



UNIVERSITI PUTRA MALAYSIA

***FRAMEWORK FOR EVALUATING SUITABILITY OF GRAPHICAL USER
AUTHENTICATION FOR MOBILE BANKING***

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**FRAMEWORK FOR EVALUATING SUITABILITY OF GRAPHICAL USER
AUTHENTICATION FOR MOBILE BANKING**

By

EJIKE EKEKE KINGSLEY

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfillment of the Requirements for the Degree of Master of Science**

December 2016

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

FRAMEWORK FOR EVALUATING SUITABILITY OF GRAPHICAL USER AUTHENTICATION FOR MOBILE BANKING

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December 2016

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User Authentication is a vital component in any Information System. There are various ways of implementing user authentication from using text-based passwords, biometric passwords and graphical images password. The importance of selecting an environment appropriate user authentication method is one of the crucial decisions in encouraging the user to adopt the application. The main purpose of User Authentication in applications is to allow the application to verify the identity of the person who wants to connect to the application being used.

In mobile banking, research shows that the current mode of user authentication plays an important role in influencing customer's intentions to use mobile banking services. The research problem stems out of the perceived low adoption of mobile banking. Further research revealed that the main problems for the low adoption of mobile banking includes the cognitive burden users' face in remembering text-based passwords, the usability issues hindering the adoptability of mobile banking based on current mobile banking user authentication methods and the current mode of user authentication. One of the motivation for this research study stems out of the positive supporting research surrounding graphical user authentication as a viable alternative to text-based passwords.

Tackling the adoption issues relating to mobile banking, a preliminary study done revealed that usability issues are one of the reasons that contribute to users' hesitation to adopt mobile banking. Research done on the current models, methods and frameworks surrounding mobile banking usability revealed that most of the studies done focused on usability issues, security issues, authentication issues but we were unable to find any that were based on the suitability of the authentication model chosen. Hence the limitation of the current models was a non-holistic framework targeted at the developer to evaluate the suitability/usability of the user authentication framework for mobile banking.

The main objective of this research study is to propose a framework for evaluating graphical user authentication suitability for mobile banking. This study approached the problem from a holistic view of mobile banking. In order to achieve this objective, an analysis of the characteristics, quality factors and the factors affecting suitability and adoptability in mobile banking was done.

In this research study, literature review was conducted on the areas critical and surrounding Mobile Banking and Graphical User Authentication. A solution was built and the framework was used to evaluate the graphical user authentication chosen. Results were statistically analyzed and discussed. The framework was evaluated against evaluation components such as Accuracy, Response Time, Password Memorability and Simplicity and an expert review was done to validate the framework. In choosing the proposed framework, a survey done showed that 75% of the respondents were open to the solution.

For testing the prototype development, respondents were asked to choose their graphical password by choosing 3 points on the image as their password. Each graphical image password had hotspots which were blocked off during authentication. A total 50 respondents were asked to use the solution.

Results from this study showed that all factors and relationships in the framework suggest a positive and high correlative significance between them. Simplicity as an evaluation component is very vital in the framework as it showed a significant relationship between Content and Convenience as well as Accuracy and Response Time.

In conclusion, this proposed framework serves as a guiding tool for evaluating the suitability of graphical user authentications for mobile banking user authentication.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

RANGKA KERJA BAGI MENILAI KESESUAIAN GRAFIK PENGESAHAN PENGGUNA UNTUK PERBANKAN MUDAH ALIH

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Pengesahan pengguna merupakan komponen penting dalam mana-mana Sistem Maklumat. Terdapat pelbagai cara untuk melaksanakan pengesahan pengguna daripada menggunakan kata laluan berasaskan teks, kata laluan biometrik dan kata laluan bergrafik. Kepentingan memilih kaedah pengesahan pengguna persekitaran yang sesuai adalah salah satu keputusan penting dalam menggalakkan pengguna untuk menggunakan aplikasi. Tujuan utama Pengesahan Pengguna dalam aplikasi adalah untuk membolehkan pengesahan identiti pengguna yang mahu menggunakan sesuatu aplikasi.

