Towards Designing Mobile Banking User Interfaces for Novice Users

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Abstract. A lot has gone into research aimed at establishing design guidelines to guide developers in developing mobile applications usable by low literate and novice users due to their technological inclination. However, despite quite a number of valuable usability constraints unveiled, corresponding recommendations made and a list of synthesized design guidelines established across various research works, those guidelines are still incomplete and not standardized. In a similar context, the World Wide Web Consortium (W3C), an international standards organization for the World Wide Web, has addressed a similar problem for web based applications. They developed a set of standard guidelines called Web Content Accessibility Guidelines (WCAG 2.0) that specifies how web content can be made more accessible to all types of user on the World Wide Web. The existence of such standard for mobile phones application would greatly impact mobile application development for such users. However none of such standards as WCAG exists for mobile applications development. It has been established that more effort is needed towards uncovering more low literate and novice user centered usability constrains with corresponding recommendations. Thus there exists the need in this research area towards achieving a set of standard guidelines for the development of mobile applications. This study aim to achieve four (4) objectives: i. to explore for low literate or novice user centered usability constraints in mobile applications and their associated design recommendations from existing literatures. ii. to build a mobile banking prototype based on design recommendations from existing literatures. iii. to perform empirical test on some selected banking applications against the developed prototype. iv. to evaluate (comparative analysis) of objective (iii.) aimed at exposing more novice user centered usability constraints using System Usability Scale (SUS) tool. Levels of significance were tested via a two sampled t-test for mean.

Keywords: Usability · Design recommendations · Mobile banking applications · Novice users · Low literate users

1 Introduction

The global mobile phone customer base has continued to grow with annual increment in the number of subscribers across both developed and developing countries [1, 2]. In

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the past three decades, three products had the most impact on the world: the internet, personal computers and mobile phones all in the Information and Communication Technology (ICT) sector [3]. Amongst these, the mobile phone has the highest penetration especially in developing and underdeveloped countries. To further explain on the penetration of mobile phones, an estimated figure of 487 million was sold across the world between July- September in 2011 [4, 5]. That was higher than the figures of personal computers (PCs) sold around the same time frame [4]. Recent statistics by the International Telecommunication Union (ITU) has shown a much higher penetration of mobile phones usage in the world, with an estimated worldwide subscription of over 7 billion in 2015 [6].

It is because of this robust mobile subscriber base that the attentions of many entities with global development focus have been gained over time. Such entities have seen the vast availability of mobile phones as an avenue to serve as a platform for delivering developmental services [7]. One of such entities is the banking sector amongst many others. Bank services are now widely available on mobile phones as a means to afford customers the opportunity to carry out transactions at their convenience, anywhere, anytime.

However, across developing and underdeveloped nations, there exist various categories of mobile phone users. Each category is determined by factors such as literacy level, and exposure level to the mobile phone technology. The tendency that such users are carried along in such developmental growth evidently tends to be low because of the low adoption levels [2]. Also, one of the difficulties to delivering such services in such parts of the world is that most of the population is non literate [8], and even majority of the literate are typically novice users of such technologies. Africa, being a continent of developing and underdeveloped countries that suffer such dilemma has the second largest mobile market in the world after Asia according to African Mobile Observatory 2011.

1.1 The World Wide Web Consortium (W3C)

The World Wide Web Consortium (W3C) is an international standards organization for the World Wide Web. It was founded by Tim Berners-Lee in 1994 with the main purpose of developing a set of standards guidelines that specifies how web content can be made more accessible to all types of user on the World Wide Web. This was to bridge a similar gap as to low literacy and technological inclination of users. The current version, WCAG 2.0, was published in December 2008 and became an ISO standard, ISO/IEC 40500:2012 in October 2012. Because of the benefits derivable from the use of such a guideline the Canadian Federal Government, the Australian Government and the Israeli Ministry of Justice, have over time mandated that all online web contents meet the accessibility requirements of WCAG 2.0.

There are a lot of ongoing research aimed at establishing design guidelines to guide developers in developing mobile applications usable by low literate and novice users. However, despite quite a number of valuable usability constrains unveiled and corresponding design recommendations made from various research work, those guidelines are still incomplete and not standardized [9–13]. Also, there is no standard for mobile

phone applications development as WCAG 2.0 exists for web content development. It has been established that more effort is needed towards uncovering more low literate and novice user centered constrain with corresponding recommendations, in anticipation to gather sufficient data to help establish a standard such as WCAG 2.0 with respect to mobile phone application interfaces for all types of user.

