Empirical Validation of Unified Theory of Acceptance and Use of Technology (UTAUT) Model for m-Agriculture Service in India

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Abstract*: With an increase in the mobile penetration in India, m-Agriculture is getting more popular among Farmers to get information about weather, crops, and market prices. The basic issues are that of information asymmetry and individual user's acceptance for the m-Agriculture among Indian farmers as an effective information sharing tool. The present study focuses on validating Unified Theory of Acceptance and Use of Technology (UTAUT) model for m-Agriculture among India Farmers and acceptance of m-Agricultural services. The study is being conducted in Western Uttar Pradesh and adjacent districts of Haryana in India. The region of India known for green revolution and cash crop farming and contributes a large quantity of food grains to Indian granary. The study also ascertains the benefit of mobile services by the Indian farmers.

Keywords: E-Service, Indian Farmers, m-Agriculture Rural Sector, Technology Adoption, UTAUT model .

I. INTRODUCTION

With a population of more than 1.2 billion, India ranks as world's second most populated country. Out of the 1.2 billion people, 69 percent of the population lives in rural area and 31 percent of the population lives in urban areas. Total area of India is around 3.3 million square kilometer; the area under agriculture is only 3.1 thousand square Kilometer (CENSUS, 2011 data). Hence one of the main challenges for India Government is to repeat of Green revolution and white revolution in the early 70's to meet the food security of ever growing population.

India is facing major problem of rising food prices and increase in the population in the present scenario. The ever increase population need more house and more land for Industrialization, This demand in land is resulting in the expansion of Urban areas and reduction in the Rural land. With the availability of agriculture land is reducing, it is imperative on policy makers to create policies and infrastructure which can help in increase in Agriculture productivity to address the food problems of India.

Various Studies (Kawan et al.,2000; Huo et al.,2011; Mohan, J.,2016) have indicated that literacy, Infrastructure development and efficient agriculture extension are the most important sources in the agriculture productivity. The easy access of the market and removal of middleman is important in getting the better prices for the crop for Indian Farmers. In Agriculture, education and easy access to knowledge source create circumstances which will enable farmers to use the acquired information for decision making in the area of harvesting and selling their crops. This situation is possible with the adoption of ICT technology and the use of modern inputs on machines, fertilizers, seeds and weather forecasts. Information technology will help in bridging the information asymmetry among Indian farmers. This research investigates appropriate use of easily and commonly available cellphone technology and its timely adoption in agricultural value chain as a digital opportunity that may help in enhancing rural productivity, and therefore contribute to decreasing urban–rural disparities. M-agriculture is defined as dissemination of agriculture-related services and technology, and communication using wireless technologies, such as cellphones, netbooks, laptops, PDAs and other wireless devices. Although there is strong push from the Indian public and private sector on agriculture trade, productivity and farmers for mobile phone services, studies on technology adoption and the diffusion process in such frameworks are limited (Chattaopadhaya, undated: Mohan J, 2016). Most of the variance in the present studies with regards to mobile technology adoption in rural population remains unexplained (Kwon and Chidambaram). It was suggested that researchers should add more constructs to technology adoption model for individuals since mobile technology is developing rapidly and fresh factors are evolving continuously. Venkatesh et al. (2003) have published the results of a study that established and validated a novel research model called Unified Theory of Acceptance and Use of Technology (UTAUT) having seven constructs. These seven constructs are, performance expectancy, effort expectancy, facilitating conditions, self-efficacy, attitude towards using technology, social influence, and anxiety. These seven constructs are hypothesized to be fundamental determining factors of the users' behavioral intention towards information technology. These constructs has been derived from previously published eight different individual user acceptance models. A major issue identified in the new model is its relationship and consistency among items of each variable combined from various models. Similar to prior research models, this model needs to be methodically examined to establish its dependability and validity in the context of mobile technology and rural setup. Against this background, this research aims at primarily investigating the factors responsible for the adoption of mobile services in the context of agriculture services provided to Indian farmers. The basic purpose of this study is to gain a better understanding of how to provide actionable information services, such as agriculture, education and health using mobile phones to the farmer community. Therefore, the study was focused on the following issues:

