Analysis of FinTech Mobile App Usability for Geriatric Users in India

by

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ABSTRACT
There has been a significant rise in FinTech mobile app offerings in India for the past 3-4 years. These mobile apps have become disruptive means of managing daily financial transactions. Given the variety of offerings, the usability of these FinTech applications across different age groups is still unclear. In this paper, we explore the usability of FinTech mobile apps across different age groups through a quantitative survey and a more focused study on factors impacting the geriatric population on adopting FinTech mobile apps in India. In addition, we propose a framework called UMETRIX to evaluate the usability of mobile apps to determine the adoption rate among geriatric population.

Author Keywords
FinTech Mobile Apps; Geriatric Population; Mobile Adoption; Usability.

ACM Classification Keywords
H.5.2. Information interfaces and presentation: User Interfaces --- User-centered design.

INTRODUCTION
Internet and smartphone usage across the world has been steadily increasing in the last decade due to better infrastructure, network connectivity and decreasing cost. Organizations are moving from 'digital first' to 'mobile first' strategy due to affordable smartphones across geographies and high bandwidth networks. China, India, and the USA have the largest user base of digitally connected people. Banking Financial services and Insurance (BFSI) sector has always been at the forefront of adopting digital technology compared to other sectors. However even today India and China have a large user base of unbanked and underbanked population [7] leading to overheads in cash management and issues in the disbursement of citizen subsidies and governmental benefits via digital technology. With Branch banking, ATMs and Business Correspondents being less impactful and resource intensive, it provides an opportunity for disruptive technologies for financial inclusion. The innovative and agile FinTechs [8] are showing the ability to bring the population into mainstream digital transactions. Increasingly, FinTech has become a metaphor for disruptive technologies which offer financial services like payments, loans, money transfers, fundraising, asset management and other banking services, mostly on mobile platforms, shown in Figure 1.

Figure 1 FinTech Landscape [8]

Since 2011, China has made significant progress on digitization and now more than 80% of the population are using banking services [4]. In the last 3 years, India also has been promoting 'Digital India' initiative including Jan Dhan Yojana (a program to include unbanked population into banking sector) and Aadhaar (citizen identity). It is expected that by 2020, India will have nearly 600 million internet users and a major part of the access will be via mobile phones [5]. Given that India has nearly 90% mobile penetration, FinTech based transactions have become a
means to reach the unbanked and underbanked population challenging the not so successful traditional banking methods. It is estimated that 80% of financial transactions in India still happen through cash as opposed to 21% for developed countries [5]. In November 2016, Indian Government announced the demonetization of all large banknotes that hold 86% of total cash to curb black economy. This cash crunch in the society led towards less cash economy [19], a push for people to switch to new disruptive FinTech applications to meet their financial requirements. Considering the opportunities ahead, India has attracted $1.5 billion FinTech investments in the recent times as compared to $247 million in 2014 [2].

In reality, this 'digital switch' is not a seamless activity and is influenced by socio-technical issues like gender, family, language, digital illiteracy, data-connectivity, attention, memory, design, and understandability, especially in India with its multi-ethnicity. Though India has a significant portion of Gen Y and Gen Z population, the population of elderly is growing steadily. The elderly (geriatrics [18]) are more than 70+ million, accounting to ~6% of the population and were born much earlier to the internet with a different adoption rate of smartphones and other digital technologies compared to later generations. This geriatric population was compelled to be a part of this FinTech revolution due to the governmental push on direct benefit transfer of social security schemes. Factors leading to the adoption of FinTech mobile apps by the large user base of geriatric population in India and the much larger user base across the world provides us with a research opportunity.

Different studies are conducted on distinct age group to understand how novice users, low-literacy users, literate but novice users perceive usability and usefulness of mobile applications. The textual interfaces are unusable for first-time low-literacy users, and error-prone for literate but novice users [14]. It was also found that the design elements and accessibility of the mobile app interface influence the mobile app usage by the geriatrics [20, 12, 14, 6]. Various usability evaluation methods and requirements elicitation studies were conducted to review the ways to improve the usability of mobile apps for geriatrics [10, 11, 3, 16]. Most of this research was focused towards addressing the overall challenges faced by geriatric users, however, our focus is to understand the usability challenges of FinTech apps with multi-ethnic (India is considered to have high diversity in population) geriatric group.

