
Information System (Is) Models: Technology as a Service for Agricultural Information Dissemination in Developing Countries (Uganda). A Systematic Literature Review

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Abstract

This article summarizes the current literature by reviewing the concepts, applications, and development of technology adoption models and theories that are supported by the literature review, with the novelty technology's prospective application being the main focus. These included, but were not limited to, the concepts of Diffusion of Innovations (DIT) (Rogers, 1995), Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1995), and Diffusion of Innovations (DIT) (Rogers, 1995). Theory of Planned Behavior (TPB) (Ajzen, 1985, 1991), Theory of Planned Behaviour, (Taylor and Todd, 1995), the Technology Acceptance Model (TAM) (Davis, Bagozzi and Warshaw, 1989, Technology Acceptance Model two (TAM2) Venkatesh and Davis (2000), Technology Acceptance Model three (TAM3) Venkatesh and Bala (2008), Unified Theory of Acceptance Model (UTAUT) Venkatesh et al; 2012 and the Extended Unified Theory of Acceptance Model (UTAUT2) Venkatesh et al; 2016. These assessments can give some information on technology adoption levels and potential applications for future researchers to consider, recognize and comprehend the underlying technology models and ideas that will have an impact on the preceding, current and future applications of technology adoption and agricultural information dissemination by smallholder rural farmers.

Keywords: TRA, DIT, TPB, TAM, UTAUT, UTAUT2, ICT, Information Systems, Technology Adoption, rural farmers, Uganda.

1. Introduction

Information and communication technologies (ICTs) have emerged as indispensable tools and drivers of change in the 21st century and beyond (Onyancha & Onyango, 2020). ICTs (Information and Communication Technologies) are electronic ways of communication, capturing, processing, storing, and communicating information (Eryılmaz, 2021). ICT promotes and distributes new and current farming information since it is conveyed to the agricultural sector at intervals and critical for agricultural and rural development, as well as the transmission of social and economic changes (Oladele, 2015).

In information systems (IS) research, theories and models are developed to elucidate users' use or adoption of technology (Macire, 2017). With the event of information technology, information communication, and dissemination theories/models are perpetually being evolved and improved and every model has its advantages and drawbacks. For the unbalanced economic development and also the variations in regions or countries, it's vital to contemplate the native characteristics once selecting an acceptable dissemination service model. The success of a new system or innovation depends on the extent of acceptance of such new technology among its users (Magableh & Al-Tarawneh, 2021).

This paper analyzes the technology acceptance and adoption models resulting in increased levels of information dissemination and use for increased agricultural productivity. These models included, but were not limited to, the Diffusion of Innovations (DIT) (Rogers,1995), which began in 1960, the Theory of Reasoned Action (TRA) (Doll&Orth,1993), and the Theory of Planned Behavior (TPB) (Vallerand et al., 1992), Decomposed Theory of Planned Behaviour (Kanimozhi&Selvarani, 2019), the Technology Acceptance Model (TAM) (Davis et al., 1992), Final version of Technology Acceptance Model (TAM) (Lala, 2014), Technology Acceptance Model a pair of (TAM2) (Venkatesh et al., 2012), Technology Acceptance Model three (TAM3) (Venkatesh & Bala, 2003) and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). This review may throw some insight on certain lightweight and possible technology applications for future researchers to develop, recognize and comprehend the underlying technology models and ideas that may have an impact on the preceding, current and future applications of technology adoption in the distribution of agricultural information in rural areas.

Theory of Reasoned Action (TRA)

This is among the earliest model that was established in the field of psychology to make a case for technology acceptance. (Doll & Orth, 1993) indicate that Fishbein and Ajzen's (1975) work centered on the prediction behavior undertaken in each laboratory and applied setting and their work was a result of a quest program that began within the latter years of the 19th century. The approach they used was a juxtaposition of various theories and analyses concerning attitudes, probably learning and expectancy-value theories, balance theory, theory of psychological feature dissonance, and theories of attribution (Forgas, 2003). They wanted to come up with a theory that might be used to predict, explain, and influence human behavior (Vallerand et al., 1992).