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- Develop a theoretical research model based on the earlier studies for adoption of m-Agriculture service for Indian rural population
- Empirically investigate factors pertinent for rural Indians in the context of m-Agriculture technology adoption
- Empirically validate the relevance of UTAUT model in adoption of m-Agriculture service among Indian farmers

II. MODEL REPLICATION

Advancement of mobile technology and knowledge necessitates a critical analysis of prior studies conducted in the same domain. A model validation, replication in new setting or re-examination evaluate reliability, validity and the consistency of the measurement scales of the previous work conducted. A validated instrument helps in strengthening the Research process. Model validation is commonly used as a primary process in empirical research. However, various studies have pointed out that model validation in research of management information systems (MIS) research has been insufficient (Straub, 1989). Straub (1989) provides several reasons why model validation in MIS failed to get the attention of researchers. Firstly, there has been such a fast pace changes happening in the information technology domain that researchers are inclined towards conducting research with a fresh perspective in this domain. Secondly, the theoretical or non-empirical research method prevalent in conducting research in information technology domain may not require similar model validation.

Although, researchers commonly adopt instruments used in prior studies, they must be aware that methodological approach needs to be improved in new studies to reflect the local and relevant variables. Therefore, there is always a need to retest the adopted instruments. The advantage of research validation is that the inaccuracies in measurement are minimal, leading to higher confidence in the new research findings. Consequently, instrument validation is an important step towards the findings in the new research.

There are majorly two key advantages of existing model replication: one is to explore new variables and findings as mentioned in the studies (Elgers, 1980; Segars, 1993; Kacmar et al., 1999). Second advantage is to validate previous studies carried out in the relevant domain (Adams et al., 1992; Szajna, 1996; Compeau et al., 1999). To develop a standardized tool for new research, Doll et al. (1994) suggested two steps in the research cycle. First step to explore prior studies and evolve a hypothesized measurement model by analysing empirical statistics from earlier research studies , and second step to validate the study by testing the hypothesized measurement model incorporating new variables relevant to existing environment against the newly compiled data.

The current study also follows the two above-mentioned steps. This study will first analyze the existing literature on UTAUT model and understand the relevance in the Indian farming settings. In the second step, the current UTAUT model will be modified to incorporate the variables relevant to mobile technology usage in rural India. The results of the revised rural UTAUT model will be interpreted to measure the acceptance and usage of new m-Agriculture technology among Indian farmers.

A. UTAUT Model

Venkatesh et al. (2003) researched on the eight prevalent research models and theories on individual user technology acceptance to develop UTAUT model. These theories and models includes Innovation Diffusion Theory (IDT), Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Motivational Model (MM), Theory of Planned Behavior (TPB), Model Combining the Technology Acceptance Model and Theory of Planned Behaviour (C-TAM-TPB), Model of PC Utilisation (MPCU), and Social Cognitive Theory (SCT). The Table 1 presented below has summarized all constructs of each model and theory including UTAUT model.

Table 1: Models and Theories of Individual Acceptance Adapted from Venkatesh et al. (2003)

Models and Theories	Author(s)	Brief Description	Constructs
Theory of Reasoned Action (TRA)	Fishbein and Ajzen (1975)	It derives from psychology to measure behavioural intention and performance.	• Attitude • Subjective norm
• Technology Acceptance Model (TAM) • Technology Acceptance Model 2 (TAM2)	• Davis (1989) • Venkatesh and Davis (2000)	• It develops new scale with two specific variables to determine user acceptance of technology. • It is adapted from TAM and includes more variables.	• Perceived Usefulness • Perceived Ease of Use • Subjective Norm* • Experience* • Voluntariness* • Image* • Job Relevance* • Output Quality* • Result Demonstrability * indicates TAM2 only
Motivational Model (MM)	Davis et al. (1992)	It stems from psychology to explain behaviour. It applies this model to the technology adoption and use.	• Extrinsic Motivation • Intrinsic Motivation
Theory of Planned Behaviour (TPB)	Ajzen (1991)	Extends TRA by including one more variable to determine intention and behaviour.	• Attitude • Subjective norm • Perceived Behavioural Control
Combined TAM and TPB (C-TAM-TPB)	Taylor and Todd (1995)		• Perceived Usefulness • Perceived Ease of Use • Attitude • Subjective norm • Perceived Behavioural Control
Model of PC Utilisation (MPCU)	Thompson et al. (1991)	It is adjusted from the theory of attitudes and behaviour by Triandis (1980) to predict PC usage behaviour.	• Social Factors • Affect • Perceived Consequences (Complexity, Job-Fit, Long-Term Consequences of Use) • Facilitating Conditions • Habits
Innovation Diffusion Theory (IDT) by Rogers (1962) is adapted to information systems innovations	Moore and Benbasat (1991)	Five attributes from Rogers' model and two additional constructs are identified.	• Relative Advantage* • Compatibility* • Complexity* • Observability* • Trialability* • Image • Voluntariness of Use * indicates Roger's constructs
Social Cognitive Theory (SCT)	Bandura (1986)	It is applied to information systems by Compeau and Higgins (1995) to determine the usage.	• Encouragement by Others • Support • Self-Efficacy • Performance Outcome Expectations • Personal Outcome Expectations • Affect • Anxiety
Unified Theory of Acceptance and Use of Technology Model (UTAUT)	Venkatesh et al. (2003)	It integrates above theories and models to measure user intention and usage on technology.	• Performance Expectancy • Effort Expectancy • Attitude toward Using Technology • Social Influence • Facilitating Conditions • Self-Efficacy • Anxiety

