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Huei Lee
Eastern Michigan University

Yu Zhang
Eastern Michigan University

Kuo Lane Chen
University of Southern Mississippi

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An Investigation of Features and Security in Mobile Banking Strategy

Huei Lee  
Department of Computer Information Systems  
Eastern Michigan University  
USA

Yu Zhang  
Department of Accounting and Finance  
Eastern Michigan University  
USA

Kuo Lane Chen  
School of Computing  
University of Southern Mississippi  
USA

ABSTRACT

The primary purpose of the article is to study the mobile banking strategies used by financial institutions with the secondary purpose to study the willingness of the financial institutions in providing mobile banking. Just several years ago, financial institutions began to face technological challenges including whether to adopt mobile banking services. The survey results reported in this article showed that credit unions were more likely to provide mobile banking services, but commercial banks tended to offer more comprehensive mobile service features than credit unions. In addition, large financial institutions tended to provide better security and security descriptions on the customer websites.

INTRODUCTION

With the popularity of mobile devices today, mobile banking is one of the important strategies the banking industry faces. The major reason is that mobile devices have surpassed desktop PCs and become the mainstream of the personal computers, especially for the younger generation. Not only have large banks such as Chase, Wells Fargo, Bank of America, and Citi Bank adopted mobile banking, but many small banks and credit unions now try to offer mobile banking to their customers. Based on a recent survey of 1, 115 U.S. consumers, Aite Group predicted, “…the number of U.S. consumers using a mobile device to access their bank account will increase from 33 million to 96 million by 2016…” (Adams, 2012). One of the major issues arising from this trend is what type of financial institutions will adopt mobile banking more quickly and what features will the institutions offer. Another one is the security and privacy concerns consumers have in using mobile devices.

Only a few years ago, most thought that only the large banks would be able to offer mobile banking, but today even the small credit unions are considering mobile banking, because it is cheaper than call centers. Furthermore, some credit unions even think that mobile banking could
be a competitive advantage when they compete with large banks (Garrett, 2011). Many studies have identified the major factors for adoption of the mobile banking services, such as perceived usefulness and risks. However, after a period of usage experience, customers tend to evaluate the features offered by the service provider and decide whether they will continue the service (Kumar G. & Ravindran, 2012). Therefore, first, this article explores the characteristics of the financial institutions that will impact their willingness to adopt mobile banking. Second, the article explores the various features offered in mobile banking, and finally, because perceived risks are considered as important factors for frequent or non-frequent users (Chen, 2013) it studies mobile banking’s security and privacy and how it differs between commercial banks and credit unions. Specifically, we explored the following research questions:

1) Do size, charter type, and number of states covered by the financial institutions affect the adoption of mobile banking?

2) How are size and number of states covered by the financial institutions related to the adoption of the mobile banking service features and security methods?

3) How is the charter type of the financial institutions related to the adoption of the mobile banking service features and security methods?

4) Are there any differences between commercial banks and credit unions in mobile banking service features and security methods?

5) How are size, number of states covered, and the charter type of the financial institutions related to the mobile devices supported by mobile banking?

This paper is organized as follows. First, we review past literature on mobile banking. Second, we discuss service features and security methods used by mobile banking. Third, we describe the research method and research framework. Fourth, we analyze the data and explain the results. Finally, we discuss the conclusions and future research implications.

**LITERATURE REVIEW**

While there have been a number of studies on the mobile banking, it has become popular only in the last few years. The focus of published literature on mobile banking can be divided into the following categories: 1) the differences between online banking and mobile banking, 2) the benefits of using mobile banking, 3) the adoption of the mobile banking or the resistance factors to mobile banking, 4) the functions or features of mobile banking, 5) the various devices for mobile banking, and 6) the security issues of mobile banking.

**Mobile Banking vs. Online Banking**

While mobile banking is a subset of online banking, there are differences between the two. Laukkanen (2007) compared customer value perceptions between the Internet (online) and mobile banking and the research showed that customer value perceptions in Internet banking differ from those in mobile banking.
First, because mobile banking uses wireless communications, the security for mobile banking is weaker than online banking where traditional wire communications are used. Second, mobile devices have become very convenient personal devices requiring only certain functions for mobile banking. Third, the fact that there are different mobile devices such as iPhone, BlackBerry, Android, and Windows Phone (Gould, 2013) implementing and controlling security in mobile banking is more complex than desktop computing. Fourth, the processing powers of mobile devices are limited because of limited random access memory.

**The Benefit of Using Mobile Banking**

Ha, Canedoli, Baur, and Bick (2012) indicated that the benefits of using mobile banking include: 1) ubiquity, 2) immediacy, 3) localization, 4) instant connectivity, and 5) proactive functionality. As mentioned in the beginning, mobile banking can actually cut the operating costs and become a competitive strategy for a small bank or credit union (Garrett, 2011).

**The Adoption of Mobile Banking**

Many articles discussed the adoption of mobile banking. The adoption of mobile banking is primarily based on the Technology Acceptance Model (TAM). However, some researchers use Innovation Diffusion Theory (IDT), Unified Theory of Acceptance and Use of Technology (UTAUT), and the Task Technology Fit (TTF) model as well (Zhou, 2012). The results conducted by Lin (2010) in Taiwan indicated that the perceived relative advantages--ease of use, compatibility, competence and integrity--significantly influenced attitudes towards the adoption of mobile banking. Cruz, Muñoz-Gallego, and Laukkanen (2010) studied the perceived obstacles to the adoption of mobile banking services in Brazil. Akturan and Tezcan (2012) conducted a survey from non-users and university students in Turkey and found that perceived usefulness, perceived social risk, perceived performance risk, and perceived benefit directly affect the adoption of mobile banking.

