QUANTITATIVE INSTRUMENT FOR MEASURING THE ACCEPTABILITY OF IRIS BIOMETRIC AUTHENTICATION APPROACH IN PUBLIC PLACES

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Abstract-***The world has turned to a global village via information technology (IT). The innovation has paved ways for ubiquitous access to IT-driven services. The fast growing and dynamic world of information technology has called for fast responding and reliable security devices. The singular fact is that almost all business data are now being converted into an electronic form which requires us to protect such information from some unethical persons who are always exploring possibilities of gaining illegal access to the information. There is serious security threat with the conventional Personal Identification Number (PIN) entry system most especially in developing nations with series of socio-economic problem. This led to the suggestion of iris-based biometric authentication to guarantee maximum authentication security in all domains. This paper discusses the development of the quantitative instrument (questionnaire) for measuring user's behavioural intention to use iris-based authentication in public places using Unified Theory of Acceptance and Use of Technology (UTAUT) as the underpinning theory. The items of the instrument were gathered from both the previous adoption theories and the previous scholarly works on iris biometric identifier. The tangible end product here is the final instrument. The reliability of the constructs is also discussed.***

Keywords-Acceptability, Quantitative, Instrument, iris-base, biometric, authentication

1.0 Background to the study

Authentication can also be defined as a means of verifying or confirming that someone or something is who or what is claimed to be. Within the context of computer networks including internet, authentication is mostly achieved via the use of logon passwords, where the knowledge of the password is assumed to confirm the authenticity of the user. The major weakness of this approach most especially for security-critical system such as exchange of money is that the password can be stolen, accidentally revealed or forgotten. This among other factors called for the need to provide a more stringent and secured authentication approach for the emerging sensitive ubiquitous transactions [3, 13].

In Nigeria, where corruption is at its peak due to series of socio-economic crisis, it has been recommended that the introduction of biometric features for public authentication will go a long way in reducing the corruption level and at the same time resulting into socio-economic growth of the country [11]. The author stressed further that there should be inclusion of biometric trait for getting access to banking services via ATM. It is recently revealed that the victims of ATM unauthorized withdrawals in Nigeria have teamed up and they have sued the central bank of Nigeria (CBN), 24 Nigerian commercial banks and the interswitch (the company responsible for inter connectivity among both Nigerian and international banks to pay a sum of fifty (50) billion naira as the general damages for the withdrawals, 2.5 million naira as the money lost to the withdrawals, 100 million naira as the cost of litigation and lastly 10 million naira as the cost of providing notice to the defendants[19].

Research on technology acceptance and diffusion becomes very crucial as it provides pre information on how organizations can benefit from the introduction and use of IT [31]. Similarly, it was revealed that no matter how robust an information technology is, it can only be profitable if such technology is accepted and used [30].

Nevertheless, the beauty of information technology does not come without its inherent problem. It was reported that

Privacy Rights Clearing House revealed that since 2005, over 93 million data records of U.S residents have been exposed as a result of data security breaches [13]. Such profile cases within corporate America and the U.S government have exposed a glaring vulnerability within organizations; such difficulty in keeping sensitive data secured called for stronger user authentication. Similarly, observed that there is an urgent need to come out with a reliable identity management system so as to reduce the epidemic growth in identity theft and as well for meeting the emerging security demands in a variety of applications [4]. This among others security problem associated with using information technology approach for public service delivery has proved the need for a more secured approach of interacting with public terminals.

Additionally, In Nigeria where corruption is at its peak due to series of socio-economic crisis, it has been recommended that the introduction of biometric features will go a long way in reducing the corruption level and at the same time resulting into socio-economic growth of the country [11]. The author stressed further that there should be inclusion of biometric trait for getting access to banking services via ATM.

Several researchers have proposed biometric identification as the alternative to the inherent problems of both token-based and knowledge-based authentication. Token-based authentication approach is a means of identifying an individual based on the evidence of holding a tangible token like identity card while knowledge-based authentication approach is a means of verifying identity based on having knowledge of something like password. It then becomes necessary to determine the acceptance of such authentication technology. This research work has to do with determination of user's acceptance of a more secured, novel approach of authenticating user's identity while using public zone's terminals (iris-based approach) using empirical method. Though, there are different forms of iris-based authentication methods proposed by a number of researchers [10, 12, 15, 16] in this study, iris-based authentication is going to be universally considered without being specific about a particular iris processing method. This is to give a universal view based on general characteristics of human iris as a biometric identifier.

