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Applying Theory of Planned Behavior to Examine Users' Intention to Adopt Broadband Internet in Lower-Middle Income Countries' Rural Areas: A Case of Tanzania

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ABSTRACT

Broadband Internet has proven to be vital for economic growth in developed countries. Developing countries have implemented several initiatives to increase their broadband access. However, its full potential can only be realized through adoption and use. With lower-middle-income countries accounting for the majority of the world's unconnected population, this study employs the theory of planned behavior (TPB) to investigate users' intentions to adopt broadband. Rural Tanzania was chosen as a case study. A cross-sectional study was conducted over three weeks, using 155 people from seven villages with the lowest broadband adoption rates. Non-probability voluntary response sampling was used to recruit the participants. Using the TPB constructs: attitude toward behavior (ATB), subjective norms (SN), and perceived behavioral control (PBC), ordinal regression analysis was employed to predict intention. Descriptive statistical analysis yielded mean scores (standard deviation) as 3.59 (0.46) for ATB, 3.34 (0.40) for SN, 3.75 (0.29) for PBC, and 4.12 (0.66) for intention. The model adequately described the data based on a comparison of the model with predictors and the null model, which revealed a substantial improvement in fit (p<0.05). Moreover, the predictors accounted for 50.3% of the variation in the intention to use broadband Internet, demonstrating the predictive power of the TPB constructs. Furthermore, the TPB constructs were all significant positive predictors of intention: ATB (β=1.938, p<0.05), SN (β=2.144, p<0.05), and PBC (β=1.437, p=0.013). The findings of this study provide insight into how behavioral factors influence the likelihood of individuals adopting broadband Internet and could guide interventions through policies meant to promote broadband adoption.

Keywords: theory of planned behavior, broadband Internet adoption, rural areas, lower-middle income countries, user behavior study, Tanzania

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1. INTRODUCTION

The fact that broadband Internet has proven to aid social and economic development at the individual and country levels has led the United Nations to categorize it as a basic human right (Katz & Callorda, 2019; Melhem, 2016). Regrettably, not all of the global population enjoys that right, as there is a usage gap in several parts of the world (Inegbedion, 2021). As recent global reports on Internet connectivity show a narrowing coverage gap (95% of the global population covered), the world now has a usage gap to deal with (International Telecommunication Union [ITU], 2022). According to reports, 3.2 billion people have access to broadband Internet but do not use it. Most of these people live in rural areas in lower-middle-income countries (LMICs), which make up 93% of the world's unconnected population (GSMA, 2021b).

Considering the potential broadband contributions to countries' economies, many nations have been taking initiatives to close the connectivity gap, majoring in building up national infrastructure and on macro-level aspects, such as governmental industry-related policies. However, as global reports show that the broadband connectivity gap is narrowing, the usage/adoption gap continues to widen (GSMA, 2022; International Telecommunication Union [ITU], 2022). As technology adoption always appears to be a continuous, long, and slow process compared to its introduction, which comes as a discrete event, understanding the adoption process and all factors that accelerate the process are of utmost importance (Hall & Khan, 2003). Hence, interventions to accelerate technology adoption require coining micro-level individual factors and macro-level efforts from both the demand and supply side of the broadband ecosystem, as these two are inseparable (Sopha et al., 2017).

To achieve large-scale technology adoption, two attributes must be considered: Each person is an autonomous decision maker on whether to adopt or not, and influences from the surroundings, such as people, governments, and service providers (Pakravan & MacCarty, 2021; Venkatesh et al., 2012). In addition to technological attributes, several technology adoption theories have underlined the critical roles of user attitudes, perspectives, assessments, social factors, and impediments in the adoption of any technology (Sharma et al., 2014). Thus, the theory of planned behavior (TPB), one of the most popular theories in behavioral sciences, is used in this study to assess consumers' intentions to adopt broadband Internet in rural LMICs (Bosnjak et al., 2020; Lai, 2017). Where there are many applications of TPB in studying technologies adoption, with some listed here: Gantz (2020), Kamble et al. (2019), Pakravan and MacCarty (2020), Pakravan and MacCarty (2018), and Zhou (2016), little is known about its application around broadband Internet arena, specifically in the rural areas of LMICs. With an emphasis on rural inhabitants in LMICs and their intention to adopt broadband Internet, this study contributes to the expanding body of research on this topic. The LMICs in this study are exemplified by Tanzania. It will also assist policymakers in making decision-based intervention mechanisms to address the broadband adoption gap. The remaining sections of the paper are organized as follows: theoretical background, related studies, methodology, results, discussion of the results, conclusion, and limitations and future studies.

2. THEORETICAL BACKGROUND AND HYPOTHESES DEFINITION

2.1. Broadband Internet Overview

Broadband networks are defined by the ITU as those that are able to deliver the Internet at a speed faster than the Integrated Services Digital Network principal rate of 1.5 Mbps or 2.0 Mbps (International Telecommunication Union [ITU], 2003). Broadband networks provide broadband Internet. Digital subscriber lines, cable modems, fiber optics, broadband overpower lines, satellites, and wireless radio, all of which are divided into fixed and wireless categories, are just a few of the several underlying technologies that can be used to access these networks. Fixed broadband technologies have proven costly and challenging to build in developing countries, especially in rural areas; hence, wireless mobile technologies play a central role in broadband service provision (Prieger, 2015).

Broadband technology is regarded as a general-purpose technology that serves a broad range of uses (Naughton, 2016). It has been able to revolutionize people's lives in many aspects, such as education, industries and manufacturing, health, governance, and the environment; good examples are seen in developed countries (Koutroumpis, 2019). According to studies, mobile broadband penetration boosts countries' gross domestic product (GDP); for every 10% penetration increase, middle-income countries' GDP increases by 1.8%, while low-income countries' GDP increases by 2% (Bahrini & Qaffas, 2019; Ghosh, 2017; Katz & Callorda, 2019). However, until broadband is adopted and used at its full potential, the technology is of little use.

