An Assessment of QR Code as a User Interface Enabler for Mobile Payment Apps on Smartphones

Pradipta De
SUNY Korea
pradipta.de@sunykorea.ac.kr

Kuntal Dey
IBM Research India
kuntadey@in.ibm.com

Vinod Mankar
IBM Research India
vinomank@in.ibm.com

Sougata Mukherjea
IBM Research India
smukherj@in.ibm.com

ABSTRACT

Mobile enabled payment technologies have seen an upsurge with advancement in smartphone technology. Several companies, including Google, Paypal, Amazon, Facebook have launched mobile payment solutions. Easy to adopt user interfaces play a pivotal role in wider adoption of such solutions. Typically, existing mobile payment solutions are designed for the user to *type in* the details of a transaction, like recipient id, amount, authorization code. Use of a pictorial mode to capture the transaction information can make the user interaction easier and faster during a transaction. We use a popular pictorial encoding format, called Quick-Response (QR) code, to auto-fill necessary details during a transaction, thus relieving the user from typing in the details. In this study using 48 participants from different literacy levels, we have compared the use of standard typing based system against inputs using pictorial format for enabling mobile payments. Our study indicates the benefits of QR code in designing UIs for mobile payment applications.

CCS Concepts

•**Human-centered computing** → *Empirical studies in interaction design;*

Keywords

Mobile HCI, QR-code, Mobile Payment

1. INTRODUCTION

With advancement of smartphone technology, there is a boom in novel applications on smartphones. Mobile based payments have long been touted as one of the most lucrative applications on mobile devices. Most of the earlier mobile payment ventures were targeted to suit basic phones with limited capabilities. Although in developing regions the usage of smartphones is just picking up, it is projected that in the near future smartphone usage will surpass basic phones.

Several companies, like Google, Paypal and Facebook, are launching mobile payment services as smartphone apps to enable wider mobile financial transactions than just mobile banking [1, 3, 11]. Typical mobile banking solutions differ from the current genre of mobile payment solutions since the former mainly enabled web-based access to the banking transactions using cellular connectivity. On the other hand, apps for mobile payments open the possibility to enable financial transactions in more diverse settings [4].

One main challenge for the adoption of these apps in developing regions is that a significant proportion of the users is still not literate [12]. Even for the literate category of users, the choice of the user interface is critical. Often existing mobile payment solutions, which typically use an interface for typing in transactions details, and communicate over SMS, is cumbersome to use. Difficulty in typing text on a phone, even for a smartphone, has been highlighted by Nicolau and Jorge [10]. [6] showed that non-literate and semi-literate subjects find it difficult to make sense of the text-based UI, and have better task-completion rates with richer multimedia. Thereafter, [7] designed mobile interfaces for such users using graphics, motivated by [2, 8], and numerical digits, which are acceptable as found by [9].

Use of pictorial formats for enabling transactions can ease the user experience significantly. It has been shown earlier that voice-based or rich media based interfaces can lead to higher acceptability of mobile payment services, especially among semi-literate and non-literate users [6]. We propose the use of an alternative pictorial format, known as Quick-Response (QR) code, to enable the user interface. QR code can be used to embed information in a picture.

In order to enable a Business-to-Customer (B2C) transaction, a merchant (money recipient) can generate a QR-code with entire billing information, viz. merchant id, phone number, amount payable. A customer simply takes a picture of the QR code to extract and fill a form with the information, and with one further click can complete the payment transaction. The same transaction model can be applied for day-to-day financial exchanges, like paying a cab driver.This eliminates the necessity of typing the information. QR codes have also been shown to be have strong error correction features, making them amenable for easy scanning under different conditions, like low lighting, imperfect display [5].

In this study, our goal is to compare user responses to the typical text-based mobile services (using SMS as communication channel) against one that uses QR code. We conducted the study across all literacy classes, who had different smartphone usage experience. The study reveals the efficacy of the pictorial format (QR-code) in designing mobile payment UIs. The study also helps assess the difficulty in adopting smartphone based mobile payment app for people with limited smartphone usage experience.

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2. METHOD

The study is focused on understanding the ease of use of the text based mobile payment applications against ones that uses pictorial formats. The participants were instructed to make the same payment to a merchant using both interfaces. We measured the time taken to complete the task. Once the task is completed, we interviewed the participant to collect feedback on the usage experience.

