Korea, Singapore and South Africa to bring out their success factors and a comparative analysis were made. A further analysis of why Korea succeeds was also made and it is our believe that this would also help policy makers to monitor trends, identify areas for policy action and benchmark their ICT developments against other markets and most importantly, help any developing nation as how to go about improving the life of its citizen through Wireless Broadband. The findings made in this study are of considerable practical importance to developing countries and particular Nigeria based on the observation made.

Index Terms— Wireless Broadband Networks, Broadband leveraging technologies, Success factors, Broadband strategies of government, Service delivery, Developin countries

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1 INTRODUCTION

Broadband known as high-speed Internet and an important tool that motivates development in any country and if any country wants to achieve economic growth, it cannot afford to ignore it [1]. Wireless Broadband Network is a high-speed wireless Internet access and data network which can be accessed over a wide area. Before wireless broadband, we only had the wired broadband networks, which consist of Digital subscriber line (DSL) and Asymmetric Digital subscriber line (ADSL) or a cable modem which enhance the speed of the network. The cost of providing or deploying wireless broadband network infrastructure, just as any other telecommunication infrastructure investment is always aimed at providing a flexible base for upcoming businesses as it reduces cost via consolidation in the long run [2].

It has been observed, over the past decade, that investment in the telecommunications industry is growing due to liberalization, competition, and advances in mobile technology [3].

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Therefore, the access to ICT services is changing rapidly in developing countries. In addition, not only does telecommunication bring together families and government, it is able to ride on it to deliver services effectively, but also businesses are able to operate efficiently [3] telecommunications market in Africa is evolving; and it is said to be among the fastest-growing in the world. The penetration of the internet in the world (Percentage of the people that have Internet access) in developing countries, clearly displays Africa as the largest single area that has only few people with access to internet and clearly behind the digital divide.

The arrival of smart phones and other advanced mobile handsets calls for the need for wider broadband penetration in developing countries [7] which would enhance the fast adoption of mobile phones and swiftly close the digital divide.

Broadband Wireless Access technologies is being considered by Telecommunications companies in Africa as the vital component can make Internet obtainable to its population at large. Many Projects are completed in Africa as well as Nigeria and these projects are done with the aims of accomplishing Internet backbones that will help to reduce the cost of bandwidth.

The future network (Next Generation Networks) have been forecast to be mobile wireless networks, as it has been estimated that worldwide cellular phone users reached over 5

billion in 2015 [8], and mobile data traffic will continue to increase exponentially [9], due to the advanced mobile terminals and bandwidth- "hungry" applications. Most of the resent research on this subject identifies Broadband Wireless Access technologies as the most encouraging answer for consumers in the access of internet in Africa.

Research has shown that Internet access demand will continue to increase as mobile phones are used for activities like social networking, video, and music downloading [14]. Developing countries will lag behind in global competitiveness unless broadband Internet connectivity is given priority. [3] Observed that a focus on the mobile telecom networks to address an instantaneous service need of the customers has left backbone networks almost stagnant, and this has created a major impediment in the rollout of high-bandwidth services in Africa. However, without these infrastructures, broadband would remain expensive and out of the low businesses and low-income customers. [11] Reported that deploying mobile broadband brings many pricing and deployment challenges, for service providers to reach rural communities; microwave could be an advantage as it offers shorter setup cycle and fast time for operators to deploy to the market. Microwave also has a high-capacity solution for operator to bridge over any landscape and benefit from a variety of CAPEX and OPEX reductions.

However, the information given is not focused on making a mix of technology that is, using the new technology with the old one and not starting from a widespread fixed line infrastructure. A strategy that defines how to improve access and lower cost of broadband can be achieved across developing countries. Networks, such as the Fiber Optic (Optical Networks), can serve as the backbone network and wireless broadband network can be used to complement it. It calls for the creation of a national broadband strategy to speed up broadband penetration.

