An assessment framework for Internet banking system reliability

Musyoka Faith Mueni[1]
(Masinde Muliro University of Science and Technology, Kakamega, Kenya
fth_mueni@yahoo.com)

Muketha Geoffrey Muchiri[2]
(Meru University of Science and Technology, Meru, Kenya
gimuchiri@gmail.com)

Anselemo Peters Ikoha[3]
(Kibabii University College, Bungoma, Kenya
Anselp2004@yahoo.com)

Abstract: E-banking technology is very widespread in banking sector while in Kenya; banks are striving to achieve social and economic development. Banks are investing in Internet for better financial services to their customers though these systems are believed to have critical challenges in terms of reliability yet have become modern means of performing business transactions. Therefore, there is a great need to maintain reliability, which has been investigated shallowly in developing countries given the many challenges such countries face. This paper therefore sought to define a framework that can be used for assessing Internet banking system reliability. The study used multi case study design with study population being two banks in Kenya. Data was collected from a key informant using a questionnaire and document analysis guide and was analysed using both descriptive and inferential statistics. The study found out that documentation and size internal properties had significant positive effect on reliability. Further researches are required to establish effect of internal properties of Internet banking system on other software qualities.

Keywords: Internet banking, Internal properties, Reliability

1. Introduction

Technology is considered as the influence for businesses achievement and as their basic competencies, introduction of electronic banking (e-banking) has transformed the ways banks operate [22]. E-banking is referred to as the automated delivery of banking services to customers through electronic interactive communication channels that contains systems that enable financial institution customers to access bank services and products through a public or private network [16]. There are several e-banking technologies used which include; Automated Teller Machines (ATMs), Tele-banking, home banking and Internet banking. E-banking technology was conceptualized in the mid-1970s, but in 1985 few banks offered customers' e-banking [1]. In 2001 banks began to respect the Internet banking services and updated hardware and software to enhance the quality of service and provide service integration including online transaction [14]. These technologies have made banking services and products informational, automated, and digitized. In this paper, Internet banking technology is discussed.

Internet banking is a form of e-banking technology that refers to the use of Internet as a remote delivery channel for banking services and products [10]. It is a way of executing banking services where by a customer does not need to go to a bank building, stand in a queue and have a face to face communication with teller. What customer requires is a personal computer or smart phone, internet, and internet banking account of a given bank to perform all banking services that can be done in physical banking. In Kenya, banking sector strives to achieve social and economic

development by extending not only in every county but also globally in order to achieve its objectives. Internet, which is a communication medium, has assisted banks in achieving their long-term objectives. Banks are investing in Internet banking technology since they are expecting significant growth in attracting and retaining depositors yet customers are in need of not only a fast system but also a reliable one. In addition, financial services sector faces greater challenges than any other sector thus they must innovate, deploy new services to maintain the highest levels of reliability and keeping the trust of customers [3]. Thus, since Internet banking recently has become a modern means of performing business transactions, there is a great need to maintain reliability. Although software reliability is a well-studied field, no one has investigated the reliability of Internet banking systems from a developing country's perspective, especially given the many challenges such countries face. Furthermore, although several software quality frameworks are proposed in literature in areas such as usability, functionality among others, there is none that focused specifically on reliability of Internet-based software for banking.

This study aimed to develop an assessment framework for Internet banking system reliability, by establishing internal properties of internet banking system that affect reliability. The internal properties are measurable attributes that are automatically embedded in the system and do require involvement of a system developer. They include complexity, documentation, and size. In this paper, complexity is an internal property of a system that shows how a system is complex in terms of understandability. While documentation is an internal property of a system that is developed as manuals and operating procedures to give instructions to users on how to set up and use a system in case of failure or during maintenance and, size is an internal property of a system that is used by software developers to measure how large a system is. In addition, reliability is a software quality attribute that ensures services are delivered as specified within a required time without failure.