2.2. Broadband in Tanzania

Tanzania has maintained its status among the LMICs, with a gross national income of $1,136 and GDP growth of 4.2% in 2021 (World Bank, 2022). There are 61.7 million people living in the nation, and 64.05% of them live in rural areas (Tanzania National Bureau of Statistics [NBS], 2022). In Tanzania, 98% of the population subscribes to telecommunications services, with mobile networks accounting for 99.86%. Tanzania has a 50.6% Internet penetration rate, with the majority of users accessing it through mobile devices (Tanzania Communications Regulatory Authority, 2022).

Research claims that 86% of rural residents lack Internet access, compared to 44.6% of urban residents, making them the most deprived group (Mothobi et al., 2017). Moreover, 48% of the Tanzanian population lives under a broadband footprint, but they do not use it (GSMA, 2021a). Initiatives to push Internet uptake, especially in rural areas, were put in place, such as the Universal Communication Services Access Fund and National Information and Communication Technologies Broadband Backbone, but Internet penetration is not growing at a faster pace compared to the early Internet days of 15% between 2011-2015, as opposed to 6% between 2016-2020 (Tanzania Communications Regulatory Authority, 2021). With such statistics, Tanzania is a better candidate to exemplify other LMICs in this study.

2.3. Adoption Theories

As there is still a broadband usage gap globally, establishing successful strategies for promoting end-user acceptance and the subsequent use of broadband remains a fundamental challenge (GSMA, 2021b; International Telecommunication Union [ITU], 2021; International Telecommunication Union [ITU] and United Nations Educational, Scientific and Cultural Organization, 2021). Many theoretical models have been established to comprehend user adoption of technologies. In their theory of reasoned action (TRA), Fishbein and Ajzen (1975) highlighted that the main determinants of technology adoption intentions are attitudes toward behavior (ATB) and the impact of subjective norms (SN). Despite its application in several settings, TRA failed to consider volition control as one of the factors driving adoption behavior. To address the issue of volitional control, Ajzen (1985) established TPB, which adds perceived behavioral control (PBC) to existing constructs as a driver of the intention to engage in a behavior. Moreover, as an extension of TRA, Davis (1989) introduced the technology acceptance model (TAM), which predicts a person's adoption and utilization of technology based on perceived usefulness and perceived ease of use. Although TAM is among the most popular adoption models, the attitude construct was left out in the final conceptualization, casting doubts on it, as Ajzen et al. (2018) argued that attitude is an important key predictor of behavior. Furthermore, the diffusion of innovation (DOI) theory developed by Rogers (1995) holds that the adoption of technology is influenced by social systems, innovation, time, and communication channels. However, Jokonya (2017) argues that DOI is deterministic in nature and concentrates more on the technical side of technology, ignoring the social context. Technology adoption is said to go beyond technical aspects as it must incorporate social, economic, and political factors (Sopha et al., 2017).

Given its scientific legitimacy, TPB is a notable behavioral action model compared to others when it comes to developing strategies and designing intervention mechanisms (Ajzen & Schmidt, 2020). TPB considers all the elements that could directly or indirectly influence behavior through behavioral intention, which has been proven to be the strongest predictor of one's involvement in a certain activity (Canova & Manganelli, 2020). Three variables: ATB, SN, and PBC are used in the TPB to determine intention. ATB refers to one's opinion of a behavior, whether favorable or unfavorable, whereas SN refers to the perceived influence of friends, family, or other individuals on decision making. The concept of PBC refers to how one perceives their level of control over their own conduct.

Several studies have employed TPB to investigate the intention towards using or adopting certain technologies. Recent studies are listed herein: blockchain cryptocurrency adoption in an e-government context (Schaupp & Festa, 2018), mobile learning adoption by medical students (Azizi & Khatony, 2019), blockchain adoption as a supply chain technology (Kamble et al., 2019), adoption of embedded telemedicine support services (Gantz, 2020), adoption of low-carbon agriculture technologies in China (Yang et al., 2022), ICT adoption among intensive shrimp farmers (Ulhaq et al., 2022), adoption of green technology in Pakistan (Zeng et al., 2022), and technology adoption among small retailers (Aithal et al., 2023). The aforementioned studies justify the role that TPB can play in examining the factors influencing technology adoption. However, to the best of our knowledge, there is limited research on intention-based studies using TPB in rural broadband Internet adoption.

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2.4. Hypothesis Definition

Since this study's goal is to examine rural dwellers' intention to adopt broadband Internet using TPB, its hypotheses revolve around the aforementioned theory with the addition of demographic features. The central tenet of the theory of TPB is that intentionally planned behaviors are predicted by the intention toward such behaviors expounded by ATB, SN, and PBC. This subsection formulates the hypotheses for intention exploration adopted in this study, as summarized in Fig. 1.

According to TPB, attitude acts as an evaluative inclination toward behavior because of its relationship with intention (Ajzen et al., 2018). The idea of attitude, which expresses positive or negative thoughts about a certain behavior, is seen as a key factor determining the intention in many earlier studies on technology adoption, including Azizi and Khatony (2019), Mazambani and Mutambara (2020), Yang et al. (2017), and Shalender and Sharma (2021), to mention but a few. Therefore, the definition of hypothesis H1 is

H1: The behavioral intention of LMIC rural residents to adopt broadband Internet and their attitude toward doing so are significantly and positively correlated.