The Nigerian government through the Regulator, Nigerian Communications Commission (NCC) has recently stated that the broadband policy planned by the Government as part of the strategies of government is to ensure adequate deployment of broadband facilities in the country and ensure removal of bottle necks, including right of way challenges, would help reposition the Telecommunication sector for larger exploit [15]. The policy is aimed at changing Nigeria into a complete digital economy with a lifestyle and business base by adopting broadband policy model tailored after that of Singapore. The goal is not only turning Nigeria into a major Information Technology (IT) and communications hub, but to make the country's Information and Communications Technology (ICT) and telecoms sector, one of the prime drivers of the na-

tion's economy and become more competitive on a global landscape. In Nigeria today, clearly ICT adoption, Internet connectivity, broadband availability is the major high point as there is the need not only to get broadband across the country but opening up the infrastructure that exists and setting the framework for sharing and access to the infrastructure. There is the concern that with more than 10 terabytes fiber network capacity in Nigeria, less than one per cent was being consumed.

The objective of this research is to explore the important success factors of other countries for adoption in order to enhance wireless broadband service in developing countries and in particular Nigeria. The advent of smart phones and other advanced mobile handset requires wider broadband penetration in developing countries, particularly in Nigeria. To catch up with the rest of the world in giving telecommunication services to their citizens, it is good to determine some suitable broadband technology that could be used to leverage on the fiber optical network for Nigeria among the various alternatives that are available. The technical potentials of these technologies in regards to the landscape of Nigeria is the main consideration in the analysis.

2 CASE STUDY

In this study we take three countries and compared them with Nigeria for our case analysis. These countries are South Korea, Singapore and South Africa. South Korea is chosen base on the fact that it has one of the highest internet penetration in the world couple with a good telecoms policy. Singapore is chosen because the head of the telecommunications regulator in Nigeria (NCC) made a pronouncement [15] that Nigeria is adopting the Singapore model of broadband deployment. South Africa is taken as an African country with a position that is higher than Nigeria in the broadband penetration index. We then conclude by analyzing why and how South Korea is able to succeed in their broadband implementation.

2.1 Case of South Korea

South Korea is located on the Eastern side of Asia and the southern half of the Korean Peninsula bordering the East Sea and the Yellow Sea. South Korea is a Republic government with the capital located in Seoul. The Land size of South Korea is 99,720 sq. km with the population of 48,754,652million (July 2011est.). The official language is Korean with the major religion being Christianity and Buddhism. The major export products of South Korea are Electronic products machinery and transport equipment. The GDP of Korea is $1.459trillion (2010est.) and GDP per capita is $30,000 (2010est.). The regulator of the South Korean telecoms sector is the Korean Communication Commission (KCC).

The Korean government has consistently invested on broadband and internet infrastructure which started in 1999

with the *CyberKorea 2001* project that saw the funding and human resource development for building the information and communications technology (ICT) networks, the establishment of the nationwide fiber-optic network and the deregulation of the telecommunications market. In 2002 the focus was then directed to the expansion of the ICT infrastructure and capacity building with the *E-Korea* initiative. It culminated in 2004 with the *IT 839 program* which was a strong support for mobile broadband and digital multimedia.

The broadband drivers are attributed to not only the dense population as about 80% of the population live in urban areas but also the proximity of telephone exchange which help in simplifying the broadband access. The introduction of a fair competition also helps in stimulating the broadband market which saw the competition of telecoms operator couple with the well-developed physical infrastructure and some informed, eager and sophisticated users. The government was the facilitator of the broadband development as it was committed in the development of high-speed infrastructure with specific programs in place with the strong support of the private sector through various low interest loans from banks and certificate programs. There were also the manufacturing industries which saw the manufacture of the ADSL and made sure that there is a constant supply of it in the market which kept the price low enough for the citizen's purchasing power.