This theory since has been redeveloped and refined likewise as a place to check at intervals completely different disciplines and domains like shopping behavior, the commercial sector, education, and technology adoption. TRA has been used as a base theory for several models and theories within the fields of human behavior and technology acceptance. TRA assumes that each one people are systematic in their use of knowledge that's obtainable to them which they're all rational in however they use this information once taking action: in alternative words, they take into account the implications before partaking in a very explicit behavior (Vallerand et al., 1992). An individual's behavior is decided by behavioral intentions, in keeping with TRA, and is that the most vital issue. Behavior, and therefore the intention to perform or act on behavior, could be a mixture of angles towards the performance of the behavior and subjective norms.

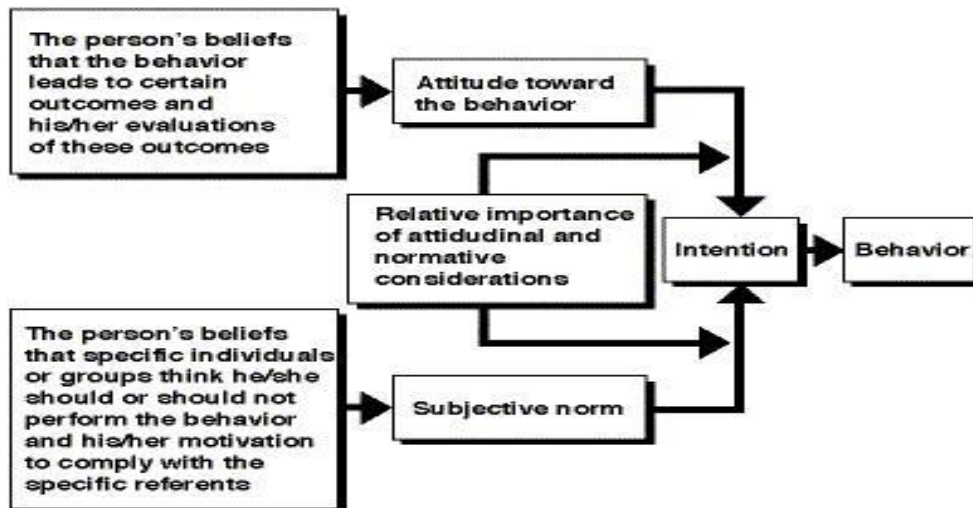


Figure 1: Showing the constructs of TRA adopted from (Fishbein et al., 1980)

2. Technology Acceptance Model (TAM)

The Technology Acceptance Model was established by (Davis, 1989) and backed by the Theory of Reasoned Action. It was developed to find what influences acceptance or rejection of information technology. Davis suggests the foremost vital individual beliefs concerning usage of information technology are perceived usefulness and perceived easy use. Perceived usefulness (PU) is outlined as "the degree to that someone believes that employing an explicit system would enhance his or her adoption levels". The definition of perceived usefulness relies on the expectancy-value model underlying the Theory of Reasoned Action. Perceived easy use (PEOU) is outlined as "the degree to that someone believes that employing an explicit system would be freed from the effort. Consequently, these 2 behavioral beliefs cause individual behavior intention (BI) and actual behavior. He found that plutonium was the strongest predictor of an individual's intention to use information technology. TAM rejects TRA's subjective norms (SN) as a predictor of behavioral purpose (BI). However, relating to empirical proof, the last version of the TAM model exempted the perspective construct of attitude because of its weak mediating result between PEOU and behavioral intention, and also the relationship between PU and appeared a lot vital. According to the TAM model, PEOU influences PU because; the benefit of the employment of explicit technology makes it a lot of helpful (Davis et al., 1989). Following TRA, the TAM model proposes that the influence of external factors on BI is mediated by PU and PEOU. Within this model, the set of variables like design characteristics, objective system, computer self-efficacy, and user involvement in style, training, and also the nature of the implementation method are all external variables (EL BILALI et al., n.d.). However, as TAM evolution progressed with new variables were emerged, for example, compatibility, computer anxiety, system quality, enjoyment, expertise, and computing supports (Lee et al., 2003). These are the foremost documented variables that affect PU, PEOU, BI, and B. The link between the four main variables in TAM is conjectured as exploitation plutonium as a variable that affects adoption and acceptance directly and conjointly because it is anticipated by PEOU.