The SN stems from the belief that people's intentions to engage in specific behaviors are influenced by the opinions of significant others. Studies by Lin et al. (2020), Rana et al. (2019), Chu and Chen (2016), Masud et al. (2016), and Jing et al. (2019), to name just a few, have shown that SN significantly affects one's intention to use technology. Therefore, the definition of hypothesis H2 is

H2: The behavioral intention of LMIC rural residents to adopt broadband Internet and their SN toward doing so are significantly and positively correlated.

Despite having a good attitude toward technology, some people may not think they are capable of using it; it is until they believe they have control over how technology is used that their intention to use it rises (La Barbera & Ajzen, 2021). Several researchers, e.g., Lin et al. (2020), Anser et al. (2020), and Mohr and Kühl (2021) have found strong empirical evidence for this association. Therefore, the definition of hypothesis H3 is

H3: The behavioral intention of LMIC rural residents to adopt broadband Internet and their perceived behavioral control toward doing so are significantly and positively correlated.

Not only do the TPB's constructs influence intention to adopt technologies, but demographic features have also been proven to do so. Numerous studies have demonstrated the impact of age, income, and education on technology use, to name a few: Yu et al. (2017), Puspitasari and Ishii (2016), Lee and Coughlin (2015), and Sharma (2015). Therefore, the definition of hypothesis H4 is

H4: The behavioral intention of LMIC rural residents to adopt broadband Internet and their age, education, and income toward doing so are significantly and positively correlated.

3. METHODOLOGY

3.1. Study Design

This study employed a cross-sectional survey approach, following Creswell and Creswell (2017) recommendations, to examine users' intentions to use broadband Internet in LMICs using Tanzania as an example. Due to its quick turnaround, data standardization, and

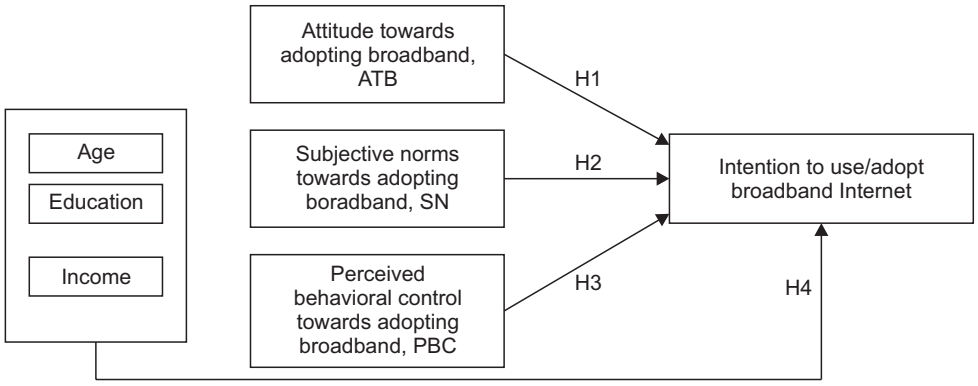

Fig. 1. Hypotheses summary.

affordability, survey research was the method of choice for gathering data (Babbie, 2021).

3.2. Target Population & Participant Recruitment

This study targeted people living in rural areas of LMICs, as exemplified by Tanzania. The study was interested in places that have a broadband footprint but poor Internet usage. The authors had to fetch information from service providers concerning rural areas with broadband services, but characterized by poor usage/adoption. People invited to participate in the survey were recruited from rural areas with such features as the villages listed herein: Olkung'wado (Arusha), Mgwashi (Tanga), Teule (Tanga), Jitengeni (Tanga), Chemba (Dodoma), Chinangali II (Dodoma), and Mlali (Dodoma). With the assistance of village executives, a non-probability voluntary response sampling was adopted to recruit participants. The survey was planned to be administered to 175 participants (25 people from each village). Jenkins and Quintana-Ascencio (2020)'s recommendations for a minimal number of participants in studies involving regression served as the basis for sample size determination. Out of the expected 175 participants, only 155 consented to participate in the survey (almost an 88.57% response rate), which was sufficient to capture the intended data.

3.3. Survey Development & Administration

Since the study employs TPB to examine the intention to adopt broadband Internet, the survey development and administration followed the guidelines of Ajzen (2006). Nonetheless, a well-established questionnaire must go through properly defined steps: the elicitation stage, pilot research, and a final questionnaire (Taherdoost, 2016). The survey started with the elicitation process, involving 30 participants from two villages among the villages of interest (Olkung'wado and Chinangali II). Exploiting focus group discussions, beliefs, and opinions regarding the topic under study were elicited using open-ended questions. Thereafter, the authors applied content analysis to summarize the themes that later paved the way for the initial questionnaire, with 45 items divided into three sections: demographic features, broadband usage, and TPB's constructs. A 5-point Likert scale, with 1 representing "strongly disagree" or the equivalent and 5 representing "strongly agree" or the equivalent, was used to score the potential answers to the TPB constructs.

To identify questionnaire issues and flaws in the question-answering process as well as other potential measurement errors, we invited three experts (survey methodologists) to analyze the questionnaires. The questionnaire was refined during this process, which decreased the number of items to 40, leading to the creation of a pilot questionnaire. A pilot survey was conducted with 30 individuals (number recommended by Viechtbauer et al. [2015]) to confirm the testing instrument. To capture different perspectives, the aforementioned individuals were sourced from Chemba and Mlali, which are different villages from those used in the elicitation stage. The pilot test led to modification of the questionnaire to contain 35 items. The survey tool is attached as Appendix A.

