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RESEARCH ARTICLE

ADOPTION OF AUTOMATED TELLER MACHINE IN NIGERIAN BANKS: USE ENHANCEMENTS AND LIMITATIONS

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Abstract— The research looked at the adoption of automated teller machine in Nigerian banks: use enhancements and limitations. The researcher used primary data throughout the work by distributing questionnaires. The questionnaires were returned and analyzed. Based on the result of our analysis, the summary of findings is as follows: The attributes of diffusion (relative advantage, complexity, compatibility, triability and observability) as a whole have significant impact on the adoption of ATM. At any given time, the interaction and combination of these five attributes will either lead to the adoption or rejection of the ATM by users. This is however subject to users' different perceptions. Relative advantage as an attribute of diffusion significantly affects the adoption of ATM. Respondents found the ATM to be of more advantage than traditional human tellers. Some of these advantages are evident in the ATM's speed, efficiency, availability and relative safety of personal information (e.g. personal identification number, PIN and account balance). Complexity as an attribute of diffusion has no significant impact on the adoption of ATM. Though most people had trouble comprehending the maze of options on the ATM initially, persistence by some users led to successful use of the machine. Besides, the model of the machine has not changed much over the years. Anyone who succeeded in using the machine ab-initio will still be able to do so now. Compatibility as an attribute of diffusion significantly impacts the adoption of the ATM. It shows that the use of the ATM accommodates the lifestyles, activities and past values of the respondents. Also, societal trend which sees the ATM as a modern way of doing things contributed to the significance of this attribute in the adoption of ATM. Triability as an attribute has no significant impact on the adoption of ATM.

Key Terms: - ATM; bank; analysis; people; data; adoption

I. INTRODUCTION

Besides the fax machines, internet, GSM one innovation by man that has changed the method of modern business operation is the Automated Teller Machine (ATM). ATMs are long-standing ubiquitous examples of walk-up-and-use computer-based technology in public places. Using an ATM, bank customers can access their bank accounts in order to make cash withdrawals, credit card advances and check their account balances and purchase prepaid cell-phone credit all without need for human tellers. The ATM as is known today first

appeared in 1960 as a working prototype, was developed in 1969 and Docutel (an American company) was issued a patent in 1973[1][7][8][9][10]

After thirty-six {36} years of the introduction of the ATM, Nigeria joined the rest of the world in its use in2005 through the tireless efforts of the Central Bank of Nigeria (CBN) in collaboration with the Bankers Committee in a bid to reform the country's payment system and its use in the country has since burgeoned. In Nigeria today, banks are the major deplorers of ATMs. However, apart from banks, other non-financial organizations such as switching and transaction companies, vendors of ATM and point-of-sale (POS) employ various forms of e-payment in order to secure and/or increase their market share. Although due tits prevalence, the ATM is not likely to be the primary means by which banks increase their' profitability because ATMs are capable of handling more transactions per unit of time than human tellers [24][11][12][13][14][15]. The increased deployment of ATMs in the banking sector has made the issue of technology relevance important.

Agboola (2006)[1] as cited by Olatokun el al (2009) reported that only a bank had an ATM in1998. By 2004, thirteen (13) more had acquired the technology. Presently, there are over fifty (50) payment cards used by existing banks. They include ATM debit/credit cards, prepaid and e-purse. In addition, it has been observed that the adoption of ICT (the ATM being a tool of ICT) in banks has produced highly positive results such as improved customer service, accurate record keeping, convenience in business time, more efficient and faster services etc. Also, the banks' image has been re-presented, creating a more competent market. Work has been made more interesting and easier, the competitive edge of banks' relationship with customers has been improved and the solution to operational and planning problems has been made easier and available [21][19][22][23][24][25][26]. As a result, banks, after many years of being apprehensive of technology, encourage customers to make use of such technology (e.g. ATM) even subtly enforcing it by ordering that amounts less than N50,000 be transacted through the ATM. An ATM typically handles 100 to 250 transactions daily [27][28][29][30]. Available data on various e-payment channels reveal that the ATM is the most patronized, accounting for over 93% of the total e-transaction in Nigeria as at June 2007[15][16][17][18][19][20].

