On the Key Factors of Usability in Small-sized Mobile Touch-Screen Application

Feyza Gündüz and Al-Sakib Khan Pathan

Department of Computer Science
Kulliyyah (Faculty) of Information and Communication Technology
International Islamic University Malaysia
Jalan Gombak, 53100, Kuala Lumpur, Malaysia
fgunduz@gmail.com, sakib@iium.edu.my

Abstract

The purpose of this work is to present a practical study on the key factors of usability in small-sized mobile touch-screen applications. Though using smart phones has brought great easiness in our daily life in many ways, many smart phone applications often remain underutilized due to the poor consideration of end-users in the development phase, thus decreasing potential profit of companies. In this paper, we investigate usability problems for a mobile flight booking application on touch-screen phones, and suggest practical solutions. The application is a critical one that can represent the cases of a wide number of smart phone applications. Main expectations of users are presented from HCI (Human Computer Interaction) perspective and discussed through the case study. Questionnaire and interview methods were used for collecting data. Prototype has also been utilized to verify users' expectations of mobile flight booking more accurately. The interviewees who were in the range of ages 18-40 have been randomly selected for this study, which could be also considered as a realistic set because of their diversity. Results have revealed that users are very much concerned about the easiness and the lucidness of functions. Usability is a highly considerable subject for users to prefer a mobile flight booking application over booking tickets via online or agencies.

Keywords: Flight, Mobile, Small-sized, Touch-Screen, Usability, User

1. Introduction

The Internet plays a very crucial role in today's world. Continuous growths of Internet users and easily accessible Internet technologies have elevated it as one of the basic needs of 'tech-based' societies. Other than being a source of ample amount of information, Internet could be used for social networking, communications among institutions and individuals, electronic banking, electronic commerce, electronic advertisement, electronic transactions, gaming, file sharing, and many other different types of operations. Numerous applications and ways of utilization of Internet have made it a vital tool of the modern world. The virtual world of Internet runs in parallel with the real world. As a great number of users are connected and participating in this virtual world, the research issues are also constantly evolving and becoming more dynamic than ever before.

One of the most significant transformations of our daily life is that how we shop for goods and services. According to the 2010 Nielsen report on Global Online Shopping [1], vacations

are high priority for planned online purchases. Airline ticket reservation represented 32%, Hotel/Tours reservation 26%, and Event tickets 20% percent of global online sales in number of sales. However, online shopping is also changing. Consumers of today use their mobile devices for shopping on-the-go with the ease of advanced mobile browsing and 3G/4G/Wi-Fi technologies [19]. Nielsen's last survey [2] supports business correlation between mobile gadgets and online shopping trends. According to the report conducted in the first quarter of 2012, the vast majority (79%) of US smartphone and tablet owners have used their mobile devices for shopping-related activities. Oracle's (ATG) survey [3] also highlights that consumers rely on their devices for more and more commerce-related activities, in addition to social and communicative activities. Combination of the results of the above surveys shows that airline and travel companies, being the owners of the third most likely sold product/service in online shopping should attract smartphone users by expanding their flight service channels into this growing mobile shopping trend.

This growth of mobile usage offers many ways to airlines and travel companies to reach their target customer as they race to provide reliable, always-on access to a new buying experience. However, customer experience with such applications significantly affect user's preference [4] to buy tickets and services via mobile over web interface and user's return rate, posing a huge challenge—and opportunity—for these service providers. There are numerous applications in application market that offer flight search and flight booking; however, low usability of those applications indicates that designs mostly were created without much consideration of user's context and preference.

There are many surveys that concern or include usability issues. Web-page usability and user experience have been discussed and many sets of guidelines are introduced in the works like [5, 6, 7, 8, 21]. Although mobile application field is new, PDA (Personal Digital Assistant) and mobile application design challenges were mentioned through recent studies. Two closely-related studies [9] and [10] to this research work, discussed usability concerns for mobile flight booking applications. However, those studies are conducted on stylus-aided PDAs and classic mobile phones; very few research works focus specifically on touch screen mobile application usability. Furthermore, none of the previous works combined usability guidelines with flight booking applications on touch-screen devices (which have small-sized interfaces). The objective of this work is to discover and describe usability challenges found especially in touch-screen mobile flight booking applications and suggest solutions to eliminate such problems for both the service provider and user.

The rest of the paper is organized as follows: Section 2 mentions the background and related works that motivated us for this work, Section 3 presents the experimental set-up, Section 4 mentions the method of study and presents the analysis of collected data. Interface design problems for small-sized touch-screen devices and our solutions are discussed in Section 5. Before concluding the work in Section 8, alongside mentioning the potential future works, we put some critical discussions in Section 6 and the limitations of our work in Section 7.

2. Literature Review and Motivation

Usability is defined as "*the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments.*", where user experience definition is "*a person's perceptions and responses that result from the use or anticipated use of a product, system or service*" [11]. Although there are commonalities between user experience and usability, the literature argues that usability is a measurable term whereas user experience is immeasurable due to its relative and

complex nature [7]. Depending on the context of use, social and cultural factors affect users' interaction and eventually the experience with the product. Figure 1 shows various facets of relationships between user interaction and user experience, which is adapted from [15].
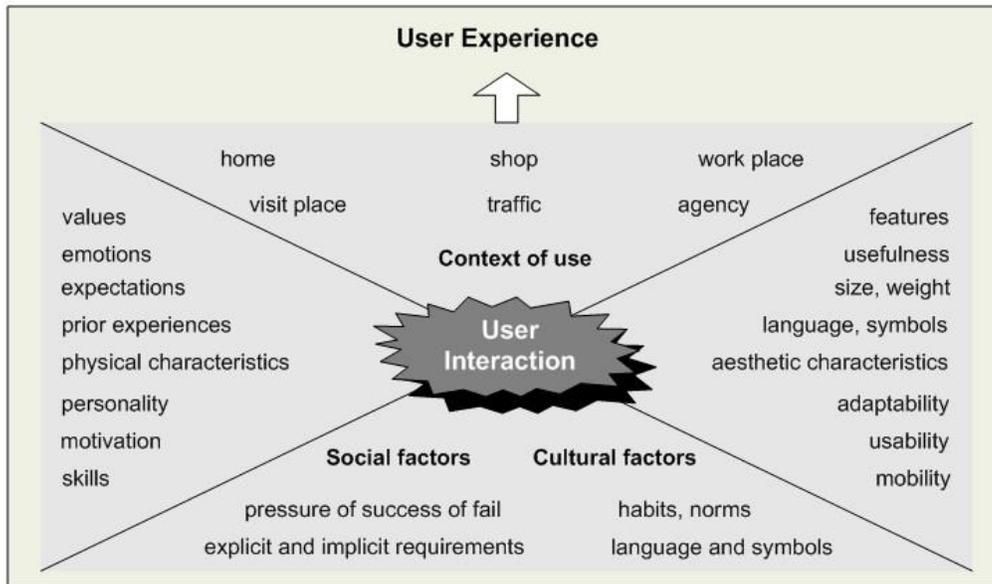

Figure 1. Relationship between user interaction and user experience based on context of use and critical factors

As it is commonly practiced by developers, functionality does not arise as standalone factor in bringing out good software or application. Jordan [12] interprets Maslow's Hierarchy of Needs in the context of consumer needs and identifies "*functionality*" at base level, followed by "*usability*" and "*pleasure*" at the top. Jordan also mentions that "*usability*" and "*aesthetics*" are major factors contributing pleasure of using products [4]. Linghammar [13] further investigates the correlation between usability and aesthetics and concludes that visual beauty (qualities that give pleasure to the sense) affects perceived usability. Moreover, design aesthetics significantly helps achieve customer loyalty through improving perceived usefulness, ease of use, and enjoyment [14].