1.2 Usability

There are various definitions of usability in the Human-computer Interaction community. There also exist frameworks for its specification and measurement. A few opinion from various standards are:

The IS0 9241-11 standard defines usability as: "The extent to which, a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". ISO/IEC 9126-1, on the other hand defines usability as 'the capability of the software products to be understood, learned, used and be attractive to the user, when used under specified conditions'.

Usability is an important quality attribute of any given product be it a mobile phone or mobile application. This then implies that usability evaluation is highly necessary to ensure usable mobile phones and mobile applications. Over time quite a number of usability evaluation methods have been developed. Such usability evaluations can basically be classified into three categories: usability testing, usability inquiry, and usability inspection [14]. Usability testing entails engaging representative users in carrying out typical tasks through interactions with a system or a prototype. Common methods include co-discovery learning, question-asking protocol and shadowing method. In Usability inquiry, an interaction with users takes place as they interact with the system in real world settings. Users are asked questions in order to help understand their feelings about the system and their information needs. On the other hand, field observation, concentrates on focus groups, while questionnaire surveys are used to gather data on usability. Another method, usability inspection, employs the use of usability experts to analyze the usability-related aspects analytically. Common available techniques are cognitive walkthrough and heuristic evaluation. Research of [15] is of the opinion that there exist two more techniques, analytical modeling and simulation. The two aim at predicting usability by using user models and interface models.

2 Research Recommendations Established Thus Far for Designing Usable UI's for Low Literate and Novice Users

A research [16] more or less covers a lot of ground with regards to design recommendations for low literate and novice users thus far. Their research findings and recommendations not only confirm the vast majority of previous works, but expose more issues. However usability still remains a major hurdle to be crossed [12, 13].

The research [16] took two steps in evaluating how best to improve the usability of mobile interfaces for low literate and novice users. Firstly, the researchers undertook an ethnographic study with the aim to identify usability barriers face by the target audience.

Ninety (90) low-literacy subjects across India, Kenya, the Philippines, and South Africa were selected. Also, via another study by the same group involving seventy (70) subjects in India, they quantitatively compared the usability of different points in the mobile design space. They considered three text-free interfaces: spoken dialog system, graphical interface and live operator. Also, text interfaces such as Short Message Service (SMS), electronic forms and Unstructured Supplementary Service Data (USSD).

Results from the studies confirmed that textual based interfaces were found to be unusable by first-time and low-literate users. It was also established that they were more error prone for novice users [16]. In the healthcare domain, result showed that a live operator is as much as ten times more accurate and effective than text-based interface, and also proved to be more cost effective in countries such as India. The researchers established a higher task completion rate in the context of mobile banking via a graphical interface. However, subjects who understood the spoken dialog system could use it more quickly due to their comfort and familiarity with speech. Similarly, the results presented in [16] were also in research works by [17–21].

2.1 Challenges Encountered by Novice Users in the Ethnographic Study

There were a number of challenges encountered by subjects in interacting with the mobile banking services and navigating through mobile phones in general. The challenges encountered by the subjects are summarized in the study [16] and similar to other research [17–21] are as follows:

Scroll Bars. Vertical scrollbars were not at first understood by quite a number of subjects. They did not understand that there were functions underneath what was shown on the screen. The researchers had to explain in detailed demonstrations what scrollbars were and how to utilize them.

Nonnumeric Inputs. Most subjects utilized their phones for making and accepting voice calls only. This category was also high when studies were carried out in India, Kenya, and South Africa. Some were unable to type words on their phones, talk less of composing an SMS message. Performing a USSD operation involving digits and symbols ("*" and "#"), subjects could type digits but couldn't find the symbols.

Language Difficulties. All the mobile banking services under the study generated and issued SMS receipts on successful completion of transactions. The text messages were completely in English, except for one of the services provider (M-PESA) which also offered in Kiswahili. Most subjects were not fluent in English and consequently found it difficult to read and understand the receipts sent via text message. Even those who could read and understand English found it difficult understanding specialized/technical terms and receipts containing multiple transaction summaries.