Based on the literature review performed on the technology adoption models, it was found that apart from UTAUT model constructs, two more constructs are significant in the context of India rural population. These two constructs are Cost and Trust. The per capita income of Indian rural population is only INR 7,378 (USD 118) per month (CSO press release). Hence, to pay for any information service is directly related to the benefit any user will receive from this service.

Information in the farming community is transferred from older to younger generation due to the existing social structure (YunfuHuo et al 2011). Therefore, Trust is an important construct in this setting.

The following eight constructs appear significant as they directly determine the intention of information technology usage for the proposed study:

Table 2: Definition of Variables

Variable	Definition
Performance Expectancy	The degree to which an individual believes that using a particular system would improve his or her job performance.
Effort Expectancy	The degree of simplicity associated with the use of a particular system.
Attitude toward using Technology	The degree to which an individual believes he or she should use a particular system.
Social Influence	The degree to which an individual perceives that others believe he or she should use a particular system.
Facilitating conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support the use of a particular system.
Self-efficacy	The degree to which an individual judges his or her ability to use a particular system to accomplish a particular job or task.
Cost	The cost is regarded as equipment cost, access cost and transaction cost.
Trust	The expectations held by the consumer that the service provider is dependable and can be relied on to deliver on its promises.

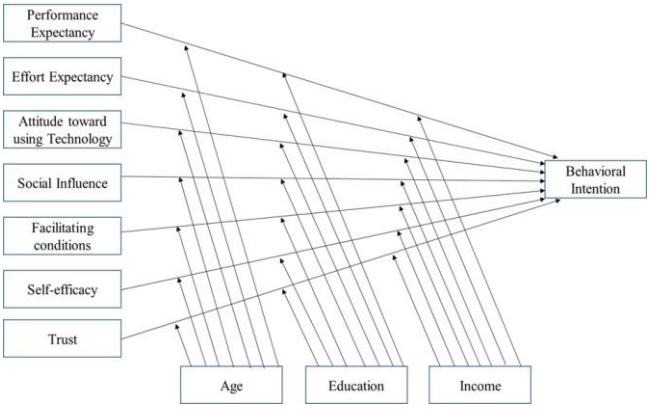

Figure 1: Revised UTAUT model for Indian Rural Population

III. RESEARCH METHOD

Quantitative phase of this research focuses on conducting survey among Indian farmers using m-Agriculture service in North India and empirically validating the rural UTAUT model in Indian rural setting using the freshly acquired data. The following section provide the research setting, instrument administration, discussion of survey participants and research results.

A. Participants and Setting

The questionnaire was developed in bilingual (Hindi and English), since north Indian farming, community is familiar with Hindi language. The layout of the questionnaire and questions ambiguity were pretested with the professionall and academic experts. Likert scale was used in the survey. Accordingly, some changes were made according to feedback received. The revised questionnaires were administrated to 318 farmers of 96 villages in the Western Uttar Pradesh region of India. The questionnaire was developed in bilingual (English and Hindi),as Hindi is the local language in that region. There were 304 completed questionnaires (an overall response of 96 percent). The remaining respondents did not use m-Agriculture service. Hence their responses were recorded as incomplete. Demographic data of respondents was also gathered during the survey. Below Table 3 provides details of the sample characteristics.