Some research works investigate usability and bring guidelines. Nielsen suggests five components to determine usability of a web page, which are "*Learnability*", "*Rememberability*", "*Efficiency of use*", "*Reliability in use*" and "*User Satisfaction*" [16]. However, there are very few works available when it comes to the investigation of mobile user interface patterns and usability. In terms of variables affecting design, web-page usability is relatively straightforward. But, in the context of mobile application development, usability yields more complex considerations. Dynamic user environment, unstable network connection, processor performance, memory size, screen size, and attention interruptions have emerged as some of the usability challenges comparing to desktop PC (Personal Computer) applications [6, 17, 18]. Among various works, [18] finds some critical Mobile Commerce (M-Commerce) challenges and proposes some potential solutions. Table 1 shows the findings at a glance.

Table 1. Mobile commerce challenges and potential solutions [18]

Challenges	Potential Solutions
Increased demands on attention	Minimal-attention interfaces
Dynamic Environment	Context-awareness
Mobile device limitations and usability	New and flexible I/O modalities
Security	Biometrics
Safety	Commonsense design and legislation
Social concerns	Societal norms and written laws

In [9], some problem-areas regarding mobile application's usability are identified like: Horizontal scrolling, handling dialogs when software keyboard is shown and hidden, mechanisms for entering text, interacting with applications without using stylus, creating a design that supports branding, aesthetics, and utilizing screen space, and user interaction during waiting for long-lasting operations. Usability concerns that are specific to 'travel websites' are generally discussed from information presentation and offered functions in [8]. Later on, Burmistrov interpreted the findings of travel usability guidelines from the perspective of mobile flight booking and brought general guidelines using classical mobile phone [10].

Other than the works mentioned above, there are some other works that have given us a broader picture of the subject topic. The basic ideas of a few of those selected works are discussed here. [22] presents a methodology and framework that aims to ease the task of the developers and analysts for the usability analysis of mobile applications. The key focus of this work is the simplification of the developer's task in preparing the system for evaluation and the processing of the collected usability data by automating some of the tasks involved in the process. The authors divide the typical developer's tasks into mainly four steps: (i) Preparation, (ii) Collection, (iii) Extraction, and (iv) Analysis. The proposed EvaHelper (Evaluation Helper) framework takes these steps of tasks to prepare the system, collect information by simplifying logged entries, extract and process the collected data, and analyze usability with graph plots. The drawback of the work is that the developed framework only supports applications that use the Android platform. Also, the steps and methodologies of evaluation are too general in their meanings without appropriate details.

[23] is an interesting work that explores the issues of usability for M-Commerce (Mobile Commerce) transactions performed on wireless devices. The work basically is a small-scale pilot investigation. The key finding is that no significant differences are observed in performance or user satisfaction for tasks completed on a mobile phone and a PDA. The complexity and nature of the task itself appeared to be more important factors than the device on which they were run. [24] is another interesting work which studies the effects of stylus pen length on user performance via two experiments; writing a sentence and drawing a table. Though this work is not directly related to our work, some points regarding usability of touch-screen devices have helped us better understand the user's needs and requirements for better interaction. [25] is a focused work that evaluates the usability factors on Mobile Payment Application on two different service providers in Thailand. Because of the limitation of the participants' diversity, though some findings are useful, the overall outcome cannot be generalized for other regions and set of people. We have a similar objective to analyze the usability factors of some implemented application but our methodology, targeted scope of research, and choosing of diverse sample set would justify the generality of the outcomes, which we will present later in this paper.

In [27], the authors perform experiments on the effects of font size and page presentation method of e-book reading on small screens especially for elderly people. The work shows that objective measures (time and accuracy) of reading performance are not affected significantly by changes in font size, but only affected by the page presentation method for the aged people. This study helps understand the possible impact of font size on small-sized screen however as our application does not require constant reading of lines after lines (as in the case of an e-book) but rather small chunks of texts or words, our results show a direct relation between font size and performance, which will be discussed later.

Small sized handheld devices are taken into consideration in [28], however the objectives and focus of the work is fairly different than ours. What is related to our work is the finding that combining interactive imaging and energy efficient high performance computing could enable new mobile applications and user interactions. Better meaningful interactive images or icons could make the processes faster and thus save energy of small handheld devices which need constant recharging.

[26] presents some observations on various studies that performed usability evaluations for mobile applications. The methodologies for evaluating mobile usability are categorized into: (a) Laboratory experiments, (b) Field studies, and (c) Hands-on measurement. In our work, we have combined all these methodologies to get more concrete and plausible results.

Given all these previous works and findings, we have found that there is no research work available for mobile flight booking usability challenges specifically for small-sized touch-screen devices. This particular fact has motivated us in investigating on this topic taking the practically implemented Turkish Airline's commercial mobile flight booking application: "*FlyTurkish*". It should be noted that some snapshots of the existing application alongside our designed prototype are presented later in this paper.

3. Overview of the Experimental Setting

The study was carried out with a qualitative research approach. Qualitative approach is suitable for usability analysis, since mobile usability's concerns of easiness, efficiency, user satisfaction, and embracement of the application can be best investigated by studying user's actions and reactions towards the application in their own contexts and collecting their opinions through their own way of expressions. Research is also supported with questionnaires to increase accuracy of the analysis. The experiment was conducted as a case study, analyzing usability factors over Turkish Airline's commercial mobile flight booking application: "*FlyTurkish*". Apple iPod 2G was used as test medium.

To conduct the experiment, we designed various graphical interfaces for the application associated with various functionalities. 20 interviewees in the range of ages 18-40 were randomly chosen. However, we selected a diverse set of people based on various nationalities and backgrounds. This is because we wanted to add dynamism in people's preferences and mind-set. The sample size though may seem to be small at

first look, is representative enough to produce some clearly understandable outcomes, which we will discuss later in this paper. In fact, by increasing the sample size (*i.e.*, number of participants) step by step, we have observed that there are patterns for design issues to which people acted almost the same way. Increasing the sample size further cannot make much difference in the gained results as we have found. Male participants composed half of the interviewees which make an even distribution between genders. Interviewees consisted of advanced and novice users, as well as smartphone owners and non-smartphone owners. Participants used to fly at least once per year to various destinations and reasons of travel varied.

Related data were gathered with combination of both short survey questionnaires and unstructured interviews with participants to assist us of their understanding and perspective towards online shopping and mobile flight booking. The questionnaire was designed to assess user's understanding and involvement of online shopping, extract their shopping patterns and collect their opinions in measurable way. Questionnaire had multiple choice questions of "Yes / No / Maybe", Likert scale questions which participants had to choose either one of "Strongly agree / Agree / Neutral / Disagree / Strongly disagree" and one open ended question. Likert scale answers were turned into numeric scores, which are: "Strongly disagree=1", "Disagree=2", "Neutral=3", "Agree=4" and "Strongly Agree=5". Frequencies and percentages were used for descriptive analysis.

