Mobile Core-Banking Server

Cashless, Branchless and Wireless Retail Banking for the Mass Market

Insu Song
School of Business
James Cook University
Singapore Campus, Singapore
insu.song@jcu.edu.au

John Vong
Financial IT Academy,
Singapore Management University
johnvong@smu.edu.sg

***Abstract*—Banking is essential to modern economies and nearly half of the world's people are unbanked and underserved by banks. The high operating costs of banks passed on to retail customers are driving them away who otherwise should be in the financial system. Without having access to the financial system the unbanked and rural poor have little means to engage in mainstream economic activities. A mobile phone-based banking system was designed to provide retail banking services to the world's unbanked population and rural poor of 2.2 billion based on a cashless banking system that reduces operating cost and reduces lending risks and therefore can lower the current exorbitant rates charged on retail lending and micro-credit. A core-banking server on a low-cost mobile device (an Android tablet) could serve over 15,000 micro-banking customers. The system definitely appears to be suitable for most retail banks or microfinance institutions.**

Keywords—Mobile Banking, Rural Finance, Retail Banking, Cashless Payments, SMS Banking, Financial Inclusion

I. INTRODUCTION

Banking is essential to any modern economy [1], yet, 56% of the world's total population are still unbanked [2]. The main reasons for this phenomena are the high cost of core-banking systems and high operating costs (e.g., credit underwriting and transaction). The cost is invariably passed on to customers through transaction fees and highest lending rates. A third of the unbanked population, approximately 800 million people, live in Asia. These people, who are in the lowest income category (i.e., living on under $5/day), simply cannot afford the high bank charges. It is only natural to ask why banks currently cannot provide banking services to everyone. The fundamental problem is that the current banking systems, policies, and operations are designed for the top of economic pyramid, that is the wealthy mass market and the high net-worth individuals. For instance, small firms are significantly disadvantaged in financing business investment (e.g., due to 'lending bias') in many developing countries [3, 4]. Therefore, a new approach is required.

In the last decades, various solutions have been suggested, such as solidarity lending and village banking, pioneered by Grameen Bank [5] in Bangladesh that delivered basic banking services for the poor. Their new banking model lowered the operating costs but increased the risk of lending, and thereby increasing lending rates. These approaches attempt to bridge the gap between the two incompatible partners: the unbanked population usually the rural poor and banks that are designed to serve the wealthy. However, most micro finance institutions (MFIs) operate based on manual processes that involve posting transactions from one accounting ledger to another with human hands. The processes is not easily scalable and are susceptible to fraud and other accounting irregularities.

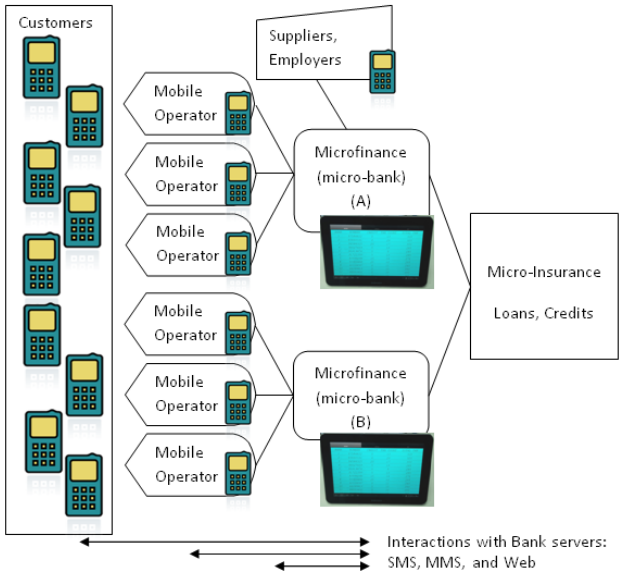

Figure 1. System diagram of cashless, branchless and wireless microbanking model. The system shows core-banking system running on mobile devices. Bank tellers now work on mobile offices, such as motor bikes. The insurance company pulls the risks to reduce the overall risk through diversification, providing low interest rates.

The extensive penetration of cell phone networks and 2G devices in many of the world's most unbanked regions (global mobile phone subscriptions have reached 87% of the global population and 79% of developing world's population [6]) suggests that mobile phone-based banking services could be the ideal solution for providing banking services to those regions. However, the current core-banking systems that support mobile phone-based banking (whether it is "Mobile Phone Banking" or "Mobile Money Services" [7, 8]), such as Sybase mCommerce 365 by SAP [9], and DELL Mobile Banking and Payments [10], are targeted at developed banking sectors. The core-banking systems are not only expensive for

978-1-4799-2845-3/13/$31.00 ©2013 IEEE

banks in emerging economies but would also incur high associated transaction cost.