With survey administration, which took three weeks, a research administered technique was opted as rural dwellers in most of the developing countries (Tanzania in this study) are characterized by poor literacy and digital skills (World Bank, 2016). With this technique, a researcher can clarify questions, ensure the completion of a questionnaire, and obtain a higher response rate, as well as greater control of the environment. Both the pilot test and the survey itself were conducted using a free open-source tool for data collection called KoboToolbox.

3.4. Measures

3.4.1. Demographic and Broadband Usage Features

Demographic and broadband usage features (12 items in total) were among the measures incorporated in this study. This helped the researcher grasp knowledge about the participant in question and hence employed a better approach to drain the data for the questionnaire. Age, sex, income, and level of education were examined as demographic features. Moreover, mobile phone ownership, smartphone ownership, Internet usage, and general Internet knowledge were investigated as broadband usage features. The most important features in this category are depicted in Table 1. This section contains background data to evaluate the accuracy of the TPB responses. Governmental and non-governmental institutions may benefit from the responses provided by these measures.

3.4.2. Attitude Toward Behavior

A measure of attitude toward the behavior itself is necessary to predict a specific action in relation to a particular conduct (Ajzen et al., 2018). This survey deployed six indirect items inquiring about attitudes toward broadband and their outcome evaluations. The items revolved around the relation between broadband Internet and income, social services (health, education, etc.), civic engagement in governmental affairs (e.g., Generally speaking, using broadband Internet in a rural area is very harmful/harm-

Table 1. Spearman rank-order correlations

	Intention	ATB	SN	PBC	Education	Age	Income
Intention							
ATB	0.53[a)]						
SN	0.56[a)]	0.51[a)]					
PBC	0.35[a)]	0.37[a)]	0.27[a)]				
Education	0.58[a)]	0.56[a)]	0.57[a)]	0.45[a)]			
Age	-0.22[a)]	-0.06	-0.19[b)]	-0.19[b)]	-0.37[a)]		
Income	0.34[a)]	0.48[a)]	0.31[a)]	0.23[a)]	0.35[a)]	0.40[a)]	

ATB, attitudes toward behavior; SN, subjective norms; PBC, perceived behavioral control.
[a)]Correlation is significant at the 0.01 level (2-tailed). [b)]Correlation is significant at the 0.05 level (2-tailed).

ful/neutral/beneficial/very beneficial). In addition, the overall attitude toward broadband adoption was directly tested using four items.

3.4.3. Subjective Norms

La Barbera and Ajzen (2020) showed the significance of perceived social pressure in predicting the intention to participate in a certain behavior, which is why SN was incorporated as a measure in this research. The elicitation stage provided information about social influences that can affect the intention to adopt broadband; hence, this construct captured them in the survey questionnaire. Using six items, this measure tested both directly and indirectly the influences of family, friends, and government (leaders) with respect to motivations to comply (e.g., "Friends and family approve of my use of broadband Internet"; strongly disagree/disagree/neutral/agree/strongly agree).

3.4.4. Perceived Behavioral Control

This measure captures the control that a person has over a behavior as well as factors influencing the performance of the behavior. La Barbera and Ajzen (2021) showed the importance of PBC as a sole determinant factor of behavior; hence, its inclusivity as among the measures in this study. The measure used six items, both direct and indirect, to capture the perception of ability towards adopting broadband and their control factors (e.g., "Because of affordability [data tariffs & devices] using Internet for me will be very difficult/difficult/neutral/easy/very easy").

3.5. Data Analysis

IBM SPSS Statistics version 26.0 (IBM Co., Armonk, NY, USA) was used for statistical analysis of the study data. Using the Kolmogorov-Smirnov test, the data used to assess the TPB's construct were examined for normality to determine if any items had *p*-values greater than 0.05, which would not have rejected the null hypothesis of normality. Cronbach's alpha was used to assess the internal consistency of the survey. According to Abu-Bader (2021), a measurement is considered reliable if its Cronbach's alpha coefficient is greater than 0.7.

Since the dependent variable (intention) was measured in an ordinal fashion, ordinal logistic regression was selected as a suitable analysis technique (Williams, 2016). As the study was correlational, the outcome was defined as the variable of interest, and the hypotheses were tested based on the defined variables (age, income, level of education, ATB, SN, and PBC) (Lau & Kuziemsky, 2016). With regard to TPB, Equation (1) represents the relationship between the anticipated outcome and the hypothesized variable; henceforth, coefficients are presented as odds ratios. If the parallel regression assumption is affirmed, the estimated coefficients (β_n) are translated as odds ratios, with β_0 and ε being the regression constant and error term, respectively.

$$\text{Intention}=\beta_0+\beta_1\,(\text{ATB})+\beta_2\,(\text{SN})+\beta_3\,(\text{PBC})+\varepsilon \quad (1)$$

4. RESULTS

4.1. Socio-Demographic Characteristics

The survey participants were 59 females (38.1%) and 96 males (61.9%). The majority age group involved in the survey was 26-45 years of age (51.6%). Moreover, only five participants attended college/university, and the majority of them ended up in primary school (64.5%). With regard to monthly income, the majority of participants (49.7%) earn between 50,000-100,000 Tanzania Shillings (Tsh.).