In this paper, authors interviewed geriatric users to identify their FinTech mobile usage. Based on the interviews, we build a heuristic usability experiment to capture real-time hurdles while participating in a real financial transaction. This study led us to build a model FinTech mobile app by incorporating derived usability guidelines. We evaluated the model app using an automated usability framework called UMETRIX.

### RESEARCH METHOD

In our work, we followed grounded theory approach with an aim to understand the adoption and usability rate of newly introduced FinTech mobile apps into Indian financial market. Figure 2 shows the step-by-step approach of our research method.

![Figure 2 Research Method](image)

### PILOT SURVEY SETUP AND OBSERVATIONS

We performed usability survey using Social Media platforms (WhatsApp, Facebook, and LinkedIn) and physical forms to understand the adoption rate of the FinTech mobile app in India. Our target audience was random and diverse (across many cities in India; Young, Middle aged and Geriatrics) population. We asked informal questions about their experience with FinTech mobile apps. Below are the questions and responses from the participants.

Q1- Please share your Gender and Age
Q2- What are your traditional methods to perform Financial Transactions?
Q3- How did you get introduced to FinTech Mobile App?
Q4- What types of FinTech Mobile apps do you use?
Q5- How frequently do you use FinTech Mobile App?
Q6- For what purchases do you mostly use the FinTech app?

In total 1147 participants responded to the above 6 questions. Out of the total participants, 601 were female, 469 were male and 77 preferred not to share their gender. Amongst the respondents, 21 of them belonged to 19-25 age-group, 479 of them between 26-40, 302 of them were between 41-65 and 345 of them were between 65 and above. We conducted a T-Test on the participant responses based on the null and alternate hypothesis identified as part of the initial study.

**NULL Hypothesis 1** - Men and Women using FinTech app have same usage pattern.

**Alternate Hypothesis 1** - Mean value of FinTech mobile App usage for men is higher than that of women with a P>0.05 i.e. men have used FinTech app significantly different compared to women.

**NULL Hypothesis 2** - The Frequency of usage, Purchase Type, Type of FinTech app is similar for all participants irrespective of different age group.
Alternate Hypothesis 2 - The mean value of the age-groups 19-25, 26-40, 41-65 are statistically close and are not significantly different. However, the mean value of age-group 65 and above is too low i.e. \( P < 0.05 \). This shows that the participants with age-group 65 and above are significantly different compared with rest of the participants from other age-groups.

In our interaction with the geriatric users, we realized that the usage of FinTech Apps is quite limited even though they were comfortable using WhatsApp and other social media and newspaper mobile sites/apps. Some of the stated reasons were that they were concerned on data security, did not really see a reason to perform financial transactions on mobile as they could go to a bank branch that provides personal attention and most importantly find mobile apps difficult to send/receive money, add beneficiary and other actions unlike adding new connection or sending a message on social media channels. Majority (93%) of the survey participants (irrespective of age-groups) have mentioned payment mobile apps in their understanding and usage pattern of FinTech apps, some of the possible reasons are the lack of compelling need and awareness, technological gaps and the branding activities (especially after demonetization event in Nov 2016) done by payment apps. The above observations led us to conduct a focused survey to capture observations on FinTech Mobile apps usability.

USABILITY SURVEY SETUP
As our focus of research is to understand the usability concerns, we gathered usability guidelines on Mobile apps from various related repositories [9, 17, 5] and listed intersecting usability guidelines that are vital for mobile app. Based on these guidelines, ten survey questions Table 1 were identified that are related to ‘Time to Action’, ‘User Interface Appearance’ and ‘Error Handling’ to determine the concerning usability issues. We again performed a survey through social media channels such as Facebook groups, LinkedIn groups, Google and Yahoo mailing lists and also paper based survey. The survey contained 13 questions including 3 questions on demographics like age-groups, gender and exposure to FinTech mobile apps. The rest of the 10 survey questions were on dimensions of usability. Table 1 contains questions related to usability guidelines where participants are requested to rate their experiences while using a FinTech mobile based on an ordinal scale using Likert method. Here the scale ranges from 0 to 5 which indicates Too Hard (0), Hard (1), Neither Hard nor Easy (2), Bit Hard but Easy (3), Easy (4) and Too Easy (5).

