بسم الله الرحمن الرحيم

"وقل اعملوا فسيرى الله عملكم ورسوله والمؤمنين"(التوبة:105)

The Design of a Context Aware Mobile Government E-Services

By Lulwah Muhammad Al-Harigy

A thesis submitted for the requirements of the degree of Master of Science in computer science

Supervised By

Dr. Hana Abdullah Al-Nuaim

FACULTY OF COMPUTING AND INFORMATION TECHNOLOGY
KING ABDULAZIZ UNIVERSITY
JEDDAH - SAUDI ARABIA
Safar 1436 H- November 2014 G

The Design of a Context Aware Mobile Government E-Services

By
Lulwah Muhammad Al-Harigy

This thesis has been approved and accepted in partial fulfillment of the requirements for the degree of Master of Science in Computer Science

EXAMINATION COMMITTEE

	Name	**Rank**	**Field**	**Signature**
Internal Examiner	Dr. Anas Fattouh	Associate Professor	Automatic Control	
External Examiner	Prof. Abdulrahman Al-Khalaf	Professor	Communications, Electronics and Physical Meteorology	
Advisor	Dr. Hana Al-Nuaim	Associate Professor	HCI & Usability Engineering	

KING ABDULAZIZ UNIVERSITY
Safar 1436 H- November 2014 G

Dedication

This work is dedicated to my parents who taught me the value of learning and have been a source of support and inspiration throughout my life, this effort is the result of their endless love, caring, and praying.

To my husband for his love, patience and support.

To my sisters and brothers for their help and encouragement.

To my children who lighten up my life.

To all those who believes in me.

Chapter I

Introduction

The last ten years has seen unprecedented advancement in the use of mobile handheld devices. The use of the mobile device as a generic tool in everyday life increased because of major technological developments that enable more complicated functions and services to be integrated. According to the rapid development of wireless communication and portable devices, tremendous accomplishments happened in a short period of time (Sanou, 2013). Nowadays, mobile phones are no longer used for only voice communication; they are used for a wide range of uses such as (Kjeldskov & Paay, 2006) (Lentz, 2011):

- SMS (Short Message Service) and MMS (Multimedia Messaging Service)
- Social networking
- WAP (Wireless Application Protocol) and miniature web browsers
- Business applications for time management and mobile access to cooperate information
- GPS (Global Positioning System) route planning

- Entertainment
- Location based services
- E-Government

Between 2000-2012 the World's Internet Usage has grown 566.4% with 2,405,518,376 Internet users (Internet World, 2013). The Internet is embedded in everything and used by almost all the cultures of the world. The same trend is already being recognized with mobile devices and their applications (Rannu, Saksing, & Mahlakõiv, 2010). In 2013, there were almost as many mobile-cellular subscriptions as people in the world, with more than half in the Asia-Pacific region (3.5 billion out of 6.8 billion total subscriptions) (Sanou, 2013). In 2013, mobile-cellular penetration rates stand at 96% globally; 128% in developed countries; and 89% in developing countries (Sanou, 2013).

It has become easier to access services and information via mobile devices such as smart phones, due to mobile networks continues improvement (ICT, 2014). The 3.5G High Speed Packet Access (HSPA) continues to be deployed as wireless broadband technologies Fourth Generation (4G) emerge and advance over the next few years (ICT, 2014).

1.1. Background

In the past decade, the mobile communication revolution and the growth of wireless access have begun to make a substantial impact on economic and social development

worldwide which forced governments to improve its interactions with citizens and businesses.

As the number of mobile users increase and with mobile device facilities improvements, due to the integration of Internet access into them, the following services are gained (Rannu, Saksing, & Mahlakõiv, 2010) (Jung, 2005):

- Information is obtained on demand
- Communication with others is made easily
- Everywhere connectivity has become a reality

Cheap and ready-to-use mobile devices are removing existing barriers and are empowering citizens to connect to governments to access a wide range of information and services in a number of policy areas, *e.g*. legal information, health, education, finance, employment, transportation and public safety (Rannu, Saksing, & Mahlakõiv, 2010) (OECD/ITU, 2011). More citizen-related services are offered via mobile devices due to the opportunity that mobile phones offer which pulled more people into the wireless world (Rannu, Saksing, & Mahlakõiv, 2010).

The use of the mobile phones offers a wide range of possibilities for interaction and participation between citizens and local authorities (Avila, 2006). Those technologies can be explored and exploited by many in order to promote and improve this interaction, supporting and creating novel ways of communication and taking as advantage of mobility as much (Avila, 2006).

Some of the potential benefits of using mobile technologies is the provision of public sector services which include increased channels for service interaction between government and citizens (Alijerban & Saghafi, 2010) (Carroll, 2006). A mobile government can be considered as a complementary for E-government and is implemented to provide information and services for government employees, citizens, businesses, and other organizations through mobile devices (Wang, Lu, Feng, & Fang, 2011). M-government has been exploited over the past few years as a means to provide an additional flow of information and public services to citizens beside the conventional e-service delivery channels (Al-Hujran, 2012). E-services are those services that can be delivered electronically over electronic networks (Evanschitzky & Iyer, 2007). M-Government can help to improve a government's performance, strengthen public good governance and improve the quality of life of many individuals by affording powerful and transformational capacity to the public sector who were previously excluded (OECD/ITU, 2011) (Carroll, 2006). There are, however, more important reasons for demanding M-Government (Rannu, Saksing, & Mahlakõiv, 2010):

- Wider reach. Public services that are offered via mobile phones are available to a greater number of people
- Always carried, always on. Public services that are offered via mobile phones are accessible everywhere and at all times because people carry their mobile phones with them all the time. This is especially important in case of urgent messages and crisis communication.
- More personalization for targeting users. Information reaches to the preferred receiver at any time through one specific device.

- Solutions to the digital divide. Information and public services can travel along with citizens while computers do not because of the immediate availability of mobile devices and/or services. Moreover, m-government is particularly suited for the developing world where mobile phone penetration is growing rapidly

A user's experience with a mobile application can be influenced by diverse, interrelated factors such as movement and lighting conditions, screen size, application type, the mode of user input and social considerations or context (Davies, 2007). Mobile handheld devices constitute an interesting platform for context-awareness because they are used in different kinds of situations, where the preferences of users may vary, and where different features are prioritized (Häkkilä, 2006). Context-awareness can facilitate the device use in demanding situations by dynamically adapting the device's behavior (Häkkilä, 2006). A context-aware application cannot be fully evaluated without the use context, as adaptation to the changing context is a fundamental part of their functionality (Häkkilä, 2006).

Interaction design in a context-aware application becomes critical when developing products to large audiences, as poor design may e.g. bring up disturbing or privacy violation issues (Häkkilä, 2006). The context of mobile computing is more varied and more dynamic than that of desktop-based computers (Davies, 2007).

1.2. Statement of the Problem

During the past few years, mobile technologies have experienced a huge increase in terms of popularity and due to the improvements of mobile technologies, the smartphone

was introduced. The current revolution of mobile technologies is mainly substantiated by two factors (Zefferer, 2011):

1. For higher data transmission rates at lower costs and that is due to the increased bandwidth of the mobile communication networks.
2. The reduction in size of the electronic components which facilitated the development of powerful mobile handheld devices.