Discoverability. It was confirmed also that functions hidden deep in any hierarchical structures were less discoverable by subjects. A similar constraint emerged from poor interaction design, for instances such as when functions were classified under apparently unrelated functions

Hierarchical Navigation. Most subjects at first were unable to comprehend and navigate hierarchical menus. This posed a problem even for basic tasks such as calling back a phone number from which a missed call was earlier received. As for non-users of mobile phones, none were able to navigate the menus, instead of simply using the call logs or address book which would have been much easier and effective, most of them dialled the numbers from scratch each time they needed to make calls. These were confirmation of some earlier research works on challenges of representing tree structures among literate but novice user [22].

Soft-key Function Mapping. Irrespective of those who owned mobile phones or not, the majority of subjects were able to effectively use "hard keys" (example of such are direct number entry and send/end keys). However, some subjects found it difficult to use soft keys mostly found beneath the screen to performed different function in different contexts. Subjects who needed to navigate through different layers of the user interface (UI) to send text message got lost and had no clue to which soft key to use in navigating.

2.2 Synthesized Design Recommendations

The six (6) challenges encountered by the novice user in the ethnographic study of [16] and related studies of [17–21] yielded corresponding design recommendations as follows:

- Provide graphical clues
- Provide voice annotation support where ever possible
- Provide local language support, both in text and audio
- Minimize hierarchical structures
- Avoid requiring nonnumeric text input
- Avoid menus that require scrolling
- Minimize soft-key mappings
- Integrate human mediators into the overall system, to familiarize potential users with scenarios and UIs

The items listed above therefore echo design recommendations from [16–21]. Thus an interesting research agenda is presented aimed to improve the usability of the items listed to make them more accessible for all type of users.

3 Research Method

This research conducted three (3) comparative studies. Each of these studies involved the comparison of two (2) simulated user interfaces. In each study the first UI was the simulation of an existing mobile banking application, tested against another simulated application developed base on the selected design recommendation discussed from past research targeted towards low literate and novice users. The design recommendations were selected based on applicability to the mobile banking context. However the scope of the research was limited to working with novice users only. Each comparative study

was in two phases. The first phase of the comparative study was an exploration for possible usability constraints novice could encounter on navigating through the UI of the existing application while performing some predefined tasks. This is done to examine mockups also known as fidelity prototypes for design flaws and usability constraints. It is a standard evaluation procedure carried out on predesigned mockups by developers to check usability barriers. It helps save cost and time as it is carried out early in the development cycle before engaging programmers.

The second phase was the testing of simulated mobile banking applications against the prototype. Both simulations were carried out on novice users. The interaction with both applications was first aimed to establish the significance of the impact of design recommendations implemented. Secondly, it was aimed to afford the researchers the opportunity to explore for more novice user centered constraints as novice user interacted with both user interfaces. The same was carried out against the prototype in two more comparative studies in the same manner. Thus in each of the three studies, each groups tested the developed prototype (developed based on the selected recommendations) against an existing mobile banking application. To achieve the project aim and objectives, the research frame work in Fig. 1 was adopted.