II. STATEMENT OF THE PROBLEM

Though ATM has become ubiquitous in Nigeria, its widespread adoption by bank customers yet remains unclear. It appears that customers' perception of the technology differ which affects the decision to use or not to use ATMs. Ideally, ATMs are set up to provide 24hour service to bank customers who cannot transact with banks in the same period of time. Nevertheless, it is observed that banks still have long queues of customers transacting with tellers within banking halls [1][2][3]. Also, the patronage of the ATM is not well defined as it is observed that sometimes long queues are seen at ATM posts while at other times, there are few or no customers waiting to use the ATM. As a technology, the ATM is supposed to make life easier and more efficient for customers and at the same time increase banks' turnover. It is therefore necessary to study and understand the reason for this and help banks establish and maintain a strong profit base by way of improving ATM services, if need be, to better satisfy customer needs [31[2][14][20][37[38[39].

III. OBJECTIVES OF THE STUDY

The central objective of the study is to examine the diffusion of ATM in Nigerian banks. The specific objectives include examining the extent of the adoption of ATM technology under the five (5) attributes of the Diffusion of Innovation theory as follows:

1. To examine the effect of the attributes as a whole on the adoption of ATM.
2. To examine the distinct effect of each attribute on the adoption of ATM.

IV. RESEARCH QUESTION(S)

Based on the statement of the problem and objectives of the study, the researcher poses the following questions:

1. To what extent do the attributes of diffusion as a whole affect the adoption of ATM?
2. To what extent does relative advantage as an attribute of diffusion affect the adoption of ATM?
3. To what extent does complexity as an attribute of diffusion affect the adoption of ATM?
4. To what extent does compatibility as an attribute of diffusion affect the adoption of ATM?
5. To what extent does triability as an attribute of diffusion affect the adoption of ATM?
6. To what extent does observability as an attribute of diffusion affect the adoption of ATM?

These questions will be answered on the basis of facts and figures that will be collected in the course of this study.

V. RESEARCH HYPOTHESIS

On the basis of the statement of the problem, objectives of the study and research questions, the following hypotheses have been formulated

H_{O1} : There is no significant effect of the diffusion attributes as a whole on the adoption of ATM.
H_{O2} : There is insignificant effect of each diffusion attribute on the adoption of ATM.

VI. SCOPE/LIMITATIONS OF THE STUDY

This study will be restricted to a survey of bank customers who use ATM in Owerri. The limitations faced in the course of carrying out this study include:

i) Limited time
ii) Epileptic power supply
iii) Reluctance on the part of users to speak their minds
iv) Lack of adequate funds.

The researchers were able to overcome the above mentioned problems.

VII. SIGNIFICANCE OF THE STUDY

The results of this study will be relevant to banks and other stakeholder organizations in using the DOI theory to model the use of ATM so that the progression of the use will be anticipated and adequately catered for. The findings of the study will also provide a wealth of information on how the technology is perceived and reveal areas that require improvements.

VIII. CHARACTERISTICS OF THE POPULATION

The totality of elements or subjects under study is called the study population. The total set of observations relevant to a study is known as the universe of population. Decisions must be made on how collected data will be used. This helps ensure the identification of the relevant universe or population. In conducting this study, the researcher had to estimate the subjects that make up the population of interest. The population of interest is carefully designed and preliminary steps taken to ensure that the sampled universe is the one intend to be sampled. This entails defining the target population- a finite population with predefined boundaries, geography and characteristics of individual subjects as well as the nature of variables under study[40][2][3][4][5][6].

For the purpose of this study, the target population is customers of all banks in Owerri who use the ATM. However, for time and financial constraints, 10banks of the 21banks present in Owerri were randomly selected. Hence customers of these 10banks who use the ATM formed the study population.

IX. SAMPLING DESIGN AND PROCEDURE

A non-probabilistic sampling method was used to select the sample for this study. A sample is non-probabilistic if the chances of selecting any element in the population is unknown and cannot be predetermined [40]. However, in the course of this study, a fairly representative sample of the population was obtained using the cluster sampling technique. The procedure involved the grouping of the study population into clusters and drawing samples from them. The number of customers patronizing a particular bank represented a cluster. Each cluster unit was considerably heterogeneous because its members were of different ages, from different backgrounds, belonged to different social classes and worked different jobs. However, members of all the clusters had a common characteristic, being ATM use. Each bank's ATM constituted a cluster while customers using the ATM of such banks constituted members of that cluster. There were altogether 10 cluster units representing the 10 selected banks.