In this paper, we present a new mobile core-banking system. The system was developed based on a new microbanking model (Figure 1). A prototype cashless payment of the banking system was installed on an Android tablet and trailed in a "small and artificial village" comprising five mobile bank operators, five merchants (sellers), seven companies and 130 buyers. The participants performed 804 transactions and sent 2,412 SMS messages over a three hour period. The results suggest that the payment system on a low-cost Android device can serve over 15,000 micro-entrepreneurs, making it large enough for most micro-banking and microfinance institutions. Section 3.4 reports on these performance results, as well as usability and user experience survey results.

II. BACKGROUND AND MOTIVATION

A. Rural Finance

World Bank [11] defines microenterprise as "informal sector business with five workers or less, and fixed assets valued at less than US$10,000." This definition is similar to that used by USAID [12] and others [13]. Provision of financial services in rural area always poses challenge for banks operating in the developing economy [14]. In developing countries, the majority of micro-entrepreneurs are self-employed or hire employees without salaries, while hoping for paid employment [15] . For instance, a third of the non-agricultural labor sector is operated by the self employed. Similarly, a half of the informal sector is operated by self employed [16]. The main three reasons for micro-entrepreneurs being in informal sectors are lack of access to credit, inability to obtain approval for a business license, or being prevented from starting a business [17]. The movement by Grameen Bank [5] in Bangladesh inspired rural finance efforts world-wide to help these micro-entrepreneurs. Recently due to the availability of internet and telecommunication services, electronic money has been proposed as possible solutions for empowering the poor. A study done in rural Cambodia [18] showed that the financial access to electronic money has changed and improved livelihoods of rural Cambodia.

B. Mobile Banking

Various terms have been used for mobile banking, such as “Mobile Phone Banking” and “Mobile Money Services” [7, 8]. Examples of mobile banking systems include Sybase mCommerce 365 by SAP [9] and DELL Mobile Banking and Payments [10]. In developed countries, much research has been conducted recently into how to make mobile phone-based banking accessible to people with disabilities [19] and security and trust issues [20], as well as public perceptions of and attitude toward such systems [21].

C. Unbanked Population

A report commissioned by World Bank Group / World Resources Institute estimated that about 80% of the world’s population (4 billion people) still have annual incomes below

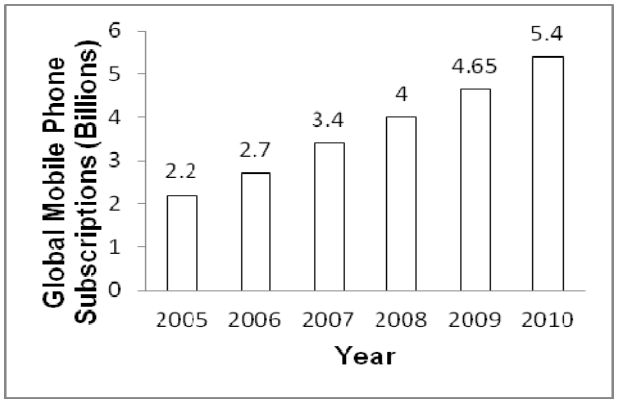

Figure 2. Number Of Global Mobile Phone Subscriptions. Source:ITU World Telecommunication/ICT Indicators Database, 2011, (http://www.itu.int/ITU-D/ict/statistics/index.html).

the equivalent of US$3,000 in local purchasing power [22]. The International Telecommunications Union (ITU) reported that global mobile phone subscriptions accelerated from 2.2 billion in 2005 to over 5 billion in 2010, reaching 87% of the total global population and 79% of the total developing world population (see Figure 2). This penetration was set to grow to 6 billion by end 2011[23]. Chaia et al. [2], CGAP [24] and Ardic et al. [25] suggested that by end 2009, there would be an estimated 2.75 billion people out of 5 billion people (that is, 56% of global adult population) without access to formal financial services for saving, borrowing, or transacting.

Very recently, the mobile phone has been widely used as a channel for providing retail banking, microbanking and microfinance services, hence the terms “Mobile Phone Banking” and “Mobile Money Services.” Furthermore, the use of mobile phones to provide financial services across developing countries has been one of the most remarkable technology stories in the past decade. By end 2009, more than 120 mobile money projects were deployed in 70 emerging countries [7]. This phenomenon has since been given impetus by a range of terminologies such as mobile banking (m-banking), mobile payments (m-payments), mobile transfers (m-transfers), and mobile finance (m-finance) [8].

