How users Interact with Commercial Websites using Smartphones?: Empirical Investigation using Protocol Analysis

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Abstract

Background/Objectives: There have been few investigations and explorations about the usability analysis of a Web based application on various emerging devices and platforms including Smart TV, Tablet PC, and Smartphones. **Methods/ Statistical Analysis:** We investigate the usability of websites interfaces of commercial websites based on three criteria, namely, interactivity, content, navigations. We adopt ANOVA analysis to detect the difference among the features provided by participants. Those features are classified into three groups. We basically categorize those issues based on systematic evaluation strategies: navigations category, interactivity, and content. We have found that more than ten issues adversely affect website usability in significant degree among the thirty issue arranged by participants. **Findings:** The results report confirmation of the significances of the discovered usability problems attached with the current mobile web design that influence the usability and interaction of consumer with commercial website accessed via smart devices. Although we did not incorporate direct scales of processing fluency such as finger expansion navigating through website pages and some signal reactions while participants engaging in the assignment. However, the results indicate that the current commercial web design strategy is lacking to some fundamental guidelines. It is significant noticing that the usability problem presented in this research is alarming web designer of special design awareness which positively affecting consumer response and satisfaction. This study is not only replicating usability problem findings effect in previous studies but also it explores and determines the severity of these problems findings influencing on consumers. Extending previous study findings help to clarify to designer the influential impacts of these problems for shoppers accessing website via smart devices. The effects of these different usability problems are quantified by participants needs for a convenient method of interacting with commercial sites. **Improvements/Applications:** Several painful issues are identified such as: (1) website is presenting small fonts; (2) unavailability of item viewers; (3); awkward item presentation; (4) lengthy menus; (5) multitude of clicks to reach the final stage of the transaction.

Keywords: Commercial Websites, Protocol Analysis, Smart Devices, Usability, User Experience

1. Introduction

Recently, Web based shopping has become one of the most conventional waysfor shopping[1]. And, it seems apparent that most people tend to be interested in mobile online shopping[2]. For example, it is reported that forty five percent of consumers with their own smart devices use the smart devices for online shopping[3].

Usability is considered important for a successful interaction between a system and its user. Recently, as for usability investigation of Web applications, many researchers are focusing on the way a user obtains precise information and a heuristic evaluation of the Web without misunderstanding and misleading[4,5]. However, there has been little attention on web localization and user's experience. It is well known that systematic and detailed

research from web designers can influence the quality of products in various aspects[6].

The objective of this paper is to apply concurrent verbal protocol analysis methodology as a mean of website usability evaluation through smart devices. We apply concurrent protocol methodology to identify critical issues in relevance to the current usability design strategy of commercial website accessed via smart device. As it is apparent, protocol analysis is a recognizable method that has been used to determine the user interactivity with a web site or a system[7]. Protocol Analysis grants users a complete freedom of speaking of dislikable features, appealing functions, undesirable web structure, etc. The remaining of this research paper is organized as follow: Section 2 reviews of previous studies of commercial websites and brief description of smart devices functionality; section 3 illustrates the research strategy and experiment methodology. Section 4 describes in details the result of this research and its implications. Section 5 explains the conclusion of the research and how it can overcome the shortcomings of the current web usability problems, which are significantly affecting consumer-response and also it is a significant research enhancement in academic and industrial ergonomics.

2. Literature Review

2.1 Protocol Analysis in Usability Evaluation Strategy

Protocol analysis is a rigorous method of tape recordings of participant emission while engaging in the performance of the assigned tasks[8]. Generally, these recordings are used to identify and analyze how the user manages to solve a problem on hand as well as how the user manages to complete a task within a specific range of time. Protocol analysis involves two or more subjects, namely, a participant in the stated-product and a moderator to instruct participants or software in charge of media recording of participant's behavior while performing a task or solving a problem. The result of instructing and monitoring participant is to firmly explore and uncover flaws, inferences, misinterpretations, assumptions, and obstacles encounter during the performance process of solving a given problem. Protocol analysis is an appropriate methodology for understanding and analyzing human verbal behavior when they are being engaged in such solving problems

or handling tasks. Protocol analysis is considered as a direct observation methodology that is the most effective approach to understand and comprehend human cognitive process and behavior[9] The utility of protocol analysis is used tremendously in sundry studies and purposes. Each study has utilized the protocol analysis to identify flaws, behaviors, responses, and reactions toward solving the problems on hand or performing a given task.