X. DATA SOURCES

Data can be defined as raw facts and figures. Data for research may be classified as primary or secondary data. Both have been used in this study. The secondary data sources were journals, previously conducted studies and the internet. Primary data for this study was collected from the field using questionnaires [33][[38[39].

XI. INSTRUMENT AND METHOD OF DATA COLLECTION

The method adopted for this study involved the use of secondary data as a basis and guideline for the study. Primary data was used in analyzing how the five (5) attributes of the DOI theory can affect a user's intention to use the ATM and ultimately ATM adoption by that user. The data collection instrument deployed in this study was a structured mail questionnaire because questionnaires have a great deal of flexibility and can be used to gather information on any topic, from any population size [32][33][34][35][36][37].

11.1 Administration of Data Collection Instrument

For this study, a total of two hundred (200) questionnaires were administered to customers of the selected banks. This number was chosen for convenience and ease of analysis sake. The pattern of distribution is as shown in the table below.

11.2 Method of Data Analysis

Data collected from the questionnaires were analyzed using simple percentage and multiple regression analysis with the aid of SPSS (Statistical Package for Social Sciences) software. The adoption of ATM was regressed against the five attributes of the DOI- relative advantage, complexity, compatibility, triability, observability. Other tools that were deployed are the Analysis of Variance (ANOVA) and a 5-point Likert scale.

11.3 Multiple Regression Analysis

Regression analysis is a statistical tool that helps to predict variables on the basis of assumed nature of relationship between them [40]. The variable being predicted is usually referred to as the dependent variable or unknown variable because its values are determined by the values of the other variables variously referred to as independent variables, explanatory variables or predictor variables.

In regression analysis, one attempts to determine how given changes in certain variables affect other variables. A regression model may be simple, multiple, linear or non-linear. A regression model is said to be simple if there's only one independent variable and multiple if there are more than one independent variable. Multiple regressions seek to examine the nature of the relationship between a given dependent variable and two or more independent variables. The model describing the relationship between the independent variable $X_{1,} X_{2,} X_{3,...,} X_K$ and the dependent variable , Y can be expressed as

$Y_i = B_O + B_1 X_1 + B_2 X_2 + \ldots + B_K X_K + e_i$ ---------- 1

For I = 1,2,3,…, n

Where

Y_i is the dependent variable

$X_1, X_{2,} X_{3,...,} X_K$ are the independent variables

$B_{O,} B_{1,} \ldots, B_K$ are the unknown parameters to be estimated known as the regression coefficients

e_i is an independent and normally distributed random error

For the purpose of this study

Y represents the adoption of the ATM; X_1 re[resents relative advantage, X_2 represents complexity, X_3 represents compatibility, X_4 represents triability, X_5 represents observability.

11.4 Multiple regression and analysis of variance (ANOVA)

In multiple regression as in simple regression, the total deviation of each observation Y_i from the mean $Y(Y_I - Y)$ can be expressed as the sum of its explained and unexplained variables. That is,

$$\sum(Y_I - Y)^2 = \sum(Y_I - Y)^2 + = \sum(Y_I - Y) \quad 2$$

$SST = SSR + SSE$

Where

$(Y_I - Y)$ is the explained variable

$(Y_I - Y)^2$ is the unexplained variables

$$SST = \sum Y_I^2 \frac{(\sum Y_I)^2}{n} \quad 3$$

$$SSR = \sum Y_I^2 \_ \frac{(\sum Y_I)^2}{N} \quad 4$$

$$SSE = \sum Y_I^2 - \frac{\sum Y^2}{SST - SSR} \quad 5$$

Where

SST is sum of square total; SSR is sum of square due to regression; SSE is sum of square due to error.

The relevant sums of squares, degrees of freedom, mean squares and variance ratios for multiple regressions are summarized on the ANOVA table below 1.

