



A Usability Evaluation of M-commerce Apps

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Abstract: In today's era, Internet has become an increasingly popular technology globally. Huge numbers of websites and applications have been developed and majority of them are selling products over the internet. Even with the availability of a large number of M-commerce applications, still the target audiences of these M-commerce applications such as students, office employees, housewives, who need a mobile application to do their online shopping, are not using them efficiently due to usability issues encountered at user interfaces of m-commerce applications. This is because of poor interface design along with neglected usability guidelines that are provided by various researchers and essentially followed by standardize companies like Apple and Google. Therefore, it is highly recommended that the interface of such a system should be explored through different stakeholders by considering numerous parameters and criteria. To tackle UX/UI problems well, this study is conducted to aim the usability improvement of m-commerce applications and for the same, two popular applications, Daraz and Elo, is selected by considering current download rate and positive reviews. They are considered as top ranked m-commerce applications, working successfully in Pakistan for the year 2020. However, some usability problems were noticed for these Apps and were reported in the reviews of the application too. So, these problems are addressed and targeted to filter out the most significant issues in usability. The methodology used for evaluation and analysis of the currently available m-commerce applications was heuristic evaluation (from expert users) and user testing (from novice users) based upon the integrated usability guidelines proposed by different usability experts. The research finding concluded the three significant criteria which are error prevention, aesthetic and minimalist design, and help & documentation. Further, different decision making techniques will be applied to attain user satisfied m-commerce platforms through prototype design in near future.

Keywords: Usability; UX/UI; User Testing; Novice Users;

I. INTRODUCTION

Online Shopping is significantly popular phenomenon globally where retailers sell their products on the internet. Due to enhancement in information technology and economic globalization, e-shopping has become an emerging trend in business development in local as well as foreign trade. Electronic commerce (e-commerce) is rapidly flourishing day by day [1]. In daily life, we mostly depend on recommendations from friends for reading books, novels, and watching movies. People like to buy products online through friend suggestions by using various websites and applications [2]. Such platforms uses standardize system as an additional tool to increase sales and also satisfy the customers as per their needs. A recommender system is a web technology which helps the customers for online shopping with the good decision in m-commerce platforms. Many authors defined e-commerce in different ways. Electronic commerce is an emerging concept in which buying and selling products is done online. There are many types of e-commerce such as business to business (B2B), business to customers(B2C), customer to customer(C2C) [3]. Human-Computer interaction (HCI) is a field that enhances the interaction between human and computer through usability guidelines. HCI makes the system easy to use, learn and understand.

Usability relies on multiple attributes to make the system more useful. There are different ways to measure these usability attributes. HCI provides numerous methods to evaluate usability issues in the user interface of the system such as user-based, Experts based, and tool base methods[4].

Mobile users are increasing very rapidly and statistics of mobile usage indicated that in 2020 mobile users will reach 2.87 billion users annually [4]. Mobile commerce transactions will also reach 1 billion in the end of year 2020. End-users use mobile devices for different purposes like marketing, banking, ticketing, social activities, and especially for online shopping [5].

M-commerce is rapidly becoming a new form of trade. Mostly, customers view the product price, quality features, and specifications on m-commerce platforms before buying a product. E-commerce transactions have reached 3.53 trillion U.S dollars worldwide. E-commerce sales revenues are estimated to grow by up to 6.54 trillion U.S dollars in 2022 [6]. According to a global digital report, there are 4.39 billion internet users in 2019. E-commerce usability is much important because unusable websites and apps will lead buyers to leave these websites and apps and eventually loss of the e-business. Nielsen, who is the founder of usability, stated that 40% of repeat visits of customers don't visit it with please who initially had bad experience with the sites and

apps. Research estimates that bad web design will result in an approximate loss of 50 percent of potential sales from customers who cannot find exactly for what they want on the sites or apps [7].

From the customer's point of view, an M-commerce platform also depends on usability factors which are beyond the accuracy of the algorithm or the software. It also depends on how the users interact with it effectively. The finding of this study will contribute towards e buying and selling for both e-commerce retailers and customers. For customers, the benefits include higher efficiency in finding wanted items, more confidence in making a purchase decision, and the potential to discover something new. For e-commerce retailers, this technology can significantly enhance the overall revenue.

The research and design community related to these m-commerce apps must take into consideration some guidelines in an array to craft technology accessible to the all ages, despite of any gender and race. By captivating this perspective in mind, this study is conducted to discover that whether m-commerce apps are accessible to the general public, office workers and IT specialists to fulfill their needs or not. M-commerce applications are used by customers for buying and selling products over the internet. They faced UX/UI issues when used on personal cell phones. Cell phones have inherited limitations like small screen size, limited input mechanism, display resolution, etc. Also, they have huge variations in different brands and all have provided different usability guidelines to their developers for making cell phone applications. According to the end-users point of view, the design of the interface of the mobile application is one of the most essential components. It is a place that the main interaction with the application will occur. In a broad sense, the problem can be described that how to increase usability for an m-commerce applications interface for cell phone users based on usability guidelines [8]. A large number of m-commerce applications are lacking usability guidelines as provided by ISO and other usability experts like Jacob Neilson and others. There is a need to redesign these application's interface to propose a new design which is based upon integrated heuristic guidelines provided by different mobile brands and usability experts [9]. To achieve this objective, it is important to assess the usability problems of the m-commerce application's user interface by selecting any prioritizing technique which is previously used efficiently and proved its successfulness in similar domain of research studies.

II. LITERATURE REVIEW

This part covers up the literature review about enhancing the usability of m-commerce applications by using usability evaluation techniques.

M-commerce is the extension of the e-commerce field. M-commerce can be defined as a monetary transaction that takes place to buy or sell products using wireless mobile devices. A mobile device has wireless fidelity technology which provides mobility to end-users. The Internet has become increasingly

popular all over the world nowadays. A lot of websites and apps have been built and used for buying and selling products over the internet like amazon.cm, alibaba.com, and many more. M-commerce is a quickly emerging field as compare to e-commerce [10].

Many authors have defined usability in many ways. Usability is the name of ease of use and learnability of products. Usability means how quickly users use a product and learn it the first time. International organization for standardization (ISO) defined usability as: "The degree to which any software product can be used for achieving specific goals by specific users in the specific context of use with efficiency, effectiveness, and satisfaction. **ISO** gives three attributes for usability [11].

- **Efficiency:** How quickly the user can perform your task using the product.
- **Effectiveness:** How quickly the user completes your tasks with less error action.
- **Satisfaction:** How many users enjoy/ pleasant with the product when it is used.

Condos proposed usability factors such as navigation, Contents, information Architecture, Error prevention, and Menu Visualization. Quim Model also proposed usability factors as Trustfulness, Accessibility, and Usefulness. Nielsen is called the father of usability. Nielsen describes the five usability attributes [12] which are:

- **Learnability:** How easily users learn product tasks when it's used for the first time to perform any task.
- **Memorability:** How much difficult for users is to again perform the same task after a period of time after leaving the system.
- **Efficiency:** How quickly the user can perform a task while using the system.
- **Error rate:** What is the error rate ratio of the product? What is the error condition?
- **Satisfaction:** How much user is pleasant when he is using the design?

Some of the usability models are mentioned in Table 1 that are used to make the product more usable. ISO 9241-11 described usability in terms of achieving the specific goals in a specific context of an environment with efficiency, effectiveness, and satisfaction [13, 16]. Similarly, Jacob Nielsen proposed five usability attributes for achieving usability goals. Jacob Nielsen's attributes described usability in terms of overall system acceptability [14, 15, 17]. Moreover, Condos also proposed usability factors such as navigation, Contents, information Architecture, Error prevention, and Menu Visualization. Quim Model also proposed usability factors Trustfulness, Accessibility, and Usefulness.