Governments must have procedures to deliver the services and information to their citizens fast and efficiently especially in emergency cases. Due to the small size and the large potential of mobile devices, the citizens use them in many situations such as checking the weather condition, traffic jams, or conduct government transactions electronically..etc. Governments can utilize m-government in the contexts of unexpected emergencies and natural disaster responses, where governments need to organize emergency and disaster management activities, collect, share and distribute information to different commands in a wide local region (Al-Hujran, 2012). Governmental organizations can deliver other information and services to the public through m-government such as information on civil affairs, small financial transactions, and electronic identifications (Al-Hujran, 2012).

The mobile web needs to be simpler than its desktop counterpart and more task-based to get the job done (Tsiaousis & Giaglis, 2008). Unlike the desktop, the portable nature of mobile devices means that the context of use may change as the user traverses different conditions of use while performing the same task (Tsiaousis & Giaglis, 2008).

Designing quality mobile web applications has its own set of complications, such as (Lentz, 2011):

1- Mobile user interfaces are a new pattern for user interaction for the following:

   - Smaller form factors
   - Touch interfaces
   - Acceleration sensing
   - Orientation awareness
   - Pervasive animation
   - Simulations of physical behavior

2- Designers must consider more variables compared to designing a traditional desktop web application because a web user interface should run on any device regardless of its size, form factor, or feature set.

1.3. Motivation

If the citizen wants to interact with the government to inform them or to solicit their opinion in community related matters; they must find an appropriate person or department and this must be done within time restrictions. In many cases this could discourage the citizen from seeking a government service. As a result, governments try to improve their relationship with their citizens by providing them with other communication channels such as web portals on mobile services (Avila, 2006).

Since the variety of mobile devices, applications and networks are growing rapidly, the challenge of developing usable applications becomes more important and a critical success factor (OECD/ITU, 2011). The most promising factors in matching the service with the user and as a result of improving the usability of the services are personalization and adaptation of services for different users, different context of use and different devices (Kolari, et al., 2004).

The importance of context awareness appears when the citizens may have to provide, or are asked for, information about their current situation such as a traffic jam, a crash, a fire and other emergencies (Avila, 2006). The challenge is to allow the citizen to react immediately, in the right place and at the right time. Such spontaneous participation inside a community can be seen as a challenging application area (Avila, 2006). As an example, in the case of floods, such as what happened in many areas in Jeddah city in Saudi Arabia in 2013, the local government did not have ways to evacuate citizens from areas that were exposed to such disasters and also to inform them where to go nor what to do in such situations.

Therefore, the primary design challenge for mobile web applications is how to create a good and efficient user experience for a website that appears on screens measuring from a few inches square taking into account different context of use such as users' mobility, the environment around them and the physical characteristics of the mobile device used. For the purpose of this research, the definition of user experience (UX) adopted was from Hassenzahl and Tractinsky (Hassenzahl & Tractinsky, 2006) where their define UX as an effect of:

- A user’s internal state such as the user's readiness, user's expectations, needs, motivation, mood, etc..
- The characteristics of the designed system such as the system complexity, purpose of the system, usability, functionality, etc..
- The context or the environment around the user within which the interaction occurs such as organizational or social setting, meaningfulness of the activity, voluntariness of use, etc..

To understand the UX during the interaction phase, three components must be taking into account: the user, the context and the system being used (Hassenzahl & Tractinsky, 2006). To improve product UX, the focus should not only be on the system component but rather must include context and the user, and in order to provide the best UX, the system should adjust to the current context as well as to user’s current needs and expectations.

Due to context issue, M-Government user interface designers and developers must fully understand the usability risks and challenges involved in providing users with efficient and comfortable experiences and not simply use mobile builder tools to transform an existing website into a mobile version (Al-Nuaim, 2014).

Mobile web builder tools are web-based tools used to develop mobile version of websites and can be used by ordinary users without needing minimal programming background.

The main motivation of this research is to provide citizens with a good and efficient user experience for government mobile websites within the context of their use.

This research is motivated by many factors:

1. The lack of researches in this area.
2. The importance of usability for mobile governments.
3. The current guidelines of m-government didn't take into account the context of use and the mobility of the users.
4. The need for mobile governments to facilitate and improve the interaction between the government and citizens in the emergency situations.
5. Most cities or local governments usually have small financial budgets to provide basic, daily services for the citizens. Citizens expect to find most government services provided on the E-Government website. Yet lack of funding and lack of expertise on website design and development, the government often fails in providing an efficient and good user experience for their E-Government website. This problem has been compounded since most e-services are migrating to mobiles and hand held devices. So, governments with all their limitations tend to find the easiest solution to provide their citizens with mobile versions of their websites that is usually accomplished by using free and easy to use mobile web builder tools to develop the mobile versions of their E-Government website.

1.4. Significance of the Study

Citizens use government websites as central points of access to government information and services across different agencies and they normally do so via wired Internet access (Trimi & Sheng, 2008).

Mobile devices are often used in dynamic, noisy environments while users may be moving (i.e. walking or in a vehicle) (Bonnie MacKay, 2005). These devices create opportunities for their users to complete certain tasks (e.g., taking notes, managing activities) on the go, which at the same time create challenges by introducing competition for attention between the surrounding environment and the device being used (Lin, Goldman, Price, Sears, & Jacko, 2007). This makes designing interaction techniques for mobile devices challenging, and classical approaches used on desktops may not always be appropriate (Bonnie MacKay, 2005). Governments must consider the role of mobile technology in its communication planning to meet the users need.

The user interface is one of the most important parts of any program because it determines how easily you can make the program do what you want (Ayob, Hussin, & Dahlan, 2009). A well-designed and usable mobile websites interface is critical since mobile device interface design is more restrictive than desktop interface design. The most challenging problems facing mobile interface designers include (Qian & WenDao, 2012):

- Constantly changing context of usage
- Limited user attention given to the device and application
- Mobile device user's hands are typically occupied with other physical tasks
- High mobility during tasks as well as the need to adopt a variety of positions and postures
- Interacting with devices while in motion (at high speed), driven by external environment

1.5. Objectives

The objective of this research is to compare the user experience of a mobile version of a local government website using design guidelines for context aware design with the designs resulting from three mobile web builder tools.

1.6. Purpose of the Research

Most companies, academic institutions, and organization websites are migrating towards mobile devices. Those with limited funding tend to use mobile builder tools because website developers lack experience in mobile users interfaces.

When mobile devices are used on the move, the demands for attention increase because the user's limited visual resources are split between interacting with the mobile devices and maintaining awareness of the surrounding environment (Lin, Goldman, Price, Sears, & Jacko, 2007). As the context changes, the interaction is not always the primary task (Lin, Goldman, Price, Sears, & Jacko, 2007). For example, on a crowded street the primary task may become to navigate through the crowd and the interaction becomes a secondary task (Lin, Goldman, Price, Sears, & Jacko, 2007). Therefore, the purpose of this research is to investigate if the M-Government mobile version of the Presidency of Meteorology and Environment PME website developed by using mobile design guidelines taking into account the context of use produced a better user experience compared to the mobile versions of the PME website developed using mobile web builder tools.

Formally stated:

Regarding an improvement in user experience:

H1: *There are statistically significant differences between the mobile version of the PME website developed by using mobile design guidelines taking into account the context of use and the websites that are developed by using mobile website builder tools for each task given to users during usability testing.*

H2: *There are statistically significant differences between the users performance on the proposed version of the PME website and the websites that were developed by using mobile website builder tools when the order of testing of the three versions was interchanged*.

Where PME is the website for Presidency of Meteorology and Environmental used as the sample website for this research. The reason for choosing PME will be discussed in detail in Chapter 4.

1.7. Research Project Design & Methodology

1- Identify major challenges for M-government when compared to e-government.