TAM is taken into account jointly of the foremost used and acceptable models among the sector of technology acceptance (Eriksson et al., 2005; Venkatesh et al., 2003; (Venkatesh & Davis, 1996). By 2010, the report revealed by Google Scholar showed that 714 citations are referred for the initial TAM model (Bradley, 2012). As mentioned before there's a continuing evolution on the TAM model over the last decade. (Wixom & Todd, 2005) have seen the evolution of TAM from its original standing and that they explained however TAM has extended through 3 views. Firstly, the extended model enclosed options from different models; for example, from the idea of planned behavior (TPB), subjective norm (SN) and perceived behavioral control (PBC). The second extension saw the introduction of extra or different beliefs.

Most of those are derived from the diffusion of innovation theory and enclosed concepts like compatibility, trialability, or visibility. The third extension examined PEOU and PU and also the external variables that affected them, like demographic characteristics and personal traits. This model has progressed among 3 main phases of development: adoption, validation, and extension (Chen et al., 2011). TAM being tested through some straightforward info systems or technologies like Fax database systems, Word, Excel, Emails, voice mail, conjointly it's been tested among such technologies that associated with net applications, for example, Worldwide internet (www) services, on-line services, E-libraries (Chen et al., 2011).

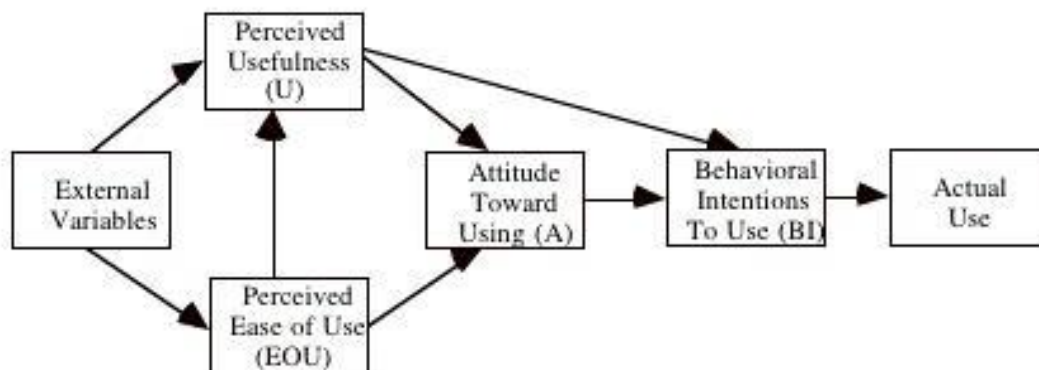


Figure 2: Showing technology acceptance factors in TAM

Source: (Davis, 1989)

3. Diffusion of Innovation Theory (DIT)

There was a requirement to know however society settles for or doesn't accept innovation (Rogers, 2010), which impressed Rogers to determine the Diffusion of Innovation Theory (DIT) in 1962. This is often thought about as one of all the foremost necessary theories within the field of social science and has been used at intervals by many inventions in several disciplines to gauge among the encircled social organization. (García-Avilés, 2020) outlined diffusion as "the method by which innovation is communicated through bound channels over a time among members of the social organization.

The adoption of a specific innovation is delineated as: "the method through that a society passes from the initial source of innovation to forming a better perspective towards the innovation, to accept or reject the new idea, as well as its implementation" (Rogers 1983,

p.21). Rogers (1995) additionally posited that the notice of the innovation's options has an associated influence on the users' activity intention toward adopting the technology. In line with Roger's (2003) oversimplification of previous analysis, studies have been objectified to incorrect analysis. He justifies this by stating that previous analysis that has targeted the variations between individuals, the users of innovations, is opposing to the variations between innovations.

According to (Oliveira & Santos, 2019); Rogers (2003), there was a requirement for a classification structure of the perceived attributes to innovation that would be applied to all or any studies. However, he additionally noted and stressed the importance of the event of measures of perceived attributes to be personal to every study as opposing any previous investigations' scales of activity. This could successively affect the speed of innovation adoption, as rather than the perceived perceptions of innovation happiness to experts; it might be an individual's perception of the attributes that might influence adoption. Based on the DIT, there are 5 perceived attributes of innovation hypnotized to predict the adoption of innovation (Rogers, 2003). In line with Rogers, these attributes have the flexibility to clarify 49 to 87% of the variance in predicting the speed of adoption of innovations, and the primary of those attributes is a relative advantage, that is that the scale of perceived attributes of associate innovation that displaces another. The second is compatibility; however, this attribute is looked as if it would be compatible with the values, expertise, and therefore the wants of the possible adopters. The third is the complexity that is looked at as if it would be easy to know and use. Trialability is the fourth perceived attribute, in different aspects of innovation, and this associated with innovation be experimented with an attempt basis before stepping into full adoption. Finally, observability or how a system can be understood before measuring the results of the innovation. These 5 attributes are interlinked while being separately distinct from every different innovation adoption process.