III. MOBILE CORE-BANKING SERVER

The core-banking system defines and exports its services through MSDL (Microbank Service Definition Language), which is a subset of WSDL (Web Service Definition Language), to allow interoperability between various systems over heterogeneous mobile devices, cell-phone networks, and internet services. MSDL includes Short Message Service (SMS) binding to allow services to be discovered and utilized over SMS. To ensure the services are usable by 2.2 billion people, the core-banking system implements a Well-Behaved Service Interface (WBSI) based on human emotion models [26, 27].

To ensure the security of the banking system, it uses one-time passcode to verify buyer and sender identities. In a face-to-face buyer-seller transaction, the transaction takes place as follows:

(1) The seller requests the phone number of the buyer and sends a credit request message to the mobile banking server.

(2) The bank server sends a one-time passcode to the buyer.

(3) The seller sends the one-time passcode to the bank to verify the passcode before handing over the items.

We should however note that the typical transaction amount of micro-entrepreneurs is very small usually few dollars or less. Therefore, the additional verification step (3) could hinder the daily business for busy markets. As credit fraud risk can be diversified when there are many customers and the insurance company can absorb the risks, an alternative was proposed considering this:

(1) The seller requests the phone number of the buyer and sends a credit request message to the mobile banking server.

(2) The bank server then sends a one-time passcode to both the seller and buyer.

(3) The seller visually verify the passcode of the buyer with his passcode before handing over the items.

(4) To cancel the transaction, the buyer can send a refute message to the bank server. The bank server then holds the transaction amount is in an escrow account, which can be resolved via a mobile teller or the seller's agreement.

The step (4) discourages both seller and buyers doing any fraudulent transactions as no-one will benefit from inappropriate behaviors. To evaluate the security risk the propose transaction protocol, a review of credit card transaction protocols was conducted [28]. We found that the proposed protocol similar to typical credit card transactions that only merchants send messages to banks for authorization. The security and trust measures of credit card (e.g., the 24 hour grace period in the event of stolen or lost cards) can be provided the insurance company for our mobile banking system to provide the same or better level of service quality, security, and trust.

IV. Evaluation of the Mobile Banking Sever

The mobile banking system shown in Figure 1 was implemented on an Android tablet and evaluated on an artificial village comprising of five mobile bank operators, five merchants (sellers), seven companies and 130 buyers. The buyers were fresh high-school graduates and most of them have never used mobile banking services. The participants performed 804 transactions and sent 2,412 SMS messages over a three hour period as shown in Figure 3.At around 11am (shown as 1090), the buyers arrived to the village and the bankers created accounts for the buyers for the first time. From 12pm, the buyers were then participated in activities organized by the seven companies to earn credits and use the earned credits to purchase items from sellers. After the trial, the participants were asked to complete a questionnaire to evaluate perceived usefulness, easy-of-use, and safety.

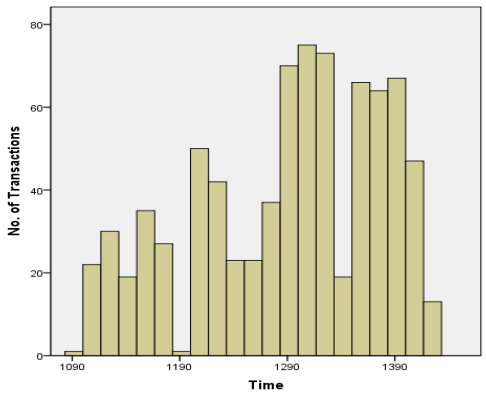

Figure 3. Each bar represents the number of transactions in 10 min intervals. It shows that the server could easily handle over 75 transactions per 10 mins (7.5 transactions per minute). Each transaction consists of 3 SMS messages.