The work was conducted in two steps and two interview sessions. First, interviewees were asked to complete a round-trip flight booking task with destination, origin, date of travel and number of passengers as their preference. Since the existing commercial application does not allow test purchases, interviewees were unable to proceed to the last page of purchase which is e-ticket information, instead they completed the given task until the last stage of ticket purchase, which is confirming payment details. Interviewees were also observed in natural manner during their execution of task.

The questionnaires were distributed to the interviewees after completing the given task. Answers of interviewees also were noted down during the interviews. After interviewing 20 participants, notes and questionnaire results were analyzed in parallel. Related literature review was conducted for reference and research findings related to flight travel, usability concerns of mobile applications, and user satisfaction criteria were utilized as guidelines. Other market applications that offer mobile flight booking service were also explored for benchmarking. Problem areas were detected and solutions have been extracted from previous research findings and benchmarking analysis.

Figure 2. A small segment of the questionnaire used

Second interview was conducted to obtain user's reaction towards the prototype that we built to eliminate problems that had been found in the first interview. Since prototype was built using a mock-up tool, user's reaction to it as working application had to be collected through a simulation. To simulate a working application, prototypes were cropped as pictures and transferred to the touch screen device. Same interviewees were asked to execute some tasks in problem areas and their reaction has been observed.

Lastly, interviewees were asked of their opinion of new design. Their answers were noted. No questionnaire was distributed for the second interview. Total time spent in gathering data for each interviewee took around 45 minutes for the first interview and 20 minutes for the second.

4. Method of Study and Outcomes

4.1. Questionnaires and Interview

Questionnaires were targeted to collect users' perception towards online shopping in general and eventually narrowed down to their travel patterns, such as flight booking mediums to frequency of travel. Participants' views of mobile flight booking over a case scenario and the assessment of their experience with the case application *FlyTurkish* are evaluated.

Qualitative survey has benefited the study thoroughly, because users had difficulty in figuring out what they liked or disliked in the application. As users do not look at the application from a designer's or researcher's point of view, their answers of overall liking or disliking were straightforward; however when it came to specific reasons of such opinion, users were required to provide further explanation and depiction. Interview method helped us observe users' reactions in their own context of use and enabled us to extract problem areas by investigating further over questionnaires. This case corroborates Arhippainen's argument of "*social and cultural factors and context of use are determinant on user's experience*" [15]. A sample small portion of our designed questionnaire is shown in Figure 2.
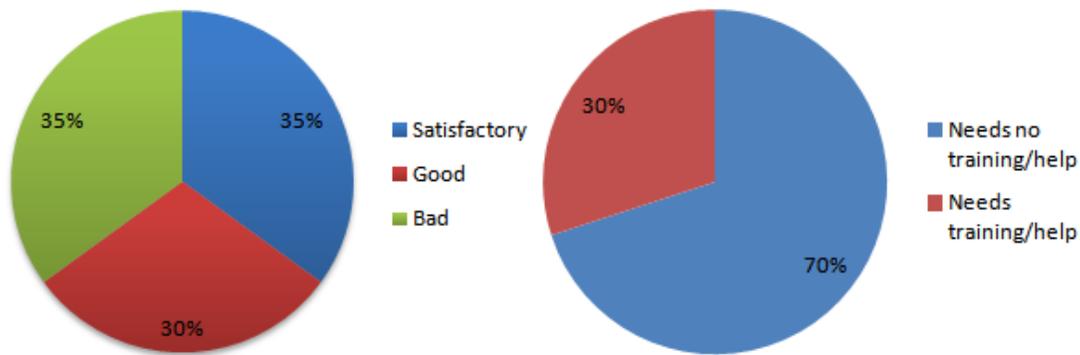
Figure 3. (left) About visual of the application. (right) About need for training or not

4.2. Analysis of the Collected Data

4.2.1. Internet Shopping and Online Flight Booking: The results had a parallel outcome to Nielsen's report in user's Internet shopping activities, showing 60% of activities are related to travel, of which 70% of the participants bought flight tickets online. 65% of the participants booked their flight via airline websites. In fact, airline websites were rated as the easiest way of buying ticket by 50% of the participants, followed by face-to-face interaction based airline office and travel agents. Mobile ticketing/GPRS (General Packet Radio Service)/WAP (Wireless Application Protocol) are considered as the second "*least preferable way of buying flight tickets*" with 25%, after Airline call centers 35%. Majority of interviewees with 75% also stated that they look for "*price*" primarily when buying flight tickets.

4.2.2. Smart Phone Ownership and Usage: Majority of the participants (80%) owned a smartphone in one of the following platforms: iPhone OS 35%, Android 30%, Blackberry 10% and Windows Mobile 5%. Although 87% of the smart phone owners have been using their smart phones for less than 2 years of period, more than half of them (56%) regarded themselves "*Advanced*" users. When users were asked about the applications they use the most, "*Facebook*" was rated the highest by 40%. More than half of the smartphone users (63%) had familiarity with mobile flight booking, as they at least searched or booked a flight using a mobile application such as Kayak, SkyScanner, AirAsia [20], *etc*.

Users were given the following scenario: "*You urgently need to book a flight ticket but you are out. You have Internet connection available on your phone. Would you use your phone to book your flight or go back home to book your ticket using PC/Notebook. Why?*" Majority of the interviewees by 65% preferred to book their flight tickets via PC or notebook even in urgent and exceptional cases, answering "No". The reasons of such preference fell under two categories, which are: "*convenience*" and "*security*", first being the primary reason!
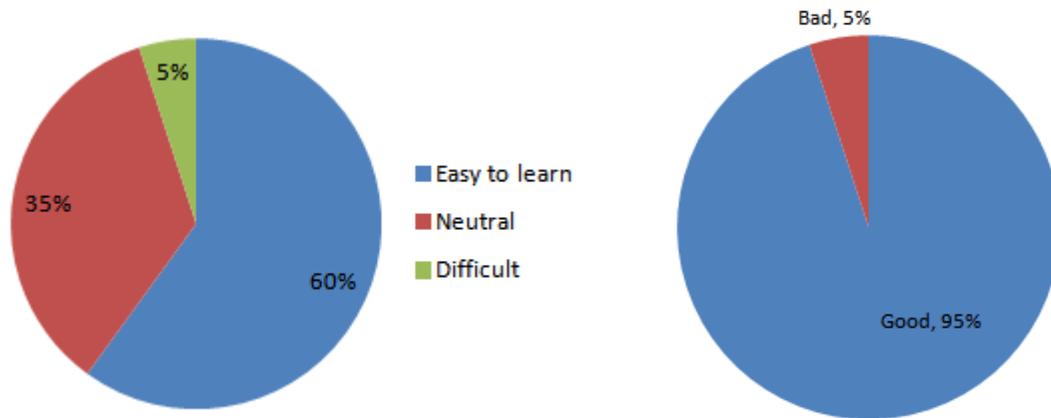
Figure 4. (left) About easiness to learn. (right) About speed and performance