2.2 Case of Singapore

Republic of Singapore is located in Southeast Asia at the southern tip of the Malay Peninsula which is 137 Km north of the equator. Singapore is a parliamentary republic with a western of unicameral parliamentary government. It is made up of 63 islands and is separated from Malaysia by the Strait of Johor to its north and from Indonesia's Riau Island by the Singapore Strait to its south. The land size of Singapore is 707 sq. km with the population of 5,076,700 million (2010 census).

Singapore has four official languages which are English, Chinese, Malay and Tamil but English is the first language of the nation which is also the language of business, government and medium of instruction. The major religions in Singapore are Buddhism, Christianity, Islam, Taoism, and Hinduism. The major products of Singapore are Computer equipment, machinery, rubber products, and petroleum products. The GDP of Singapore is $291.9 billion (2010 est.) and GDP per capita is $62,100 (2010est.). The regulator for Singaporean telecoms sector is Infocomm Development Authority of Singapore (IDA). Singapore is among the world countries with highest internet penetration which could be attributed to their dynamic investment on infrastructure. The first phase of Singapore ICT plan started in the 1980s where it introduced a national computerization program to support its economic restructuring by starting with its civil service by establishing a Civil service

computerization program (CSCP) to computerize the civil service with the aim of delivering better public service which move computer from low state utility to the high integral part of the civil service and then it included the multiple agencies later by coordinating computer education and training to ensure the steady supply of training personnel and making Singapore a software development center. The next item in their agenda, was then to use ICT to support its longstanding vision to become a develop country.

In the 1990s it formed a master plan called IT2000 Master plan which was to make Singapore an "intelligent island" that in grounded on the all-encompassing use of ICT. This was to make every home, office, and schools in Singapore to be wired to an advanced nationwide network information and communication infrastructure.

The government now came out with the vision to become the world's first country to be wired to connect every home to have broadband. It the launch the step to develop the information infrastructure with the project called Singapore ONE which was a nationwide multimedia broadband infrastructure that was jointly fronted by various agencies such as Telecommunication Authority of Singapore (TAS), the National Computer Board (NCB), the National Science & Technology Board (NSTB), the Economic Development Board (EDB), and the Singapore Broadcasting Authority (SBA) which ensure the spread of broadband.

In 2002 there was liberalization of the telecommunications sector and market in Singapore which attracted international broadband players into Singapore and regulator was formed by merging two agencies (National Computer Board and the Telecommunications Authority of Singapore) to form the Infocomm Development Authority of Singapore (IDA) and it introduce the Open Access Policy which was to enable other ISPs to use the incumbent operator (SingTel) ADSL/cable network to provide broadband service to customers.

In 2006 an advisory committee recommended the deployment of an open access fiber-optic network that will provide high-speed broadband in gigabits to homes, school and businesses through Fiber to the Premises (FTTP) to replace the copper/HFC infrastructure that was in use. It also recommended the development of a "pervasive nation-wide wireless broadband network to meet the access needs of individuals everywhere and every time". A plan was then made for the Singapore government to embark on an aspiring effort which is the plan for an Intelligent Nation 2015 to build Singapore into a Global City (iN2015) through a public-private partnership on a build and operate basis the Singapore's next generation national broadband network (NGNBN). This is to be done on a structural separation between the passive and active network infrastructure, and operational separation between the

active infrastructure and the services layer. The NGNBN when completed will be taking fiber to 1.12 million residential premises and 152,000 other premises and it supports a high speed of up to 1 Gbps as it uses an optical fiber network.