Table 3: Sample Characteristics

Sample Characteristics	Results
Gender	Male 97.00% Female 3.00%
Age	Below 25 Years 20.00% 26 - 35 Years 29.00% 36 – 45 Years 24.00% 46 – 55 Years 15.00% 56 – 65 Years 10.00% 66 Years and above 2.00%
Marital Status	Married 88.00 % Single 12.00 %
Educational Qualification	Less than High School 26.00% High School 30.00% Intermediate 31.00% Graduate 8.00% Post Graduate 6.00%
Monthly Income (in INR)	Less than 10,000 48.00% 10,000 – 20,000 20.00% 20.001 – 30,000 20.00% 30,001 and above 12.00%

The administered questionnaire was designed to assess the Indian Farmers' intention to use m-Agriculture services. M-Agriculture service is defined as the access to agriculture related information like weather, Crops , market prices , land uses through mobile devices. Indian rural population is already using mobile phone for the communication. Extending the mobile usage to provide agriculture related information to Indian farmers will address the information asymmetry. This mobile innovation, which provides agriculture information to Indian rural population, can be extended to provide education and health services using mobile devices. Hence, this innovation has far-reaching effects on the quality of life for rural population.

IV. RESULTS

Straub et al. (2004) had suggested multiple model validation guidelines for research of information systems models .Results of the current study is discussed in three areas . These three areas are construct validity, reliability, and correlation. For the current study, Cronbach's Alpha was used to measure internal consistency of reliability. Principal Component Analysis (PCA) was used to determine validity of the convergent and discriminant constructs. The reliability construct is also explained by using inter-item correlation. SPSS version 20.0 was used to perform statistical calculation.

A. Assessment of Validity

Construct validity is explained as "the degree to which a test adequately measures what it claims to be measuring" (Mokkink et al., 2010). It is important that the instrument items chosen for a given construct in new setting are a realistic operationalization of the construct (Cronbach and Meehl, 1955). For the current study, 30 instrument items in the research instrument were chosen from previous individual acceptance models as mentioned in Table 1. Subsequently these thirty instrument items were categorized into nine constructs in the proposed rural UTAUT model. Following table provide details on the abbreviations and descriptive statistics of each item and relevant construct.

Table 4: Descriptive Statistics

Scales / Items	Mean	S.D.
Performance Expectancy (PE)	**13.61**	**1.56**
PE01: I find m-Agriculture service useful by providing the agriculture related information.	4.45	0.505
PE02: I get timely information from m-Agriculture service.	4.63	0.528
PE03: m-Agriculture has help in increasing my agriculture productivity.	4.52	0.526
Effort Expectancy (EE)	**13.68**	**1.611**
EE01: I find m-Agriculture easy to use and flexible .	4.63	0.528
EE02: Learning to use m-Agriculture is easy for me.	4.57	0.509
EE03: Interacting with m-Agriculture service does not require a lot of my mental effort.	4.47	0.574
Social Influence (SI)	**13.46**	**2.095**
SI01: In general, the community encourages to use m-Agriculture and share the information as much as can .	4.53	0.556
SI02: My relatives influence my decision to use m-Agriculture services .	4.43	0.821
SI03: My Friends (Non –relatives) influence my decision to use m-Agriculture services	4.51	0.718
Facilitating Conditions (FC)	**22.05**	**3.536**
FC01: I have necessary resources to use m-Agriculture service .	4.60	0.536
FC02: I have necessary Knowledge to use m-Agriculture service.	4.62	0.507
FC03: I do not need assistance to use m-Agriculture service	4.59	0.567
FC04: Sufficient electricity and mobile network is available to use m-Agriculture service .	4.46	0.519
FC05: A specified individual (or group) is available in case of difficulty	3.78	1.407
Attitude Towards using Technology (AT)	**18.13**	**2.285**
AT01: I have fun using m-Agriculture service .	4.50	0.545
AT02: I enjoy using m-Agriculture service	4.43	0.522
AT03: Using m-Agriculture bores me.*	4.78	0.679
AT04: The actual process of using m-Agriculture is pleasant .	4.41	0.538
Cost (CT)	**14.56**	**1.482**
CT01: It costs a lot to use m-Agriculture . .*	4.88	0.478
CT02: There are financial barriers (e.g., having to pay for handset and communication time) to my using m-Agriculture . .*	4.81	0.484
CT03: Using m-Agriculture increases my mobile usage costs. .*	4.87	0.520
Trust (TT).	**12.71**	**2.623**
TT01: People of M-Agriculture service are trustworthy especially those who have contact with me .	4.43	0.552
TT02: I think that People at M-Agriculture service will not disclose my identity .	3.78	1.514
TT03: I think that information provided by m-Agriculture service is true .	4.51	0.557
Self-Efficacy (SE)	**13.58**	**1.668**
SE01: I could use the m-Agriculture if someone showed me how to do it first .	4.53	0.613
SE02: I could use the m-Agriculture service even if there was no one around to tell me what to do .	4.60	0.513
SE03: I could use m-Agriculture service if I had just built in help facility for assistance.	4.46	0.518
Behavioral Intention to Use the System (BI)	**13.59**	**1.607**
BI01: I will intend to use m-Agriculture service on regular basis in future .	4.53	0.513
BI02: I will intend to get more information about m-Agriculture service.	4.53	0.556
BI03: I will intend to use m-Agriculture service to get more information about agriculture information .	4.52	0.538