Protocol analysis famously elucidates the direct observation of participant's real interaction with a selected or a given task. Particularly, protocol analysis consists of several episodes; each episode is independent and has stand-alone purpose. In each protocol analysis episode, the participant is required to handle a given task through a real interaction between a participant and the selected-product or application, and then the participant is required to verbalize all the inner thoughts simultaneously. Specifically, the participant in the experimental subject should speak up what he/she is trying to accomplish from a given task, what obstacles he/she is hampering him/her from completing the task. Thoroughly, protocol analysis observes and catches; to what extent the participant gains control over the given task, how participant manages to interact with the selected-product or application, and what obstacles the participant faces during the involvement. In other words, the observer needs to draft the transcripts and instruct participants about the task strategy, and then the participants require rigorously looking at the given transcript and relatively reviewing it. For example, Potter at el immensely ask participants to read and review the transcripts carefully, and then analyze and explore what makes participants formed such a perceptions or commentary on the selected-product or system.

Potter at el recruit participants and award $0.02 for each participant who manages to choose a correct stimulus[10]. Protocol analysis is more into verbalization report, which is specifically about the participants' vocalization perceptions and sequential behavior while they are engaged in solving a problem. In[11] directly ask participants certain questions during the session engagement. They firmly focus on the formation and verbalization of participants perceptions about the product that in fact represent a problem space in terms of states and operators. In no particular arguments, success and effectiveness of any experimental research might be numerically subjected to the number of the participants involve in the research.

However, minority of participants can significantly represent certain organizations or district's populations, which can individually and collectively output satisfactory result. In[12] argued that group of four to five participants with iterative trails in Web/System design and developments can greatly identify 80% of usability shortcomings. Furthermore, due to the wealth of the obtained data through protocol analysis, small number of participants in studies that employ protocol analysis approach is unarguably considered reliable findings.

Rigorously, protocol analysis is a methodology to elicit the successive behavior of the participant's vocalization report. It is well-known methodology for analyzing behavior[13]. Additionally, it plays an important role in the design of interviews and surveys as well as in the Web applications and Computer software.

2.2 Usability of Commercial Website Analysis

It is factual that the efficiency and effectiveness of any web or system are aligned with mandatory system functionality. These functions empower users to manipulate and navigate through the tasks successfully and effortlessly. However, necessary functions would likely meet users' system acceptance and certain degree of user-satisfaction. Theoretically speaking, for the web or the system to be totally in a working condition manner, facility of interaction should be existed and presented clearly to users. Therefore, usability of the system or any applications is importantly worthwhile of major accurate findings to change the current usability design and evaluation strategy for improving the quality of the product and user-satisfaction. In addition, there are many sundry variables can developers bear in mind at the initial stages of system developments[14]:

1. Motivation: it concerns with product attractiveness and impression to users positively.
2. Usability: it concerns about easiness of interactions during user-performances. It concerns about providing users with simplicity of reaching and completing the task successfully.
3. Effectiveness: it concerns about the system performance in a functioning manner, which can be constantly measured if the output meets the expected output.

In this contribution, it is important examining the internal interpretive activities of the participant. Precisely, usability is not only concerned about the interfaces of the applications that consider to be as an intermediary platform between a product and the user, but it extremely concerns about the user's cognitive and experience attitude for communication and solving problems. Therefore, user's experience and usability are vitally aligned together and have a major influential comprehension on a product quality. Performance on the casual relationship between user-experience* and usability has been studied previously. In[15] studies this casual association between the two subjects and identifies that usability is likely assemble to user-experience. On top of that, he highlights a few usability principles. These principles are numerated as follow:

1. Learnability: An operation can be easily learned by observing the tasks.
2. Efficiency of use: it concerns about optimization the minimum time. He points out that completeness of a task should be less than the time user anticipates.
3. Memorability: the contents should not be too complicated for the user to remember. Contents should be concise and precise as well as easy to recall.
4. Error frequency: frequency of errors the user make, how sever these errors?
5. Satisfaction: is the design pleasant to use? Does the design have a coherent structure?

As Nielson discussion tries to break the strong association between user-experience level and usability of products, we would summarize that user-experience has a deep influential impacts on a product quality and usability. Therefore, efficiency and effectiveness of a product significantly depend on two variables: usability of a product and proficiency of user-experience.