2.3 Case of South Africa

South Africa is located at the southern tip of the African continent. South Africa is a republic government with Administrative capital in Pretoria, Legislative capital in Cape Town and Judicial capital in Bloemfontein. The land area of South Africa is 1,219,090 sq. km and the population is 49,004,031 (July 2011 est.) which consist of Black Africans, Whites, Colored, and Indian/Asian. South Africa has 11official languages English, IsiZulu, IsiXhosa, Afrikaans, Sepedi, Setswana, Sesotho, Xitsonga, IsiNdebele, Tshivenda and siSwati. The major religions in South Africa are Christianity, Islam and indigenous beliefs. The major export products of South Africa are gold, diamonds, platinum, other metals and minerals, machinery and equipment. The GDP of South Africa is $524 billion (2010 est.) and the GDP per capita is $10,700 (2010est.). The regulator of the South African Telecoms sector is the Independent Communications Authority of South Africa (ICASA).

South African telecoms was fully liberalized in February 2005 but as indeed most African countries it is faced with the problem of outdated infrastructure and high cost of telephony. A broadband policy framework was developed in 2009 with the hope of contributing to the notational broadband strategy which calls for the provision of broadband access to every town and village, achieve lowest broadband prices and was the highest penetration on the continent in 2014.

3 COMPARATIVE ANALYSIS

In this section, we first take a look at the IDI indicators which will help us to see in quick look the situation and current status of ICT in the countries that we study. The ICT price basket, which is a bench marking tool by ITU to inform policy decisions, will give us information on cost and affordability of ICT service in the countries as compared with Nigeria to see where the country stands and where it need to take strides to progress.

The ICT Development index, shown in figure 1, shows Nigeria in 2013 is in the group of countries with low level of ICT development with 2.18 number 122 in the ITU ICT Development index. This shows that Nigerian citizens have low levels of ICT access, usage and skills as indicated in fig. 2 to fig. 4.
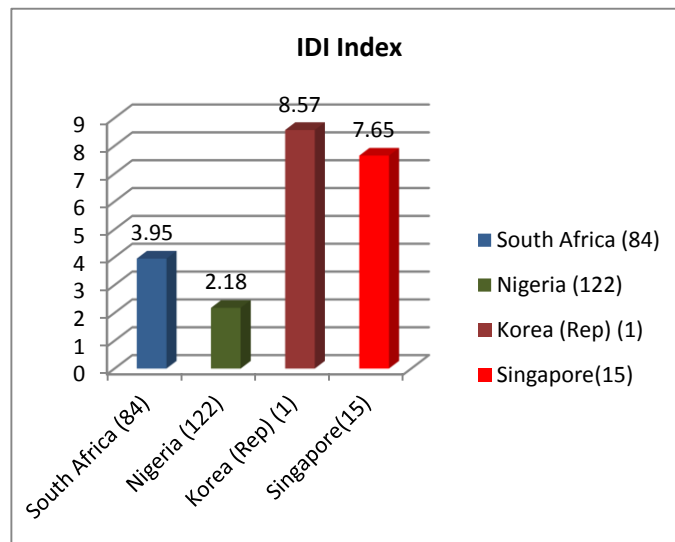

Fig. 1. ICT Development index showing the position of Nigeria as compared to Korea, Singapore and South Africa.
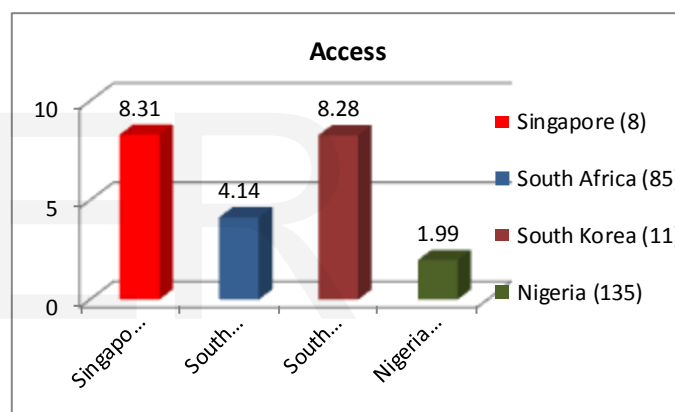