4.2.3. Assessment of FlyTurkish Application: In general, participants expressed their opinions on the neutral or positive side for the look, ease of learning, performance and help of the application. 30% of the participants found the visual of the application good [Figure 3 (left)], while 35% rated as satisfactory. 70% of the users said that the application can be used without training or someone's help [Figure 3 (right)] and 60% (including 10% strongly agreed) found it easy to learn, followed by 35% as neutral [Figure 4 (left)]. Only 5% of the users rated the applications speed and performance "*bad*" [Figure 4 (right)]. 60% of the respondents agreed that the error messages were helpful to show what they did wrong [Figure 5 (left)] and 75% considered application's suggestions and prompts to use towards the right usage "*satisfactory/okay*" [Figure 5 (right)].
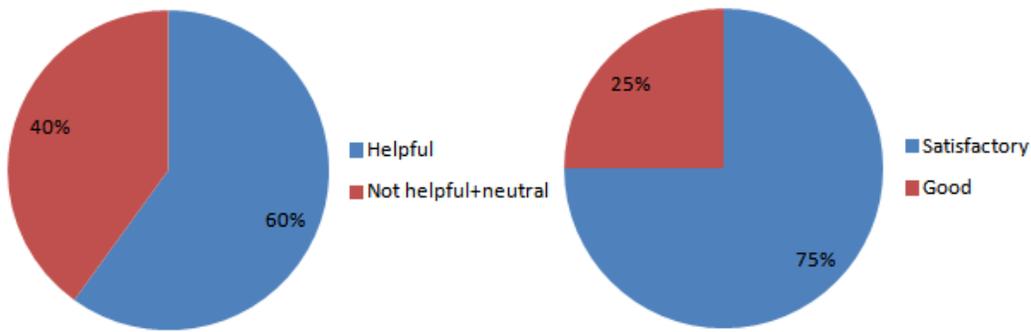
Figure 5. (left) About error message/alert. (right) About application's suggestions and prompts
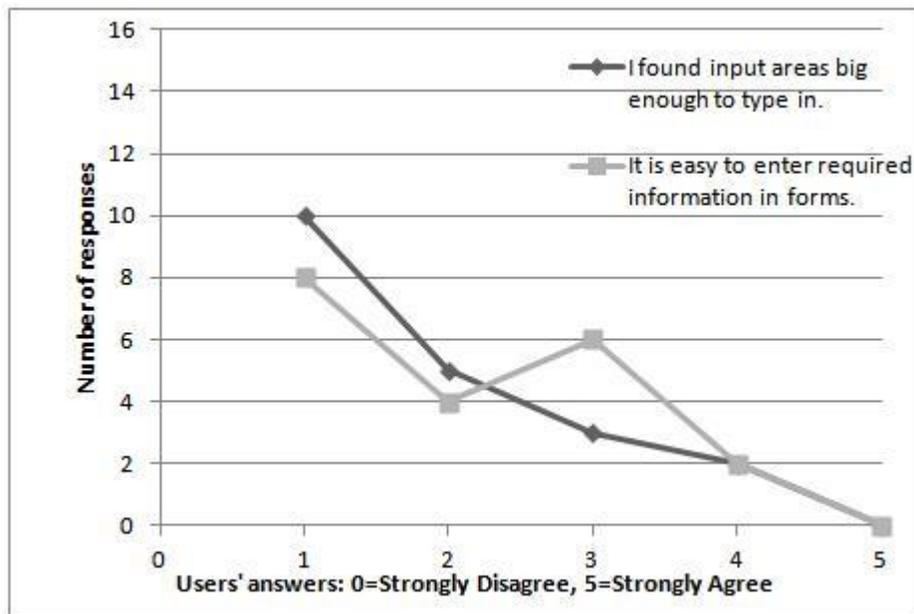
Figure 6. As input area decreases, easiness of entering information also decreases

However, respondents criticized the application in details. The study has shown that 45% of the respondents strongly did not find the calendar as visually satisfactory to select dates. Also 50% of the respondents did not get enough information of which step of the booking is being processed and how long the purchasing would take, with the mean value: 2.3. Half of the users did not find the application enjoyable to use and stated that application does not work the way that they want it to work.

Statistics also show dependence between input area size and easiness to type in information to those input fields (see Figure 6). It has been found a positive correlation between input area size and convenience to type required information in forms: as input area is found insufficient in size to type in, convenience of entering required information in forms also decreases. Among those participants surveyed, 60% encountered difficulty in entering information into input fields, while only 10% of all

had no difficulty. These data illustrate that input area size and how it is shaped are important to provide easiness in form filling.
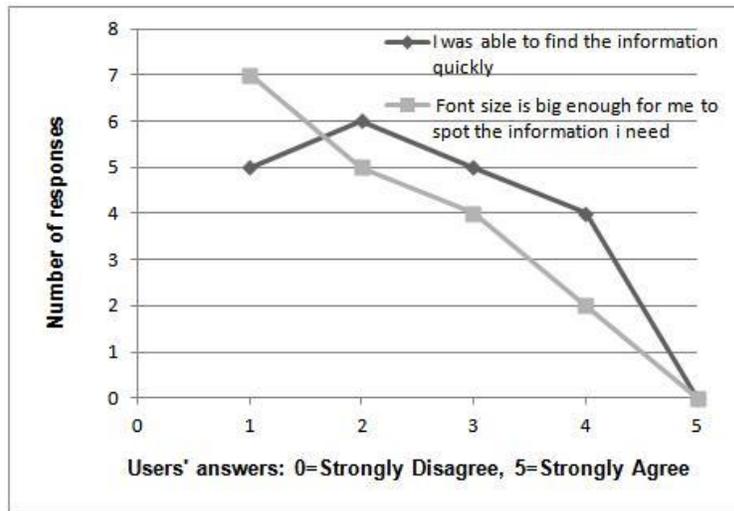
Figure 7. Font size and finding required information

Another interesting fact about the collected results is that there is a negative correlation between the time required for finding the information that is important to user and required font size to highlight needed information. When font size is not big enough to spot the important information, the time required for finding it increases (Figure 7). For example, in the case of flight details page, users were asked to rank information that is most important for them. With no exception, departure date/time, arrival date time, departure airport and arrival airport were selected as most important information that users seek for. 55% of the users found that font size is not big enough for them to spot the important information (with a mean=1.8). 35% of the users had difficulty in finding the information quickly, where the mean value was, $2.85 < Neutral(= 3)$. Correlation was questioned further in the second interview with recommended design prototype, and returned supporting answers from users, such as how highlighting the information with different styles (bold, increased font size, and differentiated color) enhance the noticeability of important information. 75% of the users also found the information not well-organized; as in the example flight information details and payment details (mean value of 2.25). Moreover, 80% of users disagreed that icons are clear to give the right information.

Easiness of finding how to proceed to the next page shows more significant association with user's level of familiarity (Novice or Advanced), comparing to the type of smartphone that they use. Novice users spent more time in figuring out what to do after each phase of flight booking, while advanced users knew better how to proceed after each step. However, different functions of the application were discovered by trial and error regardless of the level of user's familiarity, as it is stated by 40% of the respondents.

Half of the respondents opined that the steps of buying the ticket are straightforward and they easily understood what they were required to enter into the input fields. 40% of the respondents rated the application as not frustrating to use (mean value=$2.65 < Neutral$). Nevertheless, while the mean value of 3.1 has shown that users found the

application satisfactorily easy to use, 75% of the users still do not prefer to use *FlyTurkish* application to buy flight ticket.