The study was conducted in Nairobi County in Kenya using multi case design. Data was collected from key informant in two banks in Kenya using questionnaire. In addition, document analysis guide was used to cross-validate the primary data and check for consistency of response from questionnaires.

The rest of the paper is structured as follows. Section two presents related work, section three presents research methodology that is used in study, section four presents results and discussion, and section five presents conclusion.

2.   Related work

There are three basic kinds of Internet banking that are being employed in the market place as; information where a bank has marketing information about its products and services on a stand-alone server, communication that allows interaction between the bank's systems and the customer such as electronic mail (e-mail), and transaction that allows customers to execute transactions [11]. A bank must require a website to operate Internet banking. Website integration is necessary in these times since customers access multiple applications of the same bank at the same time [13]. In this integration, banks provide single sign-on to multiple online commercial banking applications. This web technology provides benefits such as high quality information, easy information accessibility, information sharing, business functions automation, and provides services to customers with low cost, quick response, and business customization [18]. To implement this web technology, a business channel requires organizational ability and resources (hardware and software) since shortage of Information Technology infrastructure can be a critical barrier to adoption as well as shortage of knowledgeable personnel [18].

Many studies have been carried out on software qualities in customer satisfaction pointing out a link between a specific software quality and customer satisfaction. Other studies have been carried out on adoption of internet banking system in establishing its benefits and barriers on adoption. An investigation of security software quality implied that security factor is an important consideration from a system design and banks should provide feedback to customers about the security mechanisms in order to increase customers understanding against the Internet banking security and inform customers about potential threats that may arise in a system [24]. Reliability is an attribute of security [15]. In this study, [15] found out that security comprises of three dimensions: reliability, safety, and privacy and found out that use of Internet banking in Tunisia is influenced most strongly by convenience, risk,

security and prior Internet knowledge. Usability software quality is investigated. Awareness of information, customer protection, response time, reliability, security, technology readiness attributes are considered important elements for e-banking [20].

Software consists of programs, documentation, and operating procedures. A program is a combination of source code and object code, documentation consists of manuals such as design, implementation, and testing documentation, while operating procedures consists of instructions to setup and use the software system and instructions on how to behave in system failure [21]. In measuring internal properties of a software, size complexity metric is measured by the number of statements and number of comment lines [8]. Also, [8] measured psychological complexity with establishing how easily user understands a program. In addition, software size can be measured by use of determining lines of code and function points. According to [7] complexity is associated with security and since Internet technology is either in-housed or outsourced, the issue of security has caused many banks to outsource their Internet banking operations by first considering their business strategies. In outsourcing, the vendor provides a company with hardware, operating systems, and applications software necessary to enable the bank to offer Internet banking activities, while in in-house or tailor-made banks provides all for itself with the help of their experts.

Maintaining reliability is very critical. According to [23], they stated that customers care about external quality characteristics such as reliability merely because it is a system characteristic that can easily be seen by the use of the product while developers care about internal quality characteristics because they relate to their development efforts. In their study, they found out that internal properties of software are to help in early prevention of errors and defects as external properties are used to calibrate internal properties tools and to provide users' perceived measurements of software quality. Reliability is measured by sub-attributes that include fault tolerance, maturity, recoverability, and reliability compliance according to ISO 9126-1 quality model [17]. However, [6] used three sub-characteristics of reliability to measure e-learning system quality that are maturity, fault tolerance, and recoverability. However, [9] in their study on evaluation of functionality, reliability and usability of Internet banking in Brazil used reliability dimension to investigate the security of a transactional site where they used six characteristics to evaluate reliability which include integrity, confidentiality, availability, privacy, non-repudiation and authenticity. They focused on internet banking in general and used security dimensions instead of reliability.