Despite the adoption of applying the DIT to predict the acceptance of innovation in some literature, it has additionally been criticized in some scenarios. For instance, (Oliveira & Santos, 2019) claimed that DIT assumes that one model is ready to predict the adoption of various sorts of innovations among completely different styles of people and contexts. (Chau et al., 2021) debated such necessary details as those associated with the specified price and special facilities are unnoticed by the DIT.

Despite the various disciplines that TAM and DIT came from, there are similarities within the 2 theories, suggesting that they complement one another (Min et al., 2019). The element construct in TAM is taken into account to be the advantage attribute of innovation and it's additionally thought-about that the complexity attribute is analogous with PEOU within TAM.

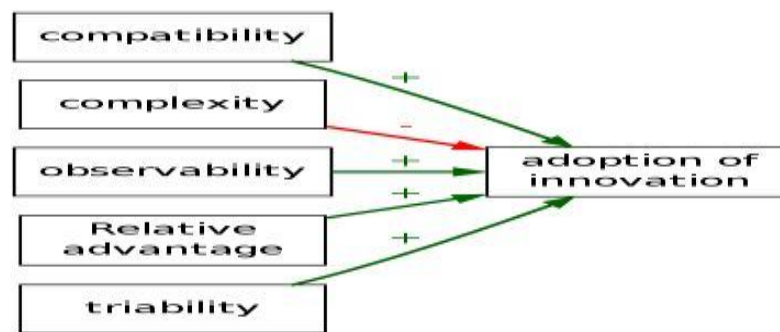


Figure 3: Showing the major constructs of diffusion of innovations model

Source: (Rogers, 2003)

4. The Unified Theory of Technology Acceptance and Use (UTAUT)

There are many models and theories applied within the context of acceptance of technologies and innovations to elucidate that most factors that affect the individual's intention to adopt an innovation and actual behavior (Kar & Dwivedi, 2020); Venkatesh et al., 2003). The researchers within the field of technology acceptance have additional possibilities to settle on a well-liked model or theory for study because of the variety of selections, and overlooked contributions afforded from different models as noted by (Venkatesh et al., 2003).

(Venkatesh et al., 2012) compared the eight models by trial and error in longitudinal field studies inside four organizations wherever new technologies were introduced to people. Three completely different times were used for measuring and were post-training; this was measured doubly while implementation at the one month and three-month interval, and usage behavior were measured over the complete six-month amount of implementation. Each of the eight models was then applied to the information that had been divided by 2 for mandatory and voluntary conditions. Moderating variables that enclosed expertise, voluntariness, age, and gender was studied as they'd been expected because of previous analysis to change usage selections, and when moderators had been enclosed prognostic validity increased across six of the eight models, except for MM and SCT.

Venkatesh et al., (2003) reported their statistical findings with a longitudinal empirical study; it shows that the aforesaid eight models had the prediction power as 17 percent to 55 percent of variance to predict the intention to use the new systems. They found that the prognostic power of those models can be increased together with some moderating variables through these models (Venkatesh et al., 2003). At that time, UTAUT was applied and examined, and by trial and error shown 70 percent of variance prediction power as by trial and error reported by Venkatesh et al., (2003). Venkatesh et al., (2003) proposed three major constructs (performance expectancy, effort expectancy, and social influences) that directly define behavioral intention and 2 different constructs that influence the particular behavior (usage), behavioral intention, and facilitating conditions as described below.

Performance expectancy (PE) is defined as "the degree to which an individual believes that using technology will improve their performance (Venkatesh *et al.*, 2003, p. 447). Venkatesh *et al.*, (2003) identified that this construct has been derived from other factors in related theories and models which are: perceived usefulness (TAM and C-TAM-TPB), outcome expectation (SCT), relative advantage (DIT), job fit (MPCU), and extrinsic motivation (MM).

Performance expectancy was the most significant factor to affect the behavioral intention amongst any individual theory within different contexts (Venkatesh *et al.*, 2003).