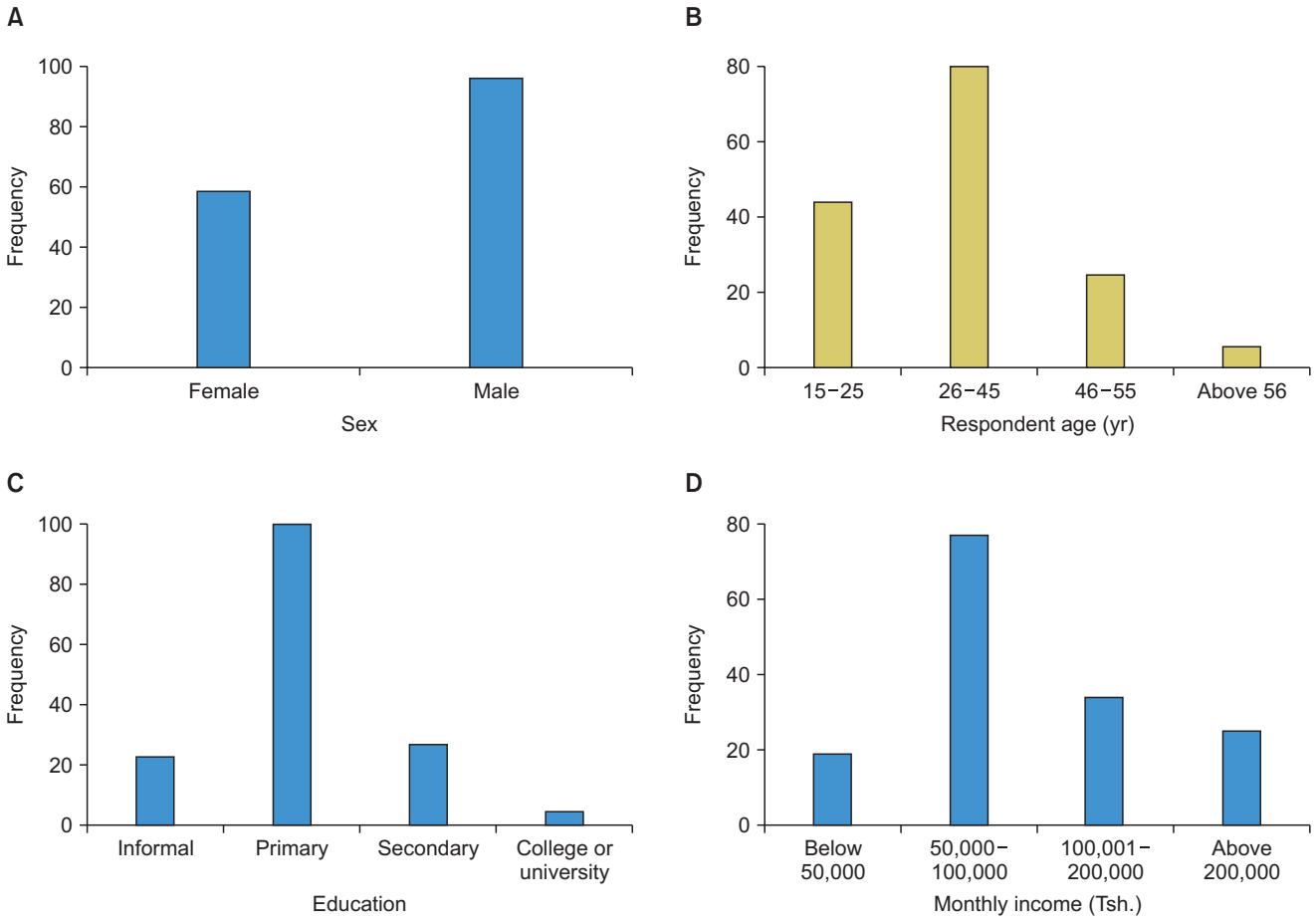

Fig. 2. Demographic features. (A) Sex distribution. (B) Age distribution. (C) Education level. (D) Income distribution (Tsh.). Tsh., Tanzania Shillings.

A

Reliability statistics

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.913	.908	22

B

Reliability statistics

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.888	.887	10

C

Reliability statistics

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.714	.681	6

D

Reliability statistics

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.712	.724	6

Fig. 3. Reliabilty analysis summary. (A) Entire survey. (B) ATB measure. (C) SN measure. (D) PBC Measure. ATB, attitudes toward behavior; SN, subjective norms; PBC, perceived behavioral control.

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The aforementioned statistics are summarized in Fig. 2. Most of the participants owned a mobile phone (91.6%), but only 18.1% of them had phones that could access the Internet, which happened to be the same percentage of Internet users among the participants.

4.2. Reliability Test

A reliability test was conducted for the entire survey (excluding demographic features) and the individual TPB constructs. Cronbach's alpha values are listed in brackets for the entire survey (0.913), ATB (0.888), SN (0.714), and PBC (0.712). The aforementioned statistics are summarized in Fig. 3. When demographic features were considered, the Cronbach's alpha value for the entire survey was 0.920. The fact that every survey measure exhibited internal consistency with Cronbach's alpha values above the suggested 0.7 indicates that the measures are reliable.

4.3. Validity Test

Owing to the ordinal nature of the survey data, the monotonic relationship between pertinent variables (intention, ATB, SN, PBC, education, age, and income) was evaluated using Spearman's correlation (Schober et al., 2018). There were positive and significant correlations between intention and ATB measure, rs=0.53, n=155, p< 0.01, intention and SN measure, rs=0.56, n=155, p<0.01, intention and PBC measure, rs=0.35, n=155, p<0.01, intention and education, rs=0.58, n=155, p<0.01, and intention and income, rs=0.34, n=155, p<0.01. Meanwhile, age and intention were negatively and significantly correlated (rs=-0.22, n=155, p=0.006). The test results are listed in Table 1.

4.4. Descriptive Statistics

Table 2 presents TPB constructs. The average ATB of the participants was 3.59, with a 0.46 standard deviation. SN had the lowest mean score (3.34) and lowest standard deviation (0.40), according to the results. The PBC mean score and standard deviation were found to be 3.75 and 0.34, respectively. With a standard deviation of 0.66, intention obtained a mean score of 4.12.