The motivation for designing the instrument came from two angles, first, the fact that there are only few studies of technology adoption on public usage [18]. The second reason for developing a specific instrument is for the fact that previous studies have linked the delay in the implementation of iris authentication to certain constraints like impossibility of working with eye glasses, relatively small distance allowed, wrong positioning, fear eye damage and fear of misuse of the iris image [2, 5, 9, 18, 22, 23]. Items added in this respect makes the designed instrument specific for measuring acceptance of iris authentication in public places not even within an organization.

2.0 Materials and Methods

2.1 Instrument Design

It gives the findings of quantitative studies more validity if the items that constitute the instrument are product of research outputs from various points of view in a given domain of study [20]. In line with this, all the items of the questions are evidenced from a number of sources of literature. For the UTAUT constructs, the main items are adapted and reframed to suite this domain of study; other items are from the result of content analysis from previous studies. The development of the main survey instrument in this study is guided by the underpinning theory UTAUT and the relevant literatures. Out of the six dimensions of behavioural intention, Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI) and Facilitating Condition (FC) are contained in the original UTAUT [31] where]only Attitude (ATT) and Anxiety (ANX) are the newly included dimensions studies [6, 8, 14, 25, 28, 29, 30]. Self-Efficacy (SEF) is also added as an effect variable to establish the correlation between self-efficacy and effort expectancy in this domain of technology diffusion [5, 14, 28, 27]. For every construct in the research instrument, a dummy item is included to discover the seriousness of the respondents in filling the questionnaire so as to determine the usability at individual respondent's level. Table 1 contains the discussion on how the items for each of the constructs are developed. The final instrument is shown in Table II.

2.1.1 Performance Expectancy (PE): This measures the degree to which an individual perceives that using the system could help improve his or her performance. Items under PE are constructed both from the theory, UTAUT and from the relevant literatures. The first four items of the construct, PE1, PE2, PE3 and PE4 are adapted from [31] and only reframed to suite this domain of study. This is supported with previous related studies [8, 27, 28, 29]. The fifth item, PE5 is constructed from the view of [18] while the sixth item, PE6 is constructed around a number of studies as well [1, 3, 7, 13, 15, 17, 22, 24, 26]. Lastly, the last item in this construct, PE7 is derived from the studies of [2] and [26].

2.1.2 Effort Expectancy (EE): This measures the degree to which an individual perceives the system will be easy to use or the degree of associated ease with the use of a system. For the EE construct, a total of five items are constructed for this dimension where all the five items, EE1, EE2, EE3, EE4 and EE5 are equally adapted from [31] and supported by various studies [8, 27, 28, 29]. The items are similar to that of the conventional perceived ease of use construct of [8]. The items are shown in Table II.

2.1.3 Social Influence (SI): This measures the degree to which an individual perceives that the person who she cares about feel that she should use the new system. The third dimension of the study, SI construct is made up of six main items where the first three items, SI1, SI2, SI3 and SI4 are adapted from the original UTAUT [31] supported by other studies [5, 30]. Other items are constructed based on the reviews from various studies in relation to the current issues about the technology under study. For the fifth item SI5, it is constructed around a number of previous studies [3, 18, 22]. The last item here, SI6 is constructed based on the views of [9] and [13].

2.1.4 Facilitating Condition (FC): This measure the degree to which an individual believes that an organizational and technical infrastructure is provided to assist in facilitating the use of the system. Considering the six items under FC dimension, similar to the SI construct, the first four items, FAC1, FAC2, FAC3 and FAC4 are adapted from the original UTAUT [31] supported by other studies [5, 30]. The last two items, FAC5 and FAC6 are constructed around the views of [18] and [2] on the fear of users about iris authentication approach.

2.1.5 Attitude (ATT): Attitudes have been defined within the context of information technology use and acceptance as individual attitudes towards behaviour as to whether to use or accept a new information technology or not [6]. For the ATT construct, the four items adapted from [31] are used which are supported by other studies [6, 8, 14].

