APPLYING AN ENHANCED TECHNOLOGY ACCEPTANCE MODEL TO KNOWLEDGE MANAGEMENT IN AGRICULTURAL EXTENSION SERVICES

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ABSTRACT

This research investigates the applicability of Davis's Technology Acceptance Model (TAM) to agriculturist's acceptance of a knowledge management system (KMS), developed by the authors. It is called AGROWIT. Although the authors used previous Technology Acceptance Model user acceptance research as a basis for investigation of user acceptance of AGROWIT, the model had to be extended and constructs from the Triandis model that were added increased the predictive results of the TAM, but only slightly. Relationships among primary TAM constructs used are in substantive agreement with those characteristic of previous TAM research. Significant positive relationships between perceived usefulness, ease of use, and system usage were consistent with previous TAM research. The observed mediating role of perceived usefulness in the relationship between ease of use and usage was also in consonance with earlier findings. The findings are significant because they suggest that the considerable body of previous TAM-related information technology research may be usefully applied to the knowledge management domain to promote further investigation of factors affecting the acceptance and usage of knowledge management information systems such as AGROWIT by farmers, extension workers, and agriculture researchers.

Keywords: Technology Acceptance Model, Knowledge management, Agricultural extension services, Triandis model, Technology adaptation

1 INTRODUCTION

It is said that technology has played no small role in the transformation of societies into the so-called post-industrial (post-modern) or information society. Time and space have been tightly linked together, particularly in people's work. Traditionally, modern work is assumed to be done primarily within a formal physical space, e.g. offices and factories, by formal employees in the firm over an extensive period of time. However, attention has been paid to changes in our familiar understanding of the relations between time and space. Harvey (1989) has used the term "time-space compression" to illustrate how global communication has altered our temporal and spatial horizons. Despite the fact that computer technology innovations have speeded up the accumulation of economic capital, the benefits this capital provides have not been sufficiently harnessed in the area of agricultural extension service provision in most countries of the world. The world is obviously changing and the incapability of the present agricultural extension service practices to meet the need of farmers must be addressed.

Agricultural extension service is vital to the development of agriculture. The extension service is responsible for simplifying research information and delivery of such information to farmers in an effective and easy to understand manner. The extension service is also a feedback mechanism to researchers on problems faced by farmers and new innovations discovered by farmers. Although the extension system seems ideal in theory, it has not been successful in many parts of the world. The problem is even more profound in developing countries where small-scale agriculture seems to be the norm.

It is an arguable fact that the most serious problem in developing research and extension programs is that of bridging the gap between research and extension. Giddens (1994) was concerned with the changing nature of societies and argued that social relations among people do not, increasingly, require their mutual physical presence. It therefore suffices to say that the bottleneck often encountered in attempts to meet the soaring need of extension services by the, usually, many sparsely-distributed farmers in terms of inadequate staffing, correct research reporting and financing can be resolved without the physical presence of extension workers. We consider a good and easily accessible knowledge management system to be a viable solution to the problems. Some of the benefits to be

derived from KMS include uniformity in the research information disseminated, quick and accessible extension information; ease in training new extension staff, retention of the sometimes transient tacit knowledge, and the need to check redundancy in agricultural research work. KMS also adds another dimension to the level of technical skills and expertise needed by extension workers, agriculture researchers, and the farmers themselves.

Although there has been a great deal of research into KMS (Liao, 2003), and even more on TAM (King and He, 2006), there is hardly any research on KMS for agricultural extension service. This fact obviously informed research and development of our KMS called AGROWIT. AGROWIT is a KMS, accessible to the university community and associated farmers via an intranet and was built primarily for the Agriculture Media Resource and Extension Centre (AMREC) of the University of Agriculture, Abeokuta, Nigeria. Figures 1 and 2 below show the structure of the AGROWIT.

Figure 1. Interface of the AGROWIT developed for AMREC of the University of Agriculture Abeokuta

Figure 2. Video clip describes a harvesting and shelling process to a farmer

After our design and implementation of AGROWIT, we considered it worthwhile to study the acceptability of this technology in improving and extending agricultural extension services using an enhanced TAM.