The second task in the experiment is designed to emulate an application using which the user can pay to a person who is in close proximity. The participant is shown another QR-code on a second smartphone, and he scans the picture to trigger the payment. Since during the second task, user has already used the application once, we could infer how users performance improve once they are familiar with the system. This task also helps us evaluate the acceptance of users to a scenario which opens the possibility of introducing mobile payment in day-to-day peer to peer transactions, unlike payments to merchants.

2.1 Participants

We conducted the study with 48 participants comprising of 11 female and 37 male participants. The group consisted of 16 non-literate, 17 semi-literate and 15 literate participants. Majority of the non-literate participants were number literate, and could read the numerals on the screens. Semi-literate users had rudimentary knowledge of English alphabets, which is used to design the buttons in the screens. During the survey, they could easily identify the different buttons after some pre-survey training and some guidance. Most of the non-literate and semi-literate users (52%) did not have prior experience of using smartphones, while 40% of users mostly from literate category had used smartphones before. None of the users has actively used mobile money applications, although most of them were familiar with the concept.

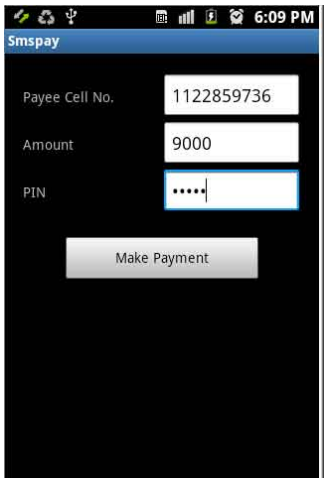
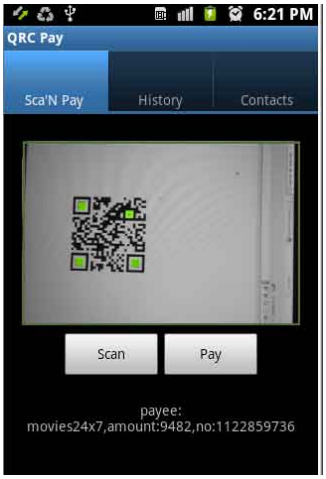


Figure 1: Screenshot of the text based payment app

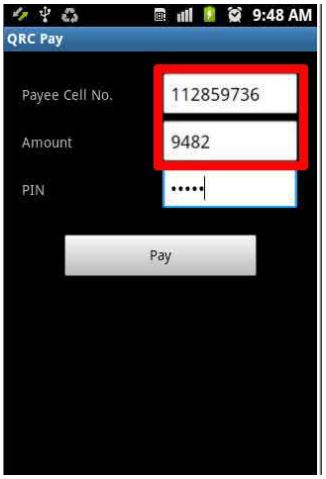
2.2 Procedure

At the beginning of each experiment, a participant was given a brief introduction on mobile based payments. The participant is also shown a QR code and how a smartphone camera can be used to decipher information encoded into it. In cases where the participant is not familiar with the use of a smartphone, we trained the user to type in using the smartphone before starting the actual experiment.

During the actual experiment, all users are shown the same transaction information on a piece of paper. For the text based interface, the user inserted the 10-digit mobile number of the merchant, the amount to pay, and a 5-character authorization pin before clicking the 'pay' button. In the QR code based payment scenario, the user is shown a QR code, which is encoded with the same transaction details. The user is trained to 'scan' the QR code from the paper. On clicking pay, the user is taken to the next screen, where the transaction fields are automatically populated, and the user enters his authorization code, and triggers payment.



(a) UI to scan the QR code with merchant information



(b) UI to enter the authorization code to trigger payment. Fields marked in red box are auto-filled using data from previous screen.

Figure 2: UI screenshots of the QR-code based payment app

2.3 Apparatus

The experiments were conducted using Samsung Galaxy Ace phone running Android OS version 2.2. We designed a mock interface for text based payment, which mimics typical text-based payment applications using SMS as communication channel (Figure 1). Similar interface was also designed for the QR code based payment (Figure 2). In QR code based payment, Figure 2(a) shows the screen which is used for scanning the QR code using the smartphone camera. If the user is satisfied with the information shown at the bottom of the screen with transaction details, she clicks the

'PAY' button. It goes to the second screen, as shown in Figure 2(b), where all text boxes except the 'PIN' field, are auto-filled.

3. RESULTS

We present the results of the survey by categorizing them mainly across the literacy dimension. Since the degree of literacy directly impacts the ease of use while using text, it helps in determining the chance of success of mobile payment solutions.

The three tasks, performed in sequence, involved making a payment to a merchant using text mode and QR code. Following these two tasks, they were given a task to transfer money to a friend/person in close proximity using QR code. The average time taken across different literacy classes, along with the standard deviation, is reported in Table 1.

