When Value is Greater than Money: a Micropayment System in Uganda

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Abstract
The Pay-E-Safe system is a token-based car battery powered electronic micropayment system for emerging markets in East Africa. This is the story of how it was developed with different ethnic groups in Kasese, Uganda, combining methods from HCI, software development, and business modeling. We created a system that is inexpensive to implement, sensitive to the Ugandan context (e.g. low incomes, unreliable power supplies and unstable Internet connections) and provides benefits to local vendors as well as added value to users and their families. Using observations, interviews and prototype evaluations with local Ugandans we studied people's spending behaviors and then explored alternative design solutions with them. Along the way, we discovered that a micropayment system could actually add value to the user experience beyond the exchange of money for services. This case study reports on how we designed the system and the additional value it afforded users.

Author Keywords
Qualitative research; field studies; prototyping; developing countries; electronic payment system.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Figure 1. Using the Pay-E-Safe system at the One-Stop-Shop.

Figure 2. Model showing internal design of the One-Stop-Shop with shower and toilet cubicles.

Introduction

East African countries are rapidly developing, creating new markets and allowing for new technological innovations for these markets [13]. In this project, we worked with a Danish sanitation company, Enviclean, introducing sanitation solutions into East Africa in the form of toilet/shower blocks, which require payments by users involving small amounts. The company was reluctant to use conventional cash as it creates difficulties with cash handling in respect to theft and fraud, but at the same time was unable to find an existing payment solution suitable for both the company and the end-users. At the same time, credit cards or phone transfers were not a viable option in Uganda either, as very few people can afford to have a bank account and the bank fees are prohibitive for most people [12]. Furthermore, the phone transfer fees for micropayments are also expensive [7].

In response to these challenges, we set out to understand the implications of the kinds of micropayment solutions that might be viable for East Africa. First, we surveyed existing micropayment solutions in Denmark and Uganda, to understand the characteristics and benefits of different alternatives. We then visited the town of Kasese in Uganda to observe and talk with local people about the technologies they are familiar with, their spending activities, and to get a feel for the context in which the sanitation blocks were being built.

Our project involved working with Enviclean to provide a payment solution sensitive to the culture, respectful of people's current payment practices, highly usable and overcoming the challenges of existing infrastructure in Uganda, while at the same time creating added value for its users. The solution also needed to provide a trustworthy, beneficial, and safe experience for local users and vendors in respect to purchasing services at the new community-shared sanitation facilities, One-Stop-Shops, in Uganda. We deployed a methodology combining user centered design, software development, and business model generation methods to create an innovative solution to the electronic payment problem. Innovation was required to adapt existing software solutions to an environment very different from Denmark, where Enviclean has its usual customer base. The system we developed is called Pay-E-Safe (see Fig. 1). It is an electronic micropayment system useful for businesses and organizations selling services in East Africa. In addition to the service purchased, we found that added value for the Ugandan people includes aspects of trust, security, community knowledge sharing, flexible family shopping, discounts, donations, and personal prestige.

Background

Poor sanitation is an overwhelming problem in Uganda leading to illness and death [15]. Enviclean is currently developing a sanitation unit called One-Stop-Shop to help with this problem. One-Stop-Shop is a combined toilet/shower facility with an adjacent shop (Fig 2). When a person pays for a toilet visit, they are issued with a discount voucher that can be used in the shop to buy personal sanitary items. Enviclean plans to form an alliance with Red Cross, where donations can be given in the form of toilet visits. Enviclean therefore needed an electronic micropayment system able to accept small payments from people wishing to use One-Stop-Shop, as well as to mediate the fair distribution of donated toilet visits. As a research project, we collaborated with Enviclean to design and build an

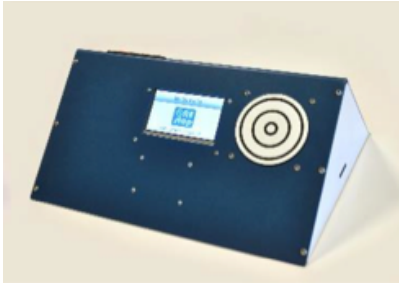

Figure 3. Pay-E-Safe: customer side.

Figure 4. Pay-E-Safe: vendor side.

interactive system to provide people with suitable, safe, and inexpensive micropayments, Pay-E-Safe, which aligns with the requirements of the company, is simple to manage for local vendors and provides a beneficial transaction for the Ugandan people using the service.