2- Review the literature for mobile design guidelines for context aware design.

3- Choose a local government website from a selection of major cities is KSA based on certain criteria for e-government related to context aware services.

4- Choose two mobile website builder tools that fit the criteria discussed in the review of literature.

5- Select an average screen size mobile phone as a tool for the usability test.

6- Design a mobile version of the website using design guidelines identified in step 2.

7- Use the mobile website builder tools to convert the proposed government website into two mobile formats.

8- Conduct a formal usability test of all three versions of the local government.

9- Data analysis of user experience.

10- Conclusion and recommendation.

1.8. Scope and Limitations

Given the wide range of mobile devices and their varying capabilities, the mobile device we will use in this research is iPhone5 as an example of an iOS platform or a Samsung Galaxy s4 as an example of an Android platform because they are the most popular. The sample of this research will be local Jeddah citizens and employees from female campus of King Abdulaziz University, Jeddah, Saudi Arabia.

1.9. Thesis Organization

This thesis is organized as follows:

- **Chapter 2:** literature review of the mobile government and the context awareness.
- **Chapter 3:** represents the mobile design guidelines that collected in this thesis.

- **Chapter 4:** shows different categories of mobile builder tools and the differences among them.
- **Chapter 5:** represents the proposed mobile version that built using HTML5 and the design decision that made.
- **Chapter 6:** discuses the guidelines measurement and the methodology approach that used in this thesis.
- **Chapter 7:** shows the results of the usability testing of the proposed mobile version and the mobile versions that results from the mobile builder tools.
- **Chapter 8:** concludes the work that has been done in this study and proposes the work that can be done in the future.

Chapter II

Literature Review

The total number of mobile subscriptions in Saudi Arabia reached to 50 million by the end of the first quarter (Q1) of 2014, with a penetration rate of 165.1% (ICT, 2014). Figure 1 shows the mobile service market growth and the total subscriptions from 2006 to Q1 2014 (ICT, 2014).

According to (ICT, 2014), there are continued decrease in the number of mobile subscriptions since 2012 as shown in figure 1 and this is due to of the adoption of CITC's decision linking the sale and activation of pre-paid SIM cards with the national ID systems. The total number of subscriptions and the penetration rate is impacted as companies deactivated a large number of unidentified SIM cards (ICT, 2014).

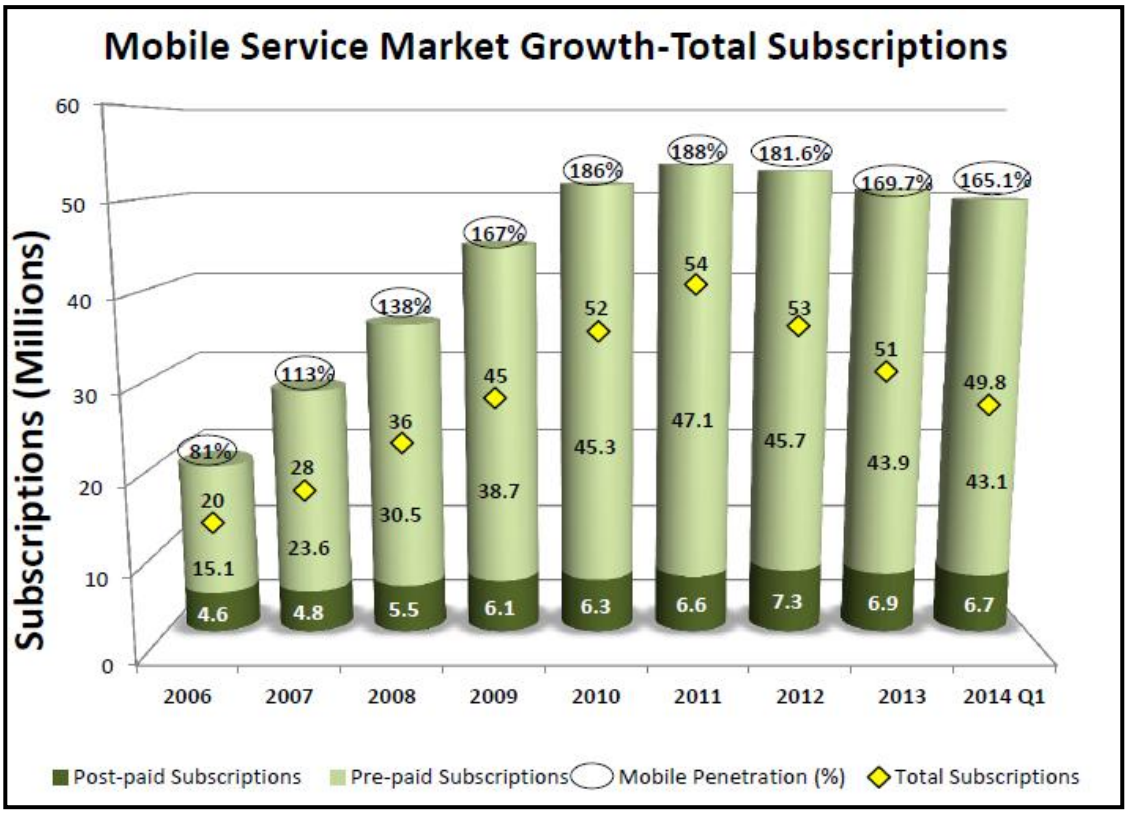

Figure 1: The Mobile subscription growth (ICT, 2014)

The number of Internet users in the Kingdom reached about 18.1 million users at the end of the Q1 of 2014 with Internet penetration 58.7% and it is expected that the demand for Internet services will increase significantly in the next few years (ICT, 2014). According to the Commission of Communications and Information Technology ICT, due to high use of social networking applications, video downloading and gaming, there is an increasing demand for Internet services and broadband that were observed.

2.1. Mobile Devices

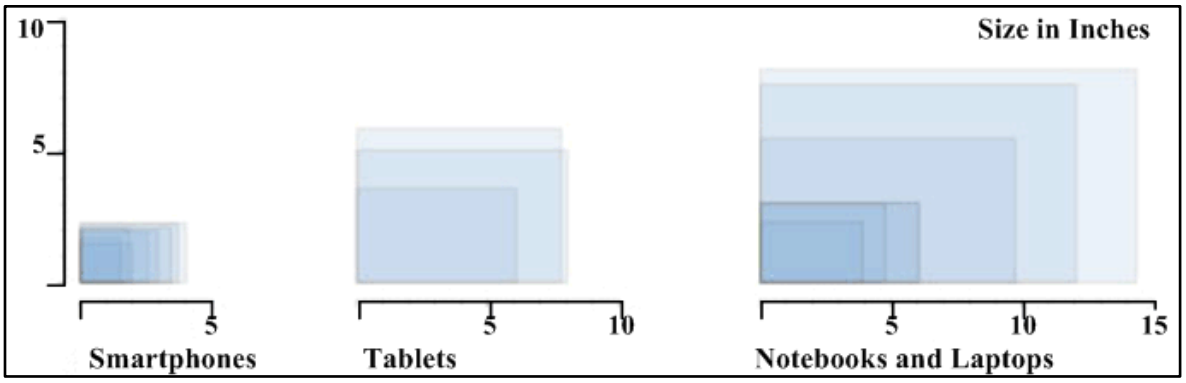

Figure 2: Mobile device displays, relative sizes (Lentz, 2011)

A small screen limits the information that can be legibly displayed (Lentz, 2011). Smartphones are small, and tablets are in the range of notebook to laptop sizes (Lentz, 2011). Mobile devices can be categorized into three main categories as follows (Al-Hujran, 2012):

- Personal Digital Assistant (PDA): Small handheld devices which combine the capabilities of personal computers and telephones. They offer many interesting functionalities such as:
    - Organizing personal schedules
    - Multimedia support
    - Recognizing text and voice input
    - Offer the user the ability to connect the Internet to check an e-mail or to search the web.