Yu (2012) employed the UTAUT model to study the factors leading to adoption of mobile banking. His study in Taiwan found that mobile banking adoption was significantly affected by social influence, perceived financial cost, performance expectancy, and perceived credibility. Abiud, Okiko, and Kadondi (2013) studied the major factors which have affected mobile banking services offered by selected commerce banks in Rwanda. They found perceived ease of access, perceived usefulness, perceived risk of usage, and perceived cost of usage have an impact on the adoption of mobile banking services. Sohail and Al-Jabri (2013) found that males and youth were the predominant users of mobile banking in Saudi Arabia.

Chemingui and Ben lallouna (2013) conducted a study in Tunisia that found the main factor of resistance to the adoption of mobile financial service is “the resistance to change imposed by the use of this service on customers used to tangible branch location.” Based on the elaboration likelihood model (ELM), Zhou (2012) indicated that service providers should consider self-efficacy on the initial trust in adopting mobile banking service. Wei, Hu, and Carley (2013) built a qualitative simulation model to examine the interactions among adoptive drivers. Their study results in China were basically consistent with previous studies.
Features in Mobile Banking

Mallat, Rossi, and Tuunainen (2004) discussed possible functions for mobile banking, especially payment through mobile devices. Today’s mobile device is a personal device which includes cell phones, schedulers, and simple GPS. Mobile banking has to incorporate these features in their mobile devices. The banking-related features include: 1) checking the balances of accounts, 2) using bill pay, 5) sending text messages, 6) consulting an investment advisor, 7) and using business intelligence features, such as budget limit control. Video and the ability for social media are other potential features for mobile banking. Figure 1 shows a typical website which displays mobile banking features.

Figure 1: Mobile banking features displayed in PNC Bank’s website.

Zhang, Chen, Lee & Yang (2012) discussed major online banking features. While most features of mobile banking are similar to those of online banking, the following features are unique to mobile banking:

1. Mobile device check depositing: a customer can scan a check and deposit it into the bank even if he or she is not at home or the office.
2. Short Message Service (SMS): The end-user can send a text message through a mobile device (Alafeef, Singh, & Ahmad, 2012).

3. ATM locator: A customer can use mobile device to find the location of nearby ATMs or banking locations.

U.S. mobile service has been considered to be at least two years behind Europe, South Korea, and Japan (Kang, Lee, & Lee; 2013). Eventually, mobile devices will become a “mobile wallet” which can do anything a traditional wallet can do. In the future, even voice recognition technology could be a new feature for mobile banking (Crosman, 2012).

Various Devices for Mobile Banking

As mentioned previously, one of the problems for mobile banking is that there are different devices available for mobile banking. In addition, different terminologies exist because mobile devices have different size and functionalities, as shown in Figure 2. These terminologies include: tablet, smart phones, features phones, and cell phones.

Figure 2: Different mobile devices in terms of size and functionality.

Another classification model refers to the operating system or platform used by mobile devices. These operating systems include Apple IOS (iPad and iPhone), Google Android Platform, Black Berry, and Windows Phone. In general, the applications on iPhone and Windows Phone are strictly controlled by Apple and Microsoft respectively. There have been some attempts to hack BlackBerries such as ZueS Trojan in 2011. Most of the problems are in the Android platform. According to the Kaspersky Security Bulletin 2012, “99% of newly discovered mobile malicious programs target the Android platform...,” Kaspersky Labs (2012) further indicated that, “The most widespread malicious objects detected on Android smartphones can be divided into three main groups: SMS Trojans, advertising modules and exploits to gain root access to smartphones.”
Garrett (2011) indicated that mobile banking is the future but that security is a concern for wireless. Vaithilingam, Nair, & Guru (2013) investigated the adoption of mobile services in Malaysia and found trust and security have a significant impact on the adoption of mobile banking. As is the case with online banking, consumers were asking these questions, “Whether the bank will store the user id and passwords in the database?” “Will the mobile banking encrypt the transaction?” To minimize the customers’ concerns about mobile security, one banking strategy is to provide more description about the mobile security such as encryptions and authentication methods. Figure 3 shows the Website for Wells Fargo which puts the emphasis on security it provides to its customers for mobile banking.

**Figure 3:** Mobile banking security description on the Well Fargo’s website.

Occasionally, a security breach is discovered. A chief investigation officer of viaForensics found “three unencrypted passwords in apps for Foursquare, LinkedIn and Netflix on the Android in a recent round of app security testing...” (Kim, 2011). Camp notes “A major iPad security hole was found, potentially exposing 114,000 users’ information. A flaw allowing users to bypass lock screens on iOS 4.1 was also exposed recently” (2010). Security attacks in a typical wireless communications include man-in-the-middle attacks and evil-twin attacks. To prevent possible middle man attacks, banks should use different authentication techniques such as strong passwords, encryptions, digital certificates, and digital signatures. However, passwords
and encryptions must be sophisticated and strong enough to be cracked. The evil twin is a fake wireless router which used to capture an end user’s user id and passwords. Unfortunately, banks cannot completely control the fake routers in the evil twins’ situation. The customers should ensure that their mobile devices and software are up-to-date.