Fig. 2. Access sub-index position of Nigeria as compared to Korea, Singapore and South Africa.
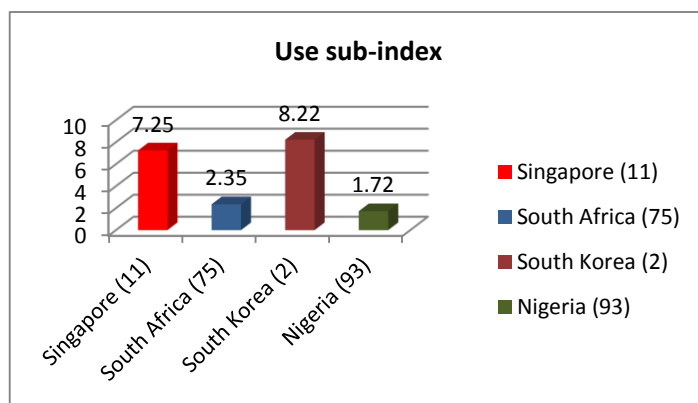

Fig. 3. Use sub-index position of Nigeria as compared to Korea, Singapore and South Africa.
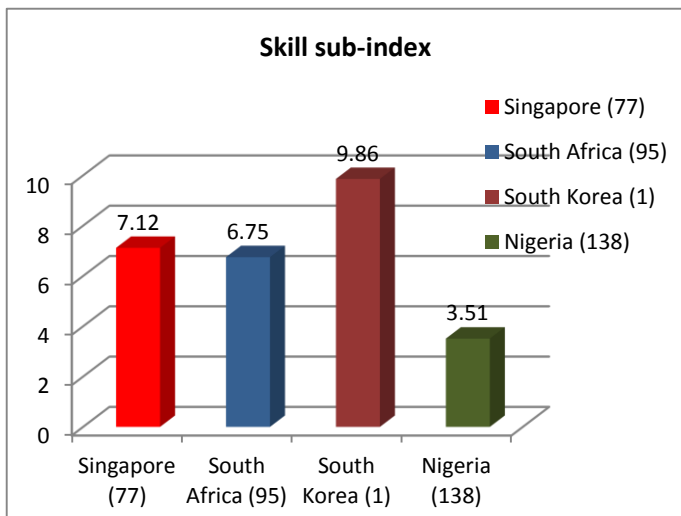
Fig. 4. Skill sub-index position of Nigeria as compared to Korea, Singapore and South Africa.

This shows that the Nigerian Communication Commission (NCC) has a lot to do to create an enabling environment in making sure that the gap in the Digital divide shrinks.

From figure 5 above, it is very clear that the cost of ICT services in Nigeria is very high as compared with Korea, Singapore and South Africa the government has to look for ways to lower the cost for the citizens and as advised by ITU, they need to look into many factors which can help in bringing down the cost; such factors include measures of regulatory intervention, level of competition, market size, operators' cost for providing services, as well as profit margins.
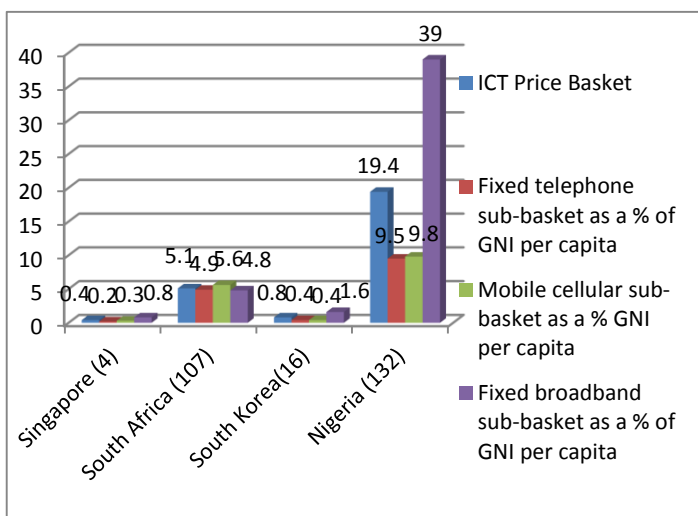

Fig. 5. ICT Price basket (2013) position of Nigeria as compared to Korea, Singapore and South Africa.