SURVEY RESULTS
The survey was conducted for 3 months and ended in December 2017 with \( N = 531 \) participants responding to 13 questions. Figure 3 shows the stacked column chart of the participant count by gender and age group. Light brown represents female and dark brown represents male participant count. Table 2 shows the percentage of users from a particular user group who have chosen an option between 0 and 5. For example, as per this table the 67.69% of users from Age group 21-40 have chosen option 4. Based on this information, we could see that the participant group with age group 65-above's response percentage is higher between ordinal scale 0 and 2 i.e. their overall user experience is close to 'Too hard' in the previously defined Likert scale of 0 to 5. These percentages are indicated in brown-red colour.

![Figure 3 Participation group by Age group and Gender](image)

Survey Observations
As we started our work based on a grounded theory approach i.e. with no significant hypothesis, the usability survey results are interesting. When compared to rest of the user responses, the responses of age group 65-above show opposing results. As per Table 2, 90.5% ‘Too Hard’ ordinal scale option was chosen by users from 65-above age group. This shows that participant group with 65-above have significant challenges on using FinTech Mobile apps. As per results in the Table 3, we could see that on an average 40.07% of 65-above participants have found 'Hard' to operate FinTech Mobile app based on their responses to individual questions. None of the users from 65-above age group found challenges with Error, Warning messages while using FinTech mobile apps.
Table 1. Survey questions to study challenges with geriatric users

<table>
<thead>
<tr>
<th>Background</th>
<th>1. What is your Gender? (Female/ Male/ Prefer not to say/ Others)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. What is your Age? (15-20, 21-40, 40-60, 60 and above)</td>
</tr>
<tr>
<td></td>
<td>3. Are you familiar with using FinTech Mobile Apps? (Yes/No)</td>
</tr>
<tr>
<td>Value-Perception</td>
<td>4. Reading Characters on the Screen</td>
</tr>
<tr>
<td></td>
<td>5. FinTech Mobile App Speed</td>
</tr>
<tr>
<td></td>
<td>6. Clicking on Buttons, Drop down &amp; Images</td>
</tr>
<tr>
<td></td>
<td>7. Able to understand the Progress</td>
</tr>
<tr>
<td></td>
<td>8. Error, Alert &amp; Warning Messages</td>
</tr>
<tr>
<td></td>
<td>9. Exploring features by Trial and Error</td>
</tr>
<tr>
<td></td>
<td>10. Help available on Screens</td>
</tr>
<tr>
<td></td>
<td>11. Understanding Tasks and Actions to Perform a desired activity</td>
</tr>
<tr>
<td></td>
<td>12. Understanding the sequence of Screen</td>
</tr>
<tr>
<td></td>
<td>13. Enough wait time to proceed further in action</td>
</tr>
</tbody>
</table>

SURVEY DISCUSSION
The results reiterated our study to understand challenges faced by geriatric population while using the FinTech mobile app. It has become evident that participant group with 65-above have challenges reading, navigating, exploring and understanding the tasks in the currently available FinTech Mobile apps.

CONTROLLED USABILITY EXPERIMENT
We conducted a cognitive walkthrough on usability for 6 random geriatric users from the survey. The aim of this experiment is to capture the usability issues while using a FinTech mobile app. 3 of the users were digitally literate and have professional banking experience.