Dalam perbankan mudah alih, kajian menunjukkan bahawa pengesahan pengguna memainkan peranan yang penting dalam mempengaruhi niat pelanggan untuk menggunakan perkhidmatan perbankan mudah alih. Masalah penyelidikan berpunca daripada kurangnya penggunaan perbankan mudah alih termasuklah bebanan kognitif yang dihadapi pengguna dalam mengingat kata laluan yang berasaskan teks, isu-isu kebolehgunaan yang menghalang perbankan mudah alih berdasarkan kaedah pengesahan pengguna semasa dan mod semasa pengesahan pengguna. Salah satu motivasi positif yang menyokong penyelidikan ini adalah daripada penyelidikan berkaitan pengesahan pengguna grafik sebagai alternatif yang berdaya maju terhadap kata laluan berasaskan teks.

Dalam usaha untuk menangani isu-isu berkaitan dengan perbankan mudah alih, kajian awal mendedahkan bahawa isu kebolehgunaan adalah salah satu sebab yang menyumbang kepada keraguan pengguna untuk mengamalkan perbankan mudah alih. Penyelidikan yang dilakukan ke atas model semasa, kaedah dan rangka kerja berkaitan kebolehgunaan perbankan mudah alih mendedahkan bahawa kebanyakan kajian yang telah dijalankan memberi tumpuan kepada isu-isu kebolehgunaan, isu-isu keselamatan, isu-isu pengesahan tetapi kami tidak dapat menemui model yang berdasarkan kepada model kesesuaian pengesahan yang dipilih. Oleh itu, model semasa adalah satu rangka kerja bukan holistik yang disasarkan kepada pembangun untuk menilai

kesesuaian/kebolegunaan rangka kerja pengesahan pengguna untuk perbankan mudah alih.

Objektif utama kajian penyelidikan ini adalah untuk mencadangkan satu rangka kerja untuk menilai kesesuaian grafik pengesahan pengguna untuk perbankan mudah alih. Kajian ini mendekati masalah dari pandangan holistik perbankan mudah alih. Untuk mencapai objektif ini, analisis ciri-ciri, faktor kualiti dan faktor yang mempengaruhi kesesuaian dan kebolegunaan dalam perbankan mudah alih telah dilakukan.

Dalam kajian penyelidikan ini, kajian literatur telah dijalankan ke atas liputan yang kritikal berkaitan Perbankan Mudah Alih dan Pengesahan Grafik Pengguna. Satu penyelesaian dibina dan rangka kerja telah digunakan untuk menilai pengesahan pengguna grafik yang dipilih. Keputusan telah dianalisis secara statistik dan dibincangkan. Rangka kerja ini telah dinilai menggunakan komponen penilaian seperti Ketepatan, masa tindakbalas, keupayaan mengingati kata laluan dan Kesederhanaan dan kajian pakar telah dilakukan untuk mengesahkan rangka kerja. Dalam memilih rangka kerja yang dicadangkan, kajian yang dilakukan menunjukkan bahawa 75% daripada responden adalah terbuka kepada penyelesaian yang dicadangkan.

Untuk menguji pembangunan prototaip, responden diminta untuk memilih kata laluan grafik mereka dengan memilih 3 titik pada imej sebagai kata laluan mereka. Setiap kata laluan imej grafik mempunyai titik panas yang telah disekat semasa pengesahan. Seramai 50 responden telah diminta untuk menggunakan penyelesaian yang dicadangkan.

Hasil daripada kajian ini menunjukkan bahawa faktor-faktor dan hubungan dalam rangka kerja memberikan respond positif dan hubungan kait signifikan yang tinggi di antara faktor-faktor. Kesederhanaan sebagai satu komponen penilaian adalah sangat penting dalam rangka kerja tersebut kerana ia menunjukkan hubungan yang signifikan antara kandungan dan mudah serta Ketepatan dan Masa Tindak balas.