2.1.6 Anxiety (ANX): Individual anxiety towards toward a particular behaviour can be generally defined as the evoking anxious or emotional reactions toward the behaviour in question. The ANX dimension is made up of five survey items, ANX1, ANX2, ANX3, ANX4 and ANX5 which are all adapted from [31] with evidences from authors of related studies [28, 28, 30]. The developed items are shown in Table II.

2.1.7 Self-Efficacy (SEF): According to [6], perceived self-efficacy can be defined as the beliefs of people about their capabilities to achieve specified level of performance which plays major role on events that affect their life. The construct SEF is developed from the views of the previous authors who have used the items to measure self-efficacy in various domain of technology diffusion studies. Evidences drawn from a number of authorities form the basis of constructing the nine items of the dimension [6, 14, 27, 28]. The importance of the sources is due to the conflicting positions between the previous studies and [31] on whether self-efficacy really influences behavioural intention or such influence has been captured by effort expectancy.

2.1.8Behavioural Intention (BI) Dimension

This being a standard variable that have been used widely in measuring technology diffusion, the four items of the construct (BI1, BI2, BI3, BI4) are all adapted from [31] with evidences from authors of related studies [28, 29, 30].

Table II shows the final instrument using five scale ("1-strongly"disagree", "2 – disagree", "3 – neutral", "4- agree" and "5- strongly disagree").

2.2 Measuring Reliability

The pilot study which was conducted between February and March, 2009 among 31 ATM users' with 18 males and 13 females. 11 of the respondents falls between age 16 and 30, 12 are between age 31 and 45 while the remaining 8 are above age 45. The reliability testing yields the following results for each of the research variable with a view to justify reliability of the construct through the consistency of its items to measures the variable in question as explained by [21]. As can be seen from the average cronbach's Alpha for all the constructs are greater than 0.7 required with performance expectance (0.882), effort expectancy (0.878), self-efficacy (0.823), attitude (0.909), social influence (0.969), facilitating condition (0.788), anxiety (0.967) and behavioural intention (0.838) as shown in Table I. This means that all the constructs of the instrument are considered reliable as revealed that any reliability of cronbach's alpha of 0.7 and above is acceptable [23]. It implies that there is consistency among the items that constitute each of the dimensions. This might be attributed to the fact that, the instrument has undergone series of peer review by experts in quantitative studies prior to the pilot study.

Table I: Average Reliability of the Construct

Construct	No. of items	Average Cronbach's Alpha
Performance Expectancy	7	0.882
Effort Expectancy	5	0.878
Self-efficacy	9	0.823
Attitude	4	0.909
Social Influence	6	0.969
Facilitating Condition	6	0.788
Anxiety	5	0.967
Behavioural Intention	4	0.838

Justification for the Instrument

The instrument is specific to iris authentication technology adoption because most of the items are drawn from the established constraints of the technology revealed by a number of studies [2, 3, 22]. Therefore, the instrument can only be used for measuring user behavioural intention of iris authentication technology. Being the first empirical study to investigate the pre-use acceptance of iris authentication technology since previous works have only being engaged in determined the usability of certain iris authentication system without consideration to the general psychological implications of using the technology as exercised by the users. The instrument thus, provides adequate means of determining the readiness of users to use iris authentication approach in general without being specific to one type or another.

Table II
Final Instrument items

Items Under Performance expectancy	Code
I would find the technology useful for authentication in public places.	PE1
Using the technology aids in accomplishing authentication more quickly in public places.	PE2
Using the technology will increase my authentication productivity.	PE3
Using the technology will open better opportunities for public transactions without any fear of security threat.	PE4
Using the technology will support the ubiquitous service delivery since nothing external is required for authentication	PE5
Using the technology will facilitate a more secured public authentication.	PE6
Using the technology will help to avoid time wastage.	PE7
Items Under Effort Expectancy	**Code**
If my interaction with the technology would be clear and understandable.	EE1
If it will be useful for me to become skillful at using the technology	EE2
If I find the authentication technology easy to use	EE3
If Learning to operate the technology is easy for me	EE4
If interaction with the system does not require a lot of my mental effort	EE5
Items Under Self-Efficacy	**Code**
If I never use the technology before	SEF1
If I have only the manuals for reference	SEF2
If I could call someone for help if I got stuck	SEF3
If I have seen someone using it before	SEF4
If someone had helped me to get started	SEF5
If a lot of time is given to me	SEF6
If I had got built-in help facility for assistance	SEF7
If someone showed me how to do it first	SEF8
If I have used similar approach before for authentication	SEF9
Items Under Attitude	**Code**
Using the technology is a good idea	ATT1
The technology will make public authentication to be more interesting	ATT2
Working with the technology will be friendly	ATT3
I will like working with the authentication technology	ATT4
Items Under Social Influence	**Code**
I am not compelled to use it by people who	SI1