Note: *indicates reversed scale

Table 5: Principal Component Analysis

Proncipal Componenet Analysis (sample size 304 with 30 variables)						
Constructs	**KMO Value**	**Chi-Squre**	**Significance**	**Variance %**	**Rotated Component Matrix**	**Comments**
Performance Expectancy (PE) PE01. PE02.PE03	0.561	63.140	0.000	50.340	1	
Social Influence (SI) SI01. SI02. SI03	0.500	58.860	0.000	71.060	1	Removed SI02
Effort Expectancy (EE) EE01, EE02, EE03	0.555	76.490	0.000	51.940	1	
Facilitating Conditions (FC) FC01 , FC02 , FC03 , FC04 , FC05	0.590	69.570	0.000	51.900	1	Removed FC04 , FC05
Attitude Towards Using Technology (AT) AT01 , AT02 , AT03 , AT04	0.666	174.610	0.000	63.610	1	Removed AT03
Cost (CT) CT01 , CT02, CT03	0.500	4.770	0.029	56.260	1	Removed CT01
Trust (TT) TT01 , TT02, TT03	0.500	65.360	0.000	73.080	1	Removed TT02
Self Efficacy (SE) SE01 , SE02 , SE03	0.511	78.710	0.000	50.270	1	
Behavioral Intention (BI) BI01 , BI02 , BI03	0.500	88.880	0.000	75.260	1	Removed BI02

Correlation among model constructs was examined in the first step. Table 5 presents the factor loading for scale items based on the Principal Component Analysis and VARIMAX rotation. While exploring the highest total variance of the item loading, it was found to be 61.51 percent by excluding items SI02, FC04, FC 05, AT03, CT01, TT02, and BI02. Therefore, these seven items were excluded from the proposed model. Majority of the remaining items presented good convergent and discriminant properties. It was revealed that variables representing sub-components of the same construct were all considerably and highly correlated. In this study, twenty-three items were segregated into nine constructs according to principal component analysis. As a whole, the constructs developed by Venkatesh et al. (2003) for UTAUT model, including two additional constructs (Trust and Cost) for individual technology adoption in rural environment setting performed well in this replication, and can be included in the proposed model. This is important because it demonstrate the general relevance of identified constructs for selected research questions for research instrument. In summary, it can be concluded that Principal Component Analysis confirmed the validity analysis of the proposed rural UTAUT model in Indian setting by showing strong correlation for the items that are part of the same construct.