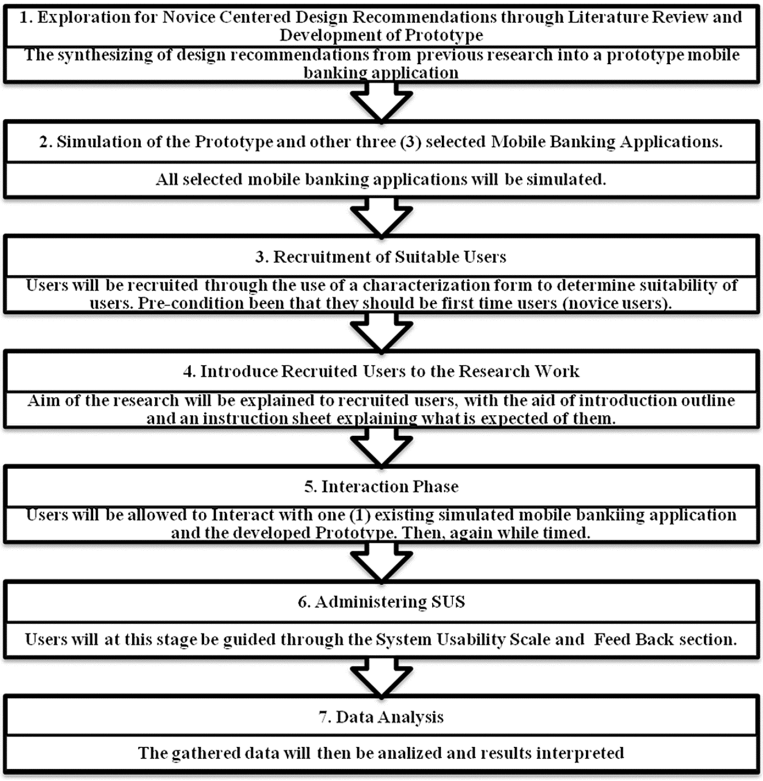

Fig. 1. Research Frame Work

3.1 Exploration for Novice Centered Design Recommendations and Development of Prototype

Analyzed through literature review, the prototype mobile banking application was developed based on five (5) out of eight (8) design recommendations related to the mobile banking application context were selected. The selected design recommendations were based on how they fit into the mobile banking context outlined below. Others were more applicable in the health domain and other contexts. Thus the implemented design recommendations are as follows:

- Provide graphical clues
- Provide voice annotation support wherever possible
- Minimize hierarchical structures
- Avoid requiring nonnumeric text input
- Avoid menus that require scrolling

3.2 Simulated Functionalities

In the interaction phase, the research work focused on predefined tasks (transaction tasks) on which users were tested. Selected were transactions that seemed to be the widest spread and carried out by users over the counter and through ATMs machines. They are as follows:

- Balance Inquiry
- Airtime recharge
- Intra bank transfer
- Interbank transfer
- Transaction History

3.3 Recruiting Suitable Users

The population of interest for this study was non mobile banking users also known as novice users or first time users. A total of 20 participants were randomly selected and recruited for each of the three (3) comparative studies. The groups consisted of individuals within and around Niger State, Nigeria. Suitable users were recruited through the use of a characterization forms. These were pre-test questionnaire, meant to ascertain most importantly that they were first time users. Also, demographic details and other information on their internet and banking experience were gathered.

3.4 Introducing Users to the Research Work

The recruited users on qualification were introduced to the overall aim and objective of the study via a guide line document. As any pre-meditated associations with respect to brand loyalty and experience would affect the research result, fictional banking names were given to the four simulated banking applications as shown in Table 1.

Table 1. List of existing Banks simulated and tested

Bank name	Details
BBank	Simulation prototype based on design recommendation gathered from previous research tested against other Banks in each comparative study
ABank	Simulation of an existing mobile banking application tested against BBank in the first comparative study
CBank	Simulation of an existing mobile banking application tested against BBank in the second comparative study
DBank	Simulation of an existing mobile banking application tested against BBank in the third comparative study

3.5 Interaction Phase

In order to further engage recruited users, an outlined scenario of a recently established bank was painted to the recruited users. The scenario explained that the bank wanted to select from two prototypes a mobile banking application for their customers. The bank hope to obtain user perception concerning the user interfaces designs. Recruited users were asked to assume recently enrolling with the bank. For the purpose of the evaluation, they were told they owned one (1) savings account and were already subscribed to the mobile banking option. A set of tasks on Table 2 expected of them to perform was outlined in an instruction sheet given and explained to them.

Table 2. List of tasks to be performed by users

Task	Task type	Task details
Task 1	Balance inquiry	Users were expected to check their account balance
Task 2	Airtime recharge	Users were expected to purchase airtime via the application
Task 3	Intra-bank transfer	Users were expected to transfer funds from their account to another person's within the same bank
Task 4	Inter-bank transfer	Users were expected to transfer funds from their account to another person's banking with another bank
Task 5	Transaction history	Users were expected to trace a past transaction from there transaction history log

3.6 Data Analysis and Method

On successfully completing the tasks, the System Usability Scale (SUS) tool questionnaire developed by Brooke in 1986 [23] was administered. The term "system" was replaced with "mobile application". The SUS tool is a 10-item questionnaire that reveals usability in terms of three (3) parameters; efficiency, effectiveness and satisfaction. Table 3 defines and gives the meaning of each parameter.