2.1   Existing frameworks

There are several existing frameworks for internet-based systems. A standard WebQual 4.0 instrument was developed that contains 20 questions under four categories; usability, information quality, service interaction, and overall experienced by users as they delve deeper into the site, embodied by trust and empathy for assessing e-commerce and e-government offerings [4]. In the context of WebQual, Web site users who are customers are asked to rate target sites against each of a range of qualities using a seven-point scale which helps gain understanding about which qualities are considered by the user to be most important in any given situation. This framework focuses on web site quality of e-commerce and e-government institutions in general as perceived by the customer. The limitation of this framework is that it assesses e-commerce and e-government websites on usability but not on reliability. The framework is validated empirically where customers rate websites' quality based on their user experience.

Internet banking security framework was proposed by [12], which was concerning identification of security requirements for Internet banking. It contains elements; identification and authentication, authorization, confidentiality, integrity, non-repudiation, availability, privacy, and auditability as security requirements. The framework is customized for uncovering ways in which SMEs, Internet banking, and security come together to initiate plan and manage day-to-day situations. This framework is a six-step framework process to help customers identify necessary security requirements along with counteracting authentication mechanism. The framework is limited to security software quality. In addition, it is not an assessment framework although it can be used to identify security requirements.

A framework for analyzing and comparing e-banking capabilities was proposed by [2]. It is a conceptual framework for understanding, analysing, evaluating, and comparing e-banking capabilities. The framework identifies key qualitative factors that affect the overall evaluation of e-banking and high level considerations that influence the choice of these factors. The factors were organized into four categories; functionality, user e-capability pre-requisites, usability, and effectiveness. In the study, it was found out that performance of e-banking aims at ensuring that authorized customers have timely and uninterrupted access to their accounts, and that committed transactions are successfully completed within acceptable times. This framework also comes with a limitation in that it focuses on Internet banking usability and functionality but not on Internet banking system reliability.

Another framework was proposed by [5] that evaluates B2B applications based on the ISO 9126 software quality model. The framework used the six characteristics including Functionality, Reliability, Usability, Efficiency, Maintainability and Portability, which are further divided into 21 sub characteristics. In this framework an expert review, was used to evaluate if aspects of a given software product follow established quality principles. This framework focused on Business to Business applications in general but fails to focus specifically on Internet banking systems. Also, the characteristics are not evaluated in a detailed way.

Only one of these earlier studies has touched on Internet banking in Kenya but the study has focused on Internet banking effectiveness that gives the results of Internet banking in banks. All these studies point to a positive link between Internet banking and bank performance on customer satisfaction, service quality, or profitability but not on Internet banking system reliability. The frameworks developed are linked to security, usability, functionality, service quality but none is linked to Internet banking reliability. The Behkamal's framework attempts to address reliability, but then it is a generalized framework that does not focus on Internet it, banking system.

3. Research Methodology

This study used multi case study design as it sought to examine in-depth cases within their real-life context. The study was carried out in Nairobi County, which is one of the forty seven (47) Counties in Kenya. Nairobi County is very expansive and huge number of banks' headquarters is situated here with Internet banking departments in these headquarters. Two banks (Kenya Commercial Bank (KCB) and Barclays Bank in Kenya) were selected and convenient sampling was carried out because information required was for Internet banking system. Primary data was collected from key informants who were IT personnel because they are people who are knowledgeable with the questions at hand. Closed ended questionnaires were the primary data collection instruments and document analysis guide was used to cross-validate the primary data and check for the consistency of response from questionnaires. Research variables were measured using Ordinal and Likert-type scales because they not only have informational value but also come handy in respondent centered studies. The respondents responded to questions under each variable on five point Likert Scale. Some demographic questions were also asked for more interpretation of responses. The questionnaire was piloted for validity and Cronbach's alpha coefficient was used to test measurement reliability. For dependent variable cronbach's alpha coefficient was 0.746 and 0.780 for independent variables, which is above the minimum acceptable Cronbach's alpha coefficient of 0.70 [19]. The questionnaire was administered personally by researcher and data analyzed in descriptive and inferential.