5. Small-sized Interface Design Problems and Our Solutions

This section presents the main usability problems discovered during the analysis of the interviews and the questionnaires. The eight problem areas have been presented and discussed from user's perspective with following subsections and suggested solutions.

Figure 8. Mobile Ticket icon did not light up its meaning

5.1. Problem Area 1: Wrong Choice of Icons

As sometimes a picture is worth a thousand words, use of visual aids improves the time of completion of tasks and helps better understanding of presented information. Regardless of the screen type (touch screen or classic screens) icons are often used in place of information in order to save space in small screens of mobile gadgets. Therefore, the right choice of icon is a key to convey the right information. Our study has revealed the difficulty of understanding among interviewees about what some icons stand for. When main menu icons were covered along with the text below them and user was asked of what his/her understanding was, none of the users interviewed managed to make the right guess for some icons (Figure 8).

Recommendation and Solution - A clear, easy to understand and simple icon choice should be adopted to enhance user's perception of its meaning. Airline companies try to achieve uniformity by using the same icons between their web and mobile applications; however a consideration should be given to their use in small-screen resolutions. Icons that are clear to comprehend in big screens may not be clear after resizing to fit small mobile screens. This is a critical matter that is often ignored.

Figure 9. Misleading flight and calendar icons

5.2. Problem Area 2: Placement of Icons

Placement of icons is more important in mobile devices than web-pages, as users perception of icon's usage is closely related to its placement on the screen. Half of the interviewees thought the calendar icon in Figure 9 was to open calendar and tapped on it to select the date of flight.

Recommendation and Solution - To understand the root cause of such perception, icon's placement has been changed from top right corner to the top left corner next to the "Departure Date" and "Return Date". When same user was asked to choose the date, none of them attempted to tap on the icon. User's perception of linked icon and presentational icon are formed by the distance of icon from the text at the same level, and right-side placement. Interviewees perceived icon at the right side as a link to information whereas the icon on the left and next to text as complementary visual for text. Therefore, icons should be placed accordingly.

5.3. Problem Area 3: Redundancy of Steps in Completing Tasks

11 of 20 users found flight ticket booking process time consuming. Another problem arose when 3G connection was lost for a moment at the beginning of flight planning. User had to go back to the first menu and start over the planning. User was impatient and reluctant to complete given flight booking task.

Figure 10. Existing Flight Planning: Required data are collected in three steps

Existing *FlyTurkish* application collects flight planning information in three steps (see Figure 10) for domestic flights and two steps for international flights. User has to choose origin and departure and proceed to the next page that date of departure and -if round trip- return date is selected. Third page collects cabin type preference and the number of passengers. Lastly, at the fourth page, flight search results are returned. Inefficiency of collecting information resulted in dissatisfaction of users in preferring mobile application to book flight ticket over web-page.

Recommendation and Solution - Previous research works like [6, 17, 18], investigated factors affecting mobile phone users and found that mobile user profile is very different from web user profile in terms of unexpected user environment, unstable network connection and environmental distractions that interrupt process of completing a mobile task. Therefore, mobile flight booking steps should be reduced to minimum and should be organized with minimal attention requirements. In Figure 11, the steps of flight planning have been compacted to a single snapshot, through analysis of other market applications for flight booking and HCI guidelines. An increment in user satisfaction was noted in the second interview, which proves the efficiency of our solution.

5.4. Problem Area 4: Naming of Menus and Sections

Flight booking menu has been named as "*Mobile Ticket*" which was regarded as confusing for some of the users, especially novice users. For example, some users thought "Mobile ticket" as referring to movie ticket purchasing. Another user expected it for buying concert tickets.

Recommendation and Solution - Naming should be direct and clear to the purpose of the menu and the possible tasks could be carried with it. User's expectation of interactive application has also a determining factor on naming. Designers are advised to avoid long, passive and complex phrases. Instead of "Mobile Ticket", "Flight Search" or "Flight Booking", instead of "Flight planning", "Plan your flight", instead of merely "Destination", "Where do you want to go?" perceived by interviewees as if a

real-smart system was talking to them. Users perceive a "*talking*" system as interactive and rate it as pleasurable experience.

Figure 11. Flight Planning after optimization of steps of collecting data (for round trip): Our Solution

5.5. Problem Area 5: Uneasiness of Single Handed Use

As is the nature of mobility, people use their mobile phones *on-the-go*, mostly with scattered attention and controlling it with single hand. This situation leads reconsideration of design to help single handed use. All of the interviewees except two were right handed users. When users were asked to complete certain tasks with single hand, existing design revealed that single hand usage has not been in the design consideration during the application design. Users had difficulty due to placement of information and input fields. Changing the number of adult passengers was relatively difficult due to its placement "at the left", where interviewee used "right thumb" to navigate through the screen.

Recommendation and Solution – A good study is performed in [29], which may give the interested readers more information about touch key sizes and locations on one-handed thumb input on a mobile phone. As we have also found, if the feature requires getting inputs from user and needs selection, it is preferable to use right side arrangement. Figure 12 shows rearrangement of number of passenger selection after user interviews.
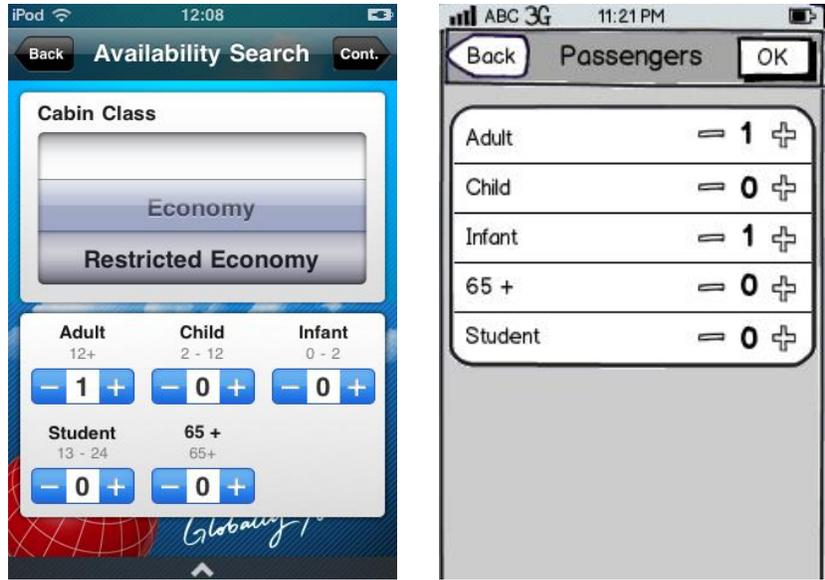
Figure 12. Comparison of passenger selection for one handed use. 1.Existing Selection (left) 2. Our Proposed Selection (right)
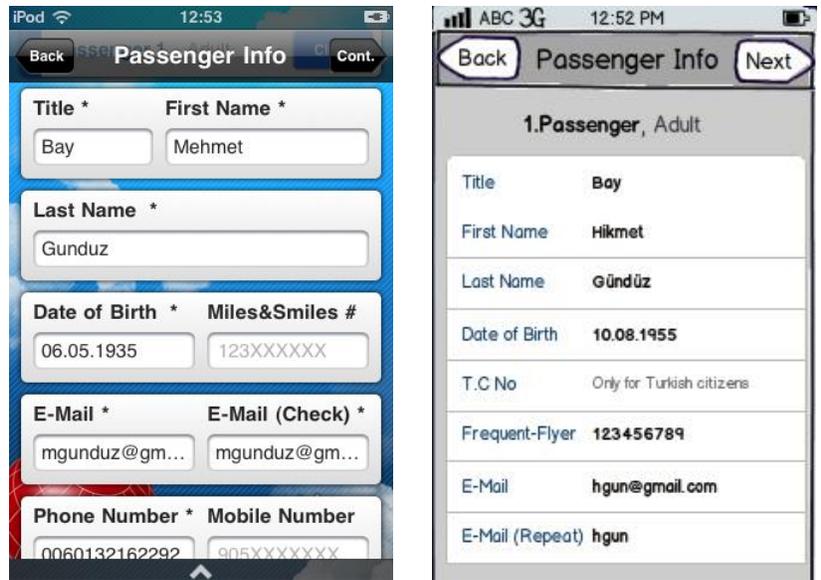
Figure 13. Comparison of passenger information form 1.Existing Form (left) 2. Proposed form (right)