Ugandan People

Uganda is a collectivist society; people belong to extended family groups where loyalty and trust are extremely important [5]. Friendliness and mutual commitment are important aspect of establishing trust in this kind of society. Uncertainty is a key factor in people's skepticism when it comes to new technologies or concepts [5]. Uganda has a high ethnic diversity. The official national language of Uganda is English [3] however, around 31% of Ugandans cannot read or speak it, but rely instead on their local ethnic languages.

The personal economic situation in Uganda has improved over the past twenty years, with absolute poverty decreasing from 58% to 31%. The official median wage in Uganda in 2009/10 was 80,000 Ugandan Shillings (UGX) per month, which is around $30 US [14]. Only 20% of Ugandans have bank accounts [6], even fewer have credit cards, as they do not have enough money and the associated fees are too expensive in respect to their low incomes. To maintain a bank account, the standard monthly fee is around 20,000 UGX, equivalent to a quarter of their monthly wage [12]. Credit card fees are added on top of that. The population in Uganda is young, with the median age being 15.5 years [3]. By comparison, the median age in Denmark and the USA is around 40 years. While mobile phone ownership in Uganda is more than 50%, access to internet connected computers is still relatively low and unreliable in Uganda [3], more than a 100 times less than in Denmark.

System Design

In developing our prototypes we combined standard user centered design techniques [9], with Essence [1], an innovative software development methodology, and the Business Model Canvas [8]. We used Schön's [10] "seeing-moving-seeing" schema to gain greater understanding of the problem. We worked iteratively with prototypes to provide discovery and reflection in action, where each iteration affected the next by using it to see a problem, resolve it, and see the effects of the solution.

Pay-E-Safe prototypes were developed to meet the design criteria of having a customer loyalty plan, anti-theft measures, fraud prevention, and provide usage statistics, reliable payments, low startup cost, and minimal transaction fees. In our survey of micropayment alternatives we concluded that using a token-based system suited this context best because it resolved the problem of cash handling, to avoid theft and fraud, requires that only a few vending agents handle cash, and can enable the saving of user information on the token rather than requiring continual access to a central server. In our token system we used an E-Card (an RFID device to store balance and transaction data) and an E-coin (the virtual currency stored on the E-Cards). One E-coin directly represents one Ugandan Shilling. The E-Card itself resembles a debit card in this respect, but without the involvement of banks. In terms of hardware, the final prototype (see Figs. 3 & 4) uses flexible, low-cost, low power consumption components including a resistive touch screen, Beagle Bone Black platform, X-Bee, and RFID cards, with a keypad entry for the vendor side.

Figure 5. Interviewing in a tent near the Market Place.

Interaction Design

In our design, we maximized the use of locally understood symbols, rather than words, to solve the literacy problem and the fact that there did not seem to be one language that could be used by all. We used touch technologies on the customer side for the purposes of hygiene, as touch screens could be cleaned and disinfected more easily than keypads, and flexibility, so that all transactional options and inputs could be enacted on the one input device. It was also important that the vendor had a separate touch interface to the customers to safe guard their health against diseases transmitted by direct contact, e.g. Ebola, as the 2014 epidemic in West Africa is the largest viral outbreak in history [2] and is of great concern to Ugandans. In addition, the vendor interface has a keypad for fast entry of figures associated with updating balances when users top-up their E-card with cash. We also designed the system with clearly identifiable targets for touching their E-cards to begin a transaction. Overall, the system offered an extremely simple interaction process with quick transactions for both customer and vendor. The main unit and interface are colored blue and white because locals regarded blue as a color of trust and commerce, while white represents health, hygiene, and wealth to them.

To buy a service, the user touches the E-card on the white target area; the system welcomes them and asks them to enter their pin code on a virtual keypad on the touch screen. The user then follows prompts and responds using touch to input his/her choices. They can make a purchase or check their current card balance. The look and feel of the system was greatly influenced by user feedback collected during field trials, including interaction paradigms, symbols and colors.

Design Constraints

Even though Uganda has over 50% mobile phone ownership, we were unable to use this as a platform for payments because it requires a phone with Near Field Communication (NFC) technologies, which not all phones have, therefore those without phones could not participate in payments. After reviewing existing micropayment solutions, we chose a token-based system using a virtual currency to directly represent real money. The advantage of this kind of system is that users are not required to have a bank account, and there are no external fees when paying.

To avoid the problem of unreliable Internet, the prototype places the user's balance and transaction details on the E-Card using RFID and NFC technologies to support data storage and asynchronous communication. To minimize the impact of intermittent power on the system (it was often off for 20mins to 2 hours a day), and reduce downtime, we used the local solution of battery backup. Batteries from 6v to 36v can be safely used with our system. We used a locally purchased motorbike battery for field tests.