B. Assessment of Reliability

Table 6: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.827	.868	30

Table 7: Item wise Reliability Statistics

Construct	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
PE01	116.22	61.202	.475	.819
PE02	116.04	61.121	.462	.819
PE03	116.16	62.015	.352	.822
EE01	116.04	61.530	.411	.821
EE02	116.11	61.454	.438	.820
EE03	116.20	59.507	.607	.814
SI01	116.15	61.691	.367	.822
SI02	116.25	60.794	.292	.825
SI03	116.17	59.368	.482	.817
FC01	116.08	61.437	.415	.821
FC02	116.06	60.577	.554	.817
FC03	116.08	60.459	.502	.818
FC04	116.21	62.367	.314	.823
FC05	116.89	59.804	.157	.844
AT01	116.18	60.232	.553	.816
AT02	116.24	60.223	.582	.816
AT03	119.46	63.398	.125	.830
AT04	116.26	60.965	.471	.819
CT01	119.55	63.681	.171	.827
CT02	119.48	65.109	-.017	.832
CT03	119.55	64.711	.027	.831
TT01	116.25	60.114	.560	.816
TT02	116.90	59.339	.153	.848
TT03	116.17	60.978	.451	.819
SE01	116.15	59.618	.551	.816
SE02	116.08	61.631	.391	.821
SE03	116.22	61.286	.450	.820
BI01	116.14	62.590	.291	.824
BI02	116.14	60.742	.480	.818
BI03	116.15	61.000	.466	.819

Reliability shows how close a set of instrument items selected for a given construct measures the same construct. While construct validity is measurement between different constructs, reliability is a measurement within individual construct. For this study, the researcher has used Cronbach's Alpha method and Inter-Item Correlation Matrix to examine whether each construct of the proposed model is independent of and can be calculated independently from other constructs.

The Cronbach's Alpha test on the research instrument found that each construct in the proposed model shows a high level of reliability coefficient or internal consistency (Table 7). According to various studies (Venkatesh et al.,2003), if reliability coefficient (Cronbach's Alpha value) is equal or greater than .70 then it is acceptable for measuring individual adoption of technology. For the overall questionnaire, Cronbach's Alpha was found to be 0.87,

which confirmed the results of reliability analysis of constructs from the proposed rural UTAUT model.

V. CONCLUSION

It is well established that inability or unpredictability of a research model through different samples and settings may lead to erroneous measurement of research outcomes. To get rid of this problem, measurement models must be accurately validated in different conditions. Various constructs and the proposed rural technology adoption model used in this study are developed from the foundations of various individual user adoption models and theories. This eventually generated an empirical research approach by providing a statistical basis for model testing and measurement assessment.

The research approach used in this study for m-Agriculture service adoption has provided three key insights concerning replication of the UTAUT model. Firstly, the coefficient factor analysis proved the acceptable construct validity of the proposed revised model, though some variables and items had to be removed in the context of m-Agriculture service adoption by Indian farmers. Secondly, items of each scale and overall survey instrument attained a high Cronbach's Alpha reliability, while each scale contained a low inter-item correlation value. Analysis of the modified rural UTAUT model revealed that Trust and Cost are significant factors in the adoption of new and evolving technology, such as mobile, in the Indian rural setting.

By means of empirical data and studies related to rural India, the researcher has detailed and rationalized the relevant factors. The conceptual individual rural technology adoption model along with local factors presented in the current study can provide useful insights for local government, policy makers, service providers, marketers, and researchers interested in serving rural communities in developing countries. Inclusion of two new external factors—Trust and Cost—may be of particular interest for researchers working in the developing economies on technology acceptance and diffusion models for upliftment of poor.

VI. LIMITATIONS AND FUTURE DIRECTIONS

Venkatesh et al. (2003) developed the UTAUT model to measure it in longitudinal observational designs throughout industries. The present study for experimental replication of UTAUT model in the rural sector of developing economy has not followed this research approach. Based on the literature review and expert opinions, moderating variables used in the original UTAUT model like experience, gender, age, and income has not been selected in the current research model validation. The present study only explores and provide statistical evidence that the revised rural UTAUT model is a sufficiently valid and reliable tool to gauge the inclination of Indian farmers towards adopting mobile technology-based agriculture service offerings. Additional investigation is still required to make rural UTAUT a more robust model. Confirmatory research approach may be used to revise and improve the instrument for future studies in this domain. The researcher also encourages future studies to retest the rural UTAUT model in the rural setting for other mobile based services—m-Banking, m-Education, and m-Health—because these factors may better predict the rural population technology adoption behaviour.

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