- Cellular Phones: They range from devices with limited functionalities, that are used for voice and short text message communications, to advanced devices with third generation (3G), which enable the user to connect to the Internet to:
    - Send or check e-mails
    - Browse web pages
    - Perform transactions
- Smartphones: Hybrid devices that take some abilities from PDAs and other abilities from cellular phones. Smartphones can be used for:
    - Text and voice communication
    - E-mail
    - Web access
    - Media or video player

Web use on a mobile device is different from web use on a desktop computer because the mobile web occurs in more diverse contexts than its stationary counterpart (Cui & Roto, 2008). Browsing large web pages which is not adapted for small-screen viewing is still very inconvenient (Shrestha, 2007). Although the mobile devices and wireless technology are being upgraded and providing variety of functionalities, web browsers which try to solve the interaction problems that occur when small screen devices are used to access web pages designed for large screen viewing are emerging (Shrestha, 2007). The small display size of the mobile devices limits their ability to

transmit information effectively in comparison to desktop computers regardless of increasing quality of displays (Shrestha, 2007). There are some challenges in designing a website's mobile version (Dunlop & Brewster, 2002):

1- **Designing for mobility:** As users are mobile, they are likely to have a far from ideal working environment and this environment will change significantly as if the user moves

2- **Designing for a widespread population:** Users will not normally have any formal training in their technologies and consider them as devices to be used rather than computers to be maintained;

3- **Designing for limited input/output facilities:** Screen sizes will improve in resolution but will always be small due to the need for portability. Keyboards are limited in size and number of keys and other pointing devices are often hard to use when on the move.

4- **Designing for incomplete and varying context information:** Through various sensors and networks, mobile devices can be made aware of their context and this gives new information to the systems but brings problems of implying task and user level activities from sensor information and unreliable sensor coverage. For example, work on position aware tourism guides highlight many of these problems.

5- **Designing for users multitasking at levels unfamiliar to most desktop users:** One of the keys to successful desktop design with mobile devices is multitasking

and support for task interruption. The interruption in mobile devices is likely to be much higher, given the environments in which the devices will be used.

The users need to have an experience that's more transactional than browsing-based. “Mobility” and “wireless” are two unique characteristics that made the advantages of M-technology (Trimi & Sheng, 2008). The interaction between the user and the mobile device is not always the primary task as the context changes (Lin, Goldman, Price, Sears, & Jacko, 2007). For example, on a crowded street the primary task may become to navigate through the crowd and the interaction becomes a secondary task (Lin, Goldman, Price, Sears, & Jacko, 2007). This point is critical to the success of the mobile sites because it may not know where the users access the website from (MobiThinking, 2013).

When it comes to usability while using mobile devices for web related activities, context is everything. The usability of a mobile website may be further obstructed by the context within which device use takes place (MobiThinking, 2013). Mobile websites have different menu hierarchies, smaller sizes, and fewer images than their desktop counterparts (Zefferer, 2011). Such design choices are necessitated by the characteristics of the client device, such as small screen size, limited input capabilities, and limited Internet connection speed, thus potentially leading to the increase usability problems (Zefferer, 2011) (MobiThinking, 2013).

The characteristics of locations where the mobile phone use may take place such as home, work, on the move, alone or with others may include several types of distractions like background noise, ongoing conversations, cars and people that pass by, and so on

(Tsiaousis & Giaglis, 2008). These distractions require the user's visual, auditory and/or cognitive resources, which are also necessary for the mobile web browsing task (Tsiaousis & Giaglis, 2008). The competition between the task that the user will do and the distractions may reach a point where the user's awareness, memory and attention resources are overloaded, thus decreasing user performance and hence the usability of the web browsing task (Tsiaousis & Giaglis, 2008).

2.2. M-Government

M-Government and E-Government are not two separate entities; M-Government is a subset of e-Government which extends E-Government benefits by releasing the latest edge of technologies from its minimal requirement, which is a personal computer (PC), to wireless technology as shown in figure 3 (Hassan, Jaber, & Hamdan, 2009) (Al-Hujran, 2012).

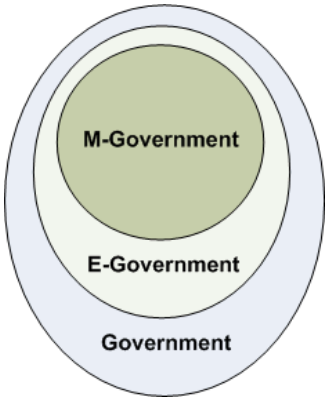

Figure 3: M-Government as part of E-Government (Hassan, Jaber, & Hamdan, 2009)

It is considered as a supplementary approach to deliver governmental services through different transmission channels and technologies anytime and anywhere (Al-Hujran, 2012) (Hassan, Jaber, & Hamdan, 2009). E-Government refers to government's

use of information technology to exchange information and services with citizens, businesses, and other arms of government (Kumar & Sinha, 2007). E-Government includes usage of all technologies to deliver services to citizens and improve the activities of government and make their processes more efficient (Mengistu, Zo, & Rho, 2009) (Wang, Lu, Feng, & Fang, 2011). On the other hand, M-Government is an add on to the E-Government confined to use of mobile technologies such as mobile phones, PDAs, Wi-Fi enabled devices, blue tooth, wireless networks in delivering services. It can help make public information and government services available "anytime, anywhere" to citizens and officials (Kumar & Sinha, 2007). With M-Government, citizens are able to save time and energy by further accessing the Internet and government networks through mobile phones and other wireless devices (Kumar & Sinha, 2007).

There are some basic differences between E- and M-Government service deliveries which pose challenges for implementation and acceptance of M-Government (OECD/ITU, 2011). E-Government involves information to geographically diverse but technologically homogenous information and communication technologies (OECD/ITU, 2011). In contrast, M-Government involves interaction in which the use contexts are unknown, where accessing government services might be one of several activities being undertaken, and where the physical constraints of interacting with mobile devices limit the amount and type of information that might be located and accessed (OECD/ITU, 2011).

M-Government services can provide particular support and solutions for citizens, as follows (Mengistu, Zo, & Rho, 2009):

- Mobility and ubiquity. This characteristic means the ability of the citizen to reach the government information and services anywhere and anytime.
- Provision of location-based government services. The ability to determine a person's exact physical location and provide location based services creates new opportunities.
- On-time information delivery. Specific benefits of mobile devices, such as real-time connections and fast access can efficiently serve producers who need crucial and certified information.
- Ease of use. Due to the enhanced level of customization and personalization of mobile devices, they are handy and therefore can be easily adopted
- Improving emergency management. Mobile and wireless technology can be used to the transmission and propagation of crucial information timely.

