ADDRESSING ACCESSIBILITY, AFFORDABILITY AND SUSTAINABILITY BARRIERS FOR BROADBAND INTERNET ACCESS AND PENETRATION IN RURAL AREAS

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ABSTRACT

It has been said that the spread of Information and Communications Technology (ICT) and global interconnectedness has a great potential to accelerate human progress, to bridge the "digital divide" and to develop knowledge societies, in countries where it is available. However, it has also been determined that certain barriers, more prevalent in rural communities, pose an incessant impediment to the access and penetration trends of broadband internet networks and infrastructure in rural areas. These barriers have been identified as 'accessibility', 'affordability', and 'sustainability'. It is hereby asserted, therefore, that a concerted effort is required to address these barriers, with great deliberation and haste, if digital inclusion is to be achieved in rural areas. This paper proposes a broadband internet system that is aimed at addressing these barriers, through a proposed model, which is intended to be implemented as a Proof of Concept (PoC) in the rural area of Mbazwana, located in the province of KwaZulu-Natal (KZN), South Africa (SA). The model has been presented to the community, and subsequently followed by a survey to determine the feasibility of the implementation thereof. This paper will present the proposed model, as well as the results obtained from the research conducted.

KEYWORDS

Accessibility, Affordability, Broadband, Digital Divide, ICT, Internet, Mbazwana, Rural, South Africa, Sustainability, Urban

1 INTRODUCTION

Accessibility, affordability, and sustainability are three of the main barriers to broadband internet access and penetration in rural areas (Ngwenya *et al.*, 2023). These barriers are the main contributing factors to the so-called "Digital Divide", which is described as "the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access ICTs and to their use of the internet for a wide variety of activities" (Souter *et al.*, 2009). In the current economic and social epoch, this is deemed to be non-progressive by several papers and studies, as the world moves into a digital era, where the internet is an essential enabler and tool for participation (Stork, Calandro and Gamage, 2014) (Institute of Electrical and Electronics Engineers, 2009) (Mosenthal, Nleya and Manthoko, 2009) (Rully *et al.*, 2005) (Su and Caballero, 2010). As a result, the demand for ICT has risen sharply as countries continually recognise the benefits and potential of it as a tool for social and economic development.

This connectivity is typically achieved by providing broadband access to the general population. Broadband penetration is considered an important factor for economic growth in a society, by improving productivity of businesses, accelerating innovation and providing opportunities for new products and services (Stork, Calandro and Gamage, 2014). The primary beneficiaries of this development at present, however, are the developed countries, referred to as 'First World' countries. Statistics show that broadband penetration has occurred vastly and much more rapidly in these countries than in their 'Third World' country counterparts. First world countries are characterised by the definition of being "industrialised" and are often leading the way in the ICT sector, including the provision of broadband infrastructure and access to most of their respective populations, who typically reside in suburban and urban areas. In third world countries, however, in most cases, a significant percentage of the population resides in underdeveloped and underserved areas, often associated with rural areas. In these areas, the same trend for ICT services, including internet access, is not seen. Generally, rural, and isolated areas of the developing world are still largely disconnected in terms of internet services. This is epitomized in some countries, like Tanzania, for example, where the majority of the population lives in rural areas (Byanyuma *et al.*, 2013). These same countries are normally characterised by poor infrastructure and services (or the complete lack thereof), low income, illiteracy and poverty amongst the population, as well as highly scattered and low-density landscape and terrains (Byanyuma *et al.*, 2013). It is therefore concluded that unequal access to internet services directly relates to unequal access to opportunities, jobs, and the ability to deal with unexpected events such as emergencies and disasters. As a result, the need to connect rural areas using broadband internet becomes more and more crucial. This paper aims to recommend a feasible proposal that will address the broadband access and penetration trends in rural areas that will be ***affordable***, ***accessible,*** and ***sustainable*** for rural communities while stimulating economic participation and growth.