Research has shown not only that 95 percent of Korean homes have access to internet/broadband connection which is the highest in the world, but also, they top the skills sub-index with the highest level of household with internet access. It was also establishing that Korea not only has the highest proportion of household with fiber optic connections but also has a strong domestic ICT industry with large ICT manufactures such as Korea Telecoms (KT), LG, LG Telecom, and Hanaro Telecom.

The irrepressible resolute could be attached to government awareness, high educational levels, and support for ICT projects. The culture of the Korea which sees them as people with the syndrome that once one person gets something everyone else wants it too helps in the adoption of new technology. The only problem that Korea has is International bandwidth which is low as Korean Internet users rely mainly on national bandwidth that is abundantly available and at relatively low cost.

Table 1 shows the summary of pull and push factors that consists of infrastructures, funding, partnership, motivation, strategies and level of success in terms of penetration of broadband for mobile and position in the world of South Korea, Singapore, South Africa and Nigeria.

TABLE 1.
COMPARISONS BROADBAND STRATEGIES BASED ON PULL AND PUSH APPROACHES

Factors for success	South Korea	Infrastructural development through demand aggregation.	South Africa	Nigeria
Infrastructures		Open access policy of the Singaporean government through the Public Private Partnership (PPP).	Built a high-speed National backbone network critical to provide international bandwidth to institutions.	Progressive Deployment of Broadband Infrastructure and Microwave Networks.
			High bandwidth research network to research community and link them to the global research networks.	3.5G (LTE) mobile networks.
		Allowing the private companies to build and operate access networks on a regulated term at arms-length from their business.		Widespread mobile coverage by the Operators.
Funding	Finance in form of pre-payment for future provision of broadband services to public institutions.	Launched a project to develop a fiber-to-the-home (FTTH) access network infrastructure project through PPP.		Liberalization of the telecommunications Sector
	Funds were provided through (PPP) in the			

	building of optical fiber network.		
Partnership	Liberalization of the telecommunications Sector	Liberalization of the telecommunications Sector	Liberalization of the telecommunications Sector	Liberalization of the telecommunications Sector
Motivation	Incentive given to the private sector to invest in exchange for the provision broadband services to public institutions over an extended period.	Subsidizing the cost of construction of access network for the private companies to build and operate.	Enable accelerated Human Capital development through the use of the network.	
Strategies	Establishment of infrastructure competition among operators. Creating demand by supporting the citizens in the provision of cheap PCs to low-income household. Free broadband access to all schools. Establishing e-government and initiating ICT literacy training for the citizens.	Construction of Private Telecoms projects in conditions and terms for the companies to sell their services in compliance and supervised by the regulatory authority.		
Level of success in terms of penetration of Broadband for Mobile and Position in the world.	100.6 subscriptions per 100 inhabitants. Ranked 4	123.3 subscriptions per 100 inhabitants. Ranked 1	26.0 subscriptions per 100 inhabitants. Ranked 62	10.2, subscriptions per 100 inhabitants. Ranked 90

From Table 1 South Korea advancement in ICT could be attributed to their infrastructural development through demand aggregation. The South Korean government enhances broadband by providing finance for the development of the country's broadband infrastructure which was in form of prepayment for the future delivery of broadband services to public institutions. Funds were provided through public and private sector partnership in the building of the country's optical fiber network in the late 90s'but most of the funds came from the private sector. After the optical fiber network was achieved focus then turn to access network and upgrading of the entire network which was done from late 90s to middle of 2000. The South Korean government gave this incentive to the private sector to invest in exchange for the operators to deliver broadband services to public institutions over a stretched period.