There have been several investigations on usability and user-experience evaluation using a traditional computer, but nowadays, web is transforming into smart devices that have small size screen. In addition, this web transformation has not yet received extensive findings. In[16] reports critical problems of the current website usability on mobiles using different methodology. He identifies that accessibility of website on smart device is destructed by the presence of animations and ads.

However, there is tremendously diversity of means to collect information of user-interaction and the evaluation

strategy of usability of any software or web application such as video analysis, interviews, questionnaires, transaction logs, and verbal protocol analysis. Environmental conditions can have small portion in the usability evaluation specifically when protocol analysis is the technique of evaluation. Therefore, evaluation and examination of usability can be performed in a laboratory or remotely, and data about the usability and user's experience can be collected in a variety of ways. However, in our case, we exploit concurrent verbal protocol analysis as an approach to collect data/information and to evaluate the usability of commercial sites on Smart devices, which recently appear to be immensely popular. Protocol analysis or think aloud method can highly help to uncover more usability problems regarding commercial, social or other web sites design as well as improvement of the design strategy[8].

2.3 Evaluation Characteristic and Subject Methodology Selection

Given that, system and web applications are growing rapidly in the recent years and accessed via mobile webs[17]. There are huge continuous research and findings on the usability of these applications, which are significantly taking wide pace and variety of aspects to offer user new experience and excellent features. These applications need dynamic and high standard usability evaluation to determine how efficient and effective when users interact with them via interfaces. Bauer and Scharl[12] have suggested that evaluation of web sites usability can be tested in three significant criteria:

1. Contents: this is about the question of how precise and concise the website contents are. Is it clear and understandable for the users?
2. Navigations: how easily a user can traverse through the web pages? How quickly and easily a user can access a particular URL's and links?
3. Interactivity: this is mainly intended to increase user **autonomy** and to facilitate the feeling of **interpersonal human communication.**

In addition, different usability principles need to be considered when evaluating websites such as simplicity, support, obviousness, encouragements, satisfactions, accessibility, versatility, and personalization. Herein, we bound our study on evaluating commercial websites on smart devices because they hugely increase user-attrac-

tion and satisfaction. Therefore, herein, we choose two free commercial website as the subjects of this research (www.egreetings.com, www.123greeting.com). These sites allow participants to manipulate occasional cards, select a card with their preference, and send card to their loved ones.

Benchunan-Fich[7] has performed a remarkable study on usability of commercial websites on traditional computers. She identifies several critical issues. One of the sever issues she identifies is the item organization presented on the web. However, her finding is only concerned about commercial web on a traditional computing mean. In summary, we would summarize that limited or few findings and investigations have been invested on usability and usability's evaluation of the web sites (commercial and social web sites) on Smart devices. The finding could be similar to the traditional computing method using smart devices.

3. Research Strategy and Experiment Procedure

3.1 Internet Speed Testing

There are many internal/external variables that can affect execution of user actions on a web. These variables include wireless connection speed, device size, memory allocation, device capacity, device capability, and so forth[18]. Herein, before the experiment, we conduct Internet speed test. This is to ensure the optimal performance of participants in terms of minimum time-consumptions, completion of tasks, etc. Since the devices used for the experiment is connected wirelessly, the testing result shows that upload speed is 13.73 Mb/s and download speed is 12.75 Mb/s as shown in table 1.

Table 1. Wireless speed test results

Download	Upload	Ping
12.75 Mb/s	13.73 Mb/s	18 ms

3.2 Type and Number of Devices used in The Experiment

In this research, we use four different devices. These devices differ in the operating platform, size, memory capacity, etc. we namely present this device as iPad1, iPod, Samsung Galaxy Tab 1, and iPhone. We perform

usability evaluation on each device by all participants. All participants perform the same evaluation and same tasks on every device.

3.3 Number of Participants

There are nine participants to contribute to this research. The demography of the participants is shown in Table 2.

Table 2. Participant demographics

Type	Expert	Intermediate	Novice
Number of participants	3	3	3
Age	Average: 23 Max: 40 Min : 22	Average: 23 Max: 27 Min :23	Average: 22 Max: 23 Min : 21
Sex	M: 3 F : 0	M: 2 F : 1	M: 2 F : 1
Shopping experience	Non: 0 1~2:2 2~above:1	Non: 0 1~2: 3 2~above: 0	Non: 2 1~2: 1 2~above: 0
Knowledge of shopping	Novice: 0 Intermediate: 0 Expert : 3	Novice: 0 Intermediate: 2 Expert :1	Novice: 2 Intermediate: 1 Expert : 0

3.4 Research Guideline and Procedure

Figure 1 presents the research procedure we develop as a strategy of the experiment, which is divided into influential portions as follow:

Step 1 – Task Introduction:

Step 2 – Training Session: We provide participants with an overview of this experiment. And we present clear description of the research objectives[19].