influence my behaviour	
Using it is not based on the decisions of people who are important to me	SI2
The organization rendering the service will support the use of the authentication technology.	SI3
The authentication device is put in a strategic location	SI4
The fear of the damage the authentication technology can do my eye is removed	SI5
I am sure that my biometric data cannot be misused for unintended purpose at my expense	SI6
Items Under Facilitating Condition	**Code**
The organization provides all resources required to aid interaction	FAC1
I have the required knowledge to use it	FAC2
The technology is compatible with the previously used one.	FAC3
A specific person is made available in case of difficult situations	FAC4
The authentication technology can work with glasses and lenses	FAC5
The technology can work at a reasonable distance away from the user to avoid the fear of eye damage.	FAC6
Item Under Anxiety	**Code**
There is possibility of feeling apprehensive about using the authentication technology	ANX1
I am likely to be scared of using such complicated technology	ANX2
I hesitate using the technology for fear of making mistakes	ANX3
I considered the technology intimidating	ANX4
I am fully prepared to use the authentication technology as soon as it is fully implemented	ANX5
Items Under Behavioural Intention	**Code**
I intend to use the technology in the nearest future	BI1
I predict I will use the technology as soon as it is fully implemented	BI2
I plan to use the technology in the nearest future	BI3
I intend using the technology provided I have access to it	BI4

3.0 Data Validity for the actual study

The Exploratory Factor Aanalysis (EFA) was performed as initial analysis employing the principal component method and Principal Factor Analysis (PFA) was used as the factor extraction method where the variance is shown in descending order. The decision to either remove an item or not is based on loading less than 0.3, double loading and wrong loading [21, 23]. All This led to many items being dropped as shown in Table III while Table IV show the result of the factor loading for the retained items. Two items are dropped under PE variable only one item was dropped under ANX and FAC.

Table III
Dropped Items after factor analysis

Constructs (variables) and number of Items dropped	Specific Items dropped	Justification
Performance Expectancy: Two	PE4 PE6	Loading less than .6 (.477)

items out of seven items		Loading less than .6 (.483)
Anxiety: Only one item out of five items	ANX3	Loaded on a wrong factor
Facilitating Condition: Only one item out of six items	FAC3	Loading less than .6 (.570)

Table IV
Exploratory Factor Loadings

Items	Component						
	1	2	3	4	5	6	7
PE1	.847						
PE2	.800						
PE3	.801						
PE5	.820						
PE6	.774						
EE1		.852					
EE2		.755					
EE3		.747					
EE4		.860					
EE5		.620					
SI1			.711				
SI2			.824				
SI3			.906				
SI4			.770				
SI5			.839				
SI6			.688				
FAC1				.789			
FAC2				.877			
FAC4				.806			
FAC5				.929			
FAC6				.794			
ATT1					.891		
ATT2					.922		
ATT3					.931		
ATT4					.860		
ANX1						.799	
ANX2						.879	
ANX4						.898	
ANX5						.706	
SEF2							.779
SEF5							.854
SEF7							.686
SEF8							.902

Total variance explained (%) is 84.872 , KMO is .705 , and at (p = .000)

4.0 Conclusion

The strength of the instrument over the existing technology adoption and diffusion instrument is its ability to integrate the identified constraints behind the successful implementation of the iris authentication technology which makes it to be suitable for the domain and also, it presents technology acceptance in public places which only few studies have contributed in this regard. This paper gives an overview of how the research instrument for measuring acceptability of iris-based authentication through behavioural intention by following both the underpinning theory and the relevant academic literatures and the result of the pilot study shows that the instrument is reliable. The reason for following the due process in the questionnaire development is to validate the contribution that the findings of this is study is going to make both to the theory and practice of technology diffusion most especially in this domain of study. After designing the instrument it is given to five experts in quantitative studies who are senior lecturers and above for proper review before proceeding to pilot testing and more so, the comments resulting from the pilot test are adequately taken care of by making some necessary adjustments to the instrument.

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