5.6. Problem Area 6: Small and Disorganized Input Fields

Users had at least one to several attempts to enter information in input fields complaining its small size. Some users also found it exhausting to browse through passenger information form, due to its disorganized horizontal and vertical input fields.

Recommendation and Solution - In case of information collection, a consistent vertical form style should be adopted, in which user can easily expect the next entry at

one level below. Native contact information form of the mobile phone facilitates the data input because of user's familiarity with the form filling. iPhone's native contact form was adopted for the improvement of existing passenger information form. Especially, experienced users gave positive feedbacks as it increased their speed of entering the data and understanding of where to key in. Figure 13 shows the comparison of existing and suggested passenger information form.

Figure 14. Redesigned interface with bigger selection fields

5.7. Problem Area 7: Small Selection Fields

Most common problem that has been observed during interviewee's completion of flight booking was erroneous tapping due to small input or selection fields. Users had tendency to give up easily by no response to their action. Users also expressed that they would not try to use the application for a second time if they do not feel comfortable using it at their first trial.

Recommendation and Solution – The interface should be designed to minimize user mistakes. In consideration to touch screens, it should be achieved by enlarging selection fields that are suitable to user's finger-tip tapping. An improved example can be seen in redesigned flight planning (see Figure 14), with which users had no trouble of tapping into the right selection area, with approximate allocation of 64 pixels for destination and date selection fields and 44 pixels for cabin type and passenger selection fields. Mentioned measures were not based on any criteria other than creating enough space for users in order to prevent wrong selections. It can be suggested as reference point where users with variety of finger sizes had no trouble with.
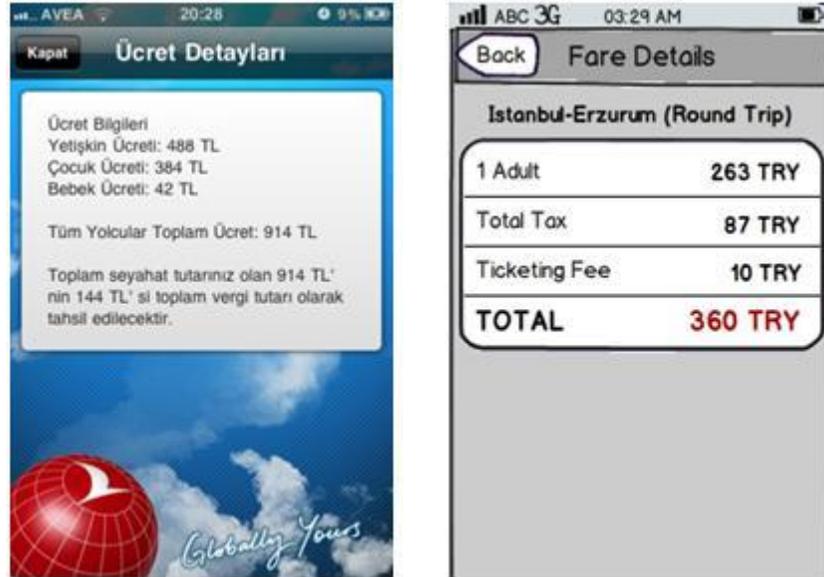
Figure 15. Comparison of payment information presentation 1. Existing (left) 2. Proposed (right)

5.8. Problem Area 8: Crowded and Disorganized Information Presentation

Last problem discovered through the experiments is the design of information presentation. User's difficulty has been observed in flight details section, which is one of the three sections that the most information has been displayed. Some of the users took quite long time on revising flight details section while some opined that the information is scattered and not comfortable to spot. Text size is also found to be small by users.

Recommendation and Solution - Existing mobile flight application uses text colors that are similar with background colors, which make the text difficult to read and differentiate those from other presented information. Important information such as date and time of travel, price of the flight ticket and passenger list are also not highlighted to get user's attention. Especially, in the context of mobile user, it is important to highlight most sought information since mobile users do not have time to review all the information (Figures 15, 16, 17). Text size should also be increased, considering the distance from user's eye while on the move. Adjustable text size function should be introduced as comfort factor.
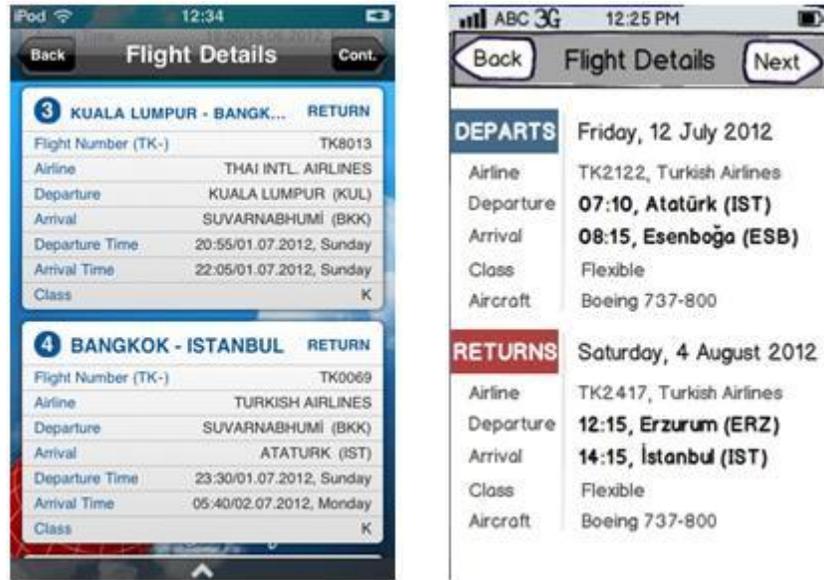
**Figure 16. Comparison of flight details presentation 1. Existing (left)
2. Proposed (right)**
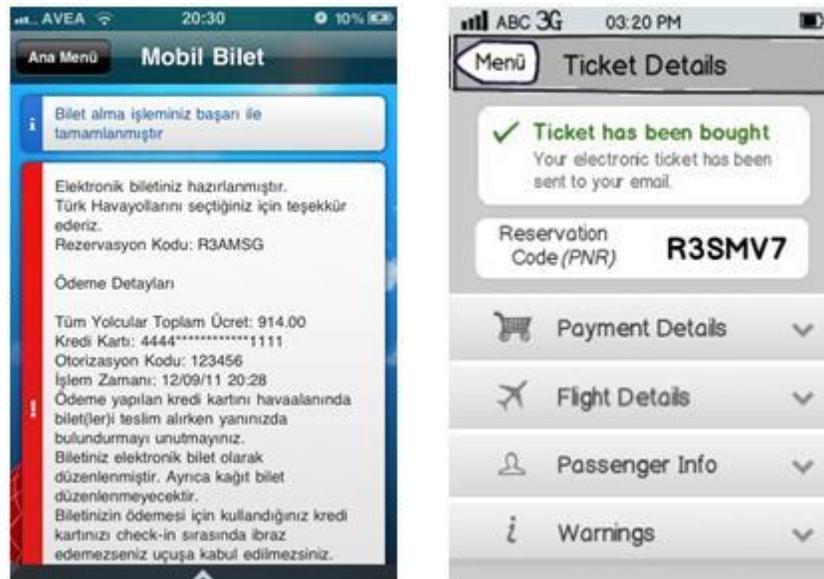
**Figure 17. Comparison of ticket details presentation 1. Existing (left)
2. Proposed (right)**