2 BACKGROUND

The Technology Acceptance Model (see Figure 4) was first introduced by Davis in 1986 and continues to be the most widely accepted theoretical model in the information science field. It proposes that applications usage and adoption can be predicted based upon the factors of perceived ease of use (PEOU) and perceived usefulness (PU) (Davis, 1987). Understanding of the predictors of KMS usage could serve a multitude of stakeholders by helping them recognize how to promote that usage. The TAM is based on Fishbein and Ajzen's Theory of Reasoned Action (TRA). The TRA (Figure 3) posits that an individual's attitude towards carrying out that behavior and an evaluation of the value of each of those outcomes influences social behavior. Behavior then is determined directly by the

intention to perform because individuals generally behave as they intend to do within the available context and time (Moon, 2001).

Davis (1987) defined perceived usefulness as "*the degree of which a person believes that using a particular system would enhance his or her job performance"* and perceived ease of use as "*the degree of which a person believes that using a particular system would be free of effort*." These beliefs determine a user's attitudes towards using a system, which in turn determine behavioral intentions and leads to actual system use. Previous research has demonstrated the TAM's validity across a variety of corporate IT systems (e.g., Taylor & Todd, 1995; Szajna, 1996; Chau, 1996; Geffen & Straub, 1997; Doll, 1998).

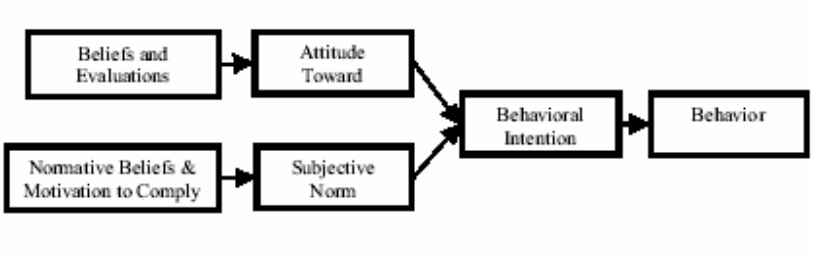


Figure 3. Theory of Reasoned Action

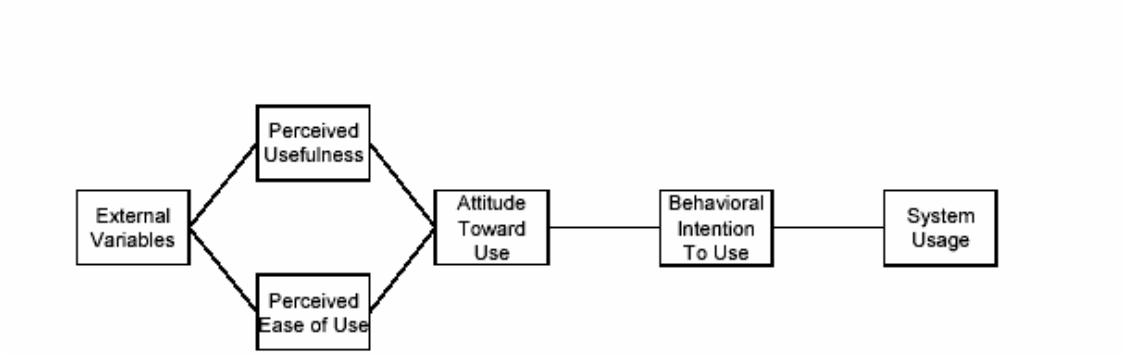


Figure 4. The Technology Acceptance Model

The Triandis Model of Choice (see Figure 5) on the other hand outlines a relationship between attitude, intention, and behavior and postulates that the probability of performing an act, such as using an AGROWIT, is a function of habit, intention to perform the act, and facilitating conditions (objects or existing conditions that make an act easy). The intention of performing a certain act can be also considered to be a function of (i) the perceived consequences of the act, (ii) the person's conception of what he or she should do (social factors), and (iii) what one would enjoy doing or pure affect (Chang, 2000). For this particular study, the factors of effect and perceived consequences are not measured as factors that affect intention. Social factors are examined because of the climate of the agrarian environment of applicability of AGROWIT and will measure if the society encourages the use of KMSs by stakeholders, especially farmers.