The main factors for the emergence of M-Government solutions are (OECD/ITU, 2011):

- Wider acceptance of mobile technologies by the public sector
- Penetration of mobile devices
- Ease of use for citizens
- Easier interoperability
- The fact it can bring governments closer to citizens
- M-Government services are cheaper than computer-based services

Most inquiries to government from citizens are for basic service information which enables real-time communications to citizens, and creates cost savings for government (OECD/ITU, 2011). Services can be related to (OECD/ITU, 2011):

- General information for citizens (e.g. weather, tourism, recreation, health, public safety, contact information, services, regulations)
- Specific information (e.g. exchange rates, market rates, exam results, events and programs, news, road closures, holiday schedules, public hearing/meeting schedules, service or fee changes)
- Emergency alerts (e.g. severe weather, terrorism, fires, accidents, health risks)
- Health and safety education (prevention and preparedness)
- Educational programs
- Notifications (e.g. library book deadlines, security notifications, social media posts, RSS feeds for news and updates)

Because users may use government services through their mobile phones while moving, we must take into account the environment and the distractions around them. The M-Government can be applied for one or more of four main purposes in the public sector (AlThunibat, Zin, & Sahari, 2010):

- M-Communication: Improving communication between Government and Citizens i.e. (G2C) and (C2G)

- M-Services: The M-Transaction and M-Payment. M-Government provide a hannel between government and citizens and also enable G2C transactions
- M-Democracy: The M-Voting and the use of mobile devices for citizen input to political decision making is an M-Government application with great potential to enhance democratic participation.
- M-Administration: Improving internal public sector operations.

M-Government is an emerging trend in public service delivery and is part of a broader phenomenon of mobile enabled development (m-development) (Mengistu, Zo, & Rho, 2009). It creates and guarantees mobility and portability for the public, business, and government (Mengistu, Zo, & Rho, 2009). Furthermore, it is convenient in accessing information, due to its real-time access, and personalization of information which guarantee to maximize benefits of using information and, in turn, create further advanced E-Government services (Mengistu, Zo, & Rho, 2009). The followings are some of the attractive features that prompted a shift towards M-Government: in developing countries (Mengistu, Zo, & Rho, 2009):

- The number of mobile users and increasing penetration: more people than ever have ownership of mobile devices capable of accessing e-services and e-contents.
- Mobiles connecting people to the Internet: in some countries, urban users are using mobiles to receive an "Internet experience" through Wireless Application Protocol (WAP) services provided over General packet radio service (GPRS).
- Mobility: enables people to access content wherever they are.

- Inclusiveness and remote area access: mobile phones, can reach those areas where the infrastructure necessary for Internet services or wired phone services is difficult to setup. In the developing countries mobile government applications may become a key method for reaching citizens in far and wide areas and promoting exchange of communications. In such countries with insufficient conventional telecom infrastructures and greater acceptance of mobile phones, the ability of reaching rural areas may be considered as an important feature of M-Government. Mobile technologies increasing inclusion of the most marginalized people in society.
- Low cost: mobile phones are a relatively low cost technology, which common people can afford to have as compared to Internet technology.
- Ease of learning: Usage of mobile devices is fairly simple thus making it easy for any common person to use and access information.
- Easy infrastructure setup: New mobile phone networks can be easily installed in countries where infrastructure is an issue and less economic constraint due to the simple architecture of mobile telephony.
- Improvement on E-Government effort: M-Government is a complementary to E-Government and not a replacement to it. It helps in expanding the scope of e-Governance in many areas like e-Democracy, e-Participation, e-Voting and provides a communication channel between the citizen and the government.

Although all of M-Government benefits and the essential and necessary role of the mobile devices in our lives, there are some challenges, however, that must be addressed before government uses such an approach:

- Physical limitations: mobile devices have some physical limitations such as small screen size, limited text input, buttery life etc which restrict and limit the amount of information that can be sent or received by mobile devices (Rannu, Saksing, & Mahlakõiv, 2010) (Mengistu, Zo, & Rho, 2009).
- High cost of Internet use on mobiles: M-Government creates additional cost because it is another channel for E-Government. For example, in Ghana it can cost a user $532.48 to download one gigabyte of data over one operator's GPRS network (Rannu, Saksing, & Mahlakõiv, 2010) (Mengistu, Zo, & Rho, 2009).
- Privacy and Security: citizens have a great concern about the privacy and security in M-Government. The general issue is the assurance that their mobile phone numbers might be traced or hacked, when they send their opinions and inquiries to the government or do some transactions so they want the government agencies to safeguard their key data from moving into the hands of unauthorized agencies or hackers. The government must overcome the mistrust, and assure mobile users that their privacy is protected and the information will not be sold to third parties (Rannu, Saksing, & Mahlakõiv, 2010) (Mengistu, Zo, & Rho, 2009).
- Responsibly managing exponential amounts of information and data overload: users of mobile phones are permanently connected "always on" which increase the pressures of a world. These permanent connections increase the number of

messages circulating and can create a storm of communications - some messages are valuable, some not - in which public service communications can come to be devalued or lost (Rannu, Saksing, & Mahlakõiv, 2010).

- Resistance to organizational change: many people resist the acceptance of this new approach for many factors such as habits, fear of the unknown, security and economic (Rannu, Saksing, & Mahlakõiv, 2010).

There are many guidelines that are available for designing a usable website for government e-services which may not all be applicable to mobile devices. The guidelines that are available for government mobile website are few and upon review the literature most did not take into account the context of use. Guidelines for M-Government website are needed that provide a good and efficient user experience.

Estonia is on the forefront of the world with its E-Government and M-Government initiatives (Rannu, Saksing, & Mahlakõiv, 2010). Estonia‘s mobile market is one of the most penetrated in Eastern Europe, with SIM card penetration exceeding 100% with many mobile networks offering e-services (Rannu, Saksing, & Mahlakõiv, 2010). Estonia has also adopted SMS tools as powerful and convenient ways to provide communication channels between government offices and citizens (Rannu, Saksing, & Mahlakõiv, 2010). This achievement of Estonia is because of the readiness of the Estonian government to quickly implement new technologies (Rannu, Saksing, & Mahlakõiv, 2010).

"*Tartu mCity is a project by Tartu City Government that aims at making the life in Tartu better by introducing, piloting and implementing new mobile solutions in various areas of city life: from public transport and neighborhood watch to education and healthcare*" (Rannu, Saksing, & Mahlakõiv, 2010).

Tartu is the second largest city in Estonia, where the services are developed in collaboration with the Tartu municipality, local and international companies, public institutions, universities and other m-cities across Europe (Rannu, Saksing, & Mahlakõiv, 2010). Some of the services that Tartu mCity provides are (Rannu, Saksing, & Mahlakõiv, 2010):

- ID-ticket/Mobile transport ticketing: in 2003, Tallinn and Tartu started to develop the electronic payment system in the sector of public transportation.
- Exam results by SMS: the first mobile SMS-based service that succeeded very well in Estonia was about notifying students about their high school final test results. The service has been popular since it was introduced in 2004. In 2007 there were altogether 24586 examinees taking 56118 exams. 15538 of them ordered SMS notification service and in sum, 37910 SMS notifications were sent out.
- Mobile parking: mobile parking is a fast and easy way to pay for parking in the districts of paid parking in five bigger Estonian cities (Tallinn, Tartu, Pärnu, Viljandi and Kuressaare). Payments are included in the mobile phone bill and there is no need to fill in special parking forms.

- M-neighbourhood watch: this service is for sending SMS notifications on issues such as missing persons, stolen car...etc that require watchful eyes. The messages are sent by the police control center to taxi and bus drivers, security companies and other active people who can participate in making Tartu safer. The service has been actively used especially in finding missing persons and the relevant cases have been covered also in the media.
- M-library: the m-library is a good example of how everyone can save time and resources by using small mobile solutions. If a person wants to borrow a book, movie or audiotape which is currently not available, he or she can register and receive an SMS when it becomes available.