Table 3. Definition of SUS parameters

S/No	Parameters	Definition and Meaning
1	Effectiveness	The ability of users to complete tasks using the system, and the quality of the output of those tasks
2	Efficiency	The level of resource consumed in performing tasks
3	Satisfaction	Users' subjective reactions to using the system)

The SUS tool is deemed as highly robust, low cost, and versatile [24]. It has been tried and tested for almost 30 years and has proven dependable for evaluating the usability of systems compared to industry standards [24]. It gives a global view of subjective assessments of usability. It has been used in over 200 studies for usability evaluation. According to a research by Tullis and Stetson, SUS performs best across sample sizes of at least 12–14 participants [25]. Also according to [26] a sample size of 20 per group across the 3 groups is sufficient to run the needed quantitative analysis.

The data analysis for each comparative study were performed in four steps which are:

- SUS Scores Computation.
- Paired T-Test analysis on the SUS Scores.
- Average Task Completion Time Computation.
- Paired T-Test analysis on the Average Task Completion Time Computation.

3.7 Paired T-Test

On obtaining both SUS scores for both applications, the SUS scores were then subjected to a Paired T-Test to test for any statistical significant difference. The paired T-Test analysis assumed an alpha (α also known as Level of Significance or Level of Certainty) value of 0.05 (CI: 95%), and the results interpreted. The t-tests were conducted based on two hypotheses.

Firstly, the Null hypotheses, that there exists no statistical significant difference between the mean SUS scores of both banks tested (H_o: $\mu_1 - \mu_2 = 0$).

Secondly, the alternative hypotheses, that there exists a statistical significant difference between the mean SUS scores of both banks tested (H_o: $\mu_1 - \mu_2 \neq 0$).

3.8 Exploring for User Constraints Before the Comparative Study

The available Usability Inspection Methods (UIMs) are the Cognitive Walkthrough (CW) and Heuristic Evaluation (HE). The HEs are used by inspectors to examine Graphical User Interfaces (GUIs) seeking for possible usability constrains. When any usability constrains is found, it is reported in association to its corresponding violated heuristics. The CW on the other hand, are used by inspectors to analyze if a user can make sense of interaction steps and flow as they proceed in a pre-defined task.

The combination of HE and CW was employed to explore for more novice centered usability constraints before engaging recruited users. It involved the evaluation of screen shot (screen grabs), from specific task perspectives (as listed in Table 2 earlier) of the

existing mobile banking applications transaction flow. They were arranged sequentially following the transaction flow sequence of each task and examined for possible usability constraints.

Secondly, to expose more novices centered usability constraints, additional feedback were gathered in a debriefing session. The debriefing session took the form of a semi structured interview, verbally interacting with users on successfully interacting with the simulated applications. This helped users convey their perception of both interfaces.

4 Result

Recruited users for all three (3) groups of the comparative study were novice. That is, first time user of the mobile banking application. Table 4 is a summary of their demographic details.

Table 4. Summary of the three groups demographic details and SUS Scores.

		Group 1		Group 2		Group 3	
Sex	M	8		10		9	
	F	12		10		11	
Age group	18–25	8		7		11	
	26–33	9		8		5	
	34–41	3		5		3	
	42 and Above	0		0		1	
SUS	SUS Scores	ABank	37.25	CBank	47.00	DBank	43.13
		BBank	85.25	BBank	85.25	BBank	83.88
		Diff	*48.00*	*Diff*	*38.25*	*Diff*	*40.75*

A total of 20 novice users were randomly recruited for each of the comparative study groups. According to the data gathered from the administered pre-test questionnaire, all participants had at least one active bank account at the time of participation with no mobile banking application experience. Participants had similar levels of experience in internet usage. Participation was entirely voluntary and each individual consented to participate in the study.

4.1 Group 1 (ABank Against BBank)

Figure 2 shows the mean SUS scores for the ABank and BBank interface. The score range is 0–100.

Figure 2 indicates an improved overall score and rating for the BBank (simulation of prototype mobile banking application base on design recommendations gathered from previous researches) interface compared to ABank (simulation of an existing mobile banking application). The mean SUS score for the BBank was 85.25 and that of ABank 37.25 with a difference of 48.00 observed between both the interfaces. To test the significance of the result, we conducted a paired t-test analysis with an alpha value of