Kesimpulannya, rangka kerja yang dicadangkan berfungsi sebagai alat bantu untuk menilai kesesuaian grafik pengesahan pengguna untuk mengesahkan pengguna perbankan mudah alih.

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I certify that a Thesis Examination Committee has met on 15 December 2016 to conduct the final examination of Ejike Ekeke Kingsley Ugochukwu on his thesis entitled "Framework for Evaluating Suitability of Graphical User Authentication for Mobile Banking" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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LIST OF ABBREVIATIONS

PIN	Personal Identification Number
SMS	Short Message Services
GUAA	Graphical User Authentication Algorithm
AHP	Analytic Hierarchy Process
MBUA	Mobile Banking User Authentication
APK	Android Package
CVR	Content Validity Ratio
Cr	Criteria
TPS	Transactions per Second
UML	Unified Modeling Language
FUNC	Functionality
EFF	Efficiency
CONV	Convenience
CONT	Content
PSWDM	Password Memorability
SIMP	Simplicity
ACCUR	Accuracy
RESPT	Response Time
TAM	Technology Acceptance Model

CHAPTER 1

INTRODUCTION

1.1 Motivation

According to Shaikh & Karjaluoto (2015), Mobile banking (MB) is one of the recent mobile technological wonders. Based on literature gotten from a number of studies done such as Mishra & Bisht (2013), Oliveira et al., (2014), one of the common themes highlighted in their studies was the fact that mobile banking is now considered as one of the innovations in the financial services sector, which has provided the flexibility consumers need to conduct their banking or financial activities. Further studies done by Anderson (2010), Boor et al., (2014) and Wonglimpiyarat (2014) echoed the above mentioned statements by revealing that mobile banking has also enabled consumers to gain convenient access to value-added and banking services, even in countries with low incomes. It didn't then come as a surprise when a report done by Juniper Research in 2014 revealed that about two (2) billion people are expected to use mobile banking globally by 2017.

The wide penetration of mobile phone usage and availability of powerful network bandwidth has made mobile devices an attractive candidate for value added services. As the banking sector is continuously looking for new delivery platforms to improve its customer satisfaction and confidence, banks must be willing to provide end-to-end security to safeguard information exchange between the bank and the customer.

To avoid the risk of forgetting passwords, users often adopt insecure behaviours, such as writing down their passwords and storing them in an insecure location or disclosing their passwords to perceived trusted parties. Gunson et al., (2011) highlights in their study that users adopt such insecure behaviours because they lack security awareness; and they often construct their own inaccurate model of possible security threats.

Hoehle et al., (2012) in their study mentioned that only 30% of European banking customers use internet banking services while only 5-10% of all consumers in most North American and Australasian banks have used mobile banking services. The motivation for this research study stems out of the perceived low adoption of mobile banking.

With the continuous rise and use of mobile devices, Graphical-based password authentication has been growing recognition mainly due to advantages such as better memory ability for images over words and texts, larger password space size, less vulnerability to attacks over text-based passwords. With the large amount of graphical user algorithms available, this research study aims to find a suitable graphical user authentication algorithm solution that can be adopted for mobile banking users.

With a lot of research and prior frameworks/models found focusing on the usability factors, security factors, adoption frameworks, there is a lack of research that tackles the problem from a holistic point of view with focus on the developer.

The significance of this study aims to assist the developer in making a more-informed decision in the implementation of the user authentication algorithm that would be more suitable to improve the mobile banking adoption rate. Given the wide range of user authentication algorithms, with user authentication playing an important role in the adoption rate of mobile banking, this study aims to provide a framework that allows developers to be able to find and decide on an algorithm that is suitable for a mobile banking platform.