Fieldwork in Uganda

There were two field visits to Uganda. We used qualitative methods with a phenomenological approach [11] to ensure data was collected based on the actual grounds and motivations behind people's choices and to gain a deeper understanding of their views and perspectives on our solutions. We were also open to the introduction of new concepts during the investigation. During the first 10-day visit to Kasese in November 2013, 3 researchers conducted semi-structured interviews, role-playing, and prototype evaluations (Fig. 5) with 21 participants, 9 females (aged 19-45) and 12

Figure 6. Training local vendors to make user observations.

males (aged 23-35), as well as many casual interactions with locals and observations during the time we were there. Two early alternative prototype design solutions were used in the interviews using role-playing to study people's reactions to our design ideas, and learn more about the context in which the system was to operate. General questions were asked to learn about people's household economies and shopping practices. Using an interpreter for this study and being foreign researchers we acknowledge that there was a risk of participant response bias in our approach [4].

In a second 3-week visit in July 2014, the final prototype, refined based on input from the first field visit, was installed and studied in-situ at a newly built One-Stop-Shop. For this trial, 255 free E-cards were handed out to locals, including 134 females (aged 14-57) and 121 males (aged 16-68), with a credit of 3000 E-coins on them (equivalent to 3000 UGX or 1.14 USD). This could buy 10 toilet visits (at 300 USG each or 11cents US) or 5 shower visits (at 600 UGX) or a mixture. To gain access to people's natural reactions to the technology, the use of the system was observed by the local One-Stop-Shop vendors, trained by us to make relevant notes during the day (Fig. 6), and then debriefed each evening by the research team. During the in-situ testing 171 successful transactions were completed across 98 different E-cards. The local observer filled out 73 observations and comment tables, each describing one customer's behavior and attitude towards the system.

Findings

From our experience in the field, both talking to users and watching how they operated the prototypes, we found several important factors that influenced the effectiveness of our solution and added value to the transactions beyond the actual cash amount involved. These included family economies, loyalty and trust, security, helping others and personal prestige. In this section we will look at each of these in more detail in terms of what we knew from our initial research on Ugandan people and their environmental context and what people told us during interview sessions. We also report on findings from observations of the system in use and how people responded to different aspects of our design.

Family Economies

In Uganda most families are patriarchal. This means that the father, or eldest brother, keeps the funds in the family and distributes them accordingly. Thus there is a series of intra-family transactions that need to take place before the mother or children are able to make purchases for the family. With the E-card it was possible for the fund-keeper to "lend" the card to family members for a toilet visit that the person could then transact on their own, using the pin-code that was openly shared amongst family members. Cards were also lent to close friends in the community. A circle of trust was woven around family and friends who shared a card (and hence the security pin-code). Observations during the in-situ trial confirmed findings from the interviews that the majority of test participants wanted to, and did, lend out their cards to relatives or close friends. At the same time, it should be noted that the cards being "lent out" to others in this case were distributed free of charge as part of our study. Perhaps the situation would be different if people had paid for the E-coins themselves.

Figure 7. Locals keen to sign up for a One-Stop-Shop card.

Loyalty and Trust
People wanted the system to greet them at the beginning of the transaction because they felt that it carried added security and was friendlier. Friendliness was considered very important in business transactions, as it engendered loyalty and trust between vendor and customer. When asked what factors make them choose one shop over another, with the same product assortment, people answered that cheap products, discounts, gift cards and a safe environment were all important, but that the shop staff's attitude was the most important. The staff has to be friendly, smiling, and helpful for people to trust that establishment and be loyal to it. The same applied to our system; it should be friendly towards them.

Security
Participants expressed a great concern for safety and security and wanted the E-cards to be protected by a pin-code rather than a fingerprint, so the card could be lent to others. The card was then a safer way to keep their money. Twice during the field study the observer noted that people complained about the pin-code being hard to remember and asked why we didn't just write the number on the card. Along with the sharing of pin-codes, this indicated that it is not about the actual level of security, but the user's perception of it. People wanted pin-codes for security, but regarded them quite differently than we expected. People also wanted their picture and name displayed on the screen for safety reasons. In this way, people nearby would know that the right person was using the card.