There is another reason banks have to be concerned over the importance of security. The Payment Card Industry-Data Security Standard (PCI-DSS) requires any institutions that use credit cards as a payment method to pay reasonable attention to control security, or the resulting lawsuits will cost them a heavy price. In general, mobile banking uses the following security methods: 1) passwords, 2) encryptions, 3) security questions, and 4) downloaded applications. Today, almost all the banks use passwords, security protocols, and encryption algorithms. However, security breach incidents occasionally break out and scare consumers.

In online banking, consumers use standard web browsers to access banking websites. In mobile banking, banks will develop different mobile applications for different devices. For example, Citibank uses the Citi Tablet applications for tablet devices. These downloaded applications do not store personal information or financial data in the device.

**RESEARCH METHODOLOGY**

This research project used website observations with a questionnaire with the underlying assumption that the website is a reflection of banking strategy. We chose 160 banking websites around the nation for study during August to November 2013. Online/mobile banking websites ranging from popular, well-known ones to less popular ones were chosen for the observation. Large financial institutions included Bank of America, Chase, Citibank, and Wells Fargo. Small ones included local banks and credit unions. They were selected based on their size and state coverage from Bank Holding Company Peer Group Average Reports and National Credit Union Administration (Zhang et al., 2012).

**Research Framework**

In step one, we first examined the impact of the number of states covered by the institution, the institution’s size, and its charter type on the adoption of mobile banking. Size represents the financial status of the institutions, and the number of states covered reflects the service coverage, and hence the institution’s customer base. The charter type included commercial banks, credit unions, and saving banks. We found only 100 financial institutions offer mobile banking among the 160 financial institutions chosen. Hypotheses 1a to 1c below are based on a sample of the 160 financial institutions. Figure 4 shows the research frame work for Hypotheses 1a, 1b, and 1c.
In step two, we eliminated the 60 financial institutions in the sample which do not have mobile banking services and investigated the remaining 100 to determine the mobile service features and security features offered by the sampled financial institutions. In order to study how different factors influence financial institutions’ adoption of mobile banking, and how service features and security strategies vary among those providing mobile banking, an initial research survey was created (See Appendix).

Based on the above research framework, we proposed the following hypotheses:

- $H_{1a}$: There is a positive relationship between the number of states covered and the adoption of mobile banking.
- $H_{1b}$: There is a positive relationship between institution size and the adoption of mobile banking.
- $H_{1c}$: There is a negative relationship between charter type and the adoption of mobile banking.
- $H_{2a}$: There is a positive relationship between the number of states covered and the mobile banking service features.
- $H_{2b}$: There is a positive relationship between bank size and the mobile banking service features.
- $H_{2c}$: There is a negative relationship between charter type and the mobile banking service features.
H$_{3a}$: There is a positive relationship between the number of states covered and the mobile banking security methods.

H$_{3b}$: There is a positive relationship between institution size and the mobile banking security methods.

H$_{3c}$: There is a negative relationship between charter type and the mobile banking security methods.

H$_{4a}$: There is a positive relationship between the number of states covered and the mobile devices (in terms of OS/brands) supported by mobile banking.

H$_{4b}$: There is a positive relationship between institution size and the mobile devices (in terms of OS/brands) supported by mobile banking.

H$_{4c}$: There is a positive relationship between charter type and the mobile devices (in terms of OS/brands) supported by mobile banking.

H$_{5a}$: There is a positive relationship between the number of states covered and the mobile devices (in terms of size and functions of mobile devices) supported by mobile banking.

H$_{5b}$: There is a positive relationship between institution size and the mobile devices (in terms of size and functions of mobile devices) supported by mobile banking.

H$_{5c}$: There is a positive relationship between charter type and the mobile devices (in terms of size and functions of mobile devices) supported by mobile banking.

H$_{6}$: There is no difference between commercial banks and credit unions in mobile banking service features.

H$_{7}$: There is no difference between commercial banks and credit unions in mobile banking security methods.

Figure 5 shows a detailed framework for Hypotheses 2a to 7.
RESULTS

Adoption of Mobile Banking Service

$H_{1a}$: There is a positive relationship between the number of states covered and the adoption of mobile banking.

$H_{1b}$: There is a positive relationship between institution size and the adoption of mobile banking.

$H_{1c}$: There is a negative relationship between charter type and the adoption of mobile banking.

Whether to adopt mobile banking is an important strategy for financial institutions to decide. Table 1 shows the relationship of financial institutions’ characteristics and their decision to adopt mobile banking. Pearson correlation tests demonstrate that financial institutions with larger size ($r=0.1443$) and more service territories ($r=0.1851$) tend to adopt mobile banking. Financial institutions with larger size are typically stronger in financial status, and a larger geographical coverage may indicate a larger customer base. Therefore, those financial institutions may have a bigger need for and better financial support in adopting the new form of servicing their customers. The charter type is weakly associated with the adoption of mobile banking with a correlation coefficient of 0.0342.
Table 1: The Relationship Matrix between States Covered/Size/Charter Type and the Mobile Banking Adoption Decision.