Table 2. Descriptive statistics for theory of planned behavior measures

	n	Minimum	Maximum	Mean	Standard deviation
Intention	155	1.00	5.00	4.12	0.66
ATB	155	2.70	4.90	3.59	0.46
SN	155	2.67	4.33	3.34	0.40
PBC	155	2.33	4.67	3.75	0.34

ATB, attitudes toward behavior; SN, subjective norms; PBC, perceived behavioral control.

Table 3. Model fitting information

Model	-2 Log likelihood	Chi-square	df	Sig.
Intercept only	174.504			
Final	89.438	85.066	3	0.000

Link function: Logit.
df, degree of freedom; Sig., value (p value); when the value is reported as 0.000 it means the actual p value is too small for the software to display and we simply report it as p<0.05.

Table 4. Goodness-of-fit tests

	Chi-square	df	Sig.
Pearson	125.248	121	0.377
Deviance	57.131	121	1.000

Link function: Logit.
df, degree of freedom; Sig., value (p value); when the value is reported as 0.000 it means the actual p value is too small for the software to display and we simply report it as p<0.05.

4.5. Ordinal Logistic Regression Predicting Intention to Adopt Broadband

Before examining the individual TPB predictors in the model, we needed to ascertain whether the model improved the ability for outcome prediction. According to the model-fitting data in Tables 3, 4, the final model fit was considerably better than that of the null model (p<0.05), demonstrating that the model accurately predicts consumers' intentions to adopt broadband Internet centered on the marginal likelihoods of the resultant categories. The Pearson and Deviance chi-square tests provide a useful measurement of a model's goodness-of-fit; both p-values were >0.05, indicating a good match between the model and the data (Tables 3, 4).

When dealing with ordinal logistic regression the pseudo-R^2 is treated as the rough analog of R^2 using three estimations: Nagelkerke (1991), McFadden (1972), and Cox and Snell (1989). Among them, the model with the largest pseudo-R^2 value is assumed to be the best; hence, upon analysis, the pseudo-R^2 values (Nagelkerke, 1991) indicate that TBP constructs describe the variance in the intention to adopt broadband Internet by 50.3% (Table 5).

This present article's key emphasis is on TPB measures, which were established by the parameter estimates shown in Table 6. The link between the predictor variables (ATB, SN, and PBC) and outcomes (intention) can be explained as follows:

i. ATB was a significant positive predictor of intention to adopt the Internet (p<0.05). The log odds of a rural resident falling into a higher category of intent to adopt broadband were projected to increase by 1.938 for every unit increase in ATB.

ii. SN was a highly significant positive predictor of intention (p<0.05); the expected increase in the log probability of a rural resident of an LMIC falling into a higher category of intention was 2.144 for every unit increase in the corresponding construct score.

iii. The least significant positive predictor among the TPB measures was PBC (p=0.013). The expected increase in the log chances of a rural resident of an LMIC falling into a higher category of intention is 1.437 for every unit increase in the PBC score.

Moreover, the selected demographic features (age, education, and income) were also checked to determine their influence in predicting the intention to adopt broadband Internet in rural settings. Both variables were significant predictors (p<0.05); however, age showed a negative correlation (β=-0.725) while education and income showed positive correlations (Table 7).

Table 5. Pseudo R-square analysis

Cox and Snell (1989)	0.422
Nagelkerke (1991)	0.503
McFadden (1972)	0.299

Link function: Logit.

Table 6. Theory of planned behavior's parameter estimates

	Estimate	Standard error	Wald	df	Sig.	95% confidence interval	
						Lower bound	Upper bound
Threshold (intention)							
1	12.908	2.750	22.039	1	0.000	7.519	18.297
2	14.343	2.683	28.583	1	0.000	9.085	19.602
3	16.107	2.735	34.671	1	0.000	10.745	21.468
4	21.414	3.091	48.010	1	0.000	15.357	27.472
Location							
ATB	1.938	0.529	13.444	1	0.000	0.902	2.974
SN	2.144	0.524	16.777	1	0.000	1.118	3.170
PBC	1.437	0.576	6.226	1	0.013	0.308	2.565

df, degree of freedom; Sig., value (p value); when the value is reported as 0.000 it means the actual p value is too small for the software to display and we simply report it as p<0.05; ATB, attitudes toward behavior; SN, subjective norms; PBC, perceived behavioral control.

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Table 7. Demographic features parameter estimates

	Estimate	Standard error	Wald	df	Sig.	95% confidence interval	
						Lower bound	Upper bound
Threshold (intention)							
1	-2.263	1.439	2.475	1	0.116	-5.083	0.556
2	-0.727	1.115	0.425	1	0.515	-2.912	1.459
3	1.026	1.023	1.006	1	0.316	-0.979	3.031
4	5.834	1.110	27.628	1	0.000	3.659	8.010
Location							
Education	1.782	0.404	19.470	1	0.000	0.991	2.574
Age	-0.725	0.342	4.484	1	0.034	-1.395	-0.054
Monthly income	0.781	0.283	7.610	1	0.006	0.226	1.336

df, degree of freedom; Sig., value (*p* value); when the value is reported as 0.000 it means the actual *p* value is too small for the software to display and we simply report it as $p<0.05$.

5. DISCUSSION OF THE RESULTS

This study used the TPB model to examine the factors related to rural residents' intention to adopt broadband in LMICs (Tanzania serves as an example). Both macro and micro-related factors aligned to broadband adoption were scrutinized to produce results that can further be used in designing intervention mechanisms through sector-related policy reforms. The model was statistically significant and hence results demonstrate the robustness of TPB in technology adoption-related studies.