Step 3 – Concurrent Protocol Analysis: We adopt concurrent verbal protocol analysis as our method. Herein, we prefer concurrent verbal protocol analysis over retrospective protocol analysis. It is because we believe verbalizations take place during decision-making process while retrospective verbalizations occur after decision-making process[20].

Step 4 – Data Analysis: In the data analysis operation, we introduce two human encoding experts and we ask them to make the protocol analysis segmentation based on profound and careful video-exposure[21]. We basically followed the experimental procedure[22]. In Table 3, we list the segments which are deduced from

both human experts. After their segmentation is constructed, we estimate Kappa validation as shown in table 4. The table demonstrates three main attributes (Segment, Rater, and Correspondence):
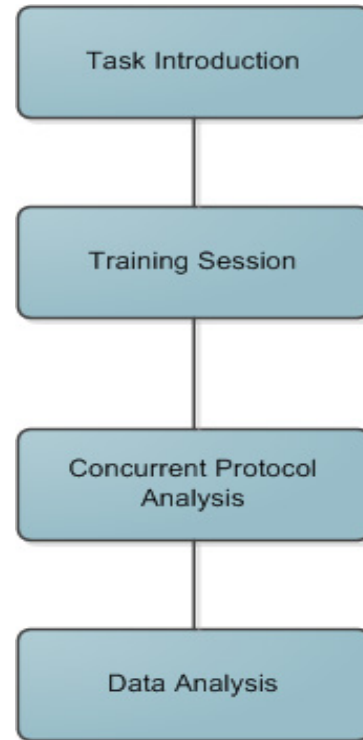

Figure 1. Research procedure.

To compute the level of intercoder reliability among encoders we use SPSS to perform the intended computation. We acquire 30 segments by the encoders and all the segments undergo to validity process as shown in table 4.
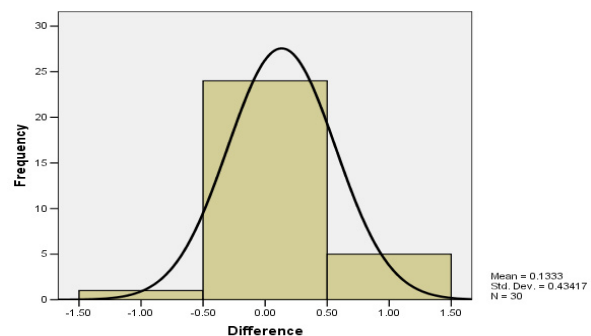

Figure 2. Interpretation of Kappa analysis among encoders (At the point 0.00, there is no discrepancy between encoders).

Table 5 presents the level of agreement between raters. Before we calculate Kappa, we perform interpretation and computation on the differences among each rater.