<table>
<thead>
<tr>
<th>Adoption of mobile banking</th>
<th>States covered</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>States covered</td>
<td>0.1851</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>0.1443</td>
<td>0.7009</td>
</tr>
<tr>
<td>Charter type</td>
<td>0.0342</td>
<td>-0.3003</td>
</tr>
</tbody>
</table>

When further examining the relationship between institution size and states covered with the adoption of mobile banking, in order to separate different types of financial institutions in their decision of adopting mobile banking, we controlled for the three types of financial institutions, namely, commercial banks, credit unions and savings banks. Table 2 shows that when considering different type of financial institutions individually, commercial bank has a stronger relationship between their characteristics and adoption decisions. Both the correlation of states covered and size in the commercial bank group have doubled compared to the pooled sample. The correlation coefficient is 0.3619 and 0.2819 for states covered and size respectively indicating that the size of the customer base and the financial status of the commercial banks had much more influence on the decision of whether to adopt mobile banking.

However, the credit union group acted differently. It had a much lower correlation between states covered and adoption of mobile banking with a low $r=0.0912$, which is about half of that in the pooled sample. It shows that credit unions are more customer based. They tend to be more relation-banking orientated. Therefore, no matter how large the customer base is, they tend to satisfy their customers first. In the credit union group, the correlation of size and the decision to adopt was roughly the same with the pooled sample ($r=0.1627$). Saving banks stayed in between. They had a correlation of states covered about 0.1945 and size about 0.1026 with their mobile banking adoption decision.

Table 2: The Relationship Matrix between States Covered/Size/Charter Type and the Mobile Banking Adoption Decision Within Different Types of Financial Institutions

<table>
<thead>
<tr>
<th>Charter type</th>
<th>Adoption of mobile banking</th>
<th>States covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Bank</td>
<td>States covered</td>
<td>0.3619</td>
</tr>
<tr>
<td></td>
<td>size</td>
<td>0.2819</td>
</tr>
<tr>
<td>Credit union</td>
<td>States covered</td>
<td>0.0912</td>
</tr>
<tr>
<td></td>
<td>size</td>
<td>0.1627</td>
</tr>
<tr>
<td>Savings bank</td>
<td>States covered</td>
<td>0.1945</td>
</tr>
<tr>
<td></td>
<td>size</td>
<td>0.1026</td>
</tr>
</tbody>
</table>

To better understand the mechanism underlying financial institutions’ mobile banking adoption decision with respect to their characteristics, a probit model was performed. The dependent variable was a binary variable, with 1 as “adopting mobile banking” and 0 as “not adopting
mobile banking.” The independent variables were “states covered,” “size” and a category variable of “charter type.” “Commercial bank” was coded as 1, “credit union” was coded as 2 and “savings bank” was coded as 3.

The probit model has a very significant fit as indicated by the chi-square test at the 1 percent level. The McFadden’s adjusted R-square is 0.098. Both size and credit union are statistically significant at the 5 percent and 1 percent levels respectively. The stronger the financial status of the institution, the more likely the institution will adopt mobile banking. In addition, corresponding to the above Pearson correlation tests controlling for different types of financial institutions, we also found that credit unions are more likely to adopt mobile banking. This is a very interesting result and reflects that the development strategy of credit unions focuses more on providing better services to customers. It may also derive from their founding nature: a credit union is a nonprofit organization that aims at serving its members having a common bond. Table 3 shows the findings.

Table 3: Probit Model.

| Variables                  | Coefficients | Std. err. | Z     | P>|Z| |
|----------------------------|--------------|-----------|-------|-----|
| States covered             | 0.0112       | 0.0256    | 0.4377| 0.6620|
| Size                       | 0.0444       | 0.0182    | 2.4356| 0.0150|
| Charter type               |              |           |       |     |
| 2(credit union)            | 1.0017       | 0.2753    | 3.6383| 0.0000|
| 3(savings bank)            | 0.4466       | 0.3070    | 1.4545| 0.1460|
| Constant                   | -0.4310      | 0.2334    | -1.8449| 0.0650|

Measures of fit for Q6 (adoption of mobile banking)
Log-Lik Intercept Only: -102.2980
Log-Lik Full Model: -86.2400
Prob>LR: 0.0000
McFadden's Adj R2: 0.098

Mobile Bank Service Features

Pearson correlation tests were used to examine Hypotheses H2a and H2b. Table 4 shows the relationship (r) between the number of states covered/size and mobile banking service features. There is a medium positive relationship between the number of states covered and mobile banking services features. The Pearson correlation coefficients are 0.2809 for mobile access of loan services, 0.2557 for mobile access of investment account, and 0.2482 for mobile access of credit card accounts.

Financial institutions with larger territorial coverage may have a larger customer base and tend to provide mobile services on loan and investment services. All financial institutions with mobile banking provide mobile balance inquiry for checking or savings accounts because it is the most
basic service for customers. Scanning and depositing checks on mobile devices has a positive correlation with the number of states covered ($r = 0.1267$).

The Pearson correlation tests show an unusual negative relationship between size and mobile banking services. There is a strong/medium negative relationship between size and mobile access of loan services ($r = -0.3439$), mobile access of investment accounts ($r = -0.2927$), and mobile access of credit card accounts ($r = -0.2306$). These results may be related to the mobile banking strategy of smaller sized credit unions. Because they are relational business based, credit unions care more about their customers and may tend to develop mobile banking features even though the credit unions are financially smaller. This is verified later on when we compare the commercial banks and credit unions.

Surprisingly, none of the financial institutions with mobile banking provided links to social media, or account activity analysis or chat help on mobile devices. Maybe it is too costly or deemed not necessary to provide those services by mobile devices.