TABLE 1: ANOVA table for multiple regressions

Source of Variation	Sum of Squares	Degree of Freedom		F-Ratio
Regression	$SSR = R^2 \sum Y^2$	K		$F = \frac{MSR}{MSE}$
Error	$SSE = \sum Y^2 - R^2 \sum Y^2$	N –k -1	$MSE = \frac{SSE}{n- k-1}$	
Total	$SST = \sum Y^2 - \frac{\sum Y^2}{N}$	N=1		

Source : Nworuh (2004)

11.5 Test for significance in multiple regressions

It is often necessary to test for a significant relationship between dependent variable Y and independent variables $X_1, X_2, \dots, X_K$. The test helps us ascertain whether or not there is a relationship between the dependent variable and the independent variables. It is a way of determining whether or not Y is dependent on $X_1, X_2, \dots, X_K$ or on the hypothesis.

$H_O : B_1 = B_{2.....} B_K = 0$ 6

H_A : Not all of B_1 _____ B_K are equal 7

$$F = \frac{MSR}{MSE}$$

The null hypothesis H_O has an F- distribution with k and n-k-1 degrees of freedom.

H_O is accepted at the α significant level if

$F^* < F_i - \alpha ; k, n- k- 1$ ---------- 8

Otherwise H_O is rejected and H_A is accepted. $F_i - \alpha ; k, m - k - 1$ is usually the critical value obtained from an * F-distribution table at the α significant level with k and n – k – 1 degrees of freedom.

Therefore, $F^* < F_i - \alpha ; k, n - k - 1$ we make our decisions.

11.6 The T-test for multiple regression co-efficient

The coefficient of regression is a very important parameter of the regression function. It measures the average change in the dependent variable Y as a result of a unit change in independent variable X. Having determined that a significant relationship exists between dependent variable Y and independent variable X from the F-test, there is need to carry out further test on the regression coefficient and hypotheses. Thus, if the null hypothesis, H_O is rejected we may further examine the individual regression coefficients to ascertain which ones contribute to the significance by testing the null hypothesis.

The test statistics is as stated below:

$$t = \frac{b_i - \beta_{iO}}{S_{bj}}$$

Where

B_{iO} is a specified value which could be zero

S_{bj} is the statistical error for b_i and is calculated thus

$$S_{bj} = \sqrt{MSE_{eij}}$$

Where

E_{ij} is a constant called Guass multiplier. The null hypothesis is accepted at the significance level if $t/ < \alpha/2, n - k - 1$. Otherwise H_O is rejected and H_A is accepted.

10.7 Coefficient of multiple determination R^2

The coefficient of multiple determination R^2 measures the proportion of the total variation in the dependent variable Y that is attributable to the dependence of Y on the independent variables X_1, X_2, $X_{3,\ldots}$ X_K, inclusive of the regression [40].

R^2 is zero when all b_i (1,2,3, . . ., k) = 0 and is 1 when all observations fall within the fitted regression line. That is when $y_i = Y_I$ for all I

R^2 is given as

$$R^2 = \frac{SSR}{SST} = \frac{SST - SSE}{SST} = \frac{1 - SSE}{SST} \quad \text{----------} \quad 9$$

11.8 The 5-Point Likert scale

A 5-point Likert scale had been deployed for this study. The Likert summated scale contains a list of attitude related statements in questions in which respondents are required to indicate their degree of agreement or disagreement with each statement [38]. A numerical score is assigned to each degree of agreement or disagreement. Each category of" strongly disagree"," disagree", "neutral", "agree" and "strongly agree" are assigned with the values of 1,2,3,4,5 respectively.

XII. RESULT PRESENTATION AND DESCRIPTION

Below is a presentation of the data collected from the field. Table 4.1 shows the summary of the assessment of the adoption of the ATM with the corresponding weighting of the factors that are believed to influence that adoption based on the opinions of ATM users of the selected banks in Owerri (Imo state). The attributes used are defined as follows:

Y = represents the adoption of ATM; X_1= represents relative advantage; X_2 :represents complexity;

X_3 : represents compatibility; X_4 :represents triability; X_5:represents observability

TABLE 2: Model Summary

Model	R	R square	Adjusted R square	Std error of the estimate
1	.463	.214	.190	3.02596

a) Predictors: (Constant) observe, complex, reladv, triab, compat

b) Dependent variable: Adoption

TABLE 3: Model Summary[b]

	Change Statistics					
Model	R square change	F change	Df1	Df2	Std F change	Durbin Watson
1	.214	8.817	5	162	.000	1.563

12.1 Estimation of Relationship Model and Interpretation

In estimating the relationship model, the data on Table 1 was subjected to multiple regression analysis using SPSS (Statistical Package for Social Sciences) version 11. The output of the regression analysis are presented in Tables 2, 3 and 4.