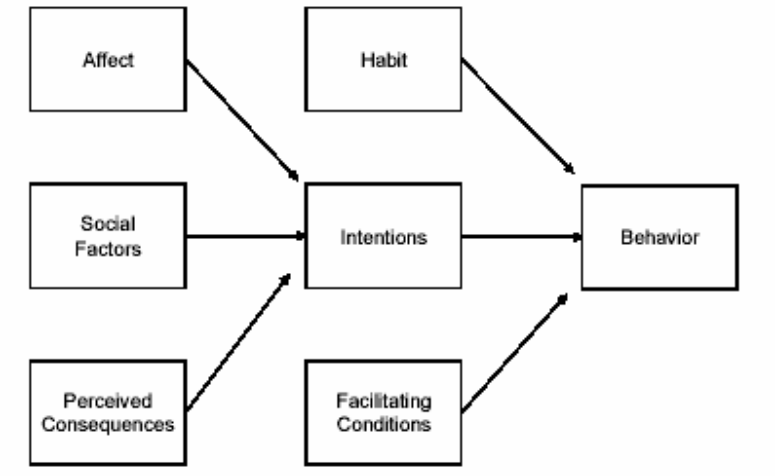


Figure 5. The Triandis Model of Choice

We examine TAM enhanced by the factors of social factors and facilitating conditions introduced by the Triandis Model of Choice (see Figure 6). Social factors and facilitating conditions are included in the model because those items are most prevalent within the rural environment where farming is usually dominant and seen as a viable for business. Social factors are defined as whether the subjects perceived that their peers and fellow farmers thought it good that they should use the 'third party,' technology-oriented knowledge and whether they would follow what others thought they should do.

As extension services require farmers to be conversant with 'state of the art' innovations in agriculture and its practices, extension workers have recognized KMS as a powerful tool to convey up-to-date information. This is an example of social factors that influence a farmer's use of the AGROWIT. Certain resources for agriculture can be found easily in the AGROWIT, including on-line lectures, periodicals, laboratory addresses, and sales outlets for hybrid seeds. Facilitating factors were conceptualized as the farmers', extension workers', and agricultural researchers' available support and ease of access to the KMS. In addition, these factors are also viewed as the results of marketing, an important aspect of business and thus an important aspect for this study to include.

3 RESEARCH MODEL AND RESEARCH HYPOTHESIS

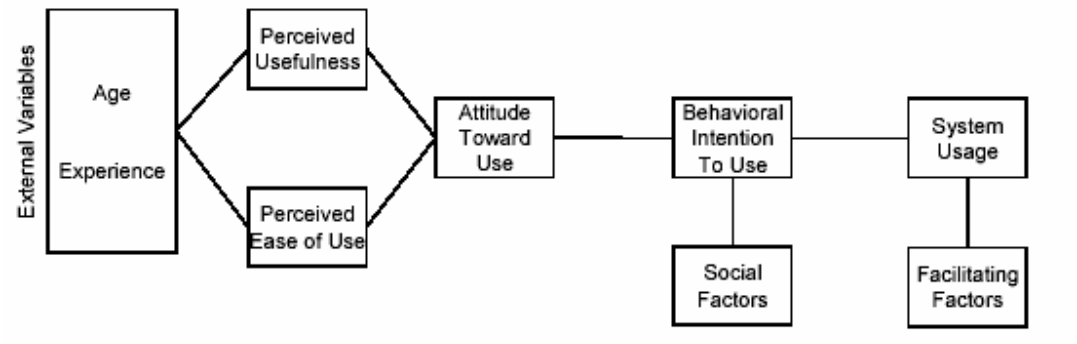


Figure 6. The enhanced TAM

3.1 Hypotheses

As mentioned previously, the model for this research is an extension of the TAM enhanced by factors adopted from the Triandis Model of Choice. The basic assumption is that social factors and facilitating factors have a positive effect on an individual's motivation to use KMS (e.g. AGROWIT). In addition, the factors of age and experience are taken into account when formulating these hypotheses. The research model is similar to Davis's original TAM (Figure 4). The "external variables" constructs are not included in the research model as there is no immediate intention to investigate antecedents for perceived usefulness and ease of use.