According to Venkatesh *et al.*, (2003, p.450) **Effort Expectancy (EE)** is described as the "degree of comfort associated with the use of system." EE has been captured from other related factors from existing theories such as ease of use (Moore and Benbasat, 1991), perceived ease of use (Davis *et al.*, 1989; Venkatesh and Davis, 2000) and complexity (Thompson *et al.*, 1991). EE showed significant impact on the behavioral intention within either mandatory or voluntary contexts either at or at mandatory setting. However, Venkatesh *et al.*, (2003) claimed that the role of this factor is limited by the time after the training-stage of the users.

Social influence is the degree to which an individual feels that others believe he or she should utilize the new system (Venkatesh *et al.*, 2003; p.451). In the models of TRA, TAM2, TPB/DTPB, and C-TAM-TPB, social influence is derived from subjective norm, social elements in MPCU, and image in DIT. Worthwhile to mention that the social influence construct has significant impact on behavioral intention exclusively within mandatory context (Venkatesh *et al.*, 2003)

According to UTAUT, **Facilitating Conditions** are defined as "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (Venkatesh *et al.*, p.453). The construct of facilitating conditions are referred to in other different factors: compatibility in DIT, perceived behavioral control in TPB, C-TAM, and, DTPB and facilitating conditions in MPCU. All of these constructs have same influences on the behavioral intention within both of mandatory or voluntary contexts (Venkatesh *et al.*, 2003). However, according to Venkatesh *et al.*, (2003), the impact of facilitating conditions on the behavioral intention could be limited or insignificant after the training stage. Moreover, Ajzen (1985) and Taylor and Todd (1995a) assumed that facilitating conditions may have direct effect on the actual usage behavior.

It is worth to mention that there is an extension of the UTAUT which has been extended by Venkatesh *et al.*, (2012) by incorporating three more factors into the original UTAUT model (hedonic motivation, price value and habit), this extension is called UTAUT2.

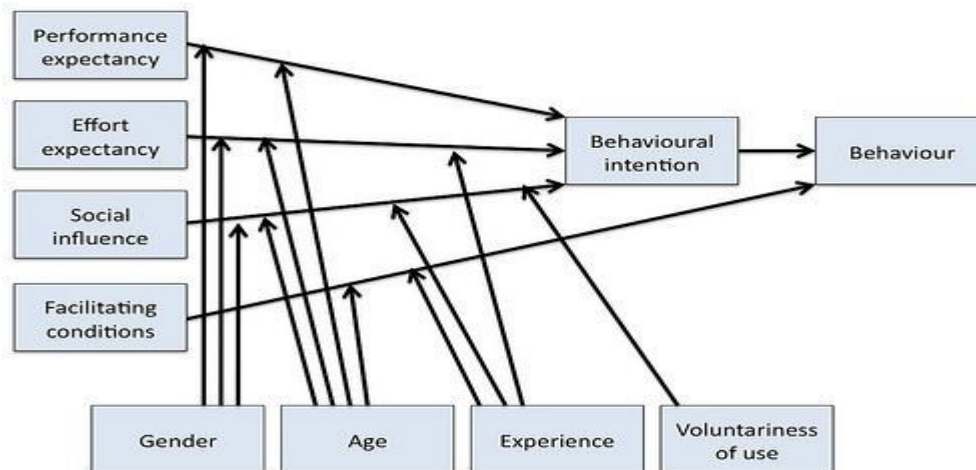


Figure 4: The Unified Theory of Technology Acceptance and Use

Source: (Venkatesh et al., 2012)

5. The Extended Unified Theory of Acceptance and Use of Technology (UTAUT2)

UTAUT2 was an extension of the initial UTAUT, extended by adding 3 external constructs (Hedonic motivation, Habit and value). (Venkatesh et al., 2016) changed the UTAUT model with the aim of validating this model from the views of customers. They assumed that individual variations (age, gender and experience) would have moderating effects over the relations between the constructs and each behavioural intention and therefore the actual usage of the mobile web.