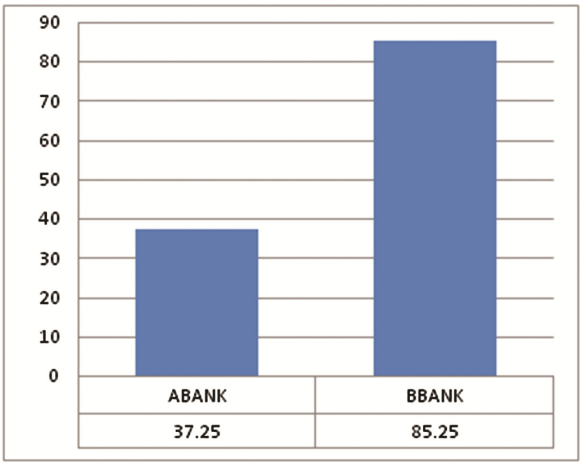

Fig. 2. ABank against BBank.

0.05 (CI: 95%). There was a significant difference in the scores for ABank (M = 37.25, SD = 22.37) and BBank (M = 85.25, SD = 11.64) interfaces; t(19) = −7.91, p <=0.001. The t-test analysis also showed a high degree of variance (ABank = 500.51, BBank = 135.46).

All participants managed to complete their given tasks in both interfaces. Figure 3 shows the average time spent in seconds for each task across participants.

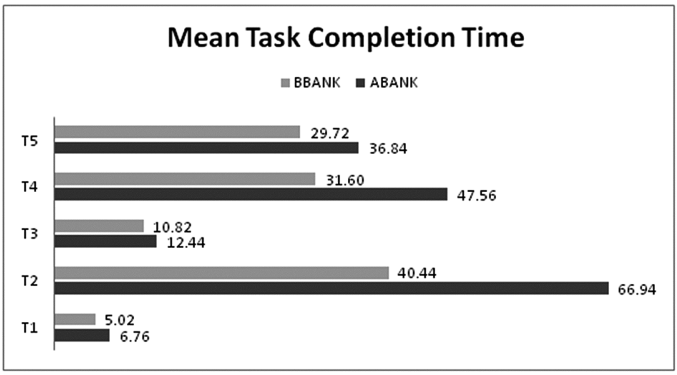

Fig. 3. ABank against BBank.

Figure 3 show's that participants in general completed the set tasks within a shorter period of time via the BBank interface. The mean completion time for ABank interface was 34.11 s and 23.52 s for the BBank interface. However a paired t-test analysis with an alpha value of 0.05 (CI: 95%) showed there was no significant difference between the mean task completion times for ABank (M = 34.11,

SD = 24.92) and the mean task completion times for BBank (M = 23.52, SD = 14.95) interfaces; t(5) = 2.22, p = 0.09.

4.2 Group 2 (CBank Againt BBank)

Figure 4 shows the mean SUS scores for the CBank and BBank interface. The score range is 0–100.

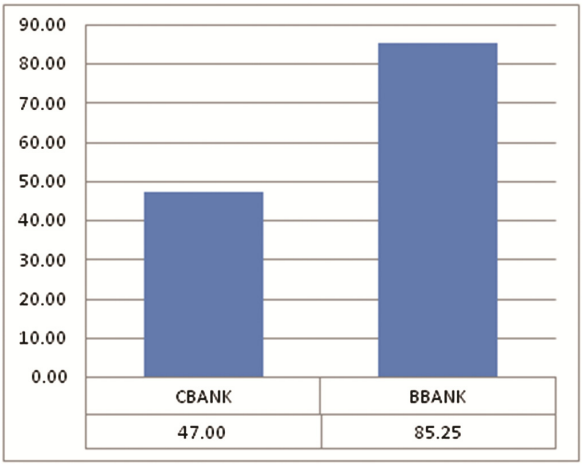

Fig. 4. CBank against BBank.

Figure 4 indicates an improved overall score and rating for the BBank (simulation of prototype mobile banking application base on design recommendations gathered from previous researches) interface compared to CBank (simulation of another existing mobile banking application). The mean SUS score for the BBank was 85.25 and that of CBank 47.00 with a difference of 38.25 observed between both the interfaces. To test the significance of the result, we conducted a paired t-test analysis with an alpha value of 0.05 (CI: 95%). There was a significant difference in the scores for CBank (M = 47.00, SD = 23.79) and BBank (M = 85.25, SD = 9.13) interfaces; t(19) = −7.66, p <=0.001. The t-test analysis also showed a high degree of variance (CBank = 536.55, BBank = 83.48).