In Section 2 of the paper, the problem statement is presented. Section 3 describes the research methodology that was employed to conduct this research. The research design, done in two parts, is expanded upon, where the process and objective thereof are described. This is followed by a presentation and analysis of the results obtained, in Section 4, and a discussion of the results in Section 5. Finally, the paper is concluded with a summary of the outcome of the research, including recommendations and proposed future work.

2 PROBLEM STATEMENT

Based on statistics published in January 2021, there were 4.66 billion active internet users worldwide, which makes up approximately 59.5% of the global population (Hassan *et al.*, 2021). The unfortunate news is that the other 40% of the global population remains offline, and most of this "other half" resides in developing countries where, on average, 45% of the population has access to the internet. Most of these digitally excluded communities are situated in emerging economy countries with large rural populations (Mekuria *et al.*, 2021). Some of the main, generally agreed upon, attributes that prevent the adoption of ICTs in rural areas, according to work done in some academic papers such as (Henry, 2019) and (Vemu, Bhatnagar and Hemachandra, 2007), are depicted as "Affordability", "Accessibility" and "Sustainability", and ultimately the problem statement that is intended to be addressed by this paper.

3 RESEARCH METHODOLOGY AND DESIGN

The methodology that was employed to conduct the research for this paper is based on public surveys and in-person interviews. This was done with the objective to consult with the community with respect to the specific challenges that they face as a community, which uphold, if not exacerbate, the digital divide. Following a visit to the rural community of Mbazwana on the 18th of March 2023, 176 community members were engaged by the research team with respect to broadband internet access barriers in the community. The first step was a

proposal for a community incentive-based data package sales model, to address the challenges of accessibility, affordability, and sustainability of rural broadband systems. This is proposed to be implemented as part of a Proof of Concept (PoC) using a Television White Space based Broadband Network (TVWS) (Mzyece, Mfupe and Mekuria, 2018), to be deployed in the community of Mbazwana. The choice of TVWS was based on the excellent propagation properties of TVWS waves and the cost efficiency of the TVWS setup. The locations of the access points (APs) were identified in collaboration with the community, based on the footfall trends, on a daily basis at these sites. This system is meant to be a bespoke solution for the community of Mbazwana, with the intention to follow the same approach with other rural areas in the future. The second and final step included the distribution of a questionnaire, which consisted of non-intrusive, concise questions, presented mostly in a multiple-choice format. Participation and completion of this questionnaire excluded minors (under the age of 18 years) in accordance with the university ethics committee's guidance.

3.1 Community Incentive Based Sales Model and PoC

The community incentive-based sales model is a proposal with the intention of addressing accessibility, affordability, and sustainability barriers to internet access, as identified by the research team. The sales model, depicted in Figure 1, includes data packages that are relatively more affordable compared to those currently offered by traditional Internet Service Providers (ISPs). These data bundles, however, will be valid for shorter periods. The internet access would be provisioned by a Television White Space (TVWS) broadband network pilot, with access points situated in four locations that have been identified by the research team, in consultation with the community. These four locations include two high schools (Mpiyakhe High School and King Moses Secondary School), a local clinic and an art centre. These locations have been chosen due to the proximity to the main economic hub of the village, as well as the number of potential users that are present at the locations, on a regular basis. These locations are also aligned with those identified as part of the objective and targets stipulated in South Africa's National Broadband Policy (NBP), the SA Connect Policy (*South Africa's Broadband Policy*, 2013).

Additionally, the community incentive-based sales model proposes that all proceeds of the data voucher sales be kept in a central repository, that will be overseen by democratically elected members of the community, by the community. The broadband system portal is to be bespoke to the community of Mbazwana with the ability to advertise local small businesses. The resellers of the data vouchers, who are proposed to be community members, are also offered an incentive to advertise their services on the platform. Finally, the tribal council is also entitled to advertise communications pertinent to the issues of the community, including social and political events, as and when they arise. The model also proposes three options for regular users, where the biggest monthly data user(s) is offered a reward of free data bundles.