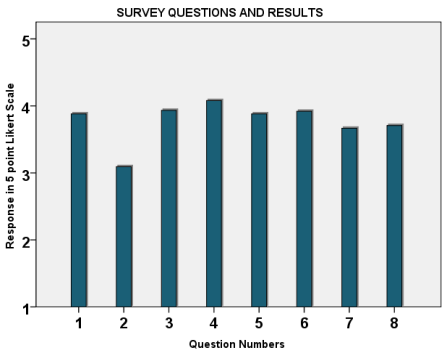

Figure 4. The answers were based on 5 point Likert scale: 1 = Strongly Disagree, 2 =Disagree, 3 = Neutral, 4 = Agree, 5= Strongly Agree. Survey questions: Q1: The mobile trading system is easy to use. Q2: I think that I would need the help of other people to be able to use this mobile. Q3: The steps required to perform mobile trading were easy to follow. Q4: I was able learn to use this system very quickly. Q5: Most people would learn to use this system very quickly. Q6: I am confident that I would remember how to use the system again. Q7: I would like to use this system again. Q8: I would recommend this system to others.

Figure 4 shows the survey results. Except question 2, all responses were statistically significant ($p<0.01$) indicating that the mobile banking system is useful. Qualitative analysis of responses to open questions suggest that some users were still doubtful of the provided security measures indicating that we need to provide security measure options for different risk-aversion profiles of customers.

V. Limitations

Although the participants in this study had never used mobile phone-based banking services nor had any knowledge of the new banking service being tested, this study reflects the perceptions of high school graduates in a highly wired and connected urban city area, Singapore.

Trust and security have been a focus in studies of adoption rates of mobile phone-based banking [21]. On the open-ended question, a few participants raised this issue, suggesting better security measures; however, this was not a major concern for most participants. This could be due to the similarity of the transaction protocol to that of credit cards, participants'

exposure to credit card system, or the perfection of credit card transaction protocol. This matter requires further study.

One critical limitation of 2G based mobile banking is the usability of 2G mobile phones. 2G mobile phones have numeric keypads laid out in a 4×3 grid for both dialing and messaging. Enquiring for a balance would not be a problem for normal users as they could just send any message for a balance statement, but in order to transfer money to someone, users would need to enter counterpart account details and verification codes. Bankers and merchants who use the system daily would not experience particular difficulty, but we expect that ordinary users would experience usability issues, such as not being able to enter messages easily and having to learn the message formats.

Additionally, it could be argued that the proposed banking system lacks security measures. However, in response, we could ask what security measure credit cards currently have. Currently, many bank card and credit card companies including DBS (Singapore's largest bank) use mobile phones to increase security (e.g, by sending transaction notifications or requesting verification codes). Although these institutions seem to believe that SMS notifications increase security. That said, methods for preventing the use of stolen mobile phones for transactions present an important future topic in research on mobile phone-based banking or mobile phone assisted banking.

ACKNOWLEDGMENT

We would like to thank Rajendhar Dayalan, Ramesh Ramachandran, and Kevin Raj, who were involved in the evaluation and development of the mobile banking server and the JCU Singapore student volunteers who helped during the trial. The authors also would like to thank the Republic Polytechnic (RP) students who participated in the trial and the RP staff who organized RP students to participate in the trial and who conducted the survey, in particular, Leslie Sim, Elaine Li, Shamla Ramasamy, Joshua Yeo, and Sim Choon Hou.

REFERENCES

[1] M. a. T. Tan, T.S.H., "Factors influencing the adoption of internet banking," *Journal of the Association for Information Systems,* vol. 1, pp. 1-42, 2000.

[2] A. D. Alberto Chaia, Tony Goland, Maria Jose Mayasudhakar, Jonathan Morduch, Robert Schiff. (2010, 17 May). *Half The World Is Unbanked*. Available: http://financialaccess.org/sites/default/files/publications/B25_Half_the_World_is_Unbanked%282011-01-21%29-1.pdf

[3] A. N. Berger and G. F. Udell, "RELATIONSHIP LENDING AND LINES OF CREDIT IN SMALL FIRM FINANCE," *Journal of Business,* vol. 68, pp. 351-381, Jul 1995.

[4] C. K. W. Chow and M. K. Y. Fung, "Small businesses and liquidity constraints in financing business investment: Evidence from Shanghai's manufacturing sector," *Journal of Business Venturing,* vol. 15, pp. 363-383, Jul 2000.

[5] M. Yunus, *Banker to the Poor: Micro-Lending and the Battle Against World Poverty*. New York: PublicAffairs, 1999.

[6] I. T. U. (ITU). (2011). *ITU World Telecommunication/ ICT*

[7] C. A. Beshouri C., Cober B. and Gravrak J. , "Banking On Mobile To Deliver Financial Services To The Poor," in *Global Financial Inclusion*, M. R., Ed., ed USA: McKinsey & Company, 2010, pp. pp. 24-31.

[8] J. a. T. Donner, C. A. , "Mobile Banking And Economic Development: Linking Adoption, Impact, And Use," *Asian Journal of Communication,* vol. 18, pp. 318-332, 2008.