All participants managed to complete their given tasks in both interfaces. Figure 5 shows the average time spent in seconds for each task across participants.

Figure 5 show's that participants in general completed the set tasks within a shorter period of time via the BBank interface. The mean completion time for CBank interface was 31.59 s and 22.40 s for the BBank interface. A paired t-test analysis with an alpha value of 0.05 (CI: 95%) showed there was a significant difference between the mean task completion times for CBank (M = 31.59, SD = 19.81) and the mean task completion times for BBank (M = 22.40, SD = 14.75) interfaces; t(5) = 3.97, p = 0.017.

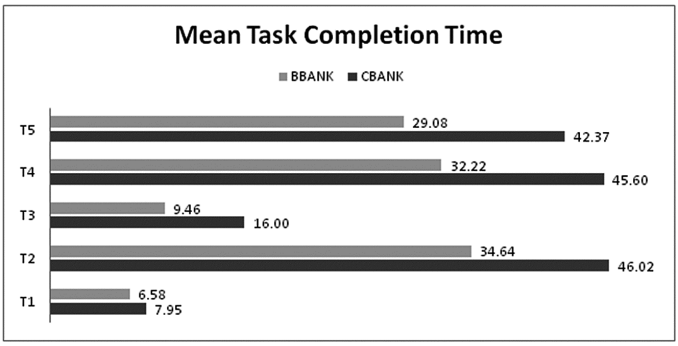

Fig. 5. CBank against BBank.

4.3 Group 3 (DBank Againt BBank)

Figure 6 shows the mean SUS scores for the DBank and BBank interface. The score range is 0–100.

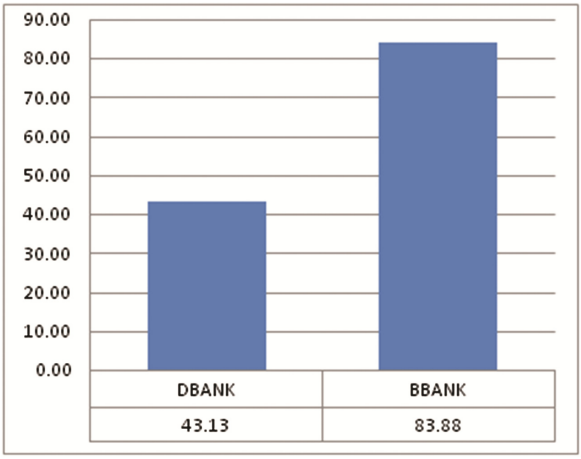

Fig. 6. DBank against BBank.

Figure 6 indicates an improved overall score and rating for the BBank (simulation of prototype mobile banking application base on design recommendations gathered from previous researches) interface compared to DBank (simulation of an existing mobile banking application). The mean SUS score for the BBank was 83.88 and that of DBank 43.13 with a difference of 40.75 observed between both the interfaces. To test the significance of the result, we conducted a paired t-test analysis with an alpha value of 0.05 (CI: 95%). There was a significant difference in the scores for DBank ($M = 83.88$, $SD = 22.62$) and BBank ($M = 83.88$, $SD = 10.08$) interfaces; $t(19) = -6.06$, $p <= 0.001$. The t-test analysis also showed a high degree of variance (DBank = 511.75, BBank = 101.62).

All participants managed to complete their given tasks in both interfaces. Figure 7 shows the average time spent in seconds for each task across participants.

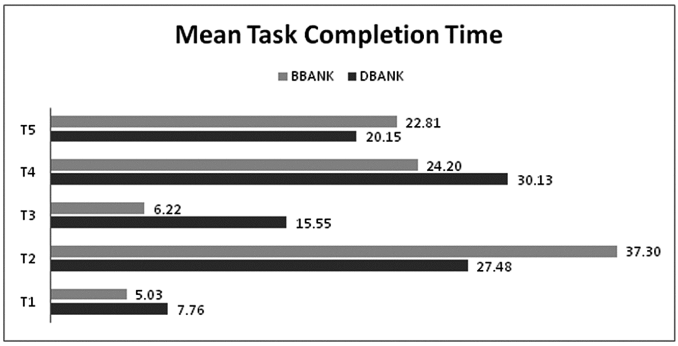

Fig. 7. DBank against BBank.