6. Discussion

Main findings in this study revealed that user's expectance is a complex matter which is not bounded only by usability. Moreover, components of usability that are "*Learnability*", "*Rememberability*", "*Efficiency of use*", "*Reliability in use*" and "*User Satisfaction*" arise as strongly interrelated attributes. As the study supports, user's perception towards the application and the satisfaction after the use of that application may show different results. Most of the users answered either neutrally or positively to

the first question in the questionnaire of "*Application is easy to use*". However, during the interview session, most of the subjects did typos in entering their information, tapped on the wrong sections, took time to find the information they needed and how to proceed. Similarly, many of the users stated that they explored the features by trial and error. Narrowing down the questions in particular details of the application revealed the application's "*not actually usable*" functions.

Another issue is regarding user's preference to use the mobile application over desktop-web flight booking. Although users found the application's look and speed favorable, satisfied with the easiness of steps in buying the flight ticket, easily navigated through the screen, clearly understood what they are required to enter the input fields and regarded error messages very helpful and clear in showing what they did wrong; all those qualities did not seem to be enough to draw the users to buy their flight tickets via mobile, even in urgent cases. The reason is the negligence of implementing usability that would be primarily concerned with the user. Users were satisfied with the use of application in pre-mentioned qualities, but 75% of the users did not prefer to book their flight tickets via mobile, indicating its difficulty in using, openness to mistype and lack-of security. Enabling the user to book their flight ticket with the minimum time and minimum effort would support application's favorability on-the-move.

Some of the users also questioned the advantage of buying the flight ticket via their mobile. When the functions are identically same with the web, mobile users tend to prefer flight booking via web. Users expect more personalized functions and more interactive services from their mobile flight booking application. This situation comes forward as another example that substantiates Jordan's study [4] on the effect of designing pleasurable products in attracting users.

7. Limitations of the Study

This work can be considered as a focused study in a particular context, in terms of the profile of the participants and the context that it had studied of. As participants were in mostly 20s and early 30s, their exposure to new technology, their expectation might differ from other age groups. Participants were also from different countries, which make this study not suitable to extract a particular cultural pattern for mobile flight booking use. The work excludes the improvement of the application's "*functions*". Functions for disable people, speech search, speech-to-text facilities, geo-locations services, personalized flight booking assistance have been omitted of this study due to its large complexity that will not fall under single work. In fact, the entire process took considerable time from collecting data to analyzing the data, then designing appropriate graphical interfaces for practical implementation. Usability improvements have been suggested based on certain assumptions: for right-handed use and reading/writing in left-to-right direction. The work also did not investigate the aspect of colors in the design, as perception of colors vary from culture to culture, from context to context. Usability problems and guidelines to eliminate such problems were given over a general picture.

8. Conclusion and Future Works

This paper has presented main challenging issues with regard to usability of mobile flight booking for small-sized touch-screen devices. Most of the discovered problems are of small input/selection fields and disorganized/unclear information presentation

that require more attention for mobile users who are often distracted by environmental and social factors. Error messages and suggestion from the application upon user's wrong selection or input is regarded highly helpful especially by novice users. All participants also agreed that simplicity of functions is important and *all-in-one* approach to application functionality is not welcomed in daily mobile usage, as they prefer to complete complex tasks on their PCs or notebooks.

The study also found that usability in design is not sufficient to achieve user's satisfaction. Interviewees expressed an important user expectation of mobile applications in which they enjoy more user-oriented and customizable applications rather than fixed-functionality applications. The sense of having mobile device in one's pocket brings more individual feelings towards the applications and services provided by mobile phone. Therefore, a typical flight booking application that offers functions of flight search and flight ticket booking is not intriguing for users. For example, users expect a smart system that will keep the itineraries of their flight dates, make helpful suggestions for travel route according to their personal preferences, detect their location and guide them through their favorite café shop or car rental in the airport. Further research works can be done to improve mobile flight booking experience by investigating feasibility of such handy features. Also, all the limitations mentioned in Section 7 could be considered to perform a relatively broader study that may reveal more useful information and aspects of the subject topic. The study basically verified the outcomes of some of the previous research findings on usability of web-page and mobile applications and brought small-sized touch-screen specific suggestions. We believe the results would be very useful if generalized and used by the mobile applications designers regardless of what kind of application is to be developed.

Though in our work, we took a particular application for performing all the experiments, other similar applications with graphical user interfaces would be directly benefitted from the recommendations. Based on our findings, practical implementation of the solutions is expected in the coming days.

Acknowledgements

References

[1] Nielsen, Trends in Online Shopping: a global Nielsen consumer report [online] 2008. Available at [Last accessed 07 January 2013]: http://at.nielsen.com/site/documents/GlobalOnlineShoppingReportFeb08.pdf, **(2008)**.

[2] "How US Smartphone and Tablet Owners Use Their Devices for Shopping | Nielsen Wire.," Global news and Insights from Nielsen [online], available at [Last accessed: 07 January 2013]: http://blog.nielsen.com/nielsenwire/online_mobile/how-us-smartphone-and-tablet-owners-use-their-devices-for-shopping/, **(2013)**.

[3] Oracle, "Mobile Trends: Consumer Views of Mobile ," [online] 2011, available at [Last accessed: 07 January 2013]: http://www.oracle.com/us/industries/%20communications/oracle-atg-mobile-wp-345770.pdf, **(2013)**.

[4] P. W. Jordan, "Human factors for pleasure in product use", Applied ergonomics, vol. 29, no. 1, **(1998)**, pp. 25-33.

[5] P. Cudd and R. Oskouie, "Combining HCI techniques for better user interfacing", IEE Colloquium on Interfaces-The Leading Edge, (Digest No. 1996/126), **(1996)**, pp. 11.

[6] P. Hertzog and M. Torrens, "Context-aware mobile assistants for optimal interaction: a prototype for supporting the business traveler", Proceedings of the 9th international conference on Intelligent user interfaces, Funchal, Portugal, **(2004)** January 13-16; pp. 256-258.