4.   Results and Discussion

The following section presents results of the study:

4.1   Internal properties of Internet banking system

Respondents answered questions of three internal properties of Internet banking systems. In terms of documentation, all Internet banking systems had user guide manuals that are used by customers for guidance on system operation. This implies that the system is well documented to direct customers on its operation. Also, all Internet banking systems had testing and design manuals that are used for guidance when managing the systems. This implies that the system is well documented to help IT department in managing and upgrading the system. In addition, from the respondents, Internet banking system is not a complex system, which implies that first time users understand the system.

To evaluate the extent of system complexity, respondents were required to state the understandability of the system. 96% agreed that new customers do take a short period to understand the system and 96% agreed that they receive few questions from first time users. This implies that internet banking system is not a complex system. In documentation internal property, 100% agreed that Internet banking system has user guide and installation manuals and 92% agreeing that Internet banking system has testing and design manuals . This implies that Internet banking systems have well documentation that guides customers in operating the system and getting help and is well documented for developers to carry out maintenance and upgrading of the system appropriately. In size property, 92% agreed that the system has minimal number of pages in Internet banking modules and 92% agreed that the customers take a short period to perform a transaction. This implies that the system is not large to go through a transaction activity and a customer accesses it appropriately.

4.2   Determination of reliability

Respondents answered questions of three reliability measures for a software system. The system was evaluated to be fault tolerant with 92% agreeing thus implying that the system is fault tolerant and operates despite failure. All respondents evaluated that Internet banking system is recoverable from errors and failure implying that the system is reliable in terms of recovering from errors. In addition, 92% evaluated the system as a compliant system, implying that the system is reliable in terms of reaching required standards of software.

In determining the extent of reliability, respondents indicated the extent where by 88% agreed that in case of system failure, there are redundant systems that are used and 92% agreed that web browser ignores any un understandable input from the customer thus the system is reliable in terms operation despite failure and reliable in terms of not accepting a wrong input. In recoverability of the system, 60% agreed that the system rolls back to a previous and correct version in case of system failure and 84% agreeing that the system restarts itself before total failure occurs. This implies that the system is reliable in terms of recovering from any error occurrence and is reliable in terms of loss of transaction activity. In compliance of the system, 88% agreed that the system has cyber-security awareness programs and 90% agreeing that there are reliable rules and regulations to be endorsed by the customer. This implies that the system is reliable in terms of reaching system standards and it binds a customer to some rules.

4.3   Effect of internal properties of internet banking system on reliability with organizational factors

The analysis in this section sought to investigate whether organizational factors had any moderating effect on the relationship between internal properties and system reliability. Individual internal properties of Internet banking system were correlated against the mean of system reliability factoring the organizational factors as control variables to obtain the partial correlation coefficients. It was found out that organizational factors significantly moderate the

relationship between complexity property of Internet banking system and system reliability. However, the degree and direction of moderation varies from one moderating variable to another. For instance, education level of IT personnel has significantly negative moderating effect ($r_{xy.z}$ = 0.492, p-value=0.015) with the experience of IT personnel having a moderately positive moderating effect ($r_{xy.z}$ = 0.445, p-value= 0.029). This implies that the presence of the education level of IT personnel suppresses the relationship while the experience of IT personnel in the correlation model improves the relationship.

In documentation internal property, the degree and direction of moderation varies from one moderating variable to another too. Education level of IT personnel has significantly positive moderating effect ($r_{xy.z}$ = 0.530, p-value=0.008) with the experience of IT personnel having a moderately negative moderating effect ($r_{xy.z}$ = 0.558, p-value= 0.005). This implies that the presence of the education level of IT personnel improves the relationship while the experience of IT personnel in the correlation model suppresses the relationship.

In size internal property, on number of web pages and time to perform a transaction, the degree and direction of moderation varies from one moderating variable to another too. Education level of IT personnel has slightly negative moderating effect ($r_{xy.z}$ = 0.644, p-value=0.001) with the experience of IT personnel having a moderately negative moderating effect ($r_{xy.z}$ = 0.640, p-value= 0.001). This implies that the presence of the education level of IT personnel slightly suppresses the relationship while the experience of IT personnel slightly improves the relationship.