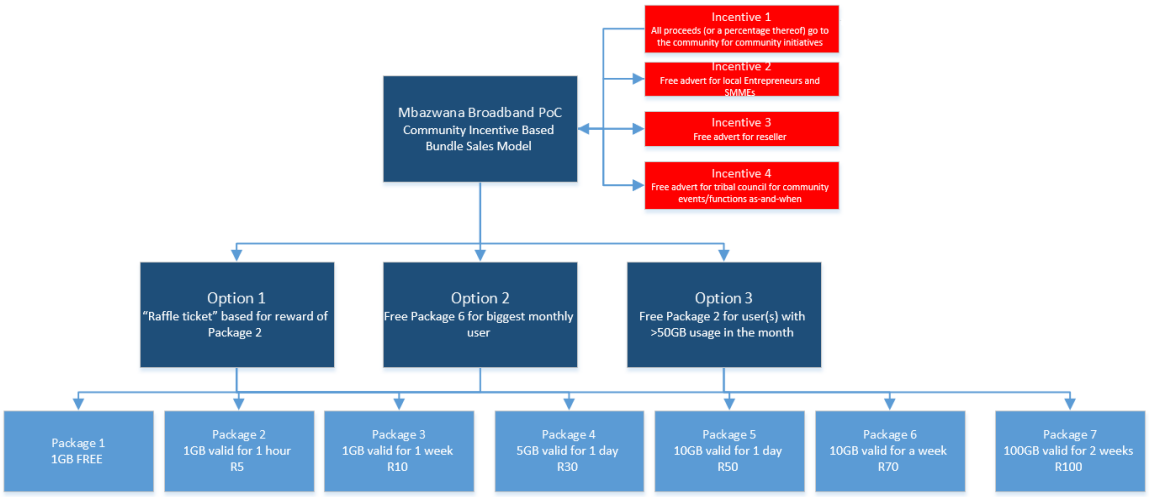

Figure 1: Community Incentive-Based Sales Model

3.2 Questionnaire

The questionnaires were distributed in physical form to all the 176 attendees. Prior to this, consent forms were distributed to all participants, in accordance with the UJ ethics committee approval. The objective of the questionnaire was to elicit the extent to which the three above-mentioned barriers are prevalent, specifically in the rural area of Mbazwana. The envisaged outcome of the questionnaire was to use the information obtained, in conjunction with the feedback received from the community incentive-based model presented, to propose/recommend the most suitable broadband system that is accessible to all in the community (all ages, genders, races, etc.), and that is also affordable and sustainable. It was anticipated, as has been done in papers such as (Mekuria *et al.*, 2021) and (Mzyece, Mfupe and Mekuria, 2018), that the involvement of the community in this process would ensure that the community members would protect and preserve the broadband system, in recognition that it would greatly benefit them, by providing readily accessible, affordable, always-on and high-speed internet, which will in turn provision access to ICT services. The results of the questionnaire are discussed in the next section.

4 RESULTS AND ANALYSIS

4.1 Age and Employment Status

Although all age groups were represented, the responses on the age profile of the participants indicate that the majority is between the ages of 18 and 29. The employment status of the participants indicates that the majority of the participants are in fact unemployed. These results are depicted in Figures 2 and 3.