- **Hypothesis 1:** There is a negative relationship between age and (a) perceived ease of use and (b) perceived usefulness for using KMSs (i.e. AGROWIT).
- **Hypothesis 2:** There is a positive relationship between experience and (a) perceived ease of use and (b) perceived usefulness for using KMSs (i.e. AGROWIT)
- **Hypothesis 3:** There is a positive relationship between perceived ease of use and attitude.
- **Hypothesis 4:** There is a positive relationship between perceived usefulness and attitude.
- **Hypothesis 5:** There is a positive relationship between attitude and intention to use KMSs (i.e. AGROWIT)
- **Hypothesis 6:** There is a positive relationship between social factors and a user's intention to use KMSs (i.e. AGROWIT).
- **Hypothesis 7:** There is a positive relationship between intention to use and actual usage of KMSs (i.e. AGROWIT).
- **Hypothesis 8:** There is a positive relationship between facilitating factors and a user's actual usage of KMSs (i.e. AGROWIT)

4 METHODOLOGY

The data were collected based on the participation of farmers, extension workers and researchers in the agriculture media resource and extension centre of the University of Agriculture and other remote locations in Abeokuta, Ogun state, Nigeria. In order to implement this research study, a questionnaire was created based upon several previous studies of the TAM and KMS usage and distributed to 691 potential respondents. The questionnaire data were collected on a seven-point Likert-type scale and were active for four weeks. With the aim of reinforcing the users' anonymity, we did not create spaces for names in the questionnaires. As an incentive for participation in this survey, but in no way influencing user input, one hundred bags hybrid variety of maize and rice were given away in a random drawing.

5 DATA ANALYSIS

We received 370 good responses, which we considered encouraging. The reliability (i.e. internal consistency) of each of the measures was investigated with Cronbach's alpha shown in table 2. Correlations among variable were calculated, and the variables represented in each hypothesis were explored through regression analysis. The tools used in carrying out the analysis are SPSS 12.0 and PLS Graph 3.0. The partial least square (PLS) software was used to validate the results of the research as it involves a second - generation multivariate technique that is used in estimating structural models. It has the capacity to recognize two components of a causal model.

6 RESULTS

A summary of the demographic data can be viewed in Table 1. As was expected, the farmer population provided the majority of the feedback because of time spent in explaining the questions and traversing farm settlements.

Table 1. Demographic characteristics

Affiliation	**Number of participants**	**Percentage**
Researchers	56	15%
Farmers	210	57%
Extension workers	104	28%
Mean Age: 31 years; Standard Deviation: 9 years		

The validity and reliability of the survey were assessed first. In order to improve the reliability of the variables to be included in the model, two adjustments were needed. The first question on the Intention to Use (IU) scale "*I will use the AGROWIT for all my consultation*" was too restrictive when compared to the other questions in that factor category. Whereas the other three questions present some uncertainty about the user's future intentions, phrasing of question one with the word "will" makes the choice to use the KMS seem more definite. Users more than likely already have the advantage of either an extension service or system they are used to, such as a farmers' group to which they have become accustomed and dependent upon daily. The question is also more direct and not as open ended as the other three. Taking this into consideration, this question was removed from the dataset in an attempt to achieve greater reliability during data analysis.

The exact opposite was true of the fourth question on the Social Factors (SOCIAL) scale "*Generally speaking, I would use this KMS without pressure from external social factors.*" This question was too openly phrased. After omitting these two questions from the dataset, the reliability test was run again with results that were satisfactory. The results from the final round of reliability analysis are reported in Table 2.