A human memory is able to understand seven chunks whereby three different events cause a short-term memory failure of human thus making a system unreliable [8]. Complexity is then measured on time used to understand system and how frequently system operators receive questions from first time system users. This infers that complexity, documentation, and size internal properties affect system reliability in the presence of education level and experience of IT personnel. This conquers with the analysis of [20] who found out that bank employees should learn new skills with bank staff hiring professional and expert graduates in order to handle business proficiently and solve problems with adequate knowledge.

4.4   Hypothesis testing

Effect of internal properties of Internet banking system on reliability is used to help in framework definition. Regression results were carried out to define a model that was used for assessment as presented in Table 1. The results showed that internal properties of Internet banking system have a positive linear effect on the system reliability as shown by the standardized beta which is the equivalent of the correlation r (r=0.728 and r^2=0.530).

Table 1. Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.728[a]	.530	.463	2.691

    a. Predictors: (Constant), Size, Documentation, Complexity

Source: Research data 2014

The relationship followed a multiple linear regression model of the nature R = 2.049X_2+1.290X_3 where R is reliability, 3.920 is a constant or intercept term (β_0=3.920), 2.049 is the beta or slope coefficient (β_2=2.049) of documentation and 1.290 is the slope coefficient ($\beta3$=1.290) of size. However, the intercept term (β_0) is not significant (p-value= 0.487>0.05). This is confirmed in the 95% confidence interval for β_0 in the coefficients part of

the regression results, which is $-6.250 \leq \beta_0 \leq 12.686$ where zero lies in the interval. In addition, complexity dimension is not significant too (p-value= 0.844>0.05) which is also confirmed in the 95% confidence interval for β_1 in the coefficients part of the regression results, which is $-2.014 \leq \beta_1 \leq 2.441$ where zero lies in the interval as presented in Table 2.

Table 2. Coefficients of the model

Coefficients[a] Model	Unstandardized Coefficients B	Std. Error coefficient	Standardized Coefficients Beta	T	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper bound
(Constant)	3.218	4.553		.707	.487	-6.250	12.686
Complexity	.213	1.071	.039	.199	.844	-2.014	2.441
Documentation	2.049	.921	.360	2.224	.037	.133	3.965
Size	1.290	.501	.495	2.573	.018	.247	2.333

a. Dependent Variable: RELIABILITY

Source: Research data 2014

4.5   Framework development

The three internal properties used in this framework are complexity, size, and documentation which work together in order to have an effect on system reliability. Complexity measures understandability of Internet banking system. This is measured in terms of how much time it takes a first time customer understand system and how frequently IT personnel receive questions from the first time customers of Internet banking system. Documentation measures presence of user guide manuals that helps customers operate the system without difficult. It also measures presence of testing and design manuals that are used by system operators to upgrade and maintain Internet banking system to operate without failure. Size measures web site size in terms of web pages in Internet banking module and time taken to perform a transaction. System reliability is a system quality that ensures banking services are delivered as specified within a required time without failure. The framework has combined reliability indicators, which include fault tolerance, recoverability, and compliance.