$H_{2c}$: There is a negative relationship between charter type and the banking service features

Table 4 below shows the relationship ($r$) between mobile banking service features and charter types. The survey covered three bank charter types: commercial banks, coded as 1; credit unions, coded as 2; and savings banks, coded as 3. The strongest correlations between mobile banking service features and charter types are: mobile statements online ($r = -0.2172$) and mobile access of credit card account ($r = -0.2463$). This means credit unions or savings banks are more likely to provide the above mobile banking services than commercial banks.

<table>
<thead>
<tr>
<th>Service features</th>
<th>States covered</th>
<th>Size</th>
<th>Charter type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check of Accounts</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Scan and Deposit Checks on Mobile Devices</td>
<td>0.1267</td>
<td>-0.0709</td>
<td>-0.0418</td>
</tr>
<tr>
<td>Statements Online</td>
<td>0.0648</td>
<td>-0.1632</td>
<td>-0.2172</td>
</tr>
<tr>
<td>Bill-Pay Service</td>
<td>-0.0715</td>
<td>0.0721</td>
<td>-0.1383</td>
</tr>
<tr>
<td>Access of Credit Card Account</td>
<td>0.2482</td>
<td>-0.2306</td>
<td>-0.2463</td>
</tr>
<tr>
<td>Access of Loan Services</td>
<td>0.2809</td>
<td>-0.3439</td>
<td>0.0667</td>
</tr>
<tr>
<td>Access of Investment Account</td>
<td>0.2557</td>
<td>-0.2927</td>
<td>0.0012</td>
</tr>
<tr>
<td>Access of Insurance Services</td>
<td>-0.0409</td>
<td>0.0657</td>
<td>0.0184</td>
</tr>
<tr>
<td>Link to Social Media on Mobile Devices</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Transfer between Accounts on Mobile Devices</td>
<td>0.0490</td>
<td>-0.0899</td>
<td>0.0215</td>
</tr>
<tr>
<td>Account Activity Analysis on Mobile Devices</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Chat Help</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Non-profit Services</td>
<td>0.0562</td>
<td>-0.1970</td>
<td>-0.1208</td>
</tr>
<tr>
<td>Text Banking</td>
<td>-0.0409</td>
<td>0.1247</td>
<td>0.1487</td>
</tr>
</tbody>
</table>
Mobile Banking Security

$H_{3a}$: There is a positive relationship between the number of states covered and the mobile banking security methods.

$H_{3b}$: There is a positive relationship between institution size and the mobile banking security methods.

Table 5 below shows that there is no strong/medium relationship between number of states covered and security methods except encryption ($r = 0.4341$), site key ($r = 0.3309$), advanced security protocol ($r=0.3001$), and mobile security description (0.2379). The impact of size is similar to states covered. The correlation coefficients between size and encryption, site key, advanced security protocol and mobile security description are 0.4946, 0.4235, 0.3374 and 0.2655, respectively. It is quite different from what one sees in online banking. Zhang, Chen, Lee, and Yang (2012) found that there is no strong/medium relationship between bank size and security methods for online banking at all. One of the possible reasons may be that mobile banking security goes through downloaded applications which have their own hidden encryptions and other crypto-graphical methods.

Table 6 below shows that there is no strong/medium relationship between number of states covered and downloadable applications. Another reason could be the mobile banking strategy for smaller financial institutions is still in the evolving stage. Like wireless technology, IEEE is in the early stages focused on the usefulness of the technology (IEEE 802.11b), with a later focus on security (IEEE 802.11i). WEP, the security protocol developed by IEEE in the early stage, is a weak protocol.

$H_{3c}$: There is a negative relationship between charter type and the mobile banking security methods

Table 5 below shows there was a negative correlation between security methods and charter types. The correlation coefficients were -0.3635, -0.2141 and -0.1966 for encryption, mobile security description and advanced security protocols respectively. Therefore, credit unions and savings banks tended to provide the mobile security methods listed above more than the commercial banks.

Table 5: The Relationship Matrix between Size/Charter Type and Security Methods.

<table>
<thead>
<tr>
<th>Mobile security method</th>
<th>States covered</th>
<th>Size</th>
<th>Charter type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Password</td>
<td>0.1001</td>
<td>0.1196</td>
<td>0.0134</td>
</tr>
<tr>
<td>Encryption</td>
<td>0.4341</td>
<td>0.4946</td>
<td>-0.3635</td>
</tr>
<tr>
<td>Security questions</td>
<td>0.0155</td>
<td>-0.0215</td>
<td>-0.0850</td>
</tr>
<tr>
<td>Registered mobile devices</td>
<td>0.0827</td>
<td>0.0021</td>
<td>-0.1208</td>
</tr>
<tr>
<td>Mobile security description</td>
<td>0.2379</td>
<td>0.2655</td>
<td>-0.2141</td>
</tr>
<tr>
<td>A banner or icon in the address Bar</td>
<td>-0.0612</td>
<td>-0.0431</td>
<td>0.0321</td>
</tr>
<tr>
<td>Site key</td>
<td>0.3309</td>
<td>0.4235</td>
<td>-0.1716</td>
</tr>
<tr>
<td>Advanced security protocols</td>
<td>0.3001</td>
<td>0.3374</td>
<td>-0.1966</td>
</tr>
<tr>
<td>Description about privacy</td>
<td>0.0803</td>
<td>0.0500</td>
<td>-0.0559</td>
</tr>
</tbody>
</table>
H4a: There is a positive relationship between the number of states covered and the mobile devices (in terms of OS/brands) supported by mobile banking.