TABLE I. USABILITY EVALUATION MODELS

Usability Guidelines	Usability Factors
ISO 9241-11 [16]	Efficiency, effectiveness, Satisfaction
Nielsen [17]	Learnability, Memorability, Satisfaction, Error Rate, Efficiency
Condos [18]	Navigation, Contents, information Architecture, Error Prevention, Presentation, Menu visualization, Input rate, and Menu visualization
Baharuddin [19]	Effectiveness, Efficiency, Satisfaction, Usefulness, Aesthetic, Learnability, Simplicity, Intuitiveness, Understandable and Attractiveness
QUIM Model [20]	Efficiency, Effectiveness, Productivity, Satisfaction, Learnability, Safety, Trustfulness, Accessibility, Universality, and Usefulness

Usability evaluation means measuring the degree of product or software functionality and interface in terms of ease of use for end-users. By using usability evaluation methods, we can identify usability issues in the product interface. Sunday, Ariyo, and Ajibola proposed different usability evaluation methods for mobile applications in their research studies. Usability evaluation can be executed at any respect levels inside the software development life cycle. Usability evaluation is divided into two parts in the software development life cycle. The formative evaluation takes place from the requirement stage to the implementation stage of the product. The summative assessment happens after the implementation stage of the system. A summative evaluation is performed on the final product after released for commercial purposes [21].

Usability evaluation methods are classified into three major categories based on users, models, and experts. The user-based evaluation method is the one in which real users of the system are involved to assess the usability of the system. On the other hand, expert-based evaluation methods are those in which expert users of the system are used to identify the usability issues in product interface based on usability guidelines. Expert users know usability guidelines which are proposed by different researchers in their studies. Similarly, Model-based evaluation methods are based on the psychological prediction of a user’s performance on given tasks in the product interface. These methods are less used to evaluate the usability of the system interface. GOMS is such a type of model in which calculates user’s time on specific tasks [22].

Reza khajouei, Misagh, and Yunes mentioned different usability evaluation methods in detail methodology framework with pros and cons in their research studies. Heuristic evaluation involves experts to assess the usability of the product interface. Experts should have experience with usability guidelines which are given by different authors in their research studies [23].

Experts validate each interface element according to usability guidelines. Experts write down violations of usability guidelines during the assessment of the product interface. In the Cognitive walkthrough method, experts are

involving the assessment of the product interface. They have performed set of tasks in the cognitive walkthrough and asked four questions during performing tasks. User testing is a method in which real users of the system performs tasks to measure usability in terms of efficiency, effectiveness, and satisfaction [23].

Heuristic Evaluation is a widely used usability technique to find out usability problems in the m-commerce application interface and for the same, it is used actively in previous research studies. Heuristic Evaluation uses three to five experts to assess the user interface of mobile commerce applications. There is no involvement of real users in heuristic evaluation. Expert users know usability guidelines which are proposed by different researchers in their studies. Nielsen’s Heuristic Evaluation is a technique to test the usability in which one or more than one usability specialists examine the user interface of a website concerning a set of Heuristics. A heuristic evaluation is a fast and less expensive way to evaluate the interface of your website [24]. Ten heuristics originated by Nielsen are the famous heuristics:

- 1) *Visibility of system status*
- 2) *Match between system and the real world*
- 3) *User control and freedom*
- 4) *Consistency and standards*
- 5) *Error prevention*
- 6) *Recognition rather than recall*
- 7) *Flexibility and efficiency of use*
- 8) *Aesthetic and minimalist design*
- 9) *Help users recognize, diagnose, and recover from errors*
- 10) *Help and documentation*

User testing is also called performance measurement. In this technique, end users are involved to evaluate the usability metrics' effectiveness, efficiency, and satisfaction. Different tasks are given to end-users. End users can be novice, intermediate, and experts. We can use think aloud and questionnaire methods to identify the most important usability issues. Using this method, we can calculate the success rate of completion tasks done by the end-users.

User experience (UX) is the overall users experience with the system interface. UX improves the quality of the user’s interaction with the system. UX designers have skills in research strategies [27]. The three attributes can better clarify the UX; firstly, the primary one is the holistic individual of UX like What is supposed through holistic nature is that UX envelops an expansive scope of characteristics and includes not just the visual, cloth, sound-related components of the framework but additionally how the framework functions beneath a suitable use condition or placing. The second characteristic is that the UX middle is vigorously tilted toward the purchaser's point of view. UX is regularly misunderstood for UI, as their abbreviations are comparable. UI tends to tilt in the direction of nine computer facet, and UI critiques are regularly subjected to quantitative measurement

or usability checking out. UX, in comparison, issues how users reflect, revel in, and act. The third attribute is that UX has premeditated well worth inside the development of an intended product. UX has currently emerged as a vital situation for the pinnacle executives of the arena due to its tremendous significance [25, 26].

The user interface (UI) is a system interface that is used for interaction with the system. UI is a visual representation of menus, buttons, icons, and contents. It is likewise the path by which a user/consumer interfaces with an application or a site. Despite the application, the intention of a good quality UI should be on usability that is user-friendly for the users. If all things considered, we apprehend that how baffling it may be to utilize a gadget that doesn't work the way in which we need it to respond [27].

It was necessary to define exclusion and inclusion criteria for conducting most relevant literatures. An inclusion and exclusion criterion is based on our key research questions. The evaluation of selected studies is based on the criteria mentioned in Table 2.

TABLE II. INCLUSION AND EXCLUSION CRITERIA FOR RELEVANT LITERATURE

Inclusion Criteria	Exclusion Criteria
Directly related to Usability evaluation of M-commerce applications.	Irrelevant to Usability evaluation of M-commerce applications.

III. METHODOLOGY

It includes the details of the selection of two m-commerce applications from the play store and app store, procedure, and evaluation through an integrated heuristic approach and user testing. Previous studies indicate that heuristic and user testing approaches are most commonly used methods in evaluating the usability of m-commerce applications. Moreover, usability is an approach to figure out effectiveness, efficiency and satisfaction. Heuristic evaluation is quick technique to identify the UX/UI issues in user interface of m-commerce applications; based on established heuristics. Many authors have defined usability in many ways. Usability is the name of ease of use and learnability of products. Usability means how quickly users use a product and learn to use it for the first time. International organization for standardization (ISO) defined usability as: “The degree to which any software product can be used for achieving specific goals by specific users in the specific context of use with efficiency, effectiveness, and satisfaction [14].

The first step is to select m-commerce applications for usability evaluation. For this purpose, top ten m-commerce

applications were reviewed on the app store and play store, and two of the m-commerce applications with the highest installations, reviews, and ratings for Pakistani users were selected for study.

The objective of this study is the evaluation of the usability of m-commerce applications to improve the m-commerce application design for enhancement of usability. Heuristic Evaluation is a widely used usability technique to find out usability problems in the m-commerce application interface in previous research studies. Heuristic Evaluation uses three to five experts to assess the user interface of m-commerce applications. There is no involvement of real users in heuristic evaluation. Expert users know usability guidelines which are proposed by different researchers in their studies.

Nielsen’s Heuristic Evaluation Technique is a technique to test the usability in which one or more than one usability specialist examines the user interface of a website through a set of Heuristics. A heuristic evaluation is a fast and less expensive way to evaluate the interface of your website.

A. Nielsen’s Heuristic Guidelines

Nielsen’s Heuristic Evaluation Technique is a technique to test the usability in which one or more than one usability specialist examines the user interface of a website through a set of Heuristics. A heuristic evaluation is a fast and less expensive way to evaluate the interface of your website [24]. Ten famous heuristics originated by Nielsen are:

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- 8) *Aesthetic and minimalist design*
- 9) *Help users recognize, diagnose, and recover from errors*
- 10) *Help and documentation*

B. Apple Usability Guidelines

Apple Company has also proposed usability guidelines for mobile applications. They guided application developers to follow usability heuristics of user control and consistency, in particular, while developing IOS Applications.

C. Google or Android Usability Guidelines

Google Company also developed usability guidelines for mobile applications. There are three main reasons behind these usability guidelines. Firstly, all mobile devices have inherited limitations. Secondly, there is a lot of variability in different mobile brands. Lastly, each company follow its own standards and policies. Most common usability heuristics for Android users are information hierarchy, structure, dynamic engagement, and visibility.