In determining the relationship, all internal properties were statistically significant, with the relationship of complexity and system reliability being slightly positive with strength of 0.471, documentation and system reliability relationship being a positive with strength of 0.541, while size and system reliability relationship being moderately positive with strength of 0.641. This strength is due to presence of moderating factors, while when IT personnel's experience and IT personnel's education level are controlled, the relationship of each individual internal property changes. In regression results, complexity is insignificant thus it is not included in the framework resulting into $R = 2.049X_2 + 1.290X_3$
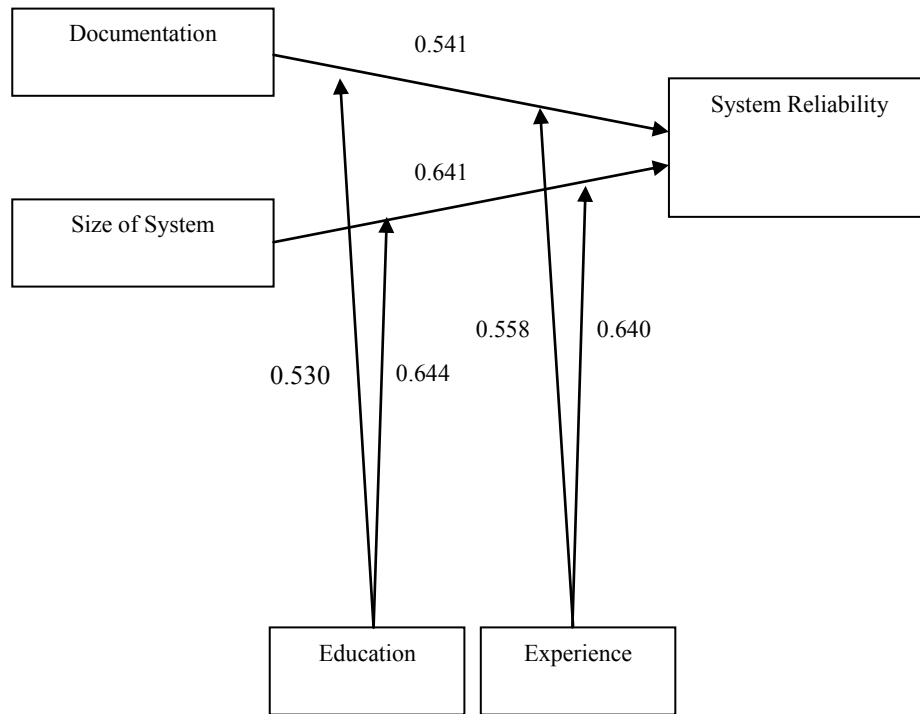
Fig.1. Assessment framework for Internet banking system reliability

Source: Research data 2014

To define a framework, it is important to know why reliability depends on system internal properties. Software developers are the ones who develop a system and maintain it thus; they should have a list of instructions to guide them. If the list of instruction is accurate, then the system will be reliable. In terms of size as an internal property, if the number of Internet banking modules is organized to take up a few web pages, then it will take customers a short period to perform a transaction activity and thus the system will be reliable.

The dependent variable is reliability and its operational definition in this study is a system quality that ensures Internet banking services are delivered as specified within a required time without failure. In this study, the formula obtained from the model in determining system reliability (R) was computed as follows.

$R = 2.049X_2 + 1.290X_3$

Where

R = Reliability

X_1 = Complexity attribute which is insignificant in the model

X_2 = Documentation attribute

X_3= Size attribute

β_0= a constant but it is insignificant in the model

β_2=2.049 = Documentation coefficients of estimates obtained from model

β_3= 1.290= Size coefficients of estimates obtained from model

ε=standard error term which is 0 from the model

In measuring documentation, which should be well documented to guide software developers and other IT personnel, the presence of testing and design manuals is determined. While in measuring system size, the number of web pages is determined and time to perform a transaction is also determined. This operationalization is presented in Table 3.

Table 3. Measurement of internal properties of Internet banking system

Internal property	Sub-property	Metric	
		Attribute	Numeric
Documentation	Presence of testing manuals	Not documented	1
	Presence of design manuals	Documented	2
		Well documented	3
Size	Number of web pages	Many web pages in module	1
		Several web pages in module	2
		Desirable web pages in module	3
Size	Time to perform a transaction	Long period to perform transaction	1
		Moderately long period to perform transaction	2
		short period to perform transaction	3

Source: Research data 2014

Measurements for internal properties range at a scale of 1 and 3 with effective attributes having scale 3 while least effective having scale 1.