The project of USE-Me is an example of M-Government services and its vision for European Citizen (Tsiaousis & Giaglis, 2008). Its aim is to support and encourage public administrations to provide new E-Government services and make all government services acceptable by the citizens at anytime and anywhere through the use of mobile communications technologies employing an innovative next-generation open service platform for mobile users (Abramowicz, et al., 2005) (Antovski & Gusev, 2005). This project is based on a few selected service types with universal applicability and potential impact for different countries and regions (Antovski & Gusev, 2005). The new platform will support usability, openness, interoperability and scalability (Antovski & Gusev, 2005). The results of this project obtained so far have shown that such properties rely on four major requirements (Abramowicz, et al., 2005):

- A comprehensive user requirements analysis: which is critical in order to create useful and efficient services that fit user characteristics, needs and conditions of use.
- An iterative and multi-disciplinary design process: design iterations are basically required since user requirements cannot be fully established at the beginning; making a service more concrete through scenarios, mock-ups and prototypes achievement, which is necessary to enrich the initial user requirement analysis and find the best solutions. Since knowledge in the field of mobile user interfaces is still incomplete to correctly predict users' behavior and opinions, the user participation in the design process is also required especially through usability test.
- Simplicity of the service: a major requirement to create easy-to-understand and easy-to-use services on mobile devices. This requirement is mainly due to three factors that should be applied to many citizen mobile services:
    1. Infrequent use which means that users always need to be appropriately guided through the service
    2. Input and output constraints such as reduced screen size and few keys
    3. Mobile use conditions, which are typically less convenient than at the office or home and with far more distraction
- Contextual adaptability: made possible by multimodal interfaces and context-awareness capabilities. Such a requirement accounts for the users' need to adapt their use to various devices and various contexts and improve user interaction (e.g. alleviating text input tasks).

2.3. Context-Awareness

Context is defined by A. Dey and G. Abowd (Abowd, 2000) as

> "*Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves*".

There are many types of context such as location, identity, activity (or environment) and time (Abowd, 2000). Context includes lighting, noise level, network connectivity, communication costs, communication bandwidth and even the social situation (Davies, 2007).

Context-awareness is often defined in relation to an application or computational services which are the ability to detect and sense, interpret and respond to the characteristics of a user's local environment (Yaiz, Selgert, & Hartog, 2006). It is also defined as a state where the device is aware of the situation in which it is used (Häkkilä, 2006). Context-aware applications look at the *who*'s, *where*'s, *when*'s and *what*'s the user is doing of entities and the using of the information to determine *why* the situation is occurring (Abowd, 2000). This technology has gained an increasing amount of attention in recent years; it may offer solutions to more efficient use of mobile applications and services while the increasing complexity and growing number of features set challenges to intuitive and easy use of devices (Häkkilä, 2006). It has appeared as an important and eligible feature in distributed mobile applications which deals with the ability of applications to exploit information about the user's environment

(context) in order to dynamically select and execute relevant services that better match the user needs (Costa, Pires, Sinderen, & Filho, 2004).

A context-aware device can infer the use condition, and adapt its behavior according to the circumstances (Häkkilä, 2006). Mobile handheld devices constitute an interesting platform for context-awareness because they have been highly adopted by large user groups especially in the form of mobile phones (Häkkilä, 2006). They are used in different kinds of situations, different users' preferences, and different prioritized features (Häkkilä, 2006).

Context awareness can facilitate the device's use in demanding situations by dynamically adapting the devices' behavior by appropriate means (Häkkilä, 2006). In short, context-awareness aims to provide users with better services and adapt the behavior of the device by using and handling of the contextual information.

Exploiting the changing environment with a new class of applications that are aware of the context in which they are run is one challenge of mobile distributed computing (Davies, 2007). Because context-awareness offers possibilities, it has been proposed as a potential step for future technology development (Häkkilä, 2006).

According to (Al-Nuaim, 2014), the challenges of the context-aware issues that designers face can be categorized into three groups:

- The mobile device and user behavior while using it.
- The usability of the mobile website design.

- The user interaction with the mobile website.

Therefore, the general needs of a context aware system are (Avila, 2006):

- Context acquisition: how to obtain the contextual information.
- Context representation: how to organize and store the context information.
- Context use: how to use the context information in an appropriate manner.

Content adaptation is a key part in the process of designing M-Government applications because we have to adapt the content presentation to meet the user preferences and the different capabilities and limitations of mobile devices and wireless technologies that are used by different users (Kumar & Sinha, 2007). We have to take into consideration four main contexts to adapt the M-Government content which are: personal context, mobile device context, connectivity context and location context (Kumar & Sinha, 2007):

- Personal context includes any information that is used to describe the user personal characteristics and information's such as name, gender, date of birth and his service and content preferences.
- Device context is any information that is used to characterize the user's mobile device. It is a critical issue to specify the user device capabilities in M-Government applications because they can have a big impact on what content is appropriate and meaningful to be delivered to the user such as small screen context and mobile device characteristics context.

- Connectivity context means that we have to specify the type of wireless technology that the user will use because each of them has different data transfer rate such as network connectivity context.
- Location context includes any information that describes the user location or any information related to their location such as lightning conditions context and social situations context.

Juha et al (Kolari, et al., 2004) have developed the project "Kontti – Context-aware services for mobile users". The project was part of the "NETS Networks of the Future" research program run by the National Technology Agency of Finland (Tekes). Kekes and VTT Information Technology financed the project with three companies: Nokia, Radiolinja and Teamwave (Kolari, et al., 2004). The results of the Kontti project indicated that the most promising applications for context-aware services are event guides and professional use (Kolari, et al., 2004). Further, contexts can be used for opening new communication channels for messaging and as a mediator where any recipient can pick up a public message (Kolari, et al., 2004).

Jesper and Jeni (Kjeldskov & Paay, 2006) have outlined an ongoing research activity into the challenges of interaction design for context-aware mobile computer systems. They have proposed the concept of indexicality as an interesting new approach to the interaction design for this emerging class of mobile systems, and have outlined three examples of context-aware prototype systems where this concept has been deployed in practice and evaluated through user studies (Kjeldskov & Paay, 2006).

The key requirement to develop and deploy a Context Aware Mobile Government Application is presented by Ariza Avila (Avila, 2006). The Context Management application was developed using open standards to communicate with other applications. A real scenario in Vila Nova de Cerveira was also modeled and represented (Avila, 2006). Vila Nova de Cerveira is a municipality in the district of Viana do Castelo in Portugal. In this scenario two hundred and twenty objects were modeled including public equipment, relationships and services (Avila, 2006). They faced some challenges in the development process such as how the context aware application must interact with the Context Manager application (Avila, 2006). One of the advantages of the researcher's general approach is the freedom to use the Context Manager in several ways, by modifying or creating new interaction models and by adding different selection algorithms for object querying (Avila, 2006). The researcher faced another challenge in the deployment of the solution which was the provision of context information which is obtained the location context dimension of mobile phones by the cell identification from the mobile phone 56 operators (Avila, 2006). The solution for the location information was to create a service that feeds the location to the model using as a source GPS embedded in the mobile device (Avila, 2006).