The task completion time reduced by 59%, 46% and 27% for the non-literate, semi-literate and literate categories. After the first task, when the users become familiar with the use of QR code for transaction, response time improves further. In addition to it, non-literate and semi-literate users responses take almost the same time. We note here that the non-literate users adapted well to the scanning activity. The semi-literate users showed increased curiosity to the use of QR code in P2P scenario, and that may have contributed to a relatively slower task completion time for the P2P task.

3.1 Choice of Interface by Users

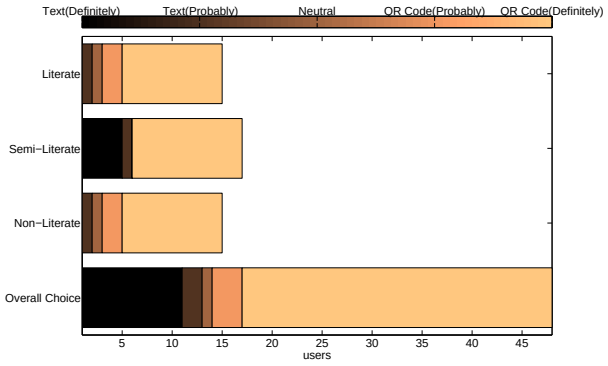


Figure 3: User preference towards text based or QR code based interface for mobile payments.

After each user has completed the same task of making a payment to a merchant using the two interfaces, we interviewed the user about the preferred mode. The user response was recorded in a scale of 1 to 5, where 1 means that the user definitely chose text based approach, while 5 means user chose the QR code as the preferred mode. Figure. 3 shows the breakup of choice among the users, and also shows the split across different literacy categories.

An overwhelming 65% (31 out of 48) of the responses were in favor of using QR code based approach. 11 out of 48 users preferred using the text based interface. 6 users were neutral to the overall choice, with no specific preference towards any one approach over the other. Interestingly, most of the users who preferred text based approach were in the semi-literate category. Based on the interview, we concluded that there was an apprehension among some users about using the unfamiliar pictorial mode. Given that they were more used to text based approach for other activities, they tended to prefer the text based mode. However, among the non-literate category, who were visibly uncomfortable using the text based approach, the ability to have an easy solution made them choose the QR code based mode. The literate category voted for the QR code approach mainly because they perceived it as less time consuming.

Task Type	Non-Literate	Semi-Literate	Literate
Text-based transfer (B2C)	68.48(21.10)	47.23(11.82)	28.11(6.52)
QR code transfer (B2C)	28.10(4.95)	23.76(5.03)	18.20(5.72)
P2P transfer QR code based	19.58(4.21)	20.92(4.16)	15.34(3.71)

Table 1: Summary of the time taken for each task by different categories of users. The times are reported in *seconds* along with the standard deviation of the measurements.

3.2 User's Perception of Effort Required

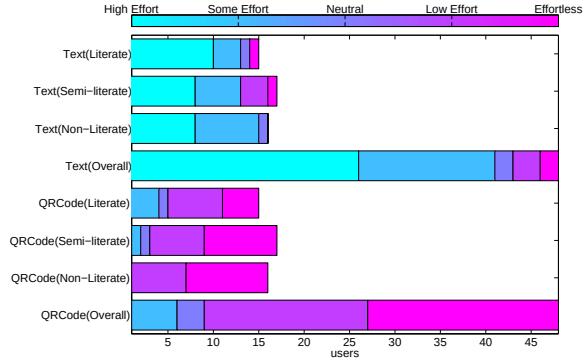


Figure 4: User perception of effort required while using a UI based on text or QR code.

The overwhelming response to the QR code from the users can be easily interpreted when we observe the perception of effort required in the two approaches from the users. The users were again asked to rate their perception of effort on a scale of 1 to 5, with 1 implying high effort required and 5 being effortless. Figure. 4 shows the perception of effort required for completing the task in two modes.

Irrespective of the literacy category, the text based approach requires more effort. Several studies, like [10], have shown that typing on a touch screen can be error-prone and slow. When it comes to QR code, the necessity of typing is minimized, but for entering the authorization code to confirm payment. [1] Across literacy categories, users rated that the effort required to execute the task was smaller while using QR code.