TABLE 3: ANOVA

Model		Sum of Squares	Df	Mean square	F	Sig
1	Regression	403.653	5	80.731	8.817	.000[a]
	Residual	483.341	162	9.156		
	Total	1886.994	167			

a) Predictors: (Constant) observe, complex, reladv, triab, compat

b) Dependent variable: Adoption

TABLE 4: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients		
	.B	Std Error	Beta	t	Sig
1. (Constant)	13.25	2.304		5.766	.000
Reladv	.277	.102	.206	2.715	.007
Complex	.129	.113	.084	1.140	.256
Compat	.154	.074	.258	3.444	.001
Triab	.126	.125	.075	1.002	.318
Observ	.113	.097	.005	1.301	.195

a) Dependent variable: Adoption

The regression results as shown in Tables 2, 3 and 4 above are as follows

R square = 0.214; Adjusted R = .190; Durbin Watson = 1.563; F_{cal}= 8.817

Significance = .000. Also using the regression results on the above Tables, we estimated the following relationship model

$Y = 13.285 + 0.277X_1 + 0.129X_2 + 0.254X_3 + 0.126X_4 + 0.113X_5$ _____ 10

The interpretation of the relationship model on the basis of our multiple regression analysis (as shown in Tables 2, 3 and 4 is as follows:

1). Equation (10) shows the level of relationship existing between Adoption of ATM and the five explanatory variables (attributes of ATM diffusion – X_1, X_2, X_3, X_4, X_5) is slightly strong.

The R is given as 0.463 that is 46.3% correlation exist between tha dependent variable, Adoption of ATM and tha five independent variables (attributes of diffusion of innovation).

2). Table 2 shows that 21.4% of the variation in the adoption of ATM can be explained by the cumulative variations in the five independent variables when all possible error in the estimation is taken into consideration.

3). The standardized error in the estimation of the adoption of ATM using the five variables (X_1, X_2, X_3, X_4, X_5) of 3.026 is not significant as the Durbin Watson statistics of 1.563 is less than 2.0, the benchmark (as shown in Table 3.

12.2 Hypotheses Testing

The formulated hypotheses were tested as follows:

12.2.1Hypothesis ONE

H_{O1}: There is no significant effect of the diffusion attributes as a whole on the adoption of ATM.

H_{A1}: There is significant effect of the diffusion attribute as a whole on the adoption of ATM.

The F-calculated value of 8.817 with probability value of $.000_a$ is significant at 0.05 level of significance. Therefore, we reject the null hypothesis and conclude that there is significant effect of the diffusion attribute as a whole on the adoption of ATM.

12.2.2Hypothesis TWO

H_{O2} : There is no significant effect of each diffusion attribute on the adoption of ATM.

H_{A2} : There is significant effect of each diffusion attribute on the adoption off ATM.

The sub-hypothesis of the second was tested using t-test as follows:

$H_{O2(a)}$: There is no significant effect of relative advantage on the adoption of ATM

$H_{A2(a)}$: There is significant effect of relative advantage on the adoption of ATM.

The t-calculated value of 2.715 with probability value of 0.007 for relative advantage is significant at 0.05 level of significance (since the p-value is less than 0.05). Hence, we reject H_O and accept H_A, thereby concluding that there is significant effect of relative advantage on the adoption of ATM.

$H_{O2(b)}$: There is no significant effect of complexity on the adoption of ATM

$H_{A2(b)}$: There is significant effect of complexity on the adoption of ATM

The t-calculated value of 1.140 with probability value of 0.256 for complexity is not significant at 0.05 level of significance (since the p-value is greater than 0.05). Hence, we accept H_O and conclude that there is no significant effect of complexity on the adoption of ATM.

$H_{O2©}$: There is no significant effect of compatibility on the adoption of ATM.

$H_{A2©}$: There is significant effect of compatibility on the adoption of ATM.

The t-calculated value of 3.444 with probability value of 0.001 for compatibility is significant at 0.05 significance level (since the p-value is less than 0.05). Hence, we reject H_O and accept H_A and conclude that there is significant effect of compatibility on the adoption of ATM.