Jonna H. (Häkkilä, 2006) had studied the user interaction issues related to context-aware mobile devices by conducting several case studies, which relate to location-awareness, information sharing and collaboration, privacy, and end-user programming with context aware mobile applications. These studies were used as the basis for developing design guidelines, which were then evaluated and iterated. The revised guidelines seek to offer some tangible help to designers, who are not necessarily

specialized either in context awareness or interaction design (Häkkilä, 2006). The design guidelines include factors related to the uncertain character of context awareness (Häkkilä, 2006). The user maintains control over the device in any situation because an appropriate level of automation for executing actions needs to be selected, and user control secured (Häkkilä, 2006). In relation to the uncertainties in context recognition, user control and user's interruptability must be balanced and appropriate visibility to system status provided (Häkkilä, 2006). As context-awareness may generate or offer access to large amounts of data or services, it is important also to avoid information overflow (Häkkilä, 2006). Moreover, the application design should respond to the user's needs on personalization and privacy, and to take into account the restrictions of the social context of the use situation (Häkkilä, 2006).

Oscar L. (Lundahl, 2009) provided some suggestions on interface design for mobile devices which were results from the design process of a prototype for mobile shopping. Additionally, the evaluation of a number of guidelines and methods for usability would show which could be used most efficiently (Lundahl, 2009). The tests and evaluations of the prototype provided suggestions for the improvement of the prototype (Lundahl, 2009).

Mobile use conditions which are typically less convenient and are far more distractive at the office or home and Contextual adaptability made possible by multimodal interfaces and context-awareness capabilities.

2.4. Mobile Website Usability

Usability of the website is the process of measuring and managing ease of use for users interacting with a website (UAE, 2009).

ISO 9241-11 defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of user." This definition identifies 3 factors that should be considered when evaluating usability (UAE, 2009) (Harrison, Flood, & Duce, 2013):

- **The Users:**

  The organization needs to know who is using the website, what is their skill level and how much the users have relevant experience.

- **The Organization and User's Goals:**

  To meet the organization and user's goal, we need to answer the following questions:

  What are the organization's objectives and requirements?

  What do users require from the website?

  Does the website address their needs?

- **The Usage Situation (or 'Context of Use'):** It means Users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a product is used.

According to (Nielsen, 1993), there are some attributes of usability that should be considered:

1. **Learnability:**
    - The system should be easy to learn so that the user can rapidly start getting work quickly with the system to accomplish basic tasks at the first time.
    - The users can navigate the website easily to find what they need.
    - The users determine where they are on the website from the navigation structure at all times.
2. **Efficiency of use:**

    Resources expended in relation to the ease of use with which users achieve goals. Ease of the website means how much time and effort is required for users to achieve their objectives when using the website.
3. **Memorability:**

    The system should be easy to remember so that the casual user is able to return to the system after some period of not having used it without having to learn everything all over again. It means is it easier for the users to navigate the website next time if they have visited the website before because of their previous experience?
4. **Low Error Rate:**
    - How often do users make errors while on the website?
    - How serious are these errors?
    - How do users recover from these errors?

- Are these errors logged, so they can be addressed?

5. **Subjective Satisfaction:**

   It is freedom from discomfort, and positive attitudes towards the use of the product. To meet the users satisfaction about the website, the following questions must be answered:

   - How do users feel about their interaction with the website?
   - How much do users like using the website?
   - Will users return to the website?

One of the biggest issues in designing a mobile website is the context in which they are used although developers sometimes ignore the fact that users will want to interact with such devices while on the move. (Harrison, Flood, & Duce, 2013). As the mobile devices are designed to enable users to use them while mobile, the effect of using them on the mobility of the user is a critical factor to the success or failure of the website especially for websites that have important information and must be used accurately (Harrison, Flood, & Duce, 2013). Some of the issues that need to be considered when designing for small, portable devices are small screen sizes, limited connectivity, high power consumption rates and limited input modalities (Harrison, Flood, & Duce, 2013).

2.5. Mobile Web Builder Tools

There are many types of mobile web builder tools which develop mobile versions of websites easily. Mobile web builders are useful tools for people without programming knowledge and are especially helpful developing government mobile websites in emergency situations or constant updates. Examples of such tools are Mobify developed

by Mobify Company, Mofuse developed by Mofuse Company and Dudamobile developed by Dudamobile Company.

Chapter III

Guidelines for Designing a Mobile Government Website

Citizens are faced with sophisticated mobile interfaces that provide many M-Government services (Zamzami & Mahmud, 2012). M-Government has become a relatively consensual perspective progressing towards the triple goals of (Zamzami & Mahmud, 2012):

- Providing better services to the citizen,
- Empowering the private economy both in terms of private-public partnerships or inter-enterprise capabilities at all levels and,
- Re-enforcing process flexibilitiation intra- and inter-administrative and government-wise

3.1. Mobile User Interface Limitations

Figure 4 represents the success factors for M-Government (Al-khamayseh, Lawrence, & Zmijewska, 2006)**.** The core success factors identified are as follow (Al-khamayseh, Lawrence, & Zmijewska, 2006):

- Privacy and Security
- Infrastructure
- User needs and preferences
- Quality and user friendly applications
- E-Government
- Acceptance
- Cost

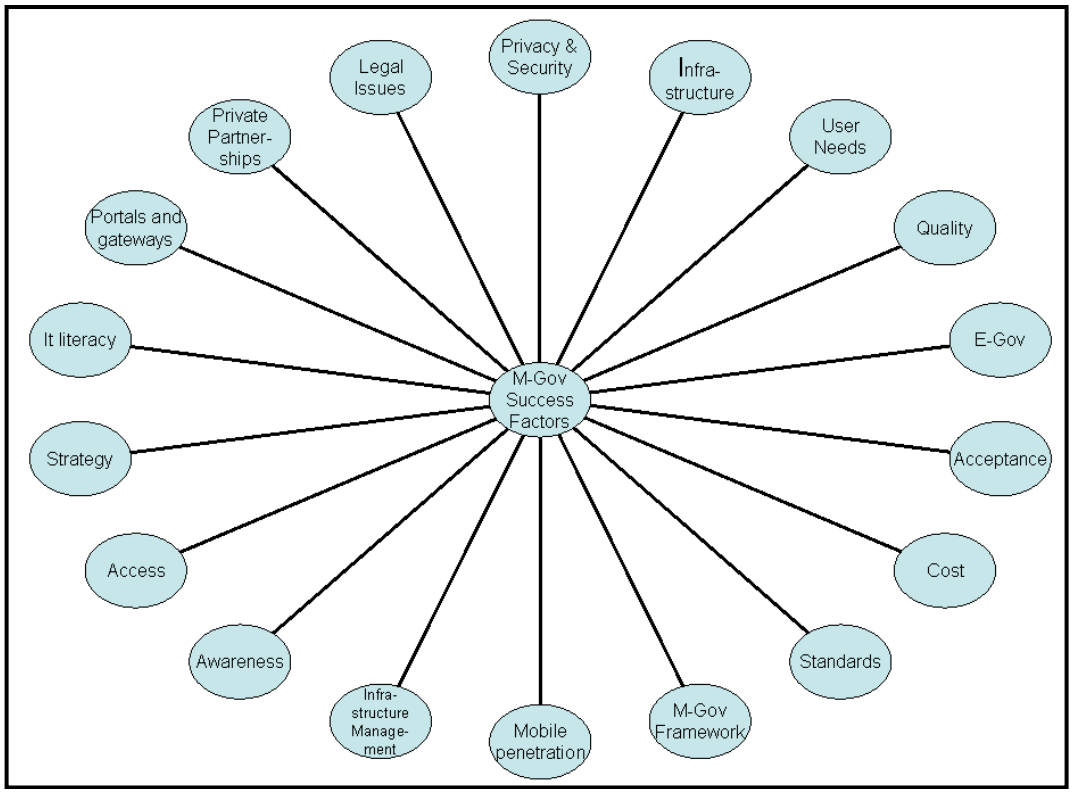

Figure 4: M-Government success factors (Al-khamayseh, Lawrence, & Zmijewska, 2006)