The government policy of promoting broadband which also include the establishment of infrastructure competition among operators through full liberalization and creating demand by supporting the citizens in the provision of cheap PCs to low-income household, giving free broadband access to all schools establishing e-government and initiating ICT literacy training for the citizens.

4 HOW DOES A NATION CREATE BROADBAND INFRASTRUCTURE?

4.1 Create Broadband Infrastructure

Based on the cases studies in sections 2 and 3 there are many questions that a nation or government needs to answer regarding the construction or development of broadband infrastructure especially if the broadband infrastructure is to serve the citizens well. The government needs to know the community the broadband services would affect (rural or urban, developed, underdeveloped or developing nation) and as such care for such community's well-being, this is as illustrated in fig. 6,
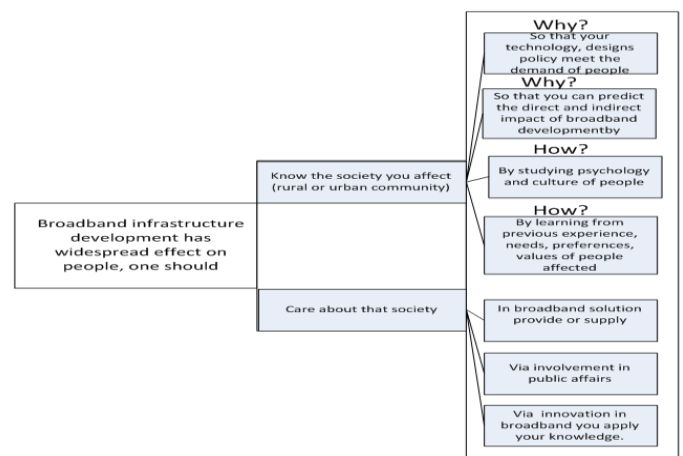

Fig. 6. How does a nation create broadband Policy?

From fig. 6, we need to know the community or society is a prerequisite to knowing about the people and their social behavior (culture of the people concerns) and this differ from one community to the other and one country to another. This is the one pronounced thing that aided South Korea to succeed in its broadband penetration; the South Korean Government

identified its people in terms of their culture. As a government, you need to identify what citizens need or prefer and what they will tolerate; this should strongly influence the design of any policy for broadband development in any country or developing nation. It is a well-known fact that replication of policies from either product, organization or country are difficult if not impossible and so therefore if one copies all good policies, theories and practices used in broadband development in South Korea to replicate in any developing nation, it may not work for them if those factors are not properly identified and taken care of. These factors can be grouped and called "hidden factors".

It is of worth to know that, when designing a new policy for broadband and you intend to satisfy the maximum identified number of people, it will be prudent to know what their specific needs are and their unique characteristics. Of cause, an average human being loves good things such as high-speed broadband at affordable price. How much importance do people attach to uses of Internet; to download very huge data and pay high price? Are people willing (have capability) to pay for high-speed broadband at high price that will make new policy and technology for broadband feasible?

How would people react to changes in technology which may incur extra cost? And how much is government ready to subsidies and for how long? Are private operators ready to move to rural areas with lower price where there is little or no market? Finding answers to the aforementioned questions is the part of knowing the people who broadband infrastructure directly and indirectly affects. While you are caring about the well-being of the community, it is important to be aware of the far-reaching effects of new technology, policy and pricing strategy; and be openly concern of the people that will be affected. It is of significance to know that, upgrading from an existing technology to a new one brings with it more cost on the present operators and sometime, its take time. Furthermore, it will be worthy to know that to be honestly or actively concern about minimizing the hardship of upgrading an existing network to new one and facilitating the economic, social and other national adjustment. It is very vital to minimize the social costs and maximizing social benefits of the broadband project.

The dividend of the policy of South Korea government for all to see is the investment in building network and the "hungry" usage of broadband services which as we know in relation to economics where demand does not exceed supply there will always be competition and where cost is low as the case of the Korean broadband services there is the relative high usage.