D. Integrated Heuristic Approach

To evaluate the usability of m-commerce applications, we will use an integrated usability heuristics approach. There are three main reasons for the adoption of an integrated heuristics approach to evaluate mobile applications. First, there is a huge variability of cell phones of different brands. Second, different cell phone brands have inherited limitations. Lastly, the most important reason is that every cell phone company offers usability guidelines for mobile applications. These integrated usability heuristic approaches identify usability issues on the top two m-commerce applications[28].

User testing is also called performance measurement. In this technique, end users are involved to evaluate the usability metrics' effectiveness, efficiency, and satisfaction. Different tasks are given to end-users. End users can be novice, intermediate, and experts. We can use think aloud and questionnaire methods to identify the most important usability issues. Using this method, we can calculate the success rate of completion tasks by end-users [29].

Success rate = completion tasks + half tasks * 0.5 / Total Number of tasks.

In this evaluation method, direct end-users are involved in testing the system. It is the best way to detect usability issues in the system because both experts and novice users are involved in this testing.

If actual users' suggestions, opinions, and feedback are involved in building a new interface/design for a product then it is called Participatory design. As in this study, both experts and novice users are the participants to identify issues in m-commerce apps, so, the end product interface would be a participatory design based on the analysis of the questionnaire filled by 26 novice users and 4 expert users. For expert, different IT offices were visited. We selected 4 experts that had good experience of these applications, HCI theories, research and industrial experience. Moreover, a training session was also given to the experts on usability guidelines. After this process, 26 novice users from different field of life were selected for the novice user's evaluation of m-commerce applications. Research aim was explained to all of them. All these 26 novice users were from IT background and they were having experience of using different mobile applications. The idea of choosing both experienced and novice users was to measure the difference in performance in these two groups. We concentrated our research to evaluate usability issues by the users. Table 3 below depicts the steps involved in the research.

TABLE III. WORK METHODOLOGY PHASE WISE STEPS

Enhancing the Usability of M-commerce Apps by using Heuristic and User Testing based on Integrated Heuristic Guidelines
Phase 1-Step 1
➤ Selection of Two M-commerce Apps; Draz.pk, Elo.com (Based on Reviews, Installation, and Rating).

Phase 1-Step 2
➤ Usability Evaluation of M-commerce apps by Expert and Novice Users.

To collect the feedback from experts on heuristic evaluation, a questionnaire was distributed and asked the experts to rank each usability violation based on the result statement according to Nielsen's severity ranking scale as mentioned in Table 4. The questionnaire that researcher have made was based on 13 usability heuristics guidelines for novice user testing and heuristic evaluation adopted from previously research studies [30, 32]. These Integrated Heuristics are mentioned in Table 5.

TABLE IV. NIELSEN'S SEVERITY RATING SCALE

Rank [0-4]	Definition
0	Not any Usability Problem
1	Only Cosmetic Usability Problem
2	Minor Usability Issues
3	Major Usability Issues
4	Usability catastrophe

TABLE V. SELECTIED INTEGRATED USABILITY HEURISTICS

Heuristic Usability Rule	Definition
NH1: Visibility of system status and content	The system should always inform users about what is going on, within reasonable time, using proper feedback.
NH2: Match between system and real world	The system should use the user's language with words, phrases that are much familiar by end-users not by system-oriented words, and phrases language.
NH3: User control and freedom	The system should provide the user's facilities to make their strategies for undo and redo activities rather than the systems do for them.
NH4: Consistency and Standards	The system should follow platform convention and users should not have to worry about different words, actions, and styles.
NH5: Error Prevention	The system should alert the user when he is doing some mistakes through pop up and prevent errors.
NH6: Recognition rather than recall	The system should provide options, objects, and actions visible to users. A user does not need to remember again these things. The system should reduce the memory load on users by providing suggestions.
NH7: Flexibility and efficiency of use	The system should provide extra advanced options to expert users according to their demands.

NH8: Aesthetic and minimalist design	The system should always provide relevant information, according to user needs, on the interface rather than irrelevant information.
NH10: Help users recognize, diagnose and recover from error	The system should always show errors in human-readable language rather than in machine code like 404 errors.
GH1: Dynamic Engagement	The app should provide facility users to engage with other apps, services, and users in two-way communications.
GH2: Information and visual hierarchy	The mobile app should display visual objects and information in a hierarchy order based on the user's function of sorting, searching, and swiping, etc.
AH1: Natural-Interaction	The mobile app should utilize the hardware and software capabilities for application gestures like a pinch.

To conduct a heuristic evaluation, two heuristic evaluation approaches were selected; first is Task-based Analysis and the second one is Free-Flow.

1) *Tasks based Approach:*

In this approach, each expert performs predefined tasks to evaluate the user interface of the system according to heuristic guidelines checklists.

2) *Free-Flow Approach:*

In this approach, each expert has already inspected the user interfaces of the system several times by using the heuristic checklist which is provided by Jacob Nielsen, Google Android Company, and Apple Company. So, each expert is free to hand to evaluate every part of the system by using heuristic guidelines and find out issues in it for further improvement [35].

Usability of m-commerce apps depends upon the sign up, login page, search product page and checkout process flow pages. In this study, task based approach is used to assess the usability of specific pages of m-commerce apps[30-32]. There are five tasks that we used to evaluate the Usability problems in m-commerce applications.

- a) *Assert the registration process to create an account and sign in to the application.*
- b) *Update your profile information.*
- c) *Adds funds: Add money into your wallet by any method.*
- d) *Search watch and add to cart: Search out the product, add the product to cart, and continue shopping.*
- e) *Find a technical solution to the problem: Find some technical help on any topic.*

f) *Add payment method: Check out the products and adds payment methods to successfully place an order.*

In Heuristic Evaluation, each usability experts assess the interface of the system alone and find out the usability issues in the system. Usability experts give the rate of each usability issue according to the Nielsen severity rating scale. Each expert user evaluates the user interface of the m-commerce applications by using the above mentioned usability heuristics and eventually problems were noted by each expert. In the post-evaluation meeting, expert evaluators meet with each other and rate the severity of usability issues applying the Nielsen severity ranking scale, which is mentioned below in Table 6. In this meeting, each expert unanimously agrees on the usability problems, category and its severity rank. The severity of the problem depends on the occurrence of the problems. Moreover, issues were categorized by the expert evaluators on the basis of this severity and occurrence basis on occurrence scale.

TABLE VI. NIELSON'S SEVERITY RATING SCALE

Rating	Description
0	This doesn't seem a usability issue.
1	Cosmetic issue. Fixed this problem when you have buffer time in your project timeline
2	Minor issue. Fixed this issue on low priority.
3	Major issue. Fixed this issue on high priority.
4	Catastrophic issue. Fixed this issue before product release.

IV. RESULTS

Two expert evaluators, who are working as Software Quality Assurance Engineer and Team Lead Developer, highlighted the problems experienced in draz.pk m-commerce app based on severity and provided solutions to resolve the problems in the current interface of m-commerce applications. Table 7 below mentions the usability issues founded by the experts collectively for the draz.pk m-commerce application. Table 7 highlights the detailed qualitative results after an assessment of the user interface of draz.pk by using above mentioned usability heuristics.