Table 2. Overall survey scores grouped by age group and scale

<table>
<thead>
<tr>
<th>Age Group</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-20</td>
<td>0</td>
<td>2.72</td>
<td>1.01</td>
<td>6.74</td>
<td>12.38</td>
<td>10.36</td>
</tr>
<tr>
<td>21-40</td>
<td>1</td>
<td>10.54</td>
<td>27.95</td>
<td>64.73</td>
<td>67.69</td>
<td>57.34</td>
</tr>
<tr>
<td>41-65</td>
<td>8.5</td>
<td>11.56</td>
<td>35.02</td>
<td>21.27</td>
<td>16.73</td>
<td>29.29</td>
</tr>
<tr>
<td>65-above</td>
<td>90.5</td>
<td>75.17</td>
<td>36.03</td>
<td>7.27</td>
<td>3.2</td>
<td>3.01</td>
</tr>
</tbody>
</table>

EXPERIMENT SETUP
We downloaded 2 widely used FinTech mobile apps in India based on their download count on play store and have made them available for the participants. We requested participants to perform below-listed tasks on a respective mobile app. Each task listed below is involved with series of steps. The minimum number of steps required to complete each task is listed in the parenthesis below. Each participant is supposed to be seated in an enclosed experiment room to avoid external disturbances. The mobile phone is placed under a High Definition camera to record participant's hand strokes and count the number of steps taken by the participant to complete the requested task. We as observers viewed participant's interaction with the mobile app in the observation room. The observation room displays a live feed of participant's activity. The observer is not visible to the participant as both experiment room and observer room are isolated from each other.

Table 3. 65-above age group response % per Question

<table>
<thead>
<tr>
<th>Age Group</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4</td>
<td>20.6</td>
<td>54.41</td>
<td>5.88</td>
<td>2.94</td>
<td>10.29</td>
<td>5.88</td>
</tr>
<tr>
<td>Q5</td>
<td>41.2</td>
<td>33.82</td>
<td>17.65</td>
<td>4.41</td>
<td>1.47</td>
<td>1.47</td>
</tr>
<tr>
<td>Q6</td>
<td>23.5</td>
<td>30.88</td>
<td>32.35</td>
<td>7.35</td>
<td>1.47</td>
<td>4.41</td>
</tr>
<tr>
<td>Q7</td>
<td>39.6</td>
<td>51.47</td>
<td>7.35</td>
<td>2.94</td>
<td>5.88</td>
<td>4.41</td>
</tr>
<tr>
<td>Q8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8.82</td>
<td>16.18</td>
<td>7.5</td>
</tr>
<tr>
<td>Q9</td>
<td>79.4</td>
<td>4.41</td>
<td>7.35</td>
<td>2.94</td>
<td>4.41</td>
<td>1.47</td>
</tr>
<tr>
<td>Q10</td>
<td>5.88</td>
<td>36.76</td>
<td>42.65</td>
<td>10.29</td>
<td>4.41</td>
<td>0</td>
</tr>
<tr>
<td>Q11</td>
<td>39.7</td>
<td>22.06</td>
<td>20.59</td>
<td>11.76</td>
<td>2.94</td>
<td>2.94</td>
</tr>
<tr>
<td>Q12</td>
<td>7.35</td>
<td>52.94</td>
<td>17.65</td>
<td>11.76</td>
<td>7.35</td>
<td>2.94</td>
</tr>
<tr>
<td>Q13</td>
<td>20.6</td>
<td>38.24</td>
<td>5.88</td>
<td>17.65</td>
<td>11.76</td>
<td>5.88</td>
</tr>
</tbody>
</table>

Table 4. Results of First FinTech Mobile App

<table>
<thead>
<tr>
<th>Users</th>
<th>Task Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AT1</td>
</tr>
<tr>
<td>U1</td>
<td>3</td>
</tr>
<tr>
<td>U2</td>
<td>3</td>
</tr>
<tr>
<td>U3</td>
<td>3</td>
</tr>
<tr>
<td>U4</td>
<td>4</td>
</tr>
<tr>
<td>U5</td>
<td>4</td>
</tr>
<tr>
<td>U6</td>
<td>3</td>
</tr>
</tbody>
</table>

FinTech Mobile 1
- AT1 - Login to view your account (3)
- AT2 - Create a payee profile (7)
- AT3 - Transfer 10 rupees to payee (4)
- AT4 - Log out from your account (2)