$H_{O2(d)}$: There is no significant effect of triability on the adoption of ATM

$H_{A2(d)}$: There is significant effect of triability on the adoption of ATM.

The t-calculated value of 1.002 with probability value of 0.318 for triability is not significant at 0.05 level of significance (since the p-value is greater than 0.05). Hence, we accept H_O and conclude that there is no significant effect of triability on the adoption of ATM.

$H_{O2(e)}$: There is no significant effect of observability on the adoption of ATM

$H_{A2(e)}$: There is significant effect of observability on the adoption of ATM.

The t-calculated value of 1.301 with probability value of 0.195 for observability is not significant at 0.05 level of significance (since the p-value is greater than 0.05). Hence, we accept H_O and conclude that there is no significant effect of observability on the adoption of ATM.

XIII. SUMMARY OF FINDINGS AND CONCLUSION

Based on the result of our analysis, the summaries of findings are as follows:

1. The attributes of diffusion (relative advantage, complexity, compatibility, triability and observability) as a whole have significant impact on the adoption of ATM. At any given time, the interaction and combination of these five attributes will either lead to the adoption or rejection of the ATM by users. This is however subject to users' different perceptions.
2. Relative advantage as an attribute of diffusion significantly affects the adoption of ATM. Respondents found the ATM to be of more advantage than traditional human tellers. Some of these advantages are evident in the ATM's speed, efficiency, availability and relative safety of personal information (e.g. personal identification number, PIN and account balance).
3. Complexity as an attribute of diffusion has no significant impact on the adoption of ATM. Though most people had trouble comprehending the maze of options on the ATM initially, persistence by some users led to successful use of the machine. Besides, the model of the machine has not changed much over the years. Anyone who succeeded in using the machine ab-initio will still be able to do so now.
4. Compatibility as an attribute of diffusion significantly impacts the adoption of the ATM. It shows that the use of the ATM accommodates the lifestyles, activities and past values of the respondents. Also, societal trend which sees the ATM as a modern way of doing things contributed to the significance of this attribute in the adoption of ATM.
5. Triability as an attribute has no significant impact on the adoption of ATM. Most people just decided to adopt and use the ATM without first trying it out. This is due in part to the fact that the use of the ATM became a societal norm and also to the fact that banks enforced the use of the ATM by ordering that amounts less than N50,000 be transacted through the ATM.
6. Observability as an attribute of diffusion has no significant impact on the adoption of ATM. This is probably due to the fact that observations are subject to respondents' perceptions and discernment so that what seems like benefit to one may not be the sane to another. Based on the summary of findings, we conclude thus;

The interaction and combination of the attributes of diffusion - relative advantage, complexity, compatibility, triability and observability – will always affect users' adoption of the ATM. The combination of these attributes must meet user's expectation and/or specific needs for the technology to be properly adopted. In addition, relative advantage- how fast, efficient and available the ATM is, how convenient it is to use the ATM and compatibility- how well the ATM supports and accommodates the lifestyles and values of users is a strong determinant in the adoption of the technology.

XIV. RECOMMENDATIONS

On the basis of the summary of findings and conclusion, we hereby recommend the following:

1. Since relative advantage had the greatest single impact on the adoption of the ATM, banks and other financial institutions should make the technology more available. They should collaborate

with designers to ensure that the machine is designed to be more efficient, record minimal error and employ stricter security measures. All of these will enhance the use of the machine as well as increase the machine's capability. This will lead to the adoption of the technology by non-adopters and greatly decongest banking halls.

2. Specifically, the following strategies would assist in consummating greater diffusion of ATM in Nigeria, and Owerri in particular. Enhanced salience of ATM to customers' needs greater compatibility of ATMs to customers' banking norms and lifestyles.
3. In addition, because complexity, triability and observability all contribute in making the attributes as a whole significant, banks should see to the development and design of less complex and easy to use systems that do not require a lot of mental and physical effort to accomplish transactions (easy to read, comprehensive instructions, prompt processing of transactions, enhanced interactivity etc). Banks should also allow users the opportunity to experiment the system before enforcing the technology. ATMs should also be made to meet users' immediate needs more. By so doing, non-adopters could observe the benefits and decide to adopt the technology.

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