H4b: There is a positive relationship between institution size and the mobile devices (in terms of OS/brands) supported by mobile banking.

H4c: There is a positive relationship between charter type and the mobile devices (in terms of OS/brands) supported by mobile banking.

H5a: There is a positive relationship between number of states covered and the mobile devices (in terms of size and functions of mobile devices) supported by mobile banking.

H5b: There is a positive relationship between institution size and the mobile devices (in terms of size and functions of mobile devices) supported by mobile banking.

H5c: There is a positive relationship between charter type and the mobile devices (in terms of size and functions of mobile devices) supported by mobile banking.

Table 6 below shows the relationship among state coverage, size, charter type and the mobile devices supported by financial institutions. It shows that larger financial institutions tended to support all different devices because of their financial strength, especially for Windows Phone, Kindle Fire, and Blackberry. Small institutions tended to support only the most popular mobile devices such as iPhone, and Android platform. There was no difference among tablets, smartphones, features phones, and cell phone.

Table 6: The Relationship Matrix between Size/Charter Type and Downloadable Mobile Applications.

<table>
<thead>
<tr>
<th>Downloadable mobile application</th>
<th>States covered</th>
<th>Size</th>
<th>Charter type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.0319</td>
<td>-0.0643</td>
<td>-0.1297</td>
</tr>
</tbody>
</table>

Supporting mobile devices brand Name

iPhone 0.1022 0.1092 -0.0609
iPad 0.3217 0.2489 0.0649
Android 0.1490 0.1325 -0.0826
Kindle Fire 0.5567 0.4337 -0.1716
Windows phone 0.5933 0.6057 -0.3564
Blackberry 0.3162 0.3302 -0.1671

Supporting mobile devices types

Tablets 0.0000 0.0000 0.0000
Smart phones 0.0000 0.0000 0.0000
Features phones 0.0406 0.0692 0.1547
Cell phones 0.0406 0.0692 0.1547
Comparison between Commercial Banks and Credit Unions

H₆: There is no difference between commercial banks and credit unions in mobile banking service features.

Wilcoxon’s sum test was used to compare the differences in service features between commercial banks and credit unions. Table 7 below shows that for the majority of the mobile banking service features, there was no significant difference between commercial banks and credit unions in mobile account balance check, mobile check-scan and deposit, mobile statement online, mobile bill-pay service, mobile investment account access, mobile insurance service access, mobile transfer between accounts, mobile device account activity analysis, mobile chat help, and mobile non-profit services. However, there was a significant difference between commercial banks and credit unions in the following areas: mobile credit card account access, mobile loan service access, and text banking at 1 percent significance level. Since credit unions are typically loan-business based, it is not surprising that credit unions provided better loan services on mobile devices.

Table 7: Comparisons between Commercial Banks and Credit Unions in Mobile Service Features.

<table>
<thead>
<tr>
<th>Mobile Service Features</th>
<th>Commercial bank</th>
<th>Credit union</th>
<th>Wilcoxon test</th>
<th>P-value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Account Check</td>
<td>43.5000</td>
<td>43.5000</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Accept</td>
</tr>
<tr>
<td>Check scan and deposit</td>
<td>44.9412</td>
<td>42.5577</td>
<td>0.6904</td>
<td>0.4899</td>
<td>Accept</td>
</tr>
<tr>
<td>Online statements</td>
<td>44.4848</td>
<td>42.0577</td>
<td>0.5854</td>
<td>0.5583</td>
<td>Accept</td>
</tr>
<tr>
<td>Bill-pay service</td>
<td>30.8636</td>
<td>38.3061</td>
<td>-1.7463</td>
<td>0.0808</td>
<td>Accept</td>
</tr>
<tr>
<td>Credit-card account Access</td>
<td>50.8824</td>
<td>38.6731</td>
<td>2.6001</td>
<td>0.0093</td>
<td>Reject</td>
</tr>
<tr>
<td>Loan-services access</td>
<td>52.2941</td>
<td>37.7500</td>
<td>3.1300</td>
<td>0.0017</td>
<td>Reject</td>
</tr>
<tr>
<td>Investment account access</td>
<td>46.3824</td>
<td>41.6154</td>
<td>1.2484</td>
<td>0.2119</td>
<td>Accept</td>
</tr>
<tr>
<td>Insurance-services access</td>
<td>43.0000</td>
<td>43.8269</td>
<td>-0.7848</td>
<td>0.4326</td>
<td>Accept</td>
</tr>
<tr>
<td>Link to social media</td>
<td>43.5000</td>
<td>43.5000</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Accept</td>
</tr>
<tr>
<td>Transfer between accounts</td>
<td>42.9706</td>
<td>43.8462</td>
<td>-0.4237</td>
<td>0.6718</td>
<td>Accept</td>
</tr>
<tr>
<td>Account activity analysis</td>
<td>43.5000</td>
<td>43.5000</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Accept</td>
</tr>
<tr>
<td>Chat help</td>
<td>43.5000</td>
<td>43.5000</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Accept</td>
</tr>
<tr>
<td>Non-profit services</td>
<td>44.2647</td>
<td>43.0000</td>
<td>1.2129</td>
<td>0.2252</td>
<td>Accept</td>
</tr>
<tr>
<td>Text banking</td>
<td>34.2647</td>
<td>49.5385</td>
<td>-3.6638</td>
<td>0.0002</td>
<td>Reject</td>
</tr>
</tbody>
</table>

H₇: There is no difference between commercial banks and credit unions in mobile banking security methods.