TABLE VII. SEVERITY RATE OF ERROR ACCORDING TO INTEGRATED HEURISTIC EVALUATION

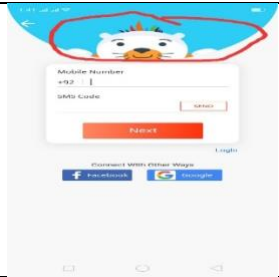
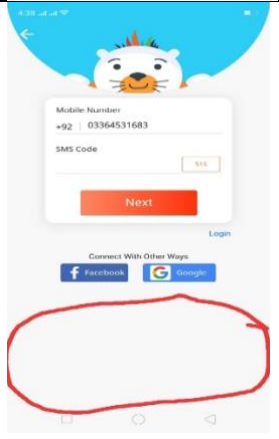
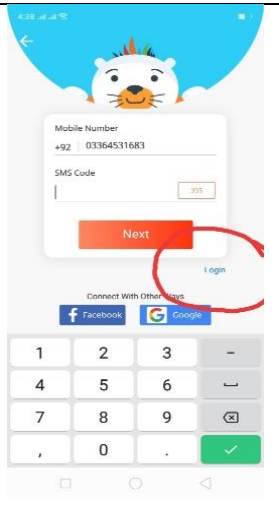
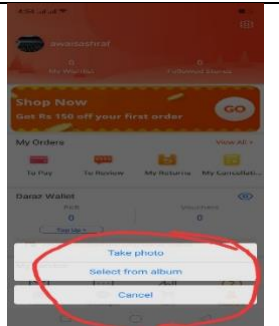
Integrated Usability Heuristics	Draz.pk M-Commerce Application
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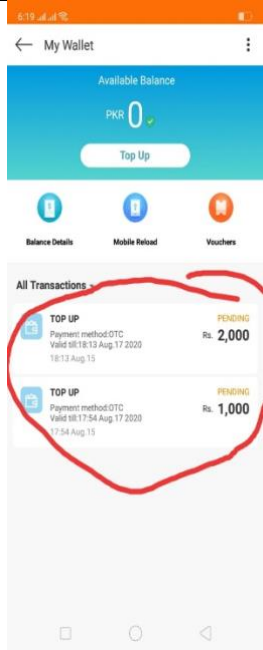
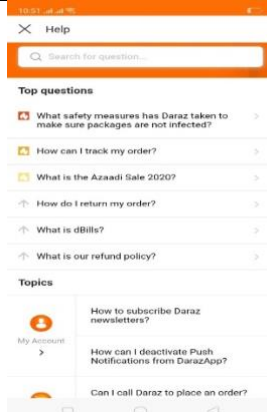
	0	1	2	3	4	Total
1. Visibility of system status	0	0	2	2	0	4
2. Match between system and real world	0	0	1	1	0	2
3. User control and freedom	1	0	1	1	0	3
4. Consistency and standard	0	1	1	0	0	2
5. Error prevention	0	0	0	2	0	2
6. Recognition rather than recall	0	1	0	0	0	1
7. Flexibility and efficiency to use	0	0	1	2	0	3
8. Aesthetic and minimalist design	0	1	0	3	0	4
9. Helps user recognize, diagnose and recover from errors	0	0	1	0	0	1
10. Help and Documentation	1	1	1	0	0	3
11. Dynamic Engagement	0	1	0	0	0	1
12. Information and visual hierarchy	0	0	2	0	0	2
13. Natural interaction	1	0	0	0	0	1
	3	5	10	11	0	29
	10.34%	17.24%	34.48%	37.93%	0%	


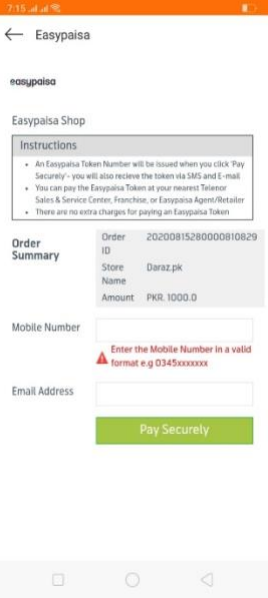

This Detailed expert evaluation shows the collective result of two expert evaluators on draz.pk. They have found a total of 29 issues in draz.pk m-commerce application. In these 29 issues, only 12 were major issues which make 37.93% of the total found issues while 10 were minor issues that make 34.48% of the total issues founded by the experts. Major issues percentage 37.93% makes it


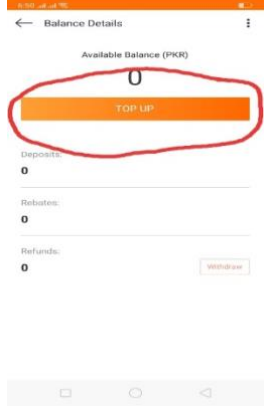

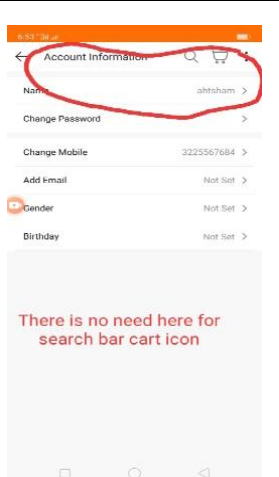
important to redesign the user interface of draz.pk application. Table 8 highlights some major usability issues in draz.pk with recommendations and screen shorts.

TABLE VIII. HEURISTIC EVALUATION FINDING WITH RECOMMENDATIONS

Sr.	Issue/Recommendation	Screen
1	<p>Visibility of the system status</p> <p>Issue: At the top bar, there is no header.</p> <p>Recommendation: Add the title on the top bar.</p>	
2	<p>Visibility of the system status</p> <p>Issue: No Confirmation Message dialog is shown on the screen after mobile number verification.</p> <p>Recommendation: Show Properly Dialog.</p>	
3	<p>Error Prevention</p> <p>Issue: Confusion between the Text label and the button on the main screen.</p> <p>Recommendation: There should be a proper login button with proper color font size.</p>	
4	<p>User Control and freedom</p> <p>Issue: There is no option available for removing the picture.</p> <p>Recommendation: There should be a proper button.</p>	

<p>5</p>	<p>Flexibility and efficiency of use</p> <p>Issue: Keywords or search tags are not available for quick search. Sorting and filtering option are less available like average rating review, A to Z alphabets.</p> <p>Recommendation: There should add some keywords for quick search and more advanced options for searching.</p>	
<p>6</p>	<p>Help users recognize, diagnose, recover from errors</p> <p>Issue: Users click on Top-up Transactions. The app does not give a pop-up dialog for any kind of suggestion.</p> <p>Recommendation: The system should provide Suggestion Dialog.</p>	
<p>7</p>	<p>Help and documentation</p> <p>Issue: There is no Video Teaching Tutorial for a user to learn application tasks.</p> <p>Recommendation: There should be a Video-based FAQ section where users can search out their common problem's solution.</p>	

<p>8</p> <p>Aesthetic and minimalist design</p> <p>Issue: Irrelevant information is displayed on the home button that creates a visibility issue.</p> <p>Recommendation: Provide only essential info on the screen.</p>		
<p>9</p> <p>Error prevention</p> <p>Issue: No confirmation dialog before payment of the product using easy paisa without the email box.</p> <p>Recommendation: There should be a confirmation dialog before pressing the pay securely button.</p>		
<p>10</p> <p>Match between the system and the real world</p> <p>Issue: The picture uploading icon is not matched with the system and the real world. It is a confusion icon.</p> <p>Recommendation: There should be a proper icon for a picture with text.</p>		

<p>11</p>	<p>User Control and Freedom</p> <p>Issue: The system goes to an unwanted stage during adding a payment method for purchasing products.</p> <p>Recommendation: The System Should Provide a Home button to back the main Page.</p>	
<p>12</p>	<p>Visibility of System Status</p> <p>Issue: Top up button in balance detail is not working or giving response after clicking on it.</p> <p>Recommendation: The system should give proper feedback.</p>	
<p>13</p>	<p>User Control and Freedom</p> <p>Issue: The keyboard is not hidden on slay out click.</p> <p>Recommendation: Hide Keyboard on Screen Touch.</p>	
<p>14</p>	<p>Aesthetic and Minimalist Design</p> <p>Issue: There is an Extra Search Bar for account information.</p> <p>Recommendation: There is no need for any search bar here.</p>	

<p>15</p> <p>Aesthetic and Minimalist Design</p> <p>Issue: Store option is an extra option as compared to Buy Now and Add to Cart here. Violation of the hick's law here.</p> <p>Recommendation: There is a need to remove it.</p>		
<p>16</p> <p>Flexibility and Efficiency to Use</p> <p>Issue: This app has not supported both orientations (Horizontal and vertical).</p> <p>Recommendation: Landscape orientation should be present in it.</p>		

Different other issues explained by expert's evaluator on draz.pk m-commerce applications are mentioned below.

- Sometimes video advertisements are shown at the draz.pk interface and there is no option available to remove it quickly.
- The app uses very small font sizes for contents in the interface.
- There is no speech to text searching facility available on draz.pk.
- There is no option available to rate the draz.pk app.
- The draz.pk app takes too much space for mobile storage.
- The speed of the draz.pk app is slow. There is a need to make better performance in terms of speed.
- Search results are not matching with the search query.
- GPS is not working properly in the draz.pk app.
- When you place your order, draz.pk app informs too late that the product is out of stock.
- The app closes when we add a picture to the review.
- Order delivery is very late in the draz.pk app.