Price value refers to the "psychological feature trade-off between the perceived benefits of the innovation/technology and the financial expenses of using it" (Venkatesh et al., 2012, p.161). Hedonic motivation is defined as the enjoyment or joy that is derived by employing a specific technology (Venkatesh et al., 2012). This construct is captured from various factors like enjoyment, playfulness, and joy, which are significantly important factors to determine the users' adoption of technology (Brown and Venkatesh, 2005; Van der Heijden 2004). According to Venkatesh et al. (2012, p.161), "habit" refers to the amount to which individuals tend to perform behavior automatically as a result of learning.

(Venkatesh et al., 2012) reported their findings after 2 stages of an online survey of 1,512 mobile web users. The results supported powerfully the predictive power of UTAUT2 that revealed 74 and 52 per cent of the variance in behavioural intention and actual usage respectively, whereas the UTAUT provided 56 percent behavioural intention and 40 percent in actual usage of mobile phones (Venkatesh et al., 2012).

Compared to previous technology acceptance models, (Venkatesh et al., 2012) thought about UTAUT2 as the most powerful model to explain behavioural intention and through empirical observation, it scored the best variance rate in behavioural intention (74%), which had never been accomplished by different models in information systems for technology adoption and usage. On the opposite hand, there are some considerations concerning the generalizability of UTAUT2, as their study was conducted in Hongkong that encompasses a high rate of mobile penetration and usage. Moreover, UTAUT2's sample was skewed which is another concern for its generalizability. And again, because the mean age of their study sample was 31;

perhaps it's irrelevant to older ages (Venkatesh et al., 2012).

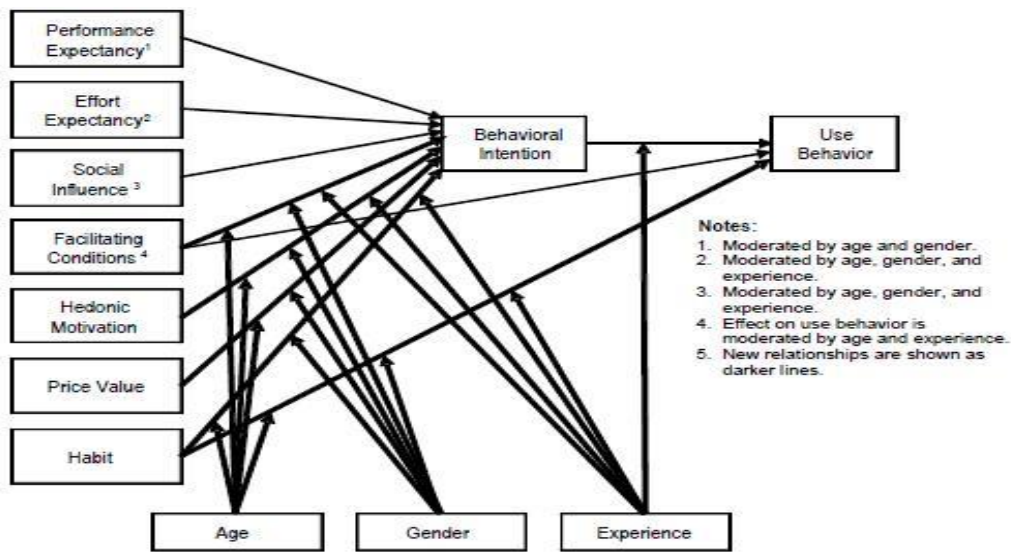


Figure 4: The Unified Theory of Acceptance and Use of Technology (UTAUT2)
Source: (Venkatesh et al., 2016)

Table 1: Showing an overview of the common constructs among Technology and Information Acceptance Models

Constructs	TRA	DIT/DOI	TAM	UTAUT	UTAUT2
Attitude	✓	×	✓	×	×
Subjective norms	✓	×	×	×	×
Perceptions	✓	×	×	×	×
Perceived usefulness	×	×	✓	×	×
Perceived ease of use	×	×	✓	×	×
Innovation features	×	✓	×	×	×
Innovators characteristics	×	✓	×	×	×
Performance expectancy	×	×	×	✓	✓
Effort expectancy	×	×	×	✓	✓
Social influence	×	×	×	✓	✓
Facilitating conditions	×	×	×	✓	✓
Habit	×	×	×	×	✓
Hedonic motivation	×	×	×	×	✓
Price value	×	×	×	×	✓

The table above provides an summary of the foremost common technology acceptance models reviewed and their common constructs when explaining the event and evolution of

each model, noted also are some models' extensions and modifications and reported some empirical results from previous studies that applied in adopting such models.