4.2 Lesson for Developing Nations to Borrow from South Korea Case Study

The policy and regulatory approaches of the government must be tailored to each country's unique characteristics according our analysis on section 4.1, even though there are a lot of lessons to be learned from South Korea's experiences for developing nations as shown in fig. 7.
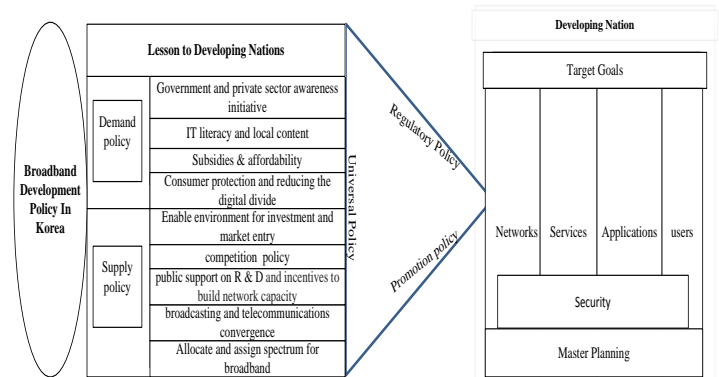

Fig. 7. Lesson for developing nations to borrow from South Korea

From Fig. 7, the first lesson is to stimulate demand and supply side of broadband development via government and private sector awareness of initiative of broadband development; IT literacy initiative for the populace with local content; subsidies the ICT equipment such as computer and other accessory with affordable price; and formulate a policy to protect consumer and digital divide via universal access and universal service to all populace.

In the same manner supply policy to deploy from Korea include: government should create enabling environment for investment and market entry via competition policy. Also, initiate public support on research and development on broadband development with incentives to build network capacity. To avoid duplication of schedule, create a policy to converge broadcasting and telecommunications. Lastly, allocate and assign better spectrum for broadband right ways.

Developing nations need to set their targets and back them up with master planning that will focus on broadband networks, services, applications and users with policies that seek to heighten promotion, universal services and access, and put regulatory processes in place to checkmate demand and supply imbalance.

5. CONCLUSIONS AND IMPLICATION

This paper duduce that there is the need for a long term strategic planning by government in the provision of broadband infrastructure as well as service delivery terms of ICT to the citizens.

more counties should be used for comparative needs.

The government policy measures interventions, level of competition, market, operators' cost for providing services, profit margins, as well as support for ICT projects needs to be reinvigorated and regulatory.

Also, there is also the need to create demand and this can be done through support given to the citizen in various form such as provision of cheap portable computers to low-income households, free broadband access to all schools establishing e-government making sure that it works and initiate ICT literacy training local government areas for the citizens.

The Government needs to enhance broadband by providing finance for the development of broadband infrastructure through incentive given the private sector to invest in exchange for the operators/private sectors to provide broadband services to public institutions over an extended period.
An open access policy done through public private partnership (PPP) can help bridge the gaps in broadband deployment, subsidize price and thus help in the provision of services by operators on a non-discriminatory basis to provide the required infrastructure.

There is the need for government to also allow the private sectors or companies to build and operate access networks on a regulated term to provide broadband infrastructure and services to the citizens.

Government need to take cognizant of the importance of research and provide a high-speed national backbone network that will help in the provision of international bandwidth network to the research communities and also enable accelerated human capital development through the use of the network.

Finally, we will like to implore government that, policies, projects and initiatives of government need to be directed at making good strategies and regulatory environment for the private sector to bring in their investment through the public private partnership.

The demand for broadband would certainly increase if training, education and services are given to the citizens which invariably would also bring down price.

The inexorable support for ICT project of Korea and the open access policy of Singapore are good example for the Nigerian government to imbibe into as it would go a long way in the provision of service to the citizens of Nigeria.

For futher study of this work, the paper is recommended that

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