- There is no message or notice provided by the app which informs that when the rider will arrive.
- There is no progress bar to give better visual hints to users to place an order from shipping to payment steps.

Similarly, two expert users evaluated the Elo.com m-commerce application. One of the expert users was a Graphic Designer in a software house. He has been using the Elo.com application on his android phone from a long time while other expert user was working as an android developer. He has been working with other team members to finalize the User interface of the applications after finding issues and hence delivering an end application to end-users. He was also the user of Elo.com application for online purchasing products from a significant time period. Table 9 below highlights the collective details of qualitative results after usability testing of the user interface of Elo.com application by using above mentioned usability Guidelines/Heuristics.

TABLE IX. SEVERITY RATE OF ERROR ACCORDING TO INTEGRATED HEURISTIC EVALUATION


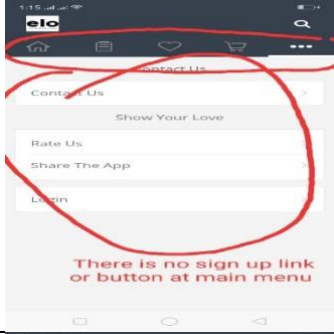

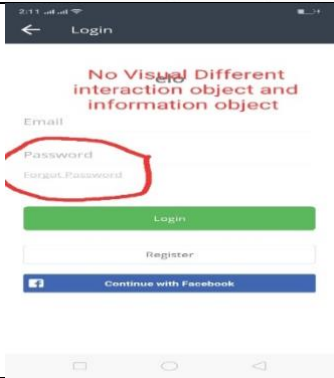
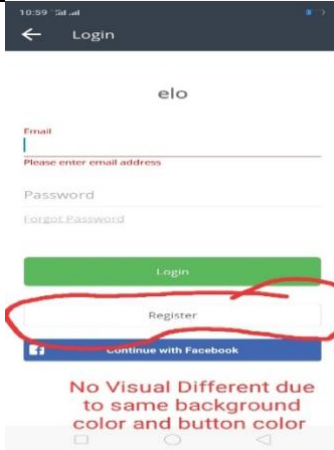
Integrated Usability Heuristics	Elo.com M-Commerce Application					
	0	1	2	3	4	Total
1. Visibility of system status	0	0	0	1	0	1
2. Match between system and real world	0	0	2	0	0	2
3. User control and freedom	0	1	0	1	0	2
4. Consistency and standard	1	0	1	0	0	2
5. Error prevention	0	1	2	1	0	4
6. Recognition rather than recall	0	0	2	1	0	3
7. Flexibility and efficiency to use	0	1	2	0	0	3
8. Aesthetic and minimalist design	0	1	1	1	0	3
9. Helps user recognize, diagnose and recover from errors	0	0	1	0	0	1
10. Help and Documentation	0	0	2	3	0	5
11. Dynamic Engagement	0	0	1	0	0	1
12. Information and visual hierarchy	0	1	1	0	0	2
13. Natural interaction	0	1	0	0	0	1
	1	6	15	8	0	30
	3.33%	20%	50%	26.66%	0%	

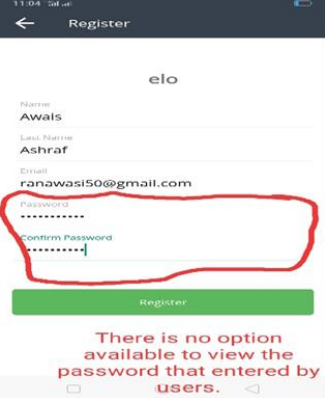
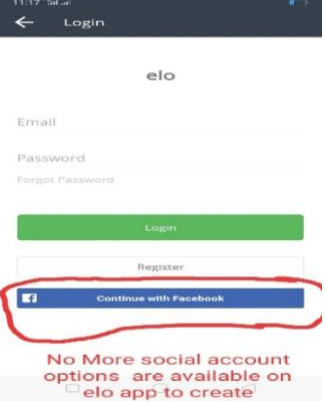

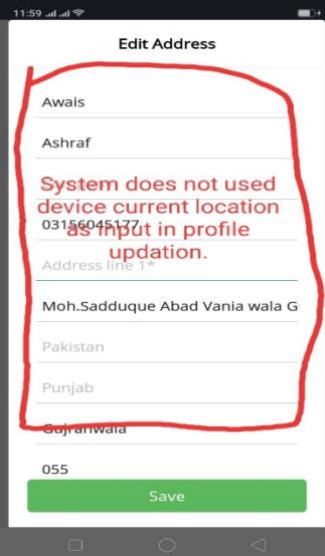
This Detailed expert evaluation shows the collective result of two expert evaluators on elo.com. They have found a total of 30 issues in the Elo.com m-commerce application. Of these 35 issues, only 8 were major issues that make 26.66% of the total issues found while 15 were minor issues that make 50% of the total issues founded by experts. Major issues

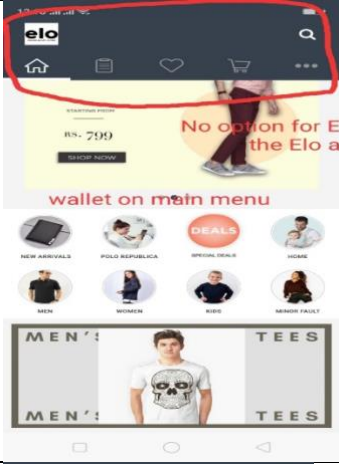
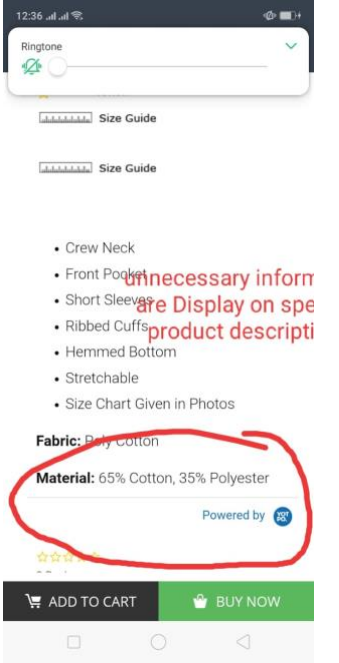
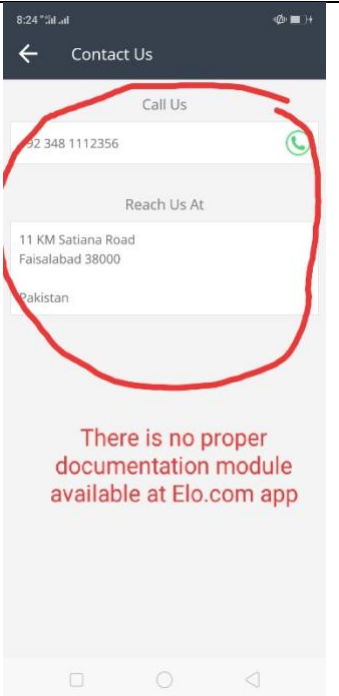
percentage was 26.66% that makes it important to redesign the user interface of the Elo.com application. Table

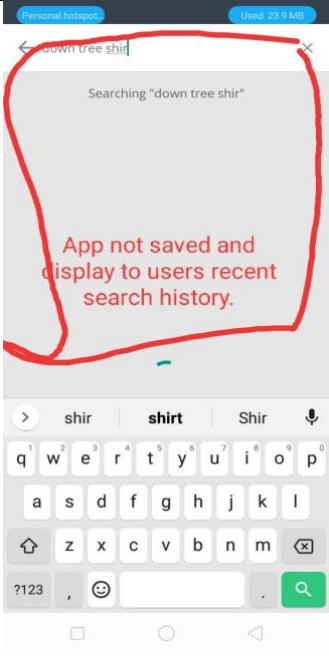
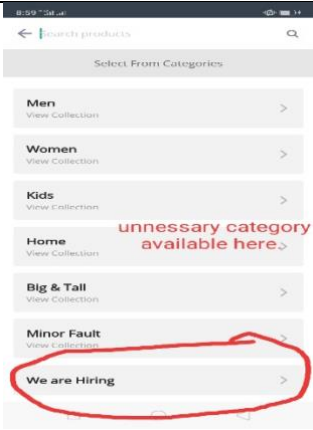
10 highlights some major usability issues in Elo.com with recommendations and screen shorts.