Table 3. Issue classification and impact factor

Segment	Description	M	SD
Interactivity: It is a mean of facilitating the feelings of consumer interpersonal communication and increase the likelihood of consumer-control over website			
A1	My eyes are hurting me looking at the content	5.44	2.19
A2	I feel comfortable with device capability and services when I am	4.44	2.13
A3	interacting with a website	4.33	1.58
A4	I certainly like the appealing (.com) button offered by the device	5.89	2.17
A5	I like the share functionality the commercial website offer (I can share on	4.56	2.01
A6	my Facebook)	4.22	1.86
A7	Sensitivity of a device screen enable me to go through the web site more	4.89	1.76
A8	effectively	3.00	1.00
A9	I feel like crying hearing the noise of banner's sound presence	4.56	1.87
A10	It is awkward way typing unnecessary information	6.00	1.41
	It feels unpleasant interacting with a lengthy menu website via smart device		
	It is irritating the presence of congested items		
	I feel website is not serving consumer in a proper manner and an attractive way		
Content: It concerns about the conciseness and precision of content presence on a website. It more concerns about clarity and understandability of the content to consumers			
D1	I don't like accessing a website that has small fonts which present in this	4.67	2.40
D2	website	4.67	1.87
D3	Why am I required to be a member to proceed with the transaction	4.00	2.34
D4	I like the website because it offers free gifts and free occasional cards	7.89	4.31
D5	Owh, it is sad there is no Adobe FlashPlayer	3.22	1.39
D6	What, I cannot view the item in its actual shape.	4.78	1.99
D7	Ahm, so many ads cover the website	2.44	1.24
D8	There are many links linking to other sites	6.67	2.87
D9	The content has ambiguity and congested items	6.11	1.27
D10	Why do I need to type in a security code, it is wasting my time	3.22	1.39
	Item selection is convenient		
Navigation: It concerns about the easiness of consumer accessing and navigating through website pages.			
E1	It is hard to navigate through the website pages, my fingers are tired	9.67	4.30
E2	expending the screen	3.67	1.00
E3	It is easy to search and navigate through an item from the listed items	3.67	1.58
E4	Response time is so long, I cannot wait	4.11	1.96
E5	Again, again, I cant preview the item I selected	4.44	1.94
E6	I don't need and offer, it is blocking me from completing the transaction	5.22	2.05
E7	Navigating through the data entry fields is inappropriate	4.56	2.01
E8	Send button is unseen and item is occupying the entire screen	5.00	1.94
E9	Item is not displayed before I act on the sending operation. I cannot send it	4.33	1.32
E10	before viewing it	3.44	1.42
	Why so many clicks to do this task. I am tired of this		
	The page is so lengthy to navigate through		

The Figure 2 depicts an interpretation of segmentations development using Kappa analysis.

As shown in the table 6, we basically categorize all issues into three dimensions.

4. Result and Discussions

The results report confirmation of the significances of the discovered usability problems attached with the current

Table 4. Segmentation developed by encoders and evaluated by raters

Segment	Rater1	Rater2	Correspondence
A1.	1	1	Yes
A 2.	1	1	yes
A 3.	1	1	yes
A4.	1	1	yes
A5.	0	1	no
A 6.	1	1	yes
A7.	1	1	yes
A8.	1	1	yes
A9.	1	1	yes
A10.	1	1	yes
D11.	1	0	No
D12.	1	1	yes
D13.	1	1	yes
D14.	1	1	yes
D15.	1	1	yes
D16.	1	1	yes
D17.	1	1	yes
D18.	1	1	yes
D19.	1	1	yes
E20.	1	0	no
E21.	1	1	yes
E22.	1	0	no
E 23.	1	1	yes
E 24.	1	1	yes
E25.	1	1	yes
E 26.	1	1	yes
E 27.	1	0	no
E28.	1	0	no
E29.	1	1	yes
E30.	1	1	yes

Table 5. Differences and discrepancies between encoders

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-1.00	1	3.3	3.3	3.3
	.00	24	80.0	**80.0**	83.3
	1.00	5	16.7	16.7	100.0
Total		30	100.0	100.0	

mobile web design that influence the usability and interaction of consumer with commercial website accessed via smart devices. Although we did not incorporate direct scales of processing fluency such as finger expansion navigating through website pages and some signal reactions while participants engaging in the assignment. However, the results indicate that the current commercial web design strategy is lacking to some fundamental guide-

lines. It is significant noticing that the usability problem presented in this research is alarming web designer of special design awareness which positively affecting consumer response and satisfaction. This study is not only replicating usability problem findings effect in previous studies but also it explores and determines the severity of these problems findings influencing on consumers. Extending previous study findings help to clarify to designer the influential impacts of these problems for shoppers accessing website via smart devices. The effects of these different usability problems are quantified by participants needs for a convenient method of interacting with commercial sites. The results present that ambiguity of contents on a site is significantly affecting consumer response. These findings also suggest that concurrent verbal protocol analysis is iteratively effective in the identifications and evaluations of products usability strength and weakness. Our study stresses the importance of evaluating a product with a diversity of users[23].