6. Discussion of the reviewed models

(Venkatesh et al., 2003) agreed that a combination of models was needed to get a unified picture of users' technology acceptance. They compared the eight principal models: Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM), combined TAM - Theory of Planned Behavior (TPB), Diffusion of Innovations (DOI), Social Cognitive Theory (SCT), Motivational Model (MM), and Model of Personalized Computer and Utilization (MPCU) that have all been used to explain technology acceptance behavior and as a result, five limitations of previous comparisons of models was derived from the study.

Firstly, the technologies that had been studied were not complex in nature but were simple and individual in nature and did not include sophisticated technology. Secondly, most of the studies had been completed with students as the sole contributors. A third limitation was that in the majority of studies the time of measurement had been generalized and completed long after acceptance or rejection of a technology, and therefore reactions were outdated. Fourthly, Cross-sectional measurement was prevalent, and the fifth limitation was that it was hard to generalize results as the majority of research had been completed in voluntary circumstance of usage rather than compulsory use.

The following is a justified critique of the each of the reviewed models;

TRA

With the theory of reasoned action, it is assumed that all individuals have systematic patterns of behavior while making use of information that is at their disposal and that they are all balanced in how they utilize this information to take the necessary actions implying that they bear in mind the implications prior to engaging in a specific pattern of behavior. However, this theory may fall short since every individual is unique and therefore they may exhibit varying sequences of behavior in using information available to them. Furthermore, some individuals may engage in certain behaviors without taking precautions of the implications.

TAM

Like many other researchers have mentioned like (Li, 2010), there is no empirical evidence to support the relation between perceived ease of use and perceived usefulness and therefore, there is need to extend TAM to include social and human factors.

DIT

Despite the different disciplines that TAM and DIT came from, there are similarities in the two theories, suggesting that they complement each other. The PU concept in TAM is considered to be the advantage attribute of an innovation. Within TAM, the complexity attribute is said to have some parallels to PEOU. However, the development of DIT began in the agricultural sector with research on ameliorated hybrid seed technologies and therefore it can be regarded appropriate in the context of study on smallholder farmers' use of ICT to obtain, adopt and use agricultural information. Also it is a beginning for studies on the

innovative use of ICT in agriculture and fits well with the identified constructs (Relative advantage, Compatibility, Simplicity, Observability, complexity and Trialability); it has been applied in technology adoption than any other technology acceptance model which include; UTAUT, UTAUT2, TAM, TRA etc by farmers in developing countries than any other model/theory.

UTAUT

UTAUT model is applied to explain the adoption of technology from the perspective of employees, so there are some concerns about its applicability within other contexts such as rural farmers. Some studies have contradicted the claim for a high prediction power of the UTAUT model, as their results found this model to have poor prediction power.

UTAUT2

There are concerns about the generalizability of UTAUT2 as study was conducted in Hong Kong which has a high rate of mobile penetration and usage. It is therefore not comparable with some studies conducted in developing countries (Uganda) which have/has a lower rate of mobile usage and internet penetration. Moreover, UTAUT2's sample was skewed which is another concern about its generalizability; because the average age of the participants in their study was 31; maybe it is inapplicable to older ages. There is therefore need to further establish how applicable it would be in such a developing country with rural settings (Uganda).

So far, the literature regarding adoption theory reviewed is void of any model which addresses specifically how the technology is adopted in a rural setting. A host of challenges are faced by rural communities particularly those dwelling in developing world and the challenges faced include: low levels of literacy, poor infrastructure as well as poverty of which all demand special attention in case success is to be achieved in adoption as well as diffusion of new innovations and technologies agricultural information dissemination.

7. Conclusion

UTAUT2 (Extended Unified Theory of Acceptance and Use of Technology Model) can be twisted to fit needs of the rural areas in Uganda and other developing countries due to the fact that it incorporates all constructs originating from original models. The model might rely significantly on social forces to encourage the adoption of information and communication technology ((ICT) among rural farmers especially in the course of the initial stages of adoption. New latent variables could be included (government policies, geographical location and availability of affordable data and power) as factors that influence the adoption and use of ICT among smallholder farmers and this can be hypothesized and deliberated on in the initial steps of lengthening the fundamental UTAUT2 particularly fitted for rural farmers in developing countries.

Conflict of interest: The authors declares no conflict of interest

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