TABLE X. HEURISTIC EVALUATION FINDING WITH RECOMMENDATIONS

Sr.	Issue/Recommendation	Screen
1	<p>Visibility of System Status</p> <p>Issue: The logo is not Sufficiently Visible.</p> <p>Recommendation: The logo design should be clear and visible.</p>	
2	<p>Error Prevention</p> <p>Issue: There is no Sign-Up link available on the main menu.</p> <p>Recommendation: There should be an option in the main menu bar.</p>	
3	<p>Match Between System and real world</p> <p>Issue: There is no menu choice order in the most logical way.</p> <p>Recommendation: There should be an order on the menu.</p>	
4	<p>Error Prevention</p> <p>Issue: There is no visual difference between the interaction object and the information object. The “forgot” button confuses the user.</p> <p>Recommendation: There should be a proper visual forgot button.</p>	
5	<p>Error Prevention</p> <p>Issue: There is no visual difference between the interaction object and the information object. The registration button confuses the user. The back group and button color are the same. It is text info or link?</p> <p>Recommendation: There should be a proper visual Register button.</p>	

<p>6</p> <p>User Control and Freedom</p> <p>Issue: There is no option to view the entered password by the users.</p> <p>Recommendation: There should be an option for viewing password.</p>		
<p>7</p> <p>Dynamic Engagement</p> <p>Issue: There is only one option for login into the app using an existing social media account.</p> <p>Recommendation: There should be more options like gmail.com, yahoo.com, etc. to create an account on elo.com.</p>		
<p>8</p> <p>Recognition rather than recall</p> <p>Issue: No text available with icons at the main menu bar.</p> <p>Recommendation: There should be the mentioned text content of used icons.</p>		
<p>9</p> <p>Flexibility and efficiency to used</p> <p>Issues: GPS is not working during profile updating and order placing.</p> <p>Recommendation: The system should use the geo location of users when needed.</p>		

<p>10</p> <p>User control and freedom</p> <p>Issues: There is no digital wallet option available at the Elo.com app.</p> <p>Recommendation: There should be a digital wallet option in-app.</p>		
<p>11</p> <p>Aesthetic and minimalist design</p> <p>Issues: The app shows unnecessary information at specific product description.</p> <p>Recommendation: The app should provide only essential information for decision making to users.</p>		
<p>12</p> <p>Help and documentation</p> <p>Issues: There is no help and documentation module available at the Elo.com application.</p> <p>Recommendation: There must be present help and documentation section in the application.</p>		

<p>13</p> <p>Information and visual hierarchy</p> <p>Issues: App does not save and display recent search history to users.</p> <p>Recommendation: The app should provide recent search history to users.</p>	
<p>14</p> <p>Aesthetic and minimalist design</p> <p>Issues: App provides unnecessary category in the Categories list.</p> <p>Recommendation: The interface of the app should be clear from unnecessary advertisements and information. The app should provide only essential information to users.</p>	

Different other issues faced by expert’s evaluator on Elo.com m-commerce applications are mentioned below along with explanation.

- There is no margin in between the item screen.
- The color scheme is poorly selected.
- The splash screen indicates the error.
- The app and website are not connected properly with each other and are two distant platforms. Favorite items in the app are not available on the website.
- There is no setting available to mute unnecessary notifications.
- The app is not redirected to my home page after login successfully on it.
- The app is not providing an option to update profiles like the picture.
- The Elo.com app is providing fewer options for payment delivery.
- There is no margin in between the item screen.
- The color scheme is poorly selected.
- The splash screen indicates the error.
- The app and website are not connected properly with each other and are two distant platforms.
- Favorite items in the app are not available on the website.
- There is no setting available to mute unnecessary notifications.
- The app is not redirected to my home page after login successfully on it.
- The app is not providing an option to update profiles like the picture.
- The Elo.com app is providing fewer options for payment delivery.
- GPS is not working on the Elo.com app.
- We cannot see “my old purchased products list” in it.
- We are receiving notifications of an update but there is no update available.
- We are not seeing the privacy policy and term of service section.
- We do not see our reviews given to products.

- The app is horrible in terms of searching. There is no appropriate search result. Users need to visit many pages for searching. No one has much time to see all pages.

The objective of user testing from novice users was to identify usability problems related to the user interface of both m-commerce apps draz.pk and elo.com. After performing user testing with novice user, researcher can easily compare the novice and expert user’s performance on both m-commerce apps. Think aloud is a famous method that is used by researchers to record the user’s suggestions, behaviour, and opinions about the system during user testing. The researcher asked the users to speak loudly during performing tasks in this method. This method also was chosen for usability testing on both m-commerce apps for novice users in this research study. Different novice users from different fields like students, office employees, and housewives were asked to perform specific tasks on these both m-commerce apps in 1 to 1 meeting. After completing the specific tasks, they were required to fill out the survey questionnaire which was based on different usability expert’s guidelines. Mobile screen recorder software (Vidma Recorder) was used to record the actual time that is used to carry out tasks by each novice users during usability testing. By user testing, we obtained the efficiency and effectiveness of the system. ISO organization proposed the usability metrics. These usability metrics are efficiency, effectiveness, and satisfaction. Efficiency means how much time is required by the system to perform each task. Effectiveness means how many tasks are successfully carried by the user [33-35]. We can calculate the effectiveness of the system by using the below formula:

$$\text{Successful Rate} = (\text{successful tasks} + (\text{partially successful tasks}) * 0.5) / \text{Total Number of tasks}$$

These novice users were divided into two groups Draz.pk and Elo.com.13 novice users were assigned to perform specific tasks on draz.pk and 13 novice users were assigned to perform specific tasks on elo.com. All novice users were having much experience with mobile applications. However, not all novice users have already used these m-commerce apps. A brief demo was given to each novice users about specific tasks on both m-commerce apps and questionnaires. Below Table 11 is giving the complete demographic of novice users.

TABLE XI. DEMOGRAPHIC INFORMATION OF NOVICE USERS

Sr. No	Gender	Age Between (18-25)	Age Between (25-30)	Age Above (30)	Experience with Mobile Applications
1	Male	14	9	1	Yes
2	Female	1	1	0	Yes

A. Specific Tasks Performed on Draz.pk Application

- 1) Create the account on Draz.pk Application.
- 2) Update your address profile information.
- 3) Find any help from the Help and Documentation Module.
- 4) Search out the KN 95 Mask and add it to the cart.
- 5) Find out the term of the return policy of Application.
- 6) Search out the surgical mask and add its favorite list.

TABLE XII. SPECIFIC TASK PERFORMANCE ON DRAZ.PK

No. of Tasks	Successful Users	Partial Successful Users	Fail Users	Rating	Average Time Taken
1	13	0	0	100%	57sec
2	10	1	2	80%	78 sec
3	13	0	0	100%	27 sec
4	13	0	0	100%	17 sec
5	8	3	2	73%	30 sec
6	13	0	0	100%	19 sec

The Table above 12 shows the expert tasks performance on draz.pk app. 2 Novice users were failed to perform task 2 regarding update personal address and 2 novice users were also not able to perform tasks 5 regarding finding return policy of product on draz.pk app.

B. Specific Tasks Performed on Elo.com Application

- 1) Create the account on Elo.com Application.
- 2) Update your address profile information.
- 3) Find any help from the Help and Documentation Module.
- 4) Search out the KN 95 Mask and add it to Cart.
- 5) Find out the term of the return policy of Application.
- 6) Search out the surgical mask and add its favorite list.