The findings of this study offer compelling evidence in favor of earlier-defined hypotheses. With ATB, which was captured by H1, the construct was significant and had a positive influence; hence, H1 was supported. The construct revolved around the overall evaluation of the benefits of adopting broadband Internet. Studies and reports have proven several benefits of broadband Internet at the individual level and in a country. Exposing the population to such successful stories about broadband Internet will boost their attitude in a positive way, fueling positive intentions leading to usage/adoption of broadband.

SN is determined by one's normative belief in whether important individuals/institutions approve or disapprove of him/her carrying out a particular action/behavior and his/her drive to comply with their wishes. The elicitation conducted in the earlier stages of the research showed that government, family, and friends were the most important referents in such cases. The results corroborated the description of this construct in H2, which showed that SN significantly and favorably influenced respondents' intention to use broadband Internet. The fact that it was the most significant construct compared to ATB and PBC shows how rural dwellers value approval of government, family, and friends the most for adopting broadband Internet. The mechanisms designed to address the usage/adoption gap in rural areas must carefully examine what encompasses this particular construct, and use them accordingly to address the problem.

H3 was captured by the TPB construct referred to as PBC. This construct focused on the perceived ease or difficulty of the behavior being studied. This construct was used to study barriers and facilitating conditions based on their respective impacts on intention to use broadband. The literature and the elicitation study based on earlier focus group discussions both pointed out affordability, digital skills, and content relevance toward adoption, and hence were included in the survey. By demonstrating that PBC is a strong predictor and positively influences the intention to use broadband Internet, these results validate H3. Henceforth, the results have emphasized the role PBC plays in enhancing intention towards use and adoption of technology and broadband Internet in this study, and hence a wakeup call for responsible authorities to address the barriers.

H4 regarding demographic features was partially supported, as one of its determining features (age) is negatively correlated with intention, regardless of its significance. It has been shown that as age increased, the likelihood of a person intending to adopt broadband Internet also diminished. Among the reasons for older people, especially rural dwellers who do not adopt broadband Internet, are

digital illiteracy and irrelevant content (Galperin, 2017; World Bank, 2016). The other demographic features depicting hypothesis H4, apart from age, were education and income, both showing a positive correlation with adoption; that is, the likelihood that someone will use and adopt the Internet increases with education and income. The level of education goes parallel with digital skills, easing the use of technology, and the same applies to income; higher income translates to a person being able to afford broadband Internet.

6. CONCLUSION

The fact that broadband Internet has proven to have potential in the current world to maximize personal utility and improve countries' economies at large has pushed several scholars to find ways to address those who are yet to benefit from what technology is offering. Several initiatives have been laid out to address macro-level factors, leaving out micro-factors related to the usage and adoption of broadband Internet. Usage is a behavior that starts with the intention of one to conduct such behavior, as suggested by noted scholars in behavioral theory such as Ajzen and Schmidt (2020). This study employed TPB to examine users' intention to adopt broadband Internet in the most unconnected part of the world, rural areas of LMICs exemplified by Tanzania.

Three TPB constructs, ATB, SN, and PBC, together with demographic features (age, education level, and income level), were used to understand the dynamics of broadband adoption from the intention perspective. With regard to demographic features, all three measures were significant, although age showed a negative correlation compared to the other measures. Moreover, all TPB constructs showed a positive correlation with intention to adopt broadband Internet. With SN as the most significant construct, emphasis needs to be placed on addressing normative beliefs, as the survey showed that the majority were obliged to comply. This does not mean that the two constructs (ATB and PBC) should be taken for granted; they also require special attention, as they contribute to the 50.3% variance in the intention to adopt broadband. The results showed that people will adopt broadband if their belief about the outcomes, together with their evaluation of the technology, is cemented (ATB). In addition, the results showed that the effects of barriers alongside perceived power (PBC), if addressed, can influence intention.

From a policy standpoint, the results of this study offer policymakers a chance to revisit their policies, thereby reflecting dominant behavioral attributes, widespread opinions, and both supply- and demand-side barriers, as they seem to influence the intention to adopt broadband Internet. The TPB's construct on its generality incorporated all the barriers and facilitating conditions (as elicited from rural dwellers) towards intention to adopt, and hence provides a good starting point if most Internet-left-out countries need to embrace the goods of the technology. To mention but a few suggestions, enhancing attitude can be achieved through awareness campaigns on the benefits broadband brings along, as people seemed to value the power of information in the conducted survey. Moreover, the affordability (belonging to PBC in this study) of both Internet packages and devices can be addressed by adjusting the tax regulatory framework; broadband should be treated as an enabling sector and not an income-earning sector. With regard to digital skills, the focus should be on developing an environment that will facilitate the execution of our curricula, which already includes ICT-related subjects. Authorities in charge should create particular initiatives to foster digital literacy for individuals not enrolled in schools; instructional training has proven to be a success in the Digital India campaign; hence, it can be useful in Tanzania if customized to our environment. The issues of relevant content can be addressed by creating a conducive environment to enforce their development as well as usage.

This work broadens our knowledge of adoption theories from a scholarly standpoint, especially regarding the application of TPB. The previous studies on application of TPB were concentrating on other technologies, but this study took the matter at hand to scrutinize both micro and macro-related factors revolving around broadband technology from a usage/adoption perspective.

7. LIMITATIONS AND FUTURE STUDIES

While the current study provides a comprehensive analysis of users' intentions to adopt broadband Internet in rural LMICs, a few important limitations should be noted for future research. Even though TPB has been helpful in addressing the research goal of this study, it focused solely on conscious decision-making processes, which, to some extent, may not have captured the complexity of human behavior. The unconscious elements that might influence decision-making processes should be considered in future studies on this subject.