4.5.1 Effective implementation

When a bank has implemented every internal property effectively then reliability is:

$R = 2.049X_2 + 1.290X_3$

X_2 = documentation attribute with metrics: (testing manuals (3) + design manuals (3) =6)

X_3 = size attribute with metrics: (desirable few pages (3) + short period to perform transaction (3) =6)

$R = 2.049(6) + 1.290(6)$

R= 20.034 (implemented effectively)

4.5.2 Moderate implementation

When a bank has implemented every internal property moderately, then reliability is:

$R = 2.049X_2 + 1.290X_3$

X_2 = documentation attribute with metrics: (testing manuals (2) + design manuals (2) =4)

X_3 = size attribute with metrics: (desirable few pages (2) + short period to perform transaction (2) =4)

$R = 2.049(4) + 1.290(4)$

R= 13.356 (implemented moderately)

4.5.3 Poor implementation

When a bank has implemented every internal property poorly, then reliability is:

$R = 2.049X_2 + 1.290X_3$

X_2 = documentation attribute with metrics: (testing manuals (1) + design manuals (1) =2)

X_3 = size attribute with metrics: (desirable few pages (1) + short period to perform transaction (1) =2)

$R = 2.049(2) + 1.290(2)$

R= 6.678 (implemented poorly)

The range of system implementation is:

Table 4. System Implementation rate.

System implementation rate	Numeric value
Effective implementation	13.357 to 20.034
Moderate implementation	6.679 to 13.356
Poor implementation	0.0 to 6.678

Source: Research data 2014

5.   Conclusion

The results of the study supported the aim since internal properties of Internet banking system were found to positively affect reliability (r=0.728) with 53.0 percent (r^2=0.530) of the variance in reliability being explained by internal properties of system. Fault tolerance, recoverability, and compliance are approaches used to assess reliability. Documentation and size attributes are internal properties that affect system reliability while complexity is considered insignificant. The proposed framework was assessed in three phases being effective (Between 13.357 and 20.034), moderate (Between 6.679 and 13.356), and poor (Between 0.0 and 6.678) using formula from the model. The proposed framework was then considered valid after validating it using a case of a private bank that showed banks have implemented Internet banking system effectively.

Based on the finding, banks should train their IT staff because education level is an important aspect in determining the reliability of Internet banking system based on its internal properties. In addition, bank's IT personnel should focus on internal properties of Internet banking system based on documentation and size of the system by providing testing and design manuals for better operation and having a consistent website with specific functionalities in order to improve system reliability. However, it is necessary for further studies to be done to establish effect of internal properties on other software qualities (usability, functionality, security, portability, efficiency, and maintainability).

6.   References

[1]   Aboulola, C. (2007). *E-banking.* Available: http://aboulola.com/E-Banking.pdf

[2]   Al Saud. F., &. Abdalla. "A framework for analyzing & comaparing E-banking capabilities". *IADIS International Conference e-society*, pp.179-186, 2004

[3]   Atos. (2012, May). *Evolve your financial services performance.* Available: http://atos.net/NR/rdonlyres/1C6FD0A7-C8FE-4A37-A147-B49D0D1F371F/0/ATOS4376TAMFactSheet_LoRes.pdf

[4]   Barnes, S. J., "Measuring website quality improvement: a case study of the forum on strategic managent knowledge exchange". *Industrial managemnt and data systems*, pp.297-309, 2003

[5]   Behkamal, B., Kahani , M., & Mohammad , K., "Customizing ISO 9126 quality model for evaluation of B2B applications". *Information and Software Technology*, pp.599-609, 2009

[6]   Chua, B. B., & Dyson, L. E., *Applying the ISO 9126 model to the evaluation of an e-learning system.* Australia: Faculty of Information Technology, University of Technology, Sydney, 2005

[7]   Dapp, T. F. (2012). *Banking and Technology Snapshot. Growing need for security in online banking*. Available: Deutsche Bank: https://www.dws-investments.com/EN/docs/research/Biometrics.pdf

[8]   Day, H., "An investigation of software metrics affect on Cobol program reliability". Virginia: Phd Dissertation, 1996