Table 2
Cronbach's Alpha

Factor	Original alpha	Final alpha
Perceived Ease of Use	.5454	.8288*
Perceived usefulness	.7411	.7634*
Intention to Use	.5903	.6918
Attitude	.7447	.7447
Social Factors	.4347	.5700
Facilitating Factors	.6294	.6294
Actual Use	.8210	.8210

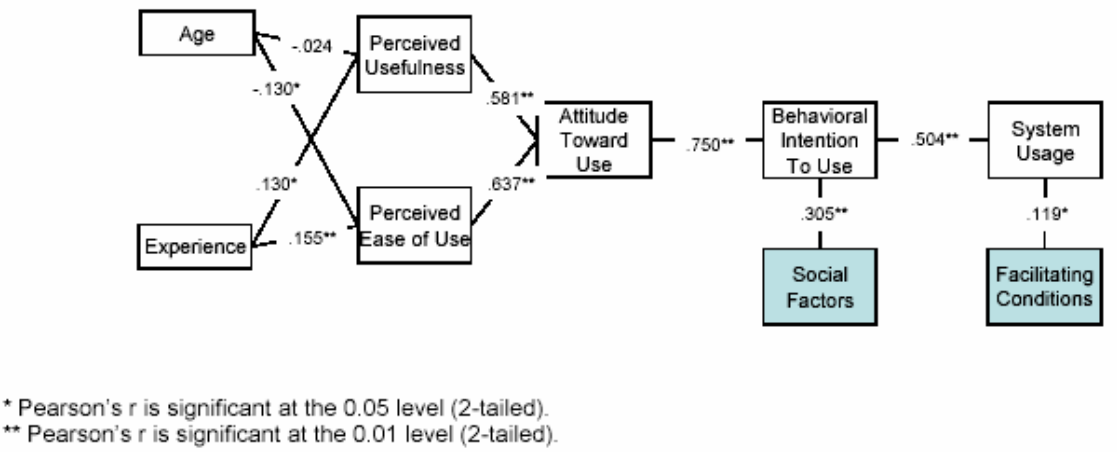
* Adjusted alpha as a result of reverse coded values for negatively phrased questions

To perform further analyses, it was necessary to create a new combined variable based on the averages of each of the seven constructs. A new variable was created based on each of the following constructs: perceived ease of use, perceived usefulness, intention to use, attitudes, social factors, facilitating factors, and actual usage. A correlation analysis was then run based on each of these constructs, and the results are reported in Table 3. Those paths relevant to the study's hypotheses are shown in Figure 7.

Table 3. Correlations

	AGE	EXPER	PEU	PU	IU	ATT	SOCIAL	FACIL	ACTUAL
Age (AGE)	1								
Experience (EXPER)	-.071	1							
Perceived Ease of Use (PEU)	-.130*	.155**	1						
Perceived Usefulness (PU)	-.024	.130*	.515**	1					
Intention to Use (IU)	-.042	.234**	.488**	.669**	1				
Attitudes (ATT)	-.102	.205**	.637**	.681**	.750**	1			
Social Factors (SOCIAL)	-.215**	.060	.126*	.398**	.305**	.263**	1		
Facilitating Factors (FACIL)	.084	.024	.581**	.476**	.414**	.553**	.188**	1	
Actual Usage (ACTUAL)	-.048	.305**	.228**	.434**	.504**	.395**	.338**	.119*	1

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).



* Pearson's r is significant at the 0.05 level (2-tailed).
** Pearson's r is significant at the 0.01 level (2-tailed).

Figure 7. Revised TAM with Bivariate Correlations

A series of regression analyses was also run on the data. Each linear regression analysis was based on the relationships between a set of independent variables and a single dependent variable. The resulting regressions were then run with two independent variables and one dependent variable. The results of the analyses are reported in Table 4, and the standardized beta coefficients are illustrated in Figure 8.

Table 4. Results of Regression Analyses

A. Dependent Variable: Perceived Ease of Use

Variables Entered	R Square	Adjusted R Square	Sig.
Age*, Experience**	.038	.033	..001

B. Dependent Variable: Perceived Usefulness

Variables Entered	R Square	Adjusted R Square	Sig.
Age, Experience*	.017	.012	.043

C. Dependent Variable: Attitudes

Variables Entered	R Square	Adjusted R Square	Sig.
Perceived Ease of Use**, Perceived Usefulness**	.575	.573	.000