FinTech Mobile 2
- BT1 - Log into your account (4)
- BT2 - Check your balance sheet (6)
• BT3 - Update your email details (8)
• BT4 - Log out from your account (3)

<table>
<thead>
<tr>
<th>Users</th>
<th>Task Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BT1</td>
</tr>
<tr>
<td>U1</td>
<td>4</td>
</tr>
<tr>
<td>U2</td>
<td>4</td>
</tr>
<tr>
<td>U3</td>
<td>5</td>
</tr>
<tr>
<td>U4</td>
<td>5</td>
</tr>
<tr>
<td>U5</td>
<td>5</td>
</tr>
<tr>
<td>U6</td>
<td>4</td>
</tr>
</tbody>
</table>

EXPERIMENT RESULTS
The participants are listed as U1, U2, U3, U4, U5, and U6 along with the tasks of first FinTech mobile app as denoted as AT1, AT2, AT3 and AT4. BT1, BT2, BT3, and BT4 are denoted as tasks of second FinTech mobile app. Here U1, U2, and U3 are digitally literate participants. U4, U5, and U6 are novice participants. The Table 4 and Table 5 shows the detailed results of our experiment. The number corresponding to each task per user indicates the steps taken by a participant to perform the task. If the number is indicated in red colour, then the participant failed to complete the task in minimum expected number of steps.

EXPERIMENT OBSERVATIONS
These results depict that there are learnability issues for geriatric users while using these FinTech mobile apps. In spite of being disruptive in financial transactions, today's FinTech mobile apps have not considered geriatric user challenges while designing them. Based on our observations from the controlled experiment, we identified existing usability guidelines which work as an alternative to address the usability challenges faced by geriatric users.

• Display overlays while choosing an option and while switching between screens - This gives a hint to geriatric users to know what exactly they are clicking on, Figure 5 gives us an insight.
• Supply a tooltip against an input field - This lets the geriatric users know what input data type is being requested as part of an input field on a form page, figure Figure 4 gives us an insight.
• Provide an inbuilt zoom-in and zoom-out feature using hand gestures - This helps geriatric users to read the content efficiently.
• Set a stand still page as a safe exit for the geriatric users whenever there is an issue with connectivity, speed, performance or timeout - This builds confidence among geriatric users as they have clear confirmation on exit from the app, Figure 7 provides example for stand-still page.

• Replace next button with swipe-based touch event to complete a step by step task - This helps geriatric users to understand the sequence of screens and progress of a task. Figure 6 shows a simple swipe action, instead choosing any next option.
• Provide a user session timeline - This helps geriatric users to know the actions performed by them while using a mobile during a particular session. The timeline events help them learn the task and make the mobile app more adoptable.

We have incorporated these usability guidelines as part of our model FinTech app and conducted the controlled experiment with same participants. We have utilized the tasks from FinTech app 1 from our previous experiment and have requested our participants to perform those task. Table 6 displays tasks of the model app as CT1, CT2, CT3 and CT4 along with the number steps taken by the participants to perform one task. The results show that the usability guidelines have improved usability challenges to some extent. Users U3 and U5 still faced issues completing the task CT2. User U4 was able to complete the task CT3 in 5 steps which show a significant improvement.
The observations captured as part of the controlled usability experiment is significant as it is difficult to identify such challenges by an interview or through a survey with a geriatric user. Such results will help us understand the problems while the target users are in action. As the mobile adoption in low among geriatric users, we were only able to find 6 participants for our controlled usability experiment.