Table 8 below compares security methods between commercial banks and credit unions. Wilcoxon sum tests show that commercial banks and credit unions differed in password (-3.1650), encryption (3.2390), and mobile security description (4.9763). They were all significant at the 1 percent level. None of the other security methods showed any difference: security questions (CHAP protocol), registered mobile device, banners/icons, site key, advanced security protocols, and description about privacy. It also showed a difference in the downloadable
applications between commercial banks and credit unions. Commercial banks were more likely to provide downloadable mobile applications.

Table 8: Comparisons between Commercial Banks and Credit Unions in Security Methods.

<table>
<thead>
<tr>
<th>Mobile security &amp; privacy</th>
<th>Commercial Bank Score mean</th>
<th>Credit Union Score mean</th>
<th>Wilcoxon test</th>
<th>P-value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Password</td>
<td>36.0588</td>
<td>48.3654</td>
<td>-3.1650</td>
<td>0.0016</td>
<td>Reject</td>
</tr>
<tr>
<td>Encryption</td>
<td>50.4118</td>
<td>38.9808</td>
<td>3.2390</td>
<td>0.0012</td>
<td>Reject</td>
</tr>
<tr>
<td>Security questions</td>
<td>45.2941</td>
<td>42.3269</td>
<td>1.4649</td>
<td>0.1429</td>
<td>Accept</td>
</tr>
<tr>
<td>Registered mobile device</td>
<td>44.2647</td>
<td>43.0000</td>
<td>1.2129</td>
<td>0.2252</td>
<td>Accept</td>
</tr>
<tr>
<td>Mobile security description</td>
<td>58.5294</td>
<td>33.6731</td>
<td>4.9763</td>
<td>&lt;0.0001</td>
<td>Reject</td>
</tr>
<tr>
<td>A banner or icon in address bar</td>
<td>42.0000</td>
<td>44.4808</td>
<td>-1.4034</td>
<td>0.1605</td>
<td>Accept</td>
</tr>
<tr>
<td>Site key</td>
<td>45.0294</td>
<td>42.5000</td>
<td>1.7424</td>
<td>0.0814</td>
<td>Accept</td>
</tr>
<tr>
<td>Advanced security protocols</td>
<td>22.7500</td>
<td>19.0000</td>
<td>-1.3531</td>
<td>0.1760</td>
<td>Accept</td>
</tr>
<tr>
<td>Privacy description</td>
<td>22.0000</td>
<td>20.5000</td>
<td>-1.3637</td>
<td>0.1727</td>
<td>Accept</td>
</tr>
</tbody>
</table>

Table 9 below shows there is no difference in the various devices (classified by brand names) supported by commercial banks and credit unions except Windows Phone. The reason is that Windows phone has a relatively small percentage of market share, so that some of the credit unions ignored it. It was also surprising to find out that the commercial banks had less focus on the features phone and cell phones. It showed that the trend is towards more sophisticated mobile devices.

Table 9: Comparisons between Commercial Banks and Credit Unions in Downloadable Mobile Applications and Devices Supported.

<table>
<thead>
<tr>
<th>Supporting mobile devices brand name</th>
<th>Commercial bank Score mean</th>
<th>Credit union Score mean</th>
<th>Wilcoxon test</th>
<th>P-value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downloadable mobile application</td>
<td>52.4706</td>
<td>37.6346</td>
<td>3.6754</td>
<td>0.0002</td>
<td>Reject</td>
</tr>
<tr>
<td>Supporting mobile devices types</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iPhone</td>
<td>46.4412</td>
<td>41.5769</td>
<td>1.3038</td>
<td>0.1923</td>
<td>Accept</td>
</tr>
<tr>
<td>iPad</td>
<td>47.2353</td>
<td>41.0577</td>
<td>1.3265</td>
<td>0.1847</td>
<td>Accept</td>
</tr>
<tr>
<td>Android</td>
<td>47.6765</td>
<td>40.7692</td>
<td>1.6795</td>
<td>0.0930</td>
<td>Accept</td>
</tr>
<tr>
<td>Kindle Fire</td>
<td>45.0294</td>
<td>42.5000</td>
<td>1.7424</td>
<td>0.0814</td>
<td>Accept</td>
</tr>
<tr>
<td>Windows phone</td>
<td>50.1471</td>
<td>39.1538</td>
<td>3.3185</td>
<td>0.0009</td>
<td>Reject</td>
</tr>
<tr>
<td>Blackberry</td>
<td>47.7059</td>
<td>40.7500</td>
<td>1.5657</td>
<td>0.1174</td>
<td>Accept</td>
</tr>
<tr>
<td>Supporting mobile devices types</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tablets</td>
<td>43.5000</td>
<td>43.5000</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Accept</td>
</tr>
<tr>
<td>Smart phones</td>
<td>43.5000</td>
<td>43.5000</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Accept</td>
</tr>
<tr>
<td>Features phones</td>
<td>33.7647</td>
<td>49.8654</td>
<td>-3.9229</td>
<td>&lt;0.0001</td>
<td>Reject</td>
</tr>
<tr>
<td>Cell phones</td>
<td>33.7647</td>
<td>49.8654</td>
<td>-3.9229</td>
<td>&lt;0.0001</td>
<td>Reject</td>
</tr>
</tbody>
</table>
CONCLUSIONS AND FUTURE RESEARCH

The purpose of this study was to examine the willingness of financial institutions to adopt mobile banking and how the service features and security methods of mobile banking vary among those financial institutions adopting mobile banking. Specifically, the research focused on whether states coverage, size and charter type will affect financial institutions’ decision in adopting mobile banking, and how those three factors will affect mobile banking service features and security methods provided. In addition, commercial banks and credit unions were compared to examine whether they differed in providing mobile banking service features and security methods.