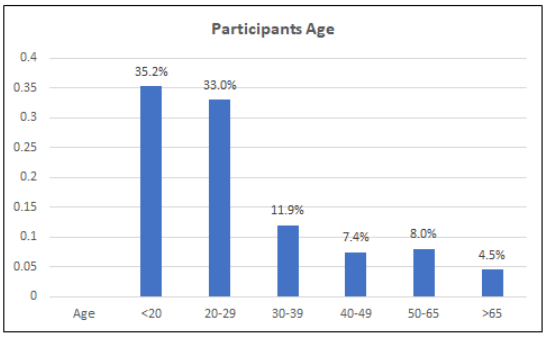

Figure 2: Age Profile

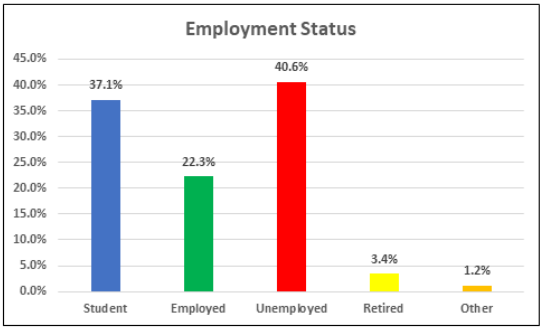

Figure 3: Employment Status

4.2 Internet Access

The majority of the participants claimed to have access to the internet, with over 90% reporting that they own a smartphone, as a primary means of their internet access. This is depicted in Figures 4 and 5.

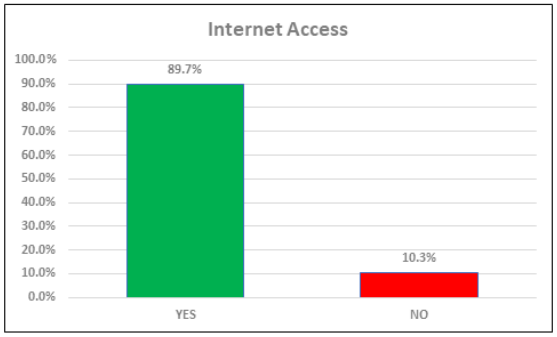

Figure 4: Internet Access

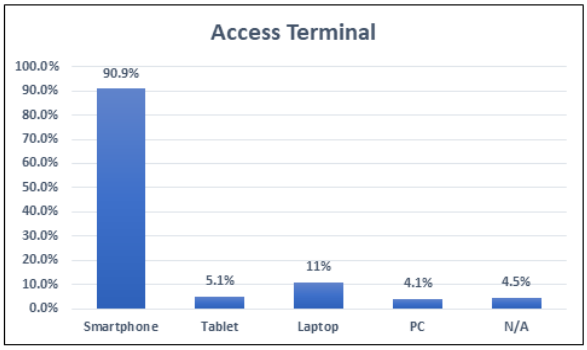

Figure 5: Internet Access Terminal

4.3 Internet Access Location

Currently, the majority of the participants claim to be able to access the internet at their homes, followed by the workplace and school. When asked where they would prefer to access the internet, should a community-based broadband system be introduced, the participants reported that their preferred location to be their home, followed by school and workplace. These results are depicted in Figure 6.

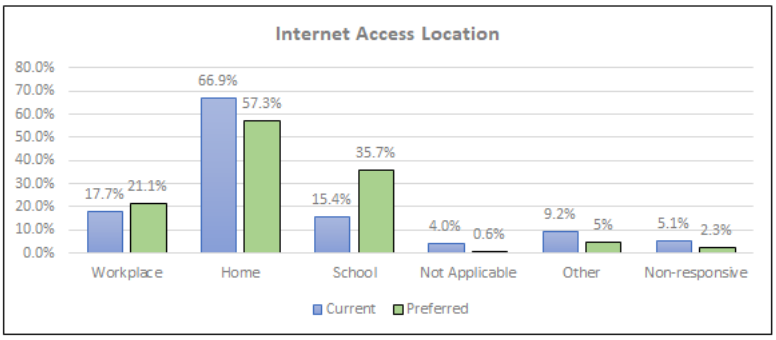

Figure 6: Current Internet Access Location

4.4 Internet Access Limitations

The participants were asked what kind of limitations they experience with their current internet access. The majority reported that money constraints are the most prevalent issue. This was followed by the quality of the broadband service, with respect to connection speeds and availability thereof. A significant number of the participants also cited distance and use time constraints as a limitation. This result is depicted in Figure 7.