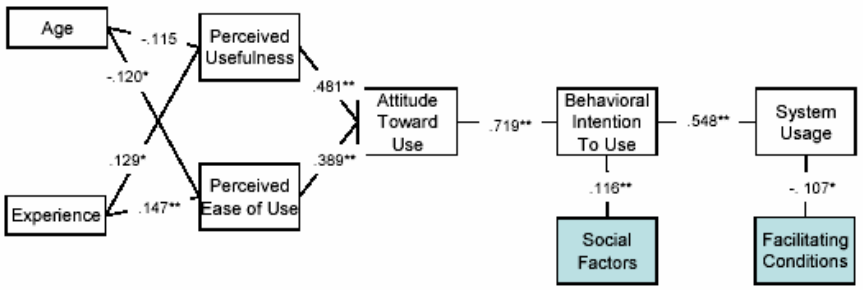
D. Dependent Variable: Intention to use

Variables Entered	R Square	Adjusted R Square	Sig.
Attitudes**, Social Factors**	.574	.572	.000

E. Dependent Variable: Actual Usage

Variables Entered	R Square	Adjusted R Square	Sig.
Intention to use**, Facilitating Factors*	.264	.260	.000

* Standardized beta coefficient is significant at the 0.05 level (2-tailed).
** Standardized beta coefficient is significant at the 0.01 level (2-tailed).



* Standardized beta coefficient is significant at the 0.05 level (2-tailed).
** Standardized beta coefficient is significant at the 0.01 level (2-tailed).

Figure 8. Extended TAM with Standardized Beta Coefficients

7 DISCUSSION

The results we obtained showed a strong Pearson correlation among the original variables of the TAM. Perceived usefulness (Pearson's r = 0.681) and perceived ease of use (Pearson's r = 0.637) both correlate strongly with user attitudes towards the intranet. These data, in addition to the R square and adjusted R-squared values of 0.575 and 0.573, support hypotheses 3 and 4, that there is a positive relationship between both PU and PEU with a user's attitudes towards KMS for agricultural extension usage. Attitude showed a strong correlation with a user's intention to use a KMS (Pearson's r = 0.750), and user intention had a strong correlation with actual use (Pearson's r = 0.04). In addition, looking at the correlations when compared with all the possible constructs, the strongest Pearson correlation values were between the original TAM constructs. Therefore the TAM and all of its constructs are significantly positively related to predicting a user's acceptance of a KMS.

Hypothesis 1 received only partial support. The relationship between age and perceived usefulness was not statistically significant. This finding was surprising given the results of previous studies regarding age and usage of the computer technologies. This discrepancy may be due to the fact that previous research on the use of computer technologies, especially KMS, incorporates a larger user base, including those that might not really fit in the research frame whose input can affect usage data.

The Pearson correlation values for the correlations between experience and perceived usefulness (Pearson's r = 0.130) and perceived ease of use (Pearson's r = 0.155) support hypothesis 2. The regression values from the data analysis back up the results from the correlations. R-square (r^2 = 0.017) and adjusted R-square (r^2 = 0.012) values for the analysis utilizing perceived usefulness as the dependent and age and experience as the independent variables were very low. This was also true when the dependent variable analyzed was perceived ease of use with low R-square (r^2 = 0.38) and adjusted R-square (r^2 = 0.033) values being returned. It also indicated that prior experience with KMS or knowledge of computer use is a stronger predictor of perceived ease of use and perceived usefulness than is age.

There were strong positive correlations for perceived ease of use (Pearson's r = 0.637) and perceived usefulness (Pearson's r = 0.681) with the construct of attitudes (Table 3). These relationships were a part of the original TAM, and the current data support the existence of these relationships (hypotheses 3 and 4 respectively). The regression analysis confirmed these findings. The highest R-square values in the regression analyses were found when attitude was the dependent variable and perceived ease of use and perceived usefulness were the independent variables. The regression analysis indicated that the relationship was stronger for perceived usefulness (â = 0.481) versus perceived ease of use (â = 0.389), as a predictor of user attitudes. The strongest relationship between any of the constructs was between attitudes and intention to use (Pearson's r = 0.750, â = 0.719), affirming hypothesis 5. There was also a positive relationship between intention to use and the last construct of the TAM, actual use. The positive relationship was found in both the correlation and regression analyses (Pearson's r = 0.504, â = 0.548).