Figure 7 show's that participants in general completed tasks 1, tasks 2, tasks 4, within a shorter period of time via the BBank interface. However, it took longer time on task 2 and task 5. The mean completion time for DBank interface was 20.21 s and 29.22 s for the BBank interface. A paired t-test analysis with an alpha value of 0.05 (CI: 95%) showed there was no significant difference between the mean task completion times for CBank ($M = 31.59$, $SD = 10.46$) and the mean task completion times for BBank ($M = 22.40$, $SD = 15.47$) interfaces; $t(5) = 3.97$, $p = 0.017$.

4.4 Exploring for More Novice Centered Usability Constraints

Novice centered usability constraints were sought using various techniques before, during and after the comparative studies involving the recruited users. A combination of Cognitive Walkthrough (CW) and Heuristic Evaluation were employed to explore for usability constraints early before the prototypes were developed.

First noticed was the transaction flow length especially that of ABank. The transaction flow seems lengthy and was assumed to require quite an amount of patience and cognitive load most especially by novice users. Thus to remedy this, the research recommends for such target audience, transaction flow should be brief and short as adopted in the simulation of the design recommendation based prototype.

Secondly, inconsistency in keyboard input format of touch screen phones from ABank and DBank was observed. Input field such as account number and phone number simply requires a numeric keyboard format to pop up. However it was observed that in some transactions, such input field came up with an alphabetic keyboard format. This implies that users would need to be knowledgeable enough to re-format the on screen keyboard to a numeric keyboard format by toggling through. This clearly would require more time and patience by novice users to perform those transactions there by taking much more transaction time than necessary. This could also pose an inconvenience to a user who cannot toggle through the various available keyboard formats, frustrate those

who can as they would need to input alphabets before realizing the need to reformate the keyboard and restart the entry all over again. As a remedy, it is recommended that there should be consistency in linking each input field to the most appropriate input keyboard format.

A number of other constraints observed were consistent with constraints already established from previous researches. Such were discoverability of functionalities, scroll bars, the use of graphical clues and audio annotation. Amongst all, the most prominent observed from the use of the prototype was the incorporations of graphical clues and audio annotations. They were clearly observed to have positively impacted the ease of use from the recruited users point of view. When asked for strengths of the prototype, majority of users mentioned the presence of these features and confirmed they made use of the prototype much easier to interact with. These were also observed to be responsible for the reason majority strongly responded positively to the SUS question number 1 (I think that I would like to use this application frequently).

Lastly, it was observed from the debriefing session that users would prefer a striped down version of mobile banking applications just as the prototype was based on. That is, a version void of functionalities they would rarely need. They admitted they would find such easer to interact with rather than surfing through deep hierarchical structures each time they needed to perform important functions, constantly distracted by functions they would rarely need.

5 Discussion

Results from data analysis proved the researcher's initial hypothesis to be true. The initial hypothesis that existing Nigerian mobile banking applications could be improved upon. This was based on the fact that there exist a wide gap between research based design recommendations prototype (BBank) and design prototypes of existing Nigerian mobile banking applications (ABank, CBank and DBank). Results show an improved usability especially in user satisfaction of BBank and this may consequently have a positive impact on the adoption and acceptance of mobile banking, particularly from a usability perspective. Participants spent less time in performing transactions on the BBank in groups 1 and 2. However, there was a statistical significant difference in mean task completion time of BBank only in group 2.

Results show they were a bit slower on task 2 and 5 in group 3, however still appeared to be more satisfied using the BBank interface. In addition to the previously established research based design recommendations, this research suggests the following design recommendation for mobile banking application development:

- That transaction length be kept as short as possible
- Input regions be properly and consistently formatted to corresponding appropriate keyboard formats especially for touch screen phones
- Functionality striped down versions of such applications is made available for such users (novice users) to reduce the complexity in their favor.

6 Conclusion

The prototype developed based on research (previously established) design recommendations performed well and better than the existing banking application prototypes across the three (3) comparative studies. Recruited users exhibited higher levels of satisfaction with the design recommendation based prototype than the existing applications. The researchers hope the results presented will draw the attention of mobile banking application developers and Managers of banks to the fact that there is a need to take seriously the peculiar needs of their customer base which includes all kinds of user. Majority are novice users and would only get the best out of mobile banking applications if the applications are developed based on established design recommendations from research. This will boost the adoption level and help achieve a deeper penetration of developmental services much needed across developing and underdeveloped nations.

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