4.1 Prioritized Recommendation for Smart Device Web Designers

Based on the findings of this study, participants, with their diversity of expertise interacting with site via smart devices, raise major concerns and awareness toward the current smart device web usability shortcomings. Meanwhile participants suggest some feature design, which can be considered in the future smart web design trend to enhance the consumer response and satisfactions. One of the things participants stress is the menu length, which should be shortening for simple accessibility and menu category clarity. They propose a menu that contains no more than 6 layers with content readability. On top of that, they also point out concerning item presentation in one web page, they impose a design strategy which page item should not present more than 4 items and each item should have clear and concise descriptions that can be easily understandable. In fact, present of fewer item in one page facilitate consumer selections. Moreover, participants clearly state that data entry fields should be neat and presentable, which lead them to a suggestion of redesign data entry fields that perfectly organize and effectively engage more consumers. Moreover, participants suggest that mobile web designer should avoid the scrolling because it certainly causes pain and fatigue to consumer reading the content. In addition, avoidance the number of clicks can highly be a good asset in terms of

Table 6. Descriptives response

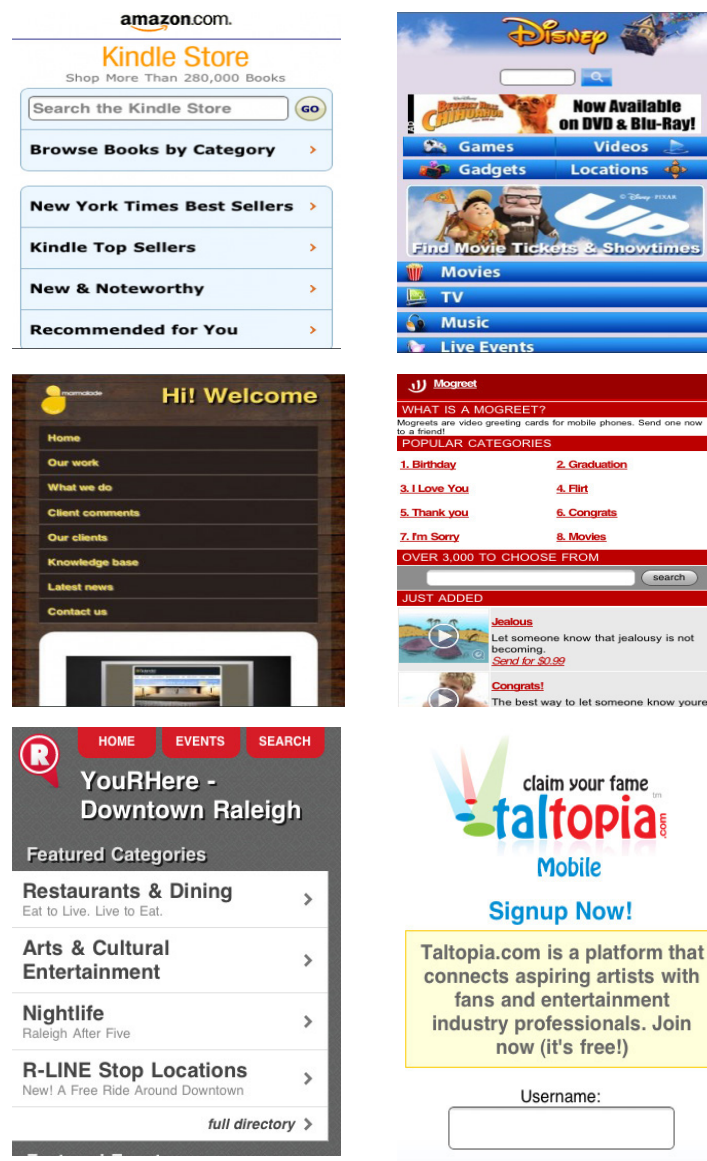|	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Interactivity	10	4.73	0.89	0.28	4.10	5.37	3.00	6.00
Content	10	4.77	1.70	0.54	3.55	5.98	2.44	7.89
Navigation	10	4.81	1.80	0.57	3.52	6.10	3.44	9.67
Total	30	4.77	1.47	0.27	4.22	5.32	2.44	9.67

Figure 3. Recommended designs for web mobile designer.

web site profitability and attractiveness and can positively enhance consumer-motive and response. Herein, we provide a few recommended designs for web mobile designer to foster in the future web mobile applications[24] as shown in Figure 3. These examples are highly desirable especially in business web application that simply can be accessed on smart devices[25].

5. Conclusion

Methodology used in this study has been used in many areas of interest (e.g. psychology, computer games, and e-commerce). Some limitations of this research need to be recognized and studied in further research:

1. There are important classifications (such as the web navigation structure, the information's layout, the value of information, number of errors, number of failures, or other diversified aspects) which are not evaluated profoundly by the study.

2. Thoroughness of information quality provides major interests and pleasure to consumer that ensures his/her returns and recommendation to friends.

6. Acknowledgements

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