Our study found that larger financial institutions are more likely to adopt mobile banking. However, surprisingly, credit unions are most prone to offer mobile banking among the three types of financial institutions investigated: commercial banks, credit unions and savings banks. This may be because credit unions, as nonprofit cooperatives, tend to care more about their customers, even though their sizes are typically smaller than their commercial bank counterparts. However, commercial banks tend to offer more mobile service features than credit unions. Commercial banks also provide better security descriptions and support more devices. Compared to online banking, credit unions seem to catch up and attempt to minimize the differences between commercial banks and credit unions. The explanation may be that commercial banks are larger in size and stronger in financial status. Once they decide to adopt mobile banking, commercial banks are in a better position to provide more sophisticated service features and security to their customers. Another possible reason is that large financial institutions simple provide a better website which has a more complete description about service features and security.

The limitations of this research include 1) its use of limited samples in the study, 2) possible bias on the web observation, and 3) the assumption that the website reflects banking strategy. Future study should include a larger sample. The first managerial implication is for those financial institutions that adopt mobile banking: they should make sure to meet necessary security compliance. Otherwise, the penalty is costly. For example, a wireless attack cost TJX, a retails chain, at least $250 million (Panko, 2009). The second managerial implication is that given the popularity of mobile devices, it is worthwhile to adopt mobile banking. Some small credit unions are more progressive and use mobile banking as a competitive strategy to gain more customers. Third, security and privacy on mobile banking will be more complex than on traditional desktop computers because of the variety of mobile devices/platforms. Google devices become popular, but security is an issue. Fourth, the service features will continue to evolve. The services include voice recognition and mobile wallet which will eventually replace traditional credit cards. Both commercial banks and credit unions should be aware of the technology development and its impact on the way we conduct banking.
REFERENCES


**APPENDIX A**

Portions of the Questionnaire For
E-Commerce Strategy on Mobile Banking

---

| Bank ID _________________________ |

1. **Web site of the bank:**
   
   ____________________________________________________________

2. **Name of bank:**
   
   ____________________________________________________________

3. **Location**
   
   a) Physical location or Mailing address (State Name)
   
   ____________________________________________________________
   
   b) Number of States or districts covered:
   
   ____________________________________________________________

4. a) **Size**
   
   ____________________________________________________________
   
   b) National _____________ Regional _____________ Local or Community _____________

5. a) **Charter Type:** Commercial Bank _____________ Credit Union _____________ Savings Bank
   
   b) **Charter Authority:** Federal (National) _____________ State (or Equivalent) ______________

6. Does the bank provide mobile banking service? Yes _____ No ______
   
   (If YES, continue the following questions, **If NO, stop here**)

7. **What mobile services are provided for a customer?**
   
   a) Mobile Check of Checking or Savings Account Balances__________________________
   
   b) Scan and Deposit Checks on Mobile Device ________________________________
   
   c) Mobile Statements Online _______________________________________________
   
   d) Mobile Bill-Pay Service _________________________________________________
   
   e) Mobile Access of Credit Card Account______________________________________
   
   f) Mobile Access of Loan Account or Online Loan Application ______________________
   
   g) Mobile Access of Investment Brokerage Account _____________________________
   
   h) Mobile Access of Insurance Account or Online Insurance Application ______________
   
   i) Link to Social Media (i.e. Facebook) on Mobile Phone_______________________
   
   j) Transfer between Depository and Other Accounts on Mobile Device _____________
   
   k) Account Activity Analysis on Mobile Device _________________________________
   
   l) Mobile Chat Help _______________________________________________________
   
   m) Mobile Non-profit Services (i.e. Calculator, Weather, etc.) ____________________
n) Text banking
 o) Other ____________________________________________

8. Mobile Security & Privacy
a) Password ____________________________________________
b) Encryption ____________________________________________
c) Security Questions (CHAP or MS/CHAP Protocol) __________
d) Registered Mobile Device ________________________________
e) Mobile Security Description ________________________________
   (0: no description 1: some description 2: more description)
f) A Banner or Icon in the Address Bar ______________________
g) Site key _______________________________________________
h) Advanced Security Protocols _____________________________
i) Description about Privacy ________________________________
j) Others _________________________________________________

9. Does the customer have to download a mobile application as a special browser for the mobile devices? __________

10. Supporting Mobile Devices (Operating Systems/Brand Name)
   iPhone _______
iPad _______
   Android _______
   Kindle Fire _______
   Windows Phone _______
   Blackberry _______

11. Supported Mobile Devices (Size & Functions)
   Tablets _______
   Smart Phones _______
   Features Phones _______
   Cell Phones _______