The new factors adopted from the Triandis Model of Choice also proved to have a role in predicting user acceptance but were not as strong an indicator as any of the original TAM constructs. Hypotheses 5 and 6 were supported. Social factors were related to intention to use a KMS (Pearson's r = 0.305), and facilitating conditions were related to actual use (Pearson's r = 0.119), as hypothesized.

Social factors and facilitating conditions also contributed to high R-square and adjusted R-square values in predicting intention to use and actual use. Thus social factors can be effectively utilized in combination with user attitudes towards use to predict intent to use, and facilitating conditions can be effectively utilized in combination with intention to use to predict actual use.

7.1 Summary

The findings of this research are summarized in the table below.

Table 5. Summary of findings

Hypothesis	Result
1. There is a negative relationship between age and (a) perceived ease of use and (b) perceived usefulness for using KMSs (i.e. AGROWIT).	Partially Supported
2. There is a positive relationship between experience and (a) perceived ease of use and (b) perceived usefulness for using KMSs (i.e. AGROWIT)	Supported
3. There is a positive relationship between perceived ease of use and attitude.	Supported
4. There is a positive relationship between perceived usefulness and attitude.	Supported
5. There is a positive relationship between attitude and intention to use KMSs (i.e. AGROWIT)	Supported
6. There is a positive relationship between social factors and a user's intention to use KMSs (i.e. AGROWIT).	Supported
7. There is a positive relationship between intention to use and actual usage of KMSs (i.e. AGROWIT).	Supported
8. There is a positive relationship between facilitating factors and a user's actual usage of KMSs (i.e. AGROWIT)	Supported

8 CONCLUSION

This study further solidifies the strong relationships between the original TAM constructs when predicting KMS in extension service usage, in this case AGROWIT. Perceived ease of use and perceived usefulness are important constructs when determining user attitudes towards KMSs. Attitudes, in turn, strongly predict intention to use and intentions strongly predict actual usage. However, two additional constructs from the Triandis Model of Choice, social factors and facilitating conditions, were found to enhance the validity of the TAM. Age and experience, two external variables, proved to be useful predictors of general KMS usage, and they do fairly affect the usage of KMS. This perhaps can be attributed to the fact that most KMS users are either within the communities (social animals) and thus are influenced by social factors, such as peer pressure or societal restrictions.

Looking at user comments regarding the current the AGROWIT, responses could be mainly grouped into four categories: interface design issues (perceived ease of use), improving and updating agriculture resources (perceived usefulness), access issues as regard mobile technologies to farms (facilitating factors), and support issues (facilitating factors). These comments, in combination with the questionnaire results, will provide empirical data useful to the further development of the AGROWIT and similar KMSs.