3.3 User's Willingness to adopt QR code based transfer in Peer-to-Peer scenario

The second task assigned to the user introduced a new scenario of mobile payment, which acts as an electronic replacement of cash transactions enacted between two users in close proximity. This study provided two insights: (a) willingness of users to adopt new usage scenarios for mobile payments, and (b) does familiarity with the QR code payment mode improves the usability of the system ? Figure. 5 summarizes the results of the question to the users: *would*

[1]For non-literate users, the interviewer typed in the authorization code. We believe that with the emergence of smartphones with biometric authentication, like Motorola ES400S, necessity for typing throughout the transaction can be eliminated.

you be willing to use QR code based transfer instead of using cash when paying another person ?.

Overall, 48% users expressed that they would use QR code based transfer instead of cash. Interestingly, non-literate and semi-literate users showed keen interest in this mode of transfer since according to them it is much easier for them to not carry cash. Often these are non-banked users, without credit cards, hence this opens up the possibility for them to use electronic currency. Interviewer had explained to them that they must deposit money beforehand into an electronic wallet through a participating collection agent.

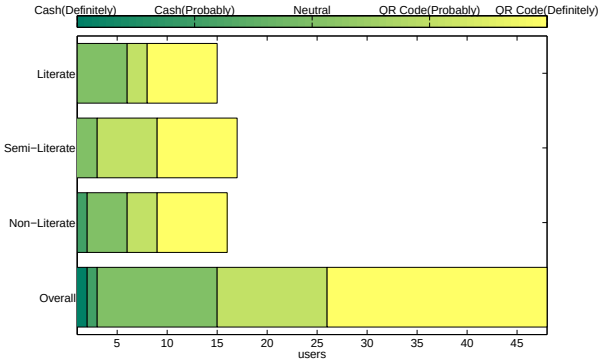


Figure 5: User willingness to adopt mobile payment as an option over cash to transfer money in a peer-to-peer setting.

Since smartphone usage is not widely prevalent in developing regions, our survey population had a mix of smartphone usage experience. Our goal was to analyze the impact of smartphone familiarity on the use of the UIs. Figure 6 shows that familiarity with smartphone usage, specially using the on-screen keyboard, significantly improves the response time in text UI. However, for QR code UI, the user's familiarity is not critical, and the user group with no prior experience can adapt well to the UI. This indicates that as smartphone usage increases, mobile payment applications will receive lower barrier to entry if designed with pictorial UIs, like QR codes.

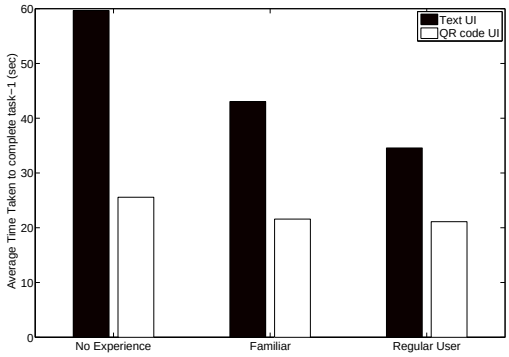


Figure 6: Experience of smartphone affects user response in text UI more significantly than in QR code UI.

4. DISCUSSION

The experiments on 48 participants revealed some other interesting observations. One of the interesting responses was regarding the use of mobile payment when the amount to be exchanged involved small changes. For example, when no change was involved in the transaction, only 20 out of 48 participants said that they will use mobile payment, but if changes were involved 39 out of 48 participants expressed interest to use the mobile payment.

The experiments were also conducted in controlled and uncontrolled environments. In controlled environment, like within a office room, it is much easier to type, as opposed to an uncontrolled environment, where the participant is just coming out of a shopping center or is waiting at a shop in the streets. 33 participants were in controlled environment and 15 were in uncontrolled setting. The average time to complete the task using text-based UI was 62 sec and 42 sec in uncontrolled and controlled setting respectively. On the other hand, when QR-code based UI is used, the time taken in uncontrolled and controlled setting were 26 sec and 22 sec respectively, which shows the benefit of using QR code based UI requires much less attention and is easier to use.

5. CONCLUSION

Mobile payment applications on smartphone, which goes beyond web-based mobile banking solutions, is expected to grow in importance. Traditionally mobile payment applications for basic phones are limited to use the text based interface. Smartphone opens up the possibility of using other interface options. However, in developing regions, with varying literacy conditions and wider difference in smartphone experience, it is challenging to design the User Interface. We performed a study with 48 users to identify answers to two different questions: (a) how do users perform with more familiar text based UI against a novel QR code based UI? (b) does lack of experience with smartphone usage act as a barrier to entry for apps designed for smartphones? The users showed significant improvement in completion task for the same task when using the QR code based UI versus the text based UI on smartphones. The user response under varying smartphone experience was not impacted while using the QR code based application.

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