In addition, among many LMICs, Tanzania is the only

country in which the study's geographic focus is restricted to a few selected rural areas. Future researchers may magnify the scope by adding more villages around other countries in LMICs, thus reflecting the almost true representation of the LMICs' context, as the relative significance of various aspects of intention may vary from population to population.

Moreover, the empirical restrictions of ordinal logistic regression, as in other research that makes use of this methodology, place limitations on the study's methodology. Future research may employ structural equation modeling, which is thought to have the potential to be powerful in establishing measurements that reveal more statistically significant correlations.

Having established the variables that influence the adoption of broadband Internet in rural areas of LMICs, computational modeling approaches can be used in future research to visualize, predict, optimize, regulate, and control the entire broadband ecosystem from an adoption perspective. Going forward, we can model various scenarios involving stakeholders in the broadband ecosystem, and explore policies to encourage adoption before implementing them in real-world situations.

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CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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APPENDIX A

Inquiring Theory of Planned Behavior Constructs Towards Modeling Agents for Improving Internet Uptake in Rural Areas

Dear respondent,

This survey is part of the research work: developing a network adoption model to accelerate Internet uptake in the rural areas of LMICs, with Tanzania regarded as a case study. It is collecting behavioral beliefs towards the use and adoption of Internet services from the rural residents who happen to live under Internet footprints. Moreover, the research will also collect demographic features from each respondent. Your responses will be treated anonymously and the participation is voluntary.

Your consent to the researcher's use of your anonymous responses for use at academic conferences and research publications is indicated by the completion of the survey.

I appreciate you taking part.

Sadiki R. Kalula
Researcher: NM-AIST Arusha

Part I: Demographic Data (Tick the Correct box)

1. Sex
☐ Male ☐ Female
2. Age group
☐ 15-25 years ☐ 26-45 years ☐ 46-55 years ☐ 56 years and above
3. Education level
☐ Informal ☐ Primary ☐ Secondary ☐ College/university
4. Income range monthly (in Tanzania Shillings)
☐ Below 50,000 ☐ 50,000-100,000 ☐ 100,001-200,000 ☐ Above 200,000
5. Do you own a mobile phone (if Yes, proceed to question 6 & 7)
☐ Yes ☐ No
6. Can your phone access Internet services
☐ Yes ☐ No
7. Is your phone broadband-abled device (3G & beyond technology)
☐ Yes ☐ No ☐ I don't know

Part II: Broadband Internet Usage (Tick the correct box)

1. Have you ever heard of the Internet
☐ Yes ☐ No
2. Have you ever used the Internet (If the answer is No, proceed to question 12)
☐ Yes ☐ No
3. How often do you recharge for Internet bundle
☐ Daily ☐ Weekly ☐ Monthly ☐ Once bundle depletes
4. Based on answer in question 5, how much (in Tanzania Shillings) do you spend on buying Internet bundle
☐ Less than 1,000 ☐ 1,000-2,000 ☐ 2,500-5,000 ☐ Above 5,000
5. Why are you not using the Internet
☐ I don't how to use it ☐ I don't have a device ☐ It is costly ☐ Contents not useful ☐ All

Part III: TPB Measures

1	If I use Internet, my income will increase	Unlikely	1	2	3	4	5	Very likely
2	If Internet is used in in the rural areas, it will improve social services (health, education, etc.)	Very unlikely	1	2	3	4	5	Very likely
3	If Internet is used, it will improve civic engagement in government affairs	Very unlikely	1	2	3	4	5	Very likely
4	For rural resident, increasing income in rural settings is	Extremely undesirable	1	2	3	4	5	Extremely desirable
5	In rural settings, improving social services (health education, etc.) is	Extremely undesirable	1	2	3	4	5	Extremely desirable
6	For rural residents, civic engagement in government affairs is	Extremely undesirable	1	2	3	4	5	Extremely desirable
7	Government leaders advocate I should use Internet as it is now a general purpose technology to maximize my personal utility	Definitely not true	1	2	3	4	5	Definitely true
8	My friends and family approve the use of Internet towards improving my living standard	Definitely not true	1	2	3	4	5	Definitely true
9	Doing what government leaders are advocating in using Internet is important to me	Totally disagree	1	2	3	4	5	Totally agree
10	My friends and family's approval of my use of Internet is very important to me	Totally disagree	1	2	3	4	5	Totally agree
11	Because of affordability (tariffs and devices), using Internet for me will be	Very difficult	1	2	3	4	5	Very easy
12	Because of digital know-how and localized contents, using Internet for me will be	Very difficult	1	2	3	4	5	Very easy
13	I am _____ to use Internet if the services are affordable (tariffs and devices)	Very unlikely	1	2	3	4	5	Very likely
14	I am _____ to use Internet if my digital skills are enriched and contents localize my need	Very unlikely	1	2	3	4	5	Very likely
15	Generally using broadband Internet in rural areas is	Bad practice	1	2	3	4	5	Good practice
		The wrong thing to do	1	2	3	4	5	The right thing to do
		Harmful	1	2	3	4	5	Beneficial
		Unpleasant	1	2	3	4	5	Pleasant
16	People who are important to me think that I should use Internet	Strongly disagree	1	2	3	4	5	Strongly agree
17	I feel under social pressure to use Internet	Strongly disagree	1	2	3	4	5	Strongly agree
18	I am confident that I can use Internet if I want to	Strongly disagree	1	2	3	4	5	Strongly agree
19	Whether I use broadband Internet available in my area is entirely up to me	Strongly disagree	1	2	3	4	5	Strongly agree
20	I intend to use and adopt the available broadband Internet	Strongly disagree	1	2	3	4	5	Strongly agree

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