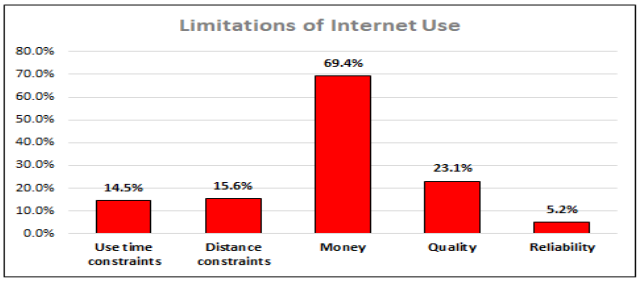

Figure 7: Internet Use Limitations

4.5 Monthly Data Spend

Currently, the majority of the participants reported to be spending the minimum amount of money, from the options presented to them. The participants further reported that they would be willing to pay a little more for monthly data if they deemed the data bundle package to be reasonably priced. This result is depicted in Figure 8.

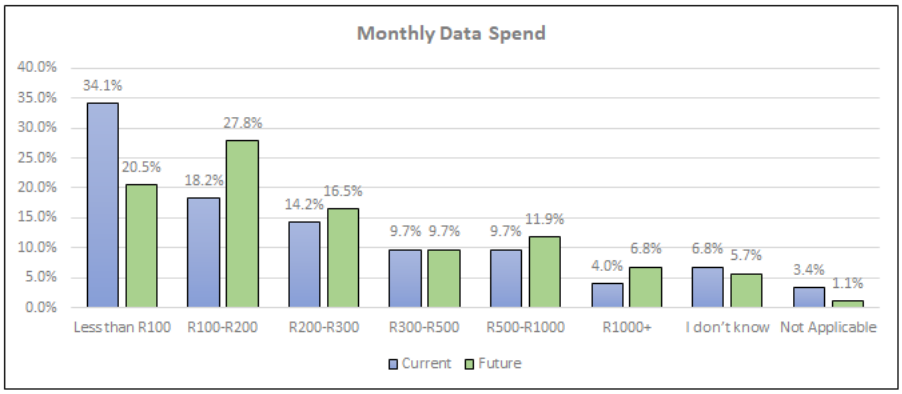

Figure 8: Current and Future Monthly Data Spend

4.6 Monthly Data Usage

The result from the previous data in Section 4.5 translates to the majority of the participants using the least amount of monthly data, from the options presented and preferring to spend a little more for a larger amount of data, should it be made available at what they perceive as a more palatable cost. This result is depicted in Figure 9.

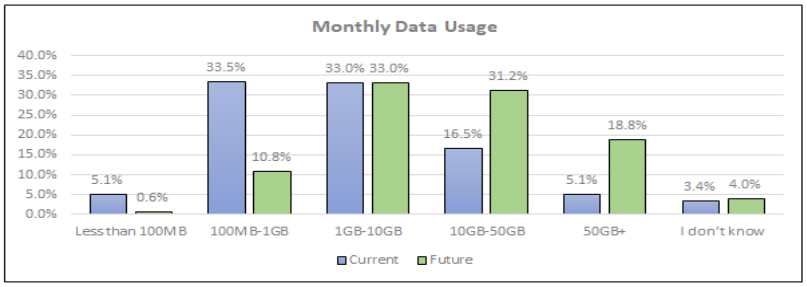

Figure 9: Current and Future Monthly Data Usage

4.7 Support

The majority of the participants reported that they are in support of the proposal as presented by the research team, as they indicated that they believe the proposal would work in their community, if implemented as per the research teams' proposal. The majority, however, also indicated that there is a concern of potential corruption if the correct individuals are not allocated to oversee this proposal. These results are depicted in Figures 10 and 11.