People wanted to check their E-coin balance during a transaction to make sure the vendor was not stealing from them, and to make sure they did not over-spend. However, they stressed that it was important that others could not see the balance, for fear of being robbed if it was high, and to avoid humiliation if it was low. Shielding the screen from sunlight and observers was not prioritized in our early designs, but observations during field-testing indicated that this physical feature was necessary. Several times it was observed both by the vendor observers and researchers that people were using their hands to shield the screen from spectators and other customers. One of the vendors noted that some found it hard to shield the screen while simultaneously inputting their pin-code, indicating that some people were aware of keeping their pin-code secret from onlookers, as well as their E-card current balance.

Helping Others
During the interviews participants often complained that they had not been given proper training in using the systems before the role-play. One participant told us, *"This is unnatural, you cannot expect people just to know. We have to learn."* We found that our participants did not want to try something if there was a chance of doing it wrong. People were very happy when someone from their community, who knew the system, guided them through the interaction. We were told by a vendor observer that one user was physically shaking with fear until the vendor guided them through the process. As it turned out, locals who had already used it were eager to teach others what they knew; explaining that helping each other is an important part of their society.

Personal Prestige
One benefit that we did not foresee was the personal prestige associated with having the One-Stop E-card.

Figure 8. One-Stop-Shop E-card - with debit/credit card form and size.

People really wanted to get a card (Fig. 7). One of the participants was very excited about having an E-card, saying *"It is like we are using ATM cards in the bank"*. As mentioned earlier, in Uganda, there is an elevated social status associated with having a debit or credit card, because of the high costs of having a bank account. Credit cards and ATM cards are reserved for the more affluent members of the society. For this reason, our participants expressed a great pleasure in having the E-card in a debit/credit card-like form (see Fig. 8). Comparisons made between ATM cards and the One-Stop-Shop E- Card gives it the potential to become a status symbol in its own right. In a recent visit, we saw locals taking out their One-Stop-Shop E-cards and displaying them with pride to their friends.

Discussion

The final Pay-E-Safe prototype continues to be in use at the Kasese One-Stop-Shop. We have had a few unexpected challenges, such as dealing with dust and insects entering the casing and interfering with the electronics, as well as the need to physically secure the valuable hardware from theft while the shop is closed, but otherwise it is working well for all parties. However, it is the additional value that people get from using our token-based micropayment system that is of most interest in this case study.

This project, originally driven by the need for a secure payment system from the company side, showed us that security had a different meaning for our users. Trust and security were not applied on a personal level, but to the family as a unit - a shared card and shared pin-code matched the way that they wanted to handle money in families. The value in this case was that a card with a pin-code provided a more secure and easily managed method for sharing money around than handing out cash to different family members who might drop it or be robbed. The main security concerns came from the point of sale - where people were wary of others seeing their balance, or the vendor stealing from them during transactions, with little concern about sharing of pin-codes amongst friend and family. In fact, shared cards gave people a sense of belonging to a trusted group. On the other hand, people's balance was regarded as a very private thing, to be communicated in a subtle and shielded way.

In terms of usability the whole concept of intuitive design was not so important in this context. People preferred to be shown how to use something new, not to explore the interface by themselves. They gained a social benefit from helping others and being helped. Additionally, the friendliness of the system was more important than the efficiency of transactions - people preferred to shop at places with friendly staff, and this included interactions with our system. It gave them positive feelings of trust and loyalty if the system greeted them. Being greeted by name and picture enhanced their experience, as well as providing additional security enacted by nearby people checking that the correct person was using the card.

Finally, the personal prestige afforded by having a One-Stop card should not be underrated. In our original design we had a standard key ring as the form factor - thinking it could have a dual purpose - but as soon as we introduced the card, so similar in look and feel to a debit card, acceptance of the system rose dramatically. Such a trivial choice for us, made an immense difference in value to the potential users.

Conclusion

In this paper we have shared the case study of designing an electronic micropayment system, Pay-E-Safe, and studying it in use with potential customers in Kasese, Uganda. This token-based system was developed with different ethnic groups with the idea of making a payment system that could be generalized to emerging markets in East Africa. The system is inexpensive to implement, sensitive to the East African context (e.g. low incomes, unreliable power supplies and unstable Internet connections), and provides benefits to local vendors as well as added value to users and their families. This added value can be seen in the issues surfaced during iterative field studies with prototypes. We found that sharing a card and pin-code amongst family members reinforced their collective trust and loyalty, and this could extend to include friends into the circle of trust. People got positive feelings from a system that greeted them, especially if it did so by name. It was also clear that people gained a strong social benefit from teaching each other how to use the system. Finally, having the E-card gave a feeling of personal prestige that would otherwise be difficult to afford in their current financial systems.

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