TABLE XIII. SPECIFIC TASK PERFORMANCE ON ELO.COM

No. of Tasks	Successful Users	Partial Successful Users	Fail Users	Rating	Average Time Taken
1	11	2	0	92%	63 sec
2	13	0	0	100%	87 sec
3	0	0	13	0%	0 sec
4	13	0	0	100%	41 sec
5	0	0	13	0%	0 sec
6	7	2	4	61%	18 sec

The Table above 13 shows the expert tasks performance on Elo.com app. 13 Novice users failed to perform task 3 regarding find any help from the help and documentation module and 13 Novice users were also not able to perform tasks 5 regarding finding return policy of product on Elo.com app.

In user testing, the last step was to fill out a questionnaire survey with novice users to identify the UI/UX issues in both of these m-commerce apps. Each survey question was categorized according to apple usability guidelines, android usability guidelines, and Jacob nelson ten heuristics.

The questions below refer to the following integrated heuristics Guidelines terms:

Question 1 - 5 – Visibility of system status, Aesthetic and Minimalist Design

Question 6 – 8 – Learnability, Flexibility, and efficiency to use

Question 9– 10 – Error Prevention

Question 11 – 12 – Help and Documentation

Question 13-14 – Dynamic Engagement

Question 15 – 16 – Effectiveness and Satisfaction

QUESTION 17 – INFORMATION AND VISUAL HIERARCH

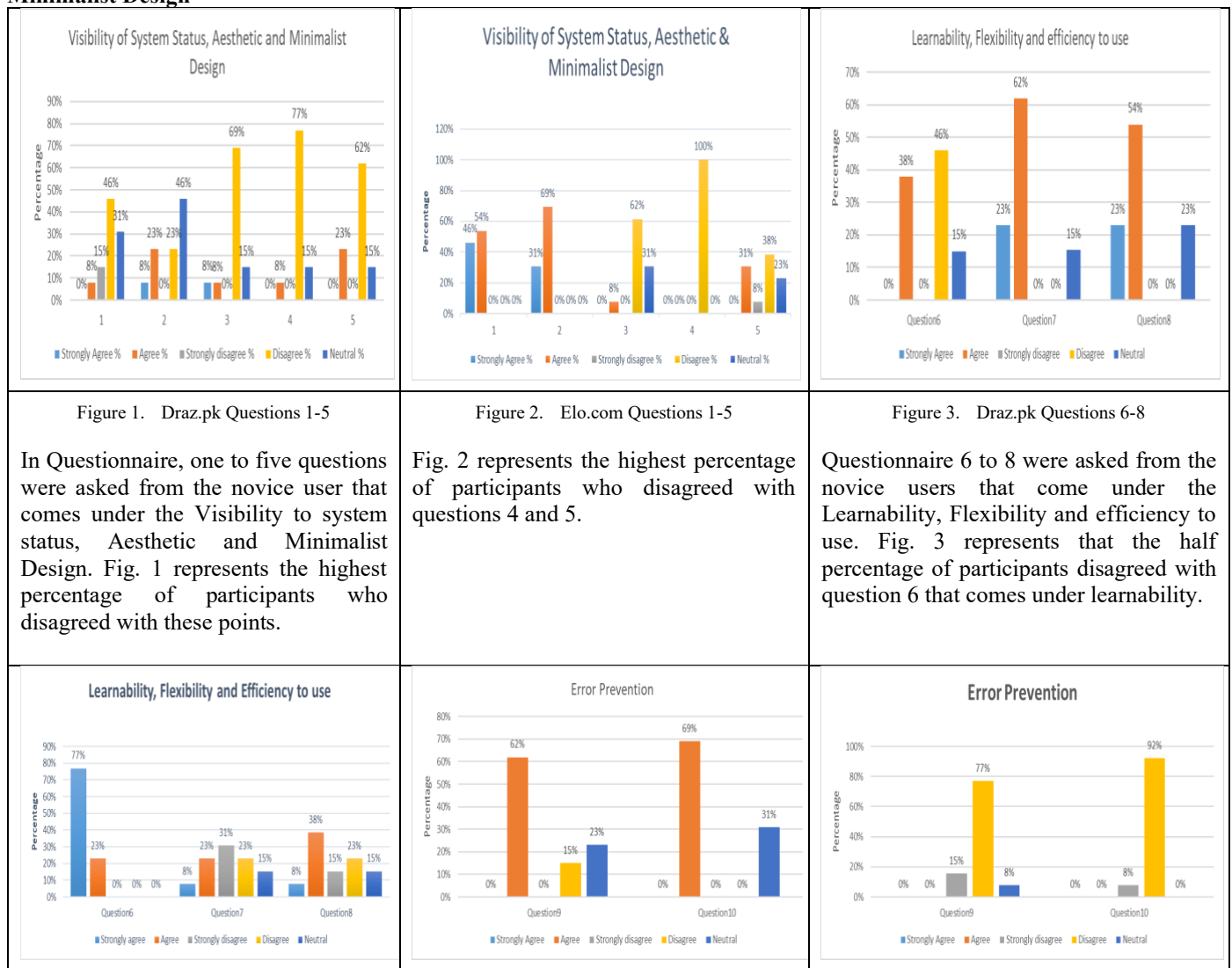


Figure 1. Draz.pk Questions 1-5

In Questionnaire, one to five questions were asked from the novice user that comes under the Visibility to system status, Aesthetic and Minimalist Design. Fig. 1 represents the highest percentage of participants who disagreed with these points.

Figure 2. Elo.com Questions 1-5

Fig. 2 represents the highest percentage of participants who disagreed with questions 4 and 5.

Figure 3. Draz.pk Questions 6-8

Questionnaire 6 to 8 were asked from the novice users that come under the Learnability, Flexibility and efficiency to use. Fig. 3 represents that the half percentage of participants disagreed with question 6 that comes under learnability.

Figure 4. Elo.com Questions 6-8

Questions 6 to 8 were asked from the novice users that come under the Learnability, Flexibility and efficiency to use. Fig. 4 represents that half percentage of participants disagreed with questions 7 and 8 that come under Flexibility and efficiency to use.

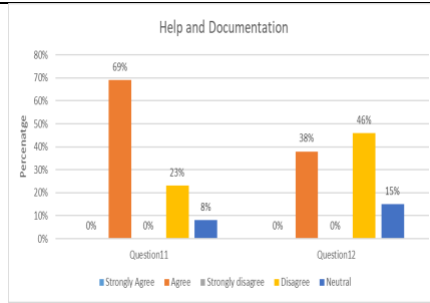


Figure 5. Draz.pk Questions 9-10

In questionnaires, 9 to 10 were asked from the novice users that come under the Error Prevention. Fig. 5 represents a high percentage of participants who agreed with it.

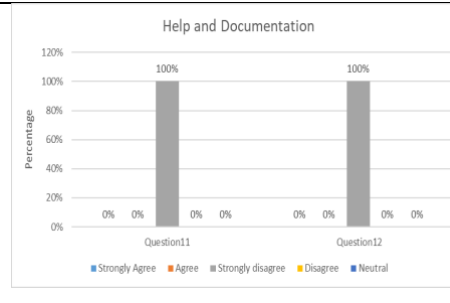


Figure 6. Elo.com Questions 9-10

In questionnaires, 9 to 10 were asked from the novice users that come under the Error Prevention. Fig. 6 represents a high percentage of participants who disagreed with it.

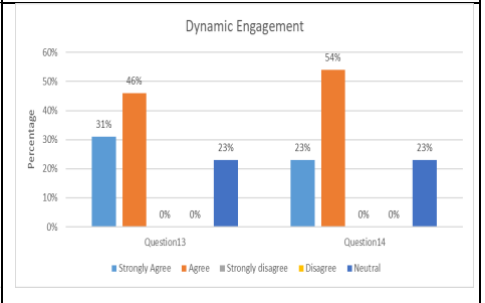


Figure 7. Draz.pk Questions 11-12

In Questionnaire 11 to 12 were asked from the novice users that come under the Help and Documentation. Fig. 7 represents a high percentage of participants agreed with it. There is a need to improve this module because some users have disagreed with its functionality and feedback.