Table 6. Results of Model FinTech App

<table>
<thead>
<tr>
<th>Users</th>
<th>Task Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CT1</td>
</tr>
<tr>
<td>U1</td>
<td>3</td>
</tr>
<tr>
<td>U2</td>
<td>3</td>
</tr>
<tr>
<td>U3</td>
<td>3</td>
</tr>
<tr>
<td>U4</td>
<td>3</td>
</tr>
<tr>
<td>U5</td>
<td>3</td>
</tr>
<tr>
<td>U6</td>
<td>3</td>
</tr>
</tbody>
</table>

As part of this experiment, we were successful in identifying the challenge in reality and was able to evaluate the challenge using a potential solution. We were partially successful by having them run through a second round of evaluation as per Table 6. However, similar studies with a larger audience are required to understand other potential challenges from the wider target audience.
GUIDELINE BASED USABILITY EVALUATION

There are several usability guidelines proposed by various usability practitioners for mobile app developers to have them implemented to improve the ease of access [17]. Various mobile operating systems like Apple-IOS and Google-Android developed usability guidelines based on their user-centric evaluations and are specific to their platform. The guidelines are heuristic and are generic in nature. However, it is inappropriate to implement a guideline while coding a FinTech mobile app that is suitable for an e-commerce mobile app. This could create a confusion among the users as these apps are bound by purpose and have a specific business need.

Most of the mobile usability guidelines are generic and are non-domain (banking, gaming, and others) specific. However, with the increase in the number of unique usability guidelines, mobile software practitioners have become unclear on implementing these guidelines through code. It is also difficult to validate and map these guidelines with usability attributes. Classifying the guidelines based on usability attributes assist software testers to validate the mobile apps effectively. Thus, the usability guidelines can be implemented programmatically. For example, let us consider a guideline [17] “Password field should reveal the password in clear text” can be programmatically implemented by providing a show-hide option through. Similarly, for the developers who haven’t developed their mobile app can use this programmatic approach for implementing the missing usability guidelines.

UMETRIX - AN AUTOMATED USABILITY EVALUATION

Automating usability guideline evaluation is a critical task. Conducting a manual usability evaluation FinTech mobile app are challenging and difficult to scale. With regards to geriatric population, this becomes even more serious as their interest to participate in usability studies can be wavering. Thus usability evaluation programmed for geriatric population could be an alternative approach. We also built an automated usability guideline evaluation tool called UMETRIX [13] to identify the presence of usability guidelines in a mobile app. This may not solve all the usability issues for a given FinTech mobile app but can help usability testers, mobile app developers and usability experts to create test cases for identifying usability gaps during the development phase and pre-release phase of a mobile app.

UMETRIX is designed to validate presence of a usability guideline in the source code of a mobile. It searches for the usability code patterns and identifies the usability issues. These usability code patterns are the physical representation of a usability guideline. The Figure 8 shows the web utility of UMETRIX tool. It uses a mobile APK file as an input and runs against the source code of the mobile app and searches for the usability code patterns which are linked.
with supplied usability guidelines. The tool also has a flexibility to add/update guidelines based on the refinement in usability guidelines. It also recommends code patterns to implement a specific usability guideline which was not implemented as part of evaluation test case.

About UMETRIX

Figure 9 provides an overview of our proposed usability evaluation framework. This framework can be extended to including all types of mobile apps (Android SDK, iOS, Windows Mobile). A developer who builds mobile apps or a Usability tester who validates a mobile app can make use of our instantiated framework. The user should possess a mobile app in an Android application package (APK) format for Android Apps or iPhone application archive (IPA) format for iOS Apps in Debug Mode. Below are the four components involved:

- **Decompile/Source Code of Mobile App**: As part of this step, an executable Mobile app file or the source code of the Mobile App should be supplied for static code analysis. In case of executable mobile app file, the framework will run the decompilation process over the file to generate the source code.

- **Load Guidelines & Validation Cases**: Usability guidelines which are planned to be evaluated against the given mobile app are to be loaded along with their corresponding validation cases. A validation case is a test case built based on a Usability Guideline. Validation case consists of steps in XML format to detect presence of usability guideline, as shown in Listing 2. Usability guidelines can be considered as conformance rules here. These rules are stored in a database called Validation Case DB. This Validation Case DB contains a variety of usability guidelines that are indexed based on a domain and category of mobile software features. For example, we might not find all features offered by an E-Commerce mobile app in a Banking App. Thus the significance of a usability guideline vary from domain to domain. The developer should be able to choose and evaluate the required guidelines based on their business need.