1.2 Research Problem

Tassabehji & Kamala (2012) and Gunson et al., (2011) in their research highlighted that commonly used PINs and username and passwords have been in practice for internet banking authentication for a long time but have been a cognitive burden for users who have to remember multiple passwords and PINs which often leads to users choosing memorable words or dates of birth, use the same password and often ignore advice for creating a secure password. In their study, this cognitive burden plays a role in hindering users to adopt or adapt to mobile banking.

Shaikh & Karjaluo (2015) in their study acknowledged that the Technology Acceptance Model (TAM) is a very popular framework for examining intentions to adopt m-banking and results showed that Perceived Ease of Use was a significant determinant to adopting mobile banking by non- mobile banking users. Hoehle et al., (2012) continued with this model in their study and performed a comprehensive review of various methods and studies on the adoption of electronic banking. In their research, they mentioned that only 30% of European banking customers use internet banking services while only 5-10% of all consumers in most North American and Australasian banks have used mobile banking services. Results from these review study found that the current mode of user authentication amongst other factors played an important role in influencing consumer's intentions to use e-banking and mobile banking services. Jeong & Yoon (2013) in their research suggest that consumers seek a simpler, easier, faster process and environment for banking transactions. For the scope of this study which focuses on User Authentication Component of Mobile Banking, Results gotten from the preliminary studies revealed that thirty three percent (33.3%) of respondents from the study mentioned that Usability Issues in the current mode of authentication were their main reasons why they were hesitant to adopt mobile banking. Seventy five percent (75%) of respondents were open and willing to adopt mobile banking if a new login procedure for mobile banking was involved.

Another factor that made up the research problem for this study was the lack of research study focused on the developer. Current Research and Frameworks found could be classified into three focus categories: Focus on Usability Attributes, Focus on Mobile Banking Portals and Focus on Authentication Schemes. Appendix 1 shows a list of

various current frameworks and models relating to mobile banking user authentication. From the perspective of the developer with relation to User Authentication, there is a lack of research study that tackles the low mobile banking adoption issue from a suitability perspective with relation to the different graphical user authentication algorithms with a holistic view on mobile banking.

1.3 Research Objectives

The objectives of this research are:

1. To propose a Mobile Banking Graphical User Authentication Framework to evaluate the Suitability of Graphical User Authentication Algorithms for Mobile Banking.
 - a. To identify the characteristics, quality factors and related issues on Mobile Banking Suitability and Adoption

1.4 Research Scope

The research scope of this project will focus on two areas as follows:

i. Mobile Banking

The scope of this research will focus on the quality and characteristic factors discussed by researchers. This research will also study different attitudes towards adoption of mobile banking.

ii. Graphical User Authentication Algorithms

The scope of this research will study the categories of the Graphical User Authentication Algorithm (Recognition-based and Recall-based) that can be modified or implemented for this research study.

1.5 Research Contribution

This research aims at contributing to the banking industry community in enhancing the various methods used in mobile banking authentication and improving on the adoptability of mobile banking. The contribution of this research includes:

A Proposed Framework for Evaluating User Authentication Suitability for Mobile Banking

Improving the knowledge and adaptability of Graphical User Authentication Algorithms for mobile banking.

1.6 Thesis Organization

The organization of this thesis includes eight chapters. Chapter 1 provides an introduction of the motivation, objectives and scope of the research study. Chapter 2 explores the literature review and related work done on the research topic. In this chapter, critical analysis of the previous research work is also presented and reviewed. Chapter 3 explains the research methodology and approach for conducting the research. Chapter 4 explains the preliminary studies done to support the research problem and expert review conducted and results. Chapter 5 explains the proposed model for this research study. Chapter 6 elaborates on the development of the prototype using the selected Graphical User Algorithm technique. Chapter 7 analyzes the data collected from the questionnaires and the system and discusses them using statistical analysis. Chapter 8 provides the conclusion for the research study and future work or enhancements that can be done.



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