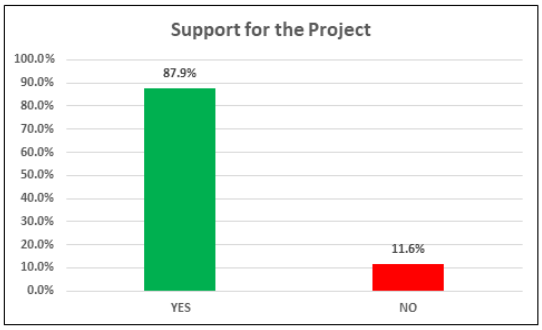

Figure 10: Support for the Proposal

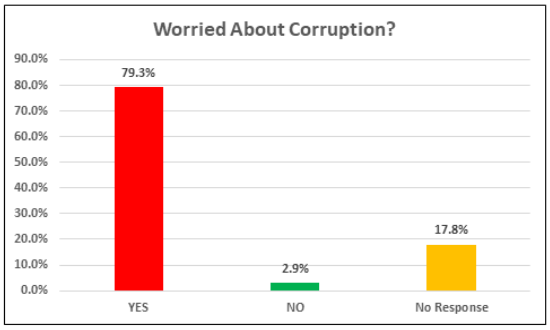

Figure 11: Concerns about Corruption

5 DISCUSSION OF RESULTS

All age groups, from the sample of respondents who participated, are represented in this survey. It has been noted, however, that young people are more represented, more than any other age group, which alludes to the interest in ICT services per age group. Unemployment amongst the group is clearly demonstrated, as the majority of the participants are unemployed. This result reflects the affordability barrier. The majority of the participants have also reported that they do have access to the internet and own smartphones, however, they have also reported that there are limitations to this access. The majority has cited that there are financial constraints which pose an impediment for regular and continuous internet access. Some have cited distance constraints, i.e., they are required to travel long distances to access the internet, and some have cited the quality of the network that is provisioned by ISPs. Some have indicated that they have time constraints imposed on them, especially where their internet access relies solely or partially on public amenities such as internet cafes, local libraries, and local community centres. This result reflects the accessibility barrier that has been identified.

The participants have also reported that they use and spend the minimum amount of internet data and money from the options presented to them, respectively. This is expected as the majority is unemployed, and so affordability becomes an issue, especially since the internet data costs in SA are considered to be relatively exorbitant by the rural community. The participants, who are largely considered to be representing the views of the community, have indicated that the proposal of a bespoke community broadband network would work, as the incentive-based model, as well as the affordable internet data offers, are deemed acceptable. The community members have also expressed their approval for the different incentives offered, particularly Option 3 in Figure 1. This is further strengthened by the fact that all proceeds will be under the auspices of the community, for further expansion of the scalable system, as well as other community development initiatives. The main concern that was expressed by the participants regarding this proposal is the embezzlement of funds, should the individuals elected to oversee the sales not be cautiously elected.

6 CONCLUSION

Following the visit to Mbazwana, the research team concluded that the community incentive-based sales model using television white space (TVWS) technology would best address the three barriers of accessibility, affordability, and sustainability. The location of the four APs that have been selected are in alignment with SA's National Broadband Policy (SA Connect Policy) and are accessible to the majority of the community members of Mbazwana. The data packages that have been offered are palatable to the community members, who have expressed interest in, and approval for the above-mentioned proposal made by the research team, which will be implemented as a proof of concept. The community has expressed its concern about corruption and mishandling of funds and has asked the research team to formulate a framework on how the sales should be conducted, to minimise the potential of corruption. As of the publication of this paper, the proof of concept, under the auspices of the University of Johannesburg (UJ), South Africa, has been approved and is to be implemented during the second half of the current year, 2023. The research team has further formulated an economic market structure proposal to the community of Mbazwana, to be used to regulate sales by the local resellers of the internet data vouchers, aimed to minimise corruption. These proposals are deemed to be sufficient to address the barriers to internet access and penetration in rural areas, and in turn bridge the digital divide in the area. For future work, it is recommended that the implementation and operation of this model is closely monitored in order to determine if it fulfils the intended objectives of an accessible, affordable and sustainable rural broadband model.

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