[9] D. C. Edgar. (2009). *Realizing the Full Potential of Mobile Commerce Orchestrating Mobile Payments and Money Transfers*. Available: http://www.sybase.com/mCommercewhitepaper

[10] DELL. (2012). *Mobile Banking and Payments*. Available: http://i.dell.com/sites/doccontent/business/solutions/engineering-docs/en/Documents/mobile-banking-payments.pdf

[11] World Bank, "The World Bank and Microenterprise Finance: From Concept to Practice," Operations Evaluation Department, World BankNovember 15 1999.

[12] R. G. Blayney and M. Otero, *Small and Micro-Enterprises: Contributions to Development and Future Directions for AID's Support*: United States. Agency for International Development, 1985.

[13] M. Ayyagari, T. Beck, and A. Demirguc-Kunt, "Small and medium enterprises across the globe," *Small Business Economics,* vol. 29, pp. 415-434, 2007.

[14] World Bank. 26/8/2013). Meeting Development Challenges Renewed Approaches to Rural Finance. [Report]. Available: http://www.ruralfinance.org/

[15] V. E. Tokman, "Modernizing the informal sector," *UN/DESA Working Paper,* pp. 1-13, 2007.

[16] S. De Mel, D. McKenzie, and C. Woodruff, "Who are the Microenterprise Owners? Evidence from Sri Lanka on Tokman versus De Soto," in *International Differences in Entrepreneurship*, ed: University of Chicago Press, 2010, pp. 63-87.

[17] H. De Soto, "The Other Path: The Invisible Revolution in the Third World, Harper and Row," *New York,* 1989.

[18] J. Vong, J. Fang, and I. Song, "Delivering financial services through mobile phone technology: a pilot study on impact of mobile money service on micro–entrepreneurs in rural Cambodia," *International Journal of Information Systems and Change Management,* vol. 6, pp. 177-186, 2012.

[19] M. Pous, C. Serra-Vallmitjana, R. Giménez, M. Torrent-Moreno, and D. Boix, "Enhancing accessibility: Mobile to ATM case study," 2012, pp. 404-408.

[20] T. Zhou, "Understanding users' initial trust in mobile banking: An elaboration likelihood perspective," *Computers in Human Behavior,* vol. 28, pp. 1518-1525, 2012.

[21] J. B. Kim and S. Kang, "A study on the factors affecting the intention to use smartphone banking: The differences between the transactions of account check and account transfer," *International Journal of Multimedia and Ubiquitous Engineering,* vol. 7, pp. 87-96, 2012.

[22] A. L. Hammond, W. J. Kramer, R. S. Katz, J. T. Tran, and C. Walker, *The next 4 billion: Market size and business strategy at the base of the pyramid*: World Resources Institute, International Finance Corporation, 2007.

[23] International Telecommunications Union (ITU). (2011, ITU World Telecommunication/ ICT Indicators Database. Available: http://www.itu.int/ITU-D/ict/statistics/index.html

[24] Consultative Group To Assist The Poor/The World Bank Group (CGAP). (2010, 8 December). *Financial Access 2010 - The State of Financial Inclusion Through the Crisis*. Available: http://www.cgap.org/p/site/c/template.rc/1.9.47743/

[25] H. M. Ardic O. P., Mylenko N. (2011, 14 January 2012). Access to Financial Services and the Financial Inclusion Agenda - A Cross-Country Analysis with a New Data Set. *Policy Research Working Paper #3357*. Available: http://www.cgap.org/gm/document-1.9.49435/Access_to_Financial_Services_and_the_Financial_Inclusion_Agenda_Around_the_World.pdf

[26] I. Song and J. Vong, "Affective Core-Banking Services for Microfinance," in *Computer and Information Science*, ed: Springer, 2013, pp. 91-102.

[27] I. Song and G. Governatori, "Affective web service design," *PRICAI 2006: Trends in Artificial Intelligence,* pp. 71-80, 2006.

[28] J. G. Bruce Binder, Alden Hart, Steve Kiser, Steve Klebe, Garry Knox, Tom Lee, Bob Lindenberg, Jim Lum, Bill Melton, Denise Paredes, Prasad Chintamaneni, Fred Silverman, Bruce Wilson, Garland Wong, Wei Wu, Mark Zalewski. (1996). *CyberCash Credit Card Protocol Version 0.8*. Available: http://tools.ietf.org/html/rfc1898#section-1.3