[9]   Diniz, E., Porto, R. M., & Adachi, T., "Internet Banking in Brazil: Evaluation of Functionality, Reliability and Usability". *The Electronic Journal of Information Systems Evaluation, 8*(1), pp.41-50, 2005

[10] Furst, K. (2000). "Internet banking: Developments and Prospects. *Economic and policy analysis"*

[11] Higa, K. a. (2008). *Strategies towards Internet Banking: products, services and user's behavior*. Available: http://www.craft.titech.ac.jp/mis/j/studyfield/ec/textfile/effect021.pdf

[12] Hutchinson, D., & Warren, M., "Security for Internet banking: a framework." *Logistics Information Management*, pp. 64-73, 2003

[13] Kumar, S., "Technology enables feature driven Internet banking global finance". *NFOSYS STRATEGIC VISION* , 2011

[14] Lin, S. a., "The relationship between internet banking quality and continuous usage". *Business and Information 2012*. Sapporo.

[15] Nasri, W., "Factors influencing the adoption of internet banking in Tunisia". I*nternational journal of business and management*, 143-160, 2011

[16] Pandey, A. *Fundamentals of electronic commerce.* New delhi: S.K Kataria & Sons, 2009

[17] Panovski, G. (2008). *Product Software Quality: Master's Thesis*. Available: http;//www.cs.ru.nl/marko/onderwijs/masterscripties/GregorPanovskiThesis.pdf

[18] Rotchanakitumnuai, S., "Corporate customer perspectives on business value of Thai Internet banking", J*ournal of electronic commerce research*, pp.270-286, 2004

[19] Santos, J., "Cronbach's Alpha: A tool for assessing the reliability of scales" Tools of Trade, 2TOT3, April. *Journal of Extension, 37*(2), 1999

[20] Shamim, S., & Sardar, K., "Electronic banking & e-rediness adoption by commercial banks in Pakistan". Project, 2010

[21] Sommerville, I., *Software engineering*, 6th ed., USA: Addison Wesley, 2000

[22] Sorouurnejad, S. a.,"Effectiveness factors on adoption of customer in the internet banking services, case study: Iran", *international conference on economics and finance research*, pp.390-394, 2011

[23] Stavrinoudis, D., & Xenos, M., "Comparing internal and external software quality measurements". *Knowledge-Based Software Engineering*, pp. 115-124, August 2008

[24] Widjana, M. a., "Factors determining acceptance level of internet banking implementation", J*journal of economics, Business and accountancy Ventura*, pp. 161-174, 2011

Authors' biography and their photos

Musyoka Faith Mueni is currently pursuing a Master degree in Information Technology from Masinde Muliro University of Science and Technology, Kenya. She holds a degree in Bachelor of Science in Computer Science from Masinde Muliro University of Science and Technology, Kenya. The author has research interests in software quality, system security, and data and information management.

Muketha Geoffrey Muchiri received the BSc degree in Information Science from Moi University in 1995, the MSc degree in Computer Science from Periyar University in 2004, and the PhD degree in Software Engineering from Universiti Putra Malaysia in 2011. He is Senior Lecturer and Dean of School of Information Technology and Engineering at Meru University of Science and Technology, Kenya. His research interests include software metrics and software quality. He is a member of the International Association of Engineers (IAENG), the IAENG Society of Software Engineering (ISSE), and the IAENG Society of Computer Science (ISCS).

.

Anselemo Peters Ikoha received his Bachelor of Education degree from Egerton University, Kenya, and a Master's degree in Computer Based Information Systems from University of Sunderland (UK). He has served as a faculty member in the department of computer science of Masinde Muliro University of science and technology (MMUST). He is currently a PhD (IT) candidate in the department at MMUST and is the chair Department of Computer Science and Information Technology of Kibabii University College. He is a reviewer of articles in a number of international peer reviewed journals. He has also supervised several post-graduate students at masters' level . His research interest covers mobile computing, artificial intelligence systems and Information and communication Technology management and development