- **Validation Execution Engine**: The validation case is loaded by execution engine and invoked. Here all the attributes and constraints defined in a validation case are passed in a sequence for guideline execution. Every validation case execution returns an individual result. These details are collated and are published in a database called MetricDB. These results are delivered to the external reporting system for visualization.

- **Recommendation Engine**: The code patterns identified for a usability guideline will be added to a code snippet (live templates\(^1\)) central library by developer/tester along with guideline descriptions. Recommendation engine uses these descriptions to match (using Lucene\(^2\) search engine) the related code snippets for code suggestions during the evaluation process. These are stored in Code Snippet DB.

**Incorporating guideline into validation case**

The framework is extensible and reusable. The validation cases designed to evaluate usability guidelines can be stored and re-used for multiple mobile apps. At any given time, a guideline can be added, removed or modified for the overall evaluation. It is not required to rebuild the validation case for a given guideline every time we perform the evaluation. This essentially implies that a non-programmer can add or remove the guidelines to perform the overall validation by just choosing the guideline. This also implies there can be multiple instances of the guidelines and corresponding validation cases based on the various types of mobile apps. Below steps gives us an insight on how the guidelines is converted to a validation case:

- **Step 1**: Select a mobile usability guideline specified in plain text form. For example “User can select to reveal or hide password as they type, during signup or sign-in (e.g. by toggling a ‘reveal’ or ‘hide’ control)”\(^9\).

- **Step 2**: Identify UI code pattern related to guideline i.e. for example, if an EditText box of type password is wrapped inside the TextTemplate widget - it does enable Show Hide password button (Eye icon) as shown in Listing 1. This code pattern can be found in the Android SDK.

```
Listing 1. Reveal or Hide Password
<android.support.design.widget.TextInputLayout
 android:id="@+id/input_layout_password">
 <EditText
```
\(^1\) https://www.jetbrains.com/help/idea/live-templates.html
\(^2\) https://lucene.apache.org/core/
• **Step 3:** Identify steps which need to be checked to validated presence of guideline.
  1. Count total number of password field which are present in source code
  2. Count total password fields which are wrapped inside the TextInputLayout widget.
  3. Check if there is a mismatch in counts
• **Step 4:** Develop UI code pattern validation case using validation case generator Figure 10. Example validation case is shown in Listing 2, which validates the above identified steps.

**Listing 2. Validation Case**

```xml
<ValidationCase Name="Check Show/Hide Passwords">
  <Variables>
    <Variable Name="PwdBoxListWithShowHide" Type=ListofStrings/>
    <Variable Name="PwdBoxListWithoutShowHide" Type=ListofStrings/>
  </Variables>
  <ReadLayoutAttribute AttributeToRead="android:id" Result=[PwdBoxListWithShowHide] XPath="/android.widget.TextInputLayout/EditText[@android:inputType=textPassword]"/>
  <ReadLayoutAttribute AttributeToRead="android:id" Result=[PwdBoxListWithoutShowHide] XPath="/EditText[@android:inputType=textPassword]"/>
  <If Condition="[PwdBoxListWithoutShowHide.Count > PwdBoxListWithShowHide.Count]">
    <Response>
      <Passed>True</Passed>
      <Text>Validation Case Passed</Text>
    </Response>
  </If.Then>
  <If.Else>
    <Response>
      <Passed>False</Passed>
      <Text>Validation Case Failed</Text>
    </Response>
  </If.Else>
</ValidationCase>
```

The validation case XML files are used to perform usability evaluation. The validation cases, once built, can be re-used based on the app chosen for evaluation. For example, in the above case, the validation case XML file generated can be used for every Android mobile app which has a password text field in any given form.