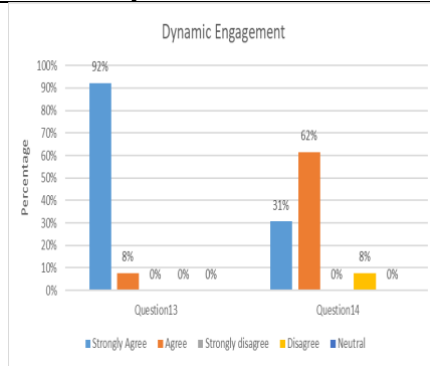


Figure 8. Elo.com Questions 11-12

Questionnaire 11 to 12 were asked from the novice users that come under the Help and Documentation. Fig. 8 represents a high percentage of participants who strongly disagreed with it. There is no present help and documentation module available in it.

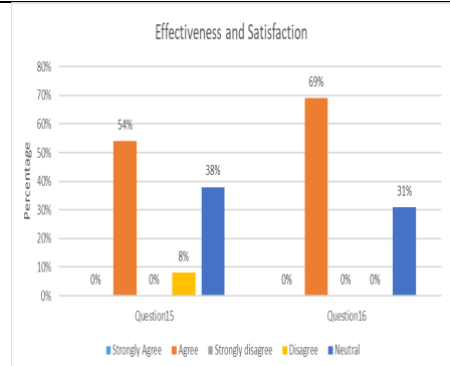


Figure 9. Draz.pk Questions 13-14

Questionnaire 13 to 14 were asked from the novice users that come under the Dynamic Engagement. Fig. 9 represents a high percentage of participants strongly agreed with it.

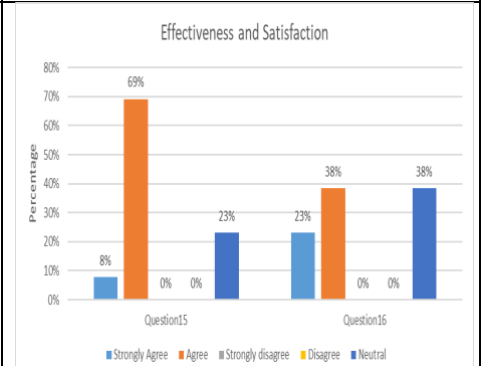


Figure 10. Elo.com Questions 13-14

Questions 13 to 14 were asked from the novice users that come under the Dynamic Engagement. Fig. 10 represents a high percentage of participants strongly agreed and agreed with it. There is a need for more improvement in this term because some users have disagreed with this point.

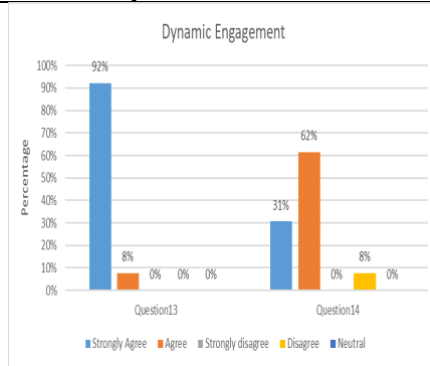


Figure 11. Draz.pk Questions 15-16

In Questionnaire, questions 15 to 16 were asked from the novice users that come under the Effectiveness and Satisfaction. Fig. 11 represents a high percentage of participants who gave neutral remarks.

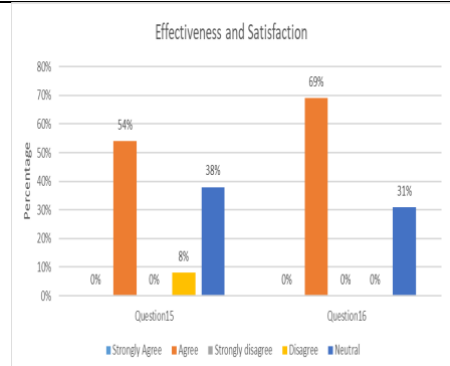
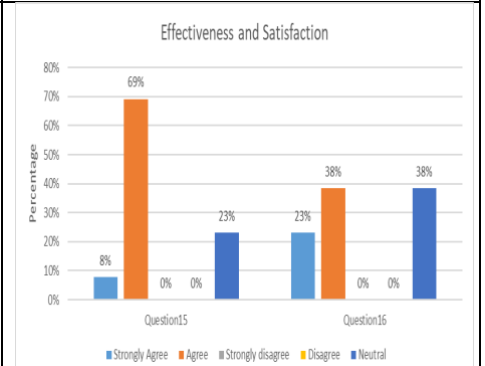


Figure 12. Elo.com Questions 15-16

In Questionnaire, questions 15 to 16 were asked from the novice users that come under the Effectiveness and Satisfaction. Fig. 12 represents that more than half the percentage of participants have shown agreeeness while others gave neutral remarks.



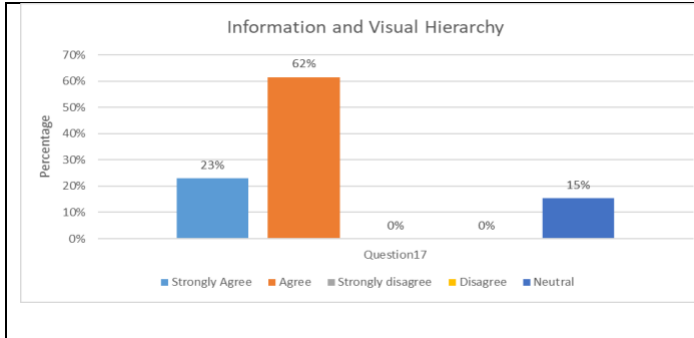


Figure 13. Elo.com Question 17

In Questionnaire, question 17 was asked from the novice users that come under the Information and Visual Hierarchy. Fig. 13 represents that less than half the percentage of participants has given disagree remarks.

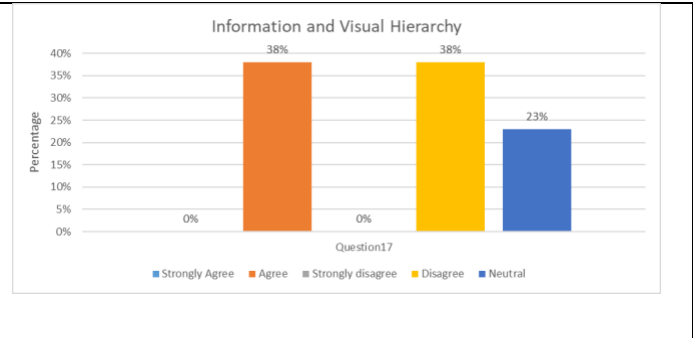


Figure 14. Draz.pk Question 17

Question 17 was asked from the novice users that come under the Information and Visual Hierarchy. Fig. 14 represents that more than half the percentage of participants has given agree response.

Below Table 14 highlights the factors that were identified after user testing on both these m-commerce apps from novice users.

TABLE XIV. FACTORS FROM USER TESTING OF BOTH APPS

Draz.pk	Elo.com
Visibility of System status Issues	Aesthetic and Minimalist Design Issues
Aesthetic and Minimalist Design Issues	Help and Documentation Issues
Learnability Issues	Flexibility and Efficiency Issues
Error Prevention Issues	Dynamic Engagement Issues
Information and Visual Hierarchy Issues	Error Prevention Issues

V. CONCLUSION AND FUTURE WORK

The main aim of which is ‘Enhancing usability of m-commerce applications’ is targeted and usability problems in the currently available applications are evaluated to resolve currently faced issues experienced by the users. It was concluded based on the integrated heuristic guidelines followed with heuristic and user testing, that we can evaluate the user interface of m-commerce applications by HCI Guidelines. Heuristics evaluation and user testing are the most popular methods to evaluate the user interface of m-commerce applications. Jacob Nielsen, famous as the father of usability, proposed the ten usability guidelines to evaluate the user interface by using different usability evaluation methods. Apple and Android companies also provided UX/UI design guidelines to evaluate the user interface of mobile applications. So, enhanced usability by m-commerce applications is achieved for novice as well as expert users that belong to various domains of life.

In future, we will continue with results of this research and will apply MCDA and AHP techniques to prioritize the

usability issues and target them well in prototype design to ultimately reach towards the user satisfied m-commerce platforms.

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