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10 APPENDIX

More screens of the AGROWIT

Figure 9. The front page of the AGROWIT

Figure 10. The password page

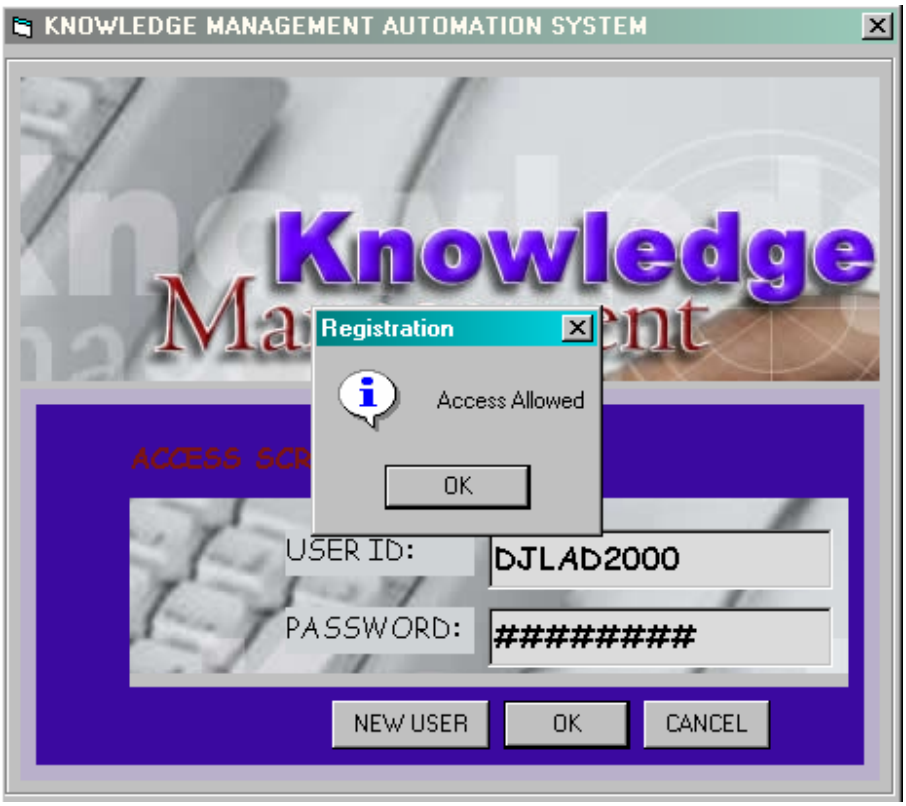

Figure 11. The database

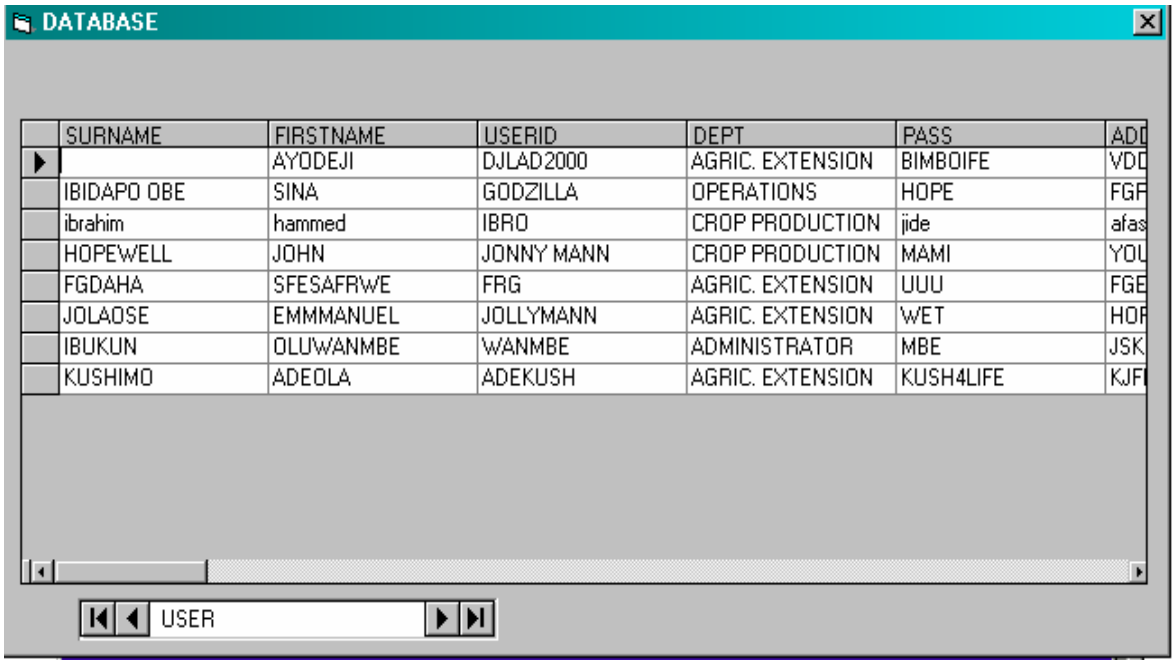

Figure 12. Some of the programs

subProgVideo : Table

ID	ProgCode	SubProg	video1	video2	video3
19	TRAINING5	AGRIC PRODUCTION AND FIELD EXPERIMENTATION			
18	TRAINING5	AGRICULTURAL TRAINNING AND WOKSHOP			
5	DEVELOPMENT8	AUDIO VISUAL PRODUCTION			
38	WOMEN7	COOPERATIVES AND GROUP FORMATION			