**UMETRIX Evaluation**

As part of automated usability evaluation on FinTech mobile apps, we have reached out to open source Mobile app developers who produce FinTech mobile apps. We obtained their debug mode version of FinTech Android mobile apps. We conducted an automated guideline based usability evaluation using our UMETRIX tool. We have chosen different guidelines for these mobile apps including the guidelines described in the previous section. The Contents of the Table 7 describes the details of app and their corresponding validation results. Here we define ‘a’ - LOC (Lines of Code), ‘b’ - SLOC-P (Physical Executable Lines of Code), ‘p’ - Passed Usability guidelines, ‘f’ - Failed Usability guidelines and ‘%’ - Success Rate. Our results reveal that these open source FinTech mobile app are not usable by geriatric users as they do not have desired usability guidelines implemented as part of the design of the mobile app. We have shared our observations with the Mobile app developers and suggested them to incorporate these guidelines as part of their apps so as to increase the adoption rate across geriatric users.

**Table 7. Mobile Apps used for UMETRIX Case Study**

<table>
<thead>
<tr>
<th>Name</th>
<th>a</th>
<th>b</th>
<th>p</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FinTech Apps</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My Expense</td>
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<td>224685</td>
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<td>9</td>
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</tr>
<tr>
<td>Lunar</td>
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<td>391765</td>
<td>17</td>
<td>8</td>
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<tr>
<td>Budget Watch</td>
<td>99156</td>
<td>85204</td>
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<td>10</td>
<td>52.38</td>
</tr>
<tr>
<td>Loyalty Card</td>
<td>138497</td>
<td>120541</td>
<td>11</td>
<td>10</td>
<td>52.38</td>
</tr>
<tr>
<td>SmartcoinsWallet</td>
<td>369971</td>
<td>314946</td>
<td>15</td>
<td>12</td>
<td>55.56</td>
</tr>
<tr>
<td>TREZORManager</td>
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<td>118819</td>
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<td>12</td>
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<tr>
<td>WALLETH</td>
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<td>55.00</td>
</tr>
<tr>
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<td>202688</td>
<td>14</td>
<td>10</td>
<td>58.33</td>
</tr>
<tr>
<td>Rental Calc</td>
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<td>117961</td>
<td>11</td>
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<td>47.83</td>
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<tr>
<td>Gift CardGuard</td>
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<td>11</td>
<td>9</td>
<td>55.00</td>
</tr>
</tbody>
</table>

**DISCUSSION**

Geriatric users always look for simple tools to meet their daily requirements. Confidence and simplicity is a key
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Figure 10. Define Validation Case

1. Toolbox Usability Controls
2. Validation case workflow
3. Arguments and properties

criterion for geriatric users to adopt a specific FinTech mobile app over other. Our survey results, controlled studies with commercial FinTech and Model app along with our UMETRIX tool unveil that the existing FinTech mobile apps in India are not efficient for geriatric users. Our observations are not limited to India but can be scaled up to geriatric users across the world as the issues reported are not constrained to ethnicity. Based on our study, we propose below recommendations to the existing FinTech mobile app producers so as to increase the usability of their app among geriatric population. Below suggested recommendations are expected to be specific to the geriatric user and should be normalized if they impact regular business targeted users. However, the guidelines suggested in the previous section will help regular digitally literate users to improve the ease of usage.

- Load the geriatric mode based on the age group shared by the user while registering the user account.
- Supply a tooltip against an input field.
- Provide an inbuilt zoom-in and zoom-out feature using hand gestures.
- Set a stand still page as a safe exit for the geriatric users whenever there is an issue with connectivity, speed, performance or timeout.
- Replace next button with swipe-based touch event to complete a step by step task.
- Provide a user session timeline.
- Have a recommender to add beneficiaries based on phone contacts. There should be a mapping between mobile phone contacts and beneficiary account number.

Literacy rate in India is around 74.04% [1]. The larger portion of the illiterate population is residing in rural areas. The government of India has taken serious measures to improve digital literacy by 2019 in rural areas by introducing a social program. However, the existing disruptive FinTech Mobile apps are not ready for the large section of geriatric users. The India specific factors like localization support i.e. to support various local languages, Mobile app design aesthetics based on culture, use-cases based on social relations and interactions among different communities, clarity on efficient local support services are key attributes for enhancing the current version of FinTech mobile app into a new age of digital economy.

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