[7]   N. McNamara and J. Kirakowski, "Defining usability: quality of use or quality of experience?", Proceedings of International Professional Communication Conference, 2005 (IPCC'05), Limerick, Ireland, **(2005)** July 10-13, pp. 200-204.

[8]   C. Chariton and M. H. Choi, "User interface guidelines for enhancing usability of airline travel agency e-commerce web sites", CHI'02 extended abstracts on Human factors in computing systems, Minneapolis, MN, USA, **(2002)** April 20-25, pp. 676-677.

[9]   E. G. Nilsson, "Design patterns for user interface for mobile applications", Advances in Engineering Software, vol. 40, no. 12, **(2009)**, pp. 1318-1328.

[10] I. Burmistrov, "Mobile air ticket booking", European Conference on Cognitive Ergonomics: Designing beyond the Product--Understanding Activity and User Experience in Ubiquitous Environments, Helsinki, Finland, **(2009)** September 30 - October 02, p. 11.

[11] I. DIS, 9241-210 (2008): Ergonomics of human system interaction-Part 210: Human-centered design for interactive systems, International Organization for Standardization, Switzerland, **(2009)**.

[12] P. W. Jordan, "Designing Pleasurable Products", London: Taylor & Francis, USA, **(2000)**.

[13] F. Linghammar, "Usability and Aesthetics: is beautiful more usable?", Linkoping University, **(2007)**.

[14] D. Cyr, M. Head and A. Ivanov, "Design aesthetics leading to m-loyalty in mobile commerce", Information & Management, Elsevier, vol. 43, no. 8, **(2006)**, pp. 950-963.

[15] L. Arhippainen, "Capturing user experience for product design", Proceeding of the 26th Information Systems Research Seminar in Scandinavia, Porvoo, Finland, **(2003)**.

[16] N. Jakob, "Designing web usability: the practice of simplicity", ISBN:156205810X, New Riders Publishing Thousand Oaks, CA, USA, **(1999)**.

[17] A. Oulasvirta, S. Tamminen, V. Roto and J. Kuorelahti, "Interaction in 4-second bursts: the fragmented nature of attentional resources in mobile HCI", Proceedings of the SIGCHI conference on Human factors in computing systems, Portland, Oregon, USA, **(2005)** April 2-7, pp. 919-928.

[18] P. Tarasewich, "Designing mobile commerce applications", Communications of the ACM, vol. 46, no. 12, **(2003)**, pp. 57-60.

[19] A. -S. K. Pathan, M. M. Monowar and Z. M. Fadlullah, "Building Next-Generation Converged Networks: Theory and Practice", ISBN: 9781466507616, CRC Press, Taylor & Francis Group, USA, **(2013)**.

[20] F. Gündüz and A.-S.K. Pathan, "Usability Improvements for Touch-Screen Mobile Flight Booking Application: A Case Study", International Conference on Advanced Computer Science Applications and Technologies (ACSAT2012), Kuala Lumpur, Malaysia, **(2012)** November 26-28.

[21] S. Minocha, "A case study-based investigation of students' experiences with social software tools", New Review of Hypermedia and Multimedia, DOI: 10.1080/13614560903494320, vol. 15, no. 3, **(2009)**, pp. 245-265.

[22] F. Balagtas-Fernandez and H. Hussmann, "A Methodology and Framework to Simplify Usability Analysis of Mobile Applications", 2009 IEEE/ACM International Conference on Automated Software Engineering, Auckland, New Zealand, **(2009)** November 16-20, pp. 520-524.

[23] J. Buranatrived and P. Vickers, "An Investigation of the Impact of Mobile Phone and PDA Interfaces on the Usability of Mobile-Commerce Applications", 2002 IEEE 5th International Workshop on Networked Appliances, Liverpool, UK, **(2002)** October 30-31, pp. 90-95.

[24] E. Park, K.J. Kim and A. P. del Pobil, "Does Length Matter? A Study Examining How Length of Stylus Pen Helps Effective Electronic Documentation", 2011 4th International Conference on Interaction Sciences (ICIS), Busan, South Korea, **(2011)** August 16-18, pp. 185-188.

[25] N. Cooharojananone, P. Kongnim, A. Mongkolnut and O. Hitoshi, "Evaluation Study of Usability Factors on Mobile Payment Application on Two Different Service Providers in Thailand", 2012 IEEE/IPSJ 12th International Symposium on Applications and the Internet (SAINT), Izmir, Turkey, **(2012)** July 16-20, pp. 233-238.

[26] F. Nayebi, J.-M. Desharnais and A. Abran, "The State of the Art of Mobile Application Usability Evaluation", 2012 25th IEEE Canadian Conference on Electrical & Computer Engineering (CCECE), Montreal, Quebec, Canada, **(2012)** April 29-May 2, pp. 1-4.

[27] W. -C. Tsai, Y. -L. Ro, Y. -T. Chang and C. -F. Lee, "The Effects of Font Size and Page Presentation Method of E-Book Reading on Small Screens for Older Adults", C. Stephanidis (Ed.): Universal Access in HCI, Part III, HCII 2011, LNCS 6767, Springer Verlag, **(2011)**, pp. 94-101.

[28] M. B. López, J. Hannuksela, O. Silvén and M. Vehviläinen, "Interactive multi-frame reconstruction for mobile devices", Multimedia Tools and Applications, Springer, DOI 10.1007/s11042-012-1252-4, **(2012)** October.

[29] Y. S. Park and S. H. Han, "Touch key design for one-handed thumb interaction with a mobile phone: Effects of touch key size and touch key location", International Journal of Industrial Ergonomics, vol. 40, no. 1, **(2010)** January, pp. 68-76.

Authors

Feyza Gündüz received her B.Sc. degree in Computer Science from Kulliyyah (Faculty) of Information and Communication Technology, International Islamic University Malaysia (IIUM), Malaysia in 2012. Her research interest includes Mobile applications, Interface design, Human Computer Interaction. She is currently in the process of enrolling for her higher studies.

Al-Sakib Khan Pathan received Ph.D. degree in Computer Engineering in 2009 from Kyung Hee University, South Korea. He received B.Sc. degree in Computer Science and Information Technology from Islamic University of Technology (IUT), Bangladesh in 2003. He is currently an Assistant Professor at Computer Science department in International Islamic University Malaysia (IIUM), Malaysia. Till June 2010, he served as an Assistant Professor at Computer Science and Engineering department in BRAC University, Bangladesh. Prior to holding this position, he worked as a Researcher at Networking Lab, Kyung Hee University, South Korea till August 2009. His research interest includes wireless sensor networks, network security, and e-services technologies. He is a recipient of several awards/best paper awards and has several publications in these areas. He has served as a Chair, Organizing Committee Member, and Technical Program Committee member in numerous international conferences/workshops like HPCS, ICA3PP, IWCMC, VTC, HPCC, IDCS, etc. He is currently serving as the Editor-in-Chief of IJIDCS, an Area Editor of IJCNIS, Editor of IJCSE, Inderscience, Associate Editor of IASTED/ACTA Press IJCA and CCS, Guest Editor of some special issues of top-ranked journals, and Editor/Author of 9 books. He also serves as a referee of some renowned journals. He is a member of Institute of Electrical and Electronics Engineers (IEEE), USA; IEEE Communications Society, USA; IEEE ComSoc Bangladesh Chapter, and several other international professional organizations.