In comparison to desktop computers, mobile device has many limitations such as (Zamzami & Mahmud, 2012):

- Lower performance such as limited input/output

- Less convenient
- Lower multimedia and processing capabilities
- Smaller screen size that could affect the navigation activities
- Lower number of scrolling within one page
- Limited content and delivery within a page
- Short-term memory, which would limit the activities and thus subsequently cause low user performance

Context of use must contain the following elements (UAE, 2009):

- Characteristics of the intended users.
- Tasks users will perform
- Environment in which website visitors will use the system

The context use of the mobile devices has deep effects on interaction when considering users on the move, instead of users using devices (mobile or not) while sitting at a desk in their office or home. These effects show at different levels (Chittaro, 2010):

- Perceptual: there are physical parameters of the mobile user's environment such as illumination, noise, temperature and humidity, vibration and motion…etc which extremely variable, limiting or excluding one or more modalities.
- Motor: mobile conditions can harm user's ability to well control her/his controlled movements or to take specific attitudes (e.g., standing) which interfere with motor operation of the device (e.g., time and errors in selecting options, effectiveness of using writing recognition or gesture recognition software,…).

- Social: even when using specific forms would be perfectly possible from a perceptual and motor point of view, social norms related to different environments may make it impossible or unadvisable. For example, keeping sound on at a conference is not accepted, while looking at the device screen is accepted.
- Cognitive: unlike office and home environments, people in mobility conditions can apply only a very limited attention to interact with applications on the device because they have to focus to a constant flow of events and stimuli that come from the environment, some of these events can affect our personal safety (e.g., noticing potential dangers while we are in a street).

3.2. Government Mobile Website Guidelines

A user interface designed for a mobile device is the main concern in designing applications (Zamzami & Mahmud, 2012). While there has been success in developing rules to guide the design and implementation of interfaces for desktop machines and their applications, the design of mobile device interfaces is still relatively unexplored and unsupported (Gong & Tarasewich, 2004). Many public and private entities design a mobile version of their websites without basing their design decisions on powerful design approaches because there is lack of research that is concerned with finding guidelines, practices and recommendations used for designing a usable mobile government website (Al-Khalifa, 2011).

Guidelines for designing E-Government websites are used by Dubai Government, and the United Nation (UN). UAE has a set of guidelines "UAE Federal Government Web Guidelines" which is useful in designing E-Government websites.

The lack of the research in M-Government design guidelines made it necessary to collect guidelines from different sources to create a group of mobile website guidelines that can be used by governments to design their mobile website to provide their citizens good usage experience especially when they use the mobile website in dangerous situations such as natural disasters.

The proposed mobile version for a government website will be based on the following guidelines. These guidelines are divided into the following categories (Grasso & Roselli, 2005) to (Cerejo, 2012):

1. Analysis Guidelines (Table 1)
2. Page Layout Guidelines (Table 2)
3. Guidelines for Using Colors (Table 3)
4. Simplicity and Clarity Guidelines (Table 4)
5. Consistency Guidelines (Table 5)
6. Content Selection Guidelines (Table 6)
7. Visual and Interaction Design Guidelines (Table 7)
8. Guidelines for Using (Graphics) Images and Icons (Table 8)
9. Guidelines for Using Tables (Table 9)
10. Site Navigation Design Guidelines (Table 10)
11. Guidelines for Managing Hyperlinks (Table 11)

12. User Input Guidelines (Table 12)

13. Feedback Guidelines (Table 13)

14. Mobile Context Guidelines (Table 14)

For readability, a check mark ✓ was used to designate the guidelines that were followed and provided on the website developed using the mobile design guidelines.

Table 1: Analysis Guidelines

Guideline # 1	**Know your users**
Sources	(Clarke, 2012); (Kaikkonen, 2005); (Grasso & Roselli, 2005)
Description or Justification	• Design systems that are, by default, suitable for all ✓ • The developer must know the properties of the people who will use the website and try to make the website compatible with the different types of the mobile devices or at least with the most common using mobile device. • Analysis of the various contexts in which the application may be used is also very important
Guideline # 2	**Determine the purpose of the site / service and identify the primary goals of the website before beginning the design process**
Sources	(Kärkkäinen & Laarni, 2002); (Budiu & Nielsen, 2011); (U.S. Dept., 2006)
Description or Justification	• Determine the purpose of the service ✓ • Design the service based on task analysis instead of how it is designed for use with conventional computers. • Goals determine the audience, content, function, and the site's unique look and feel. ✓ • Do not build a mobile site if your full site has a shallow information structure and limited functionality. ✓
Guideline # 3	**Decide whether you need more than 1 mobile site**
Sources	(Warsi, 2007); (Budiu & Nielsen, 2011)

Table 1: Analysis Guidelines (Cont'd)

Description or Justification	• Screens and processing power on mobile phones vary extremely. If your mobile website is only going to be seen by smartphone users with fast download speeds then one mobile version will be ok. However, if you want a broader reach then you should consider creating a paired down version. • If you must build only one mobile site, build a site for the high-end phones (touch phones and smartphones). ✓
Guideline # 4	**Quick access to the full site and back**
Sources	(Seward, 2011); (Budiu & Nielsen, 2011); (Rabin & McCathieNevile, 2008)
Description or Justification	• Detect if users are coming to your site on a mobile phone and direct them to your mobile site. • You should offer clear links from the desktop site to the mobile site on the home page, as well as a link back to the full site. As for link labels, "Mobile Site" and "Full Site," is recommended respectively. ✓ • Users should be able to choose whether they want to use mobile tailored or full web content. ✓
Guideline # 5	**Ensure the site information is up-to-date**
Sources	(Dubai eGovernment, 2011); (U.S. Dept., 2006)
Description or Justification	• The information included in the website must be updated periodically.
Guideline # 6	**Provide a functional bilingual website**
Sources	(Dubai eGovernment, 2011); (UN, 2012); (NSW, 2013)

Table 1: Analysis Guidelines (Cont'd)

Description or Justification	• The government website must be provided in the native language and in English language as it is the native language by many countries. • The English language can be used by the foreigner people who use the government website because it is the most common and used language between people. • Confirm the correctness of any translated text with an expert in the language and culture before publishing.

Table 2: Page Layout Guidelines

Guidelines # 7	**Design for portrait layout**
Sources	(Zamzami U. A., 2010)
Description or justification	• Designing for small portrait mobile screens is different from deigning for large landscape layout, of desktop screens. • The problem with the landscape format is that only few lines of text can be displayed at one time, and the user will be required to scroll even for short texts. ✓
Guidelines # 8	**Divide the screen area into title, content, and navigation from top to bottom**
Sources	(Zamzami U. A., 2010)
Description or justification	• The mobile users need to know answers of three basic questions of navigation in order to make an effective interaction with the mobile user interface. The three basic questions are: Where am I? What can I do? Where can I go? • These three questions describe the basic parts of the mobile application user interface.

Table 2: Page Layout Guidelines (Cont'd)

Guidelines # 9	**The main content of the screen and the most important information should be shown at the top**
Sources	(U.S. Dept., 2006); (Zamzami U. A., 2010); (Kärkkäinen & Laarni, 2002); (Fidgeon, 2012)
Description or justification	• It is recommended to ensure that information that is the most important and central to the meaning shown at the top of the page and precedes information that is not. ✓ • Provide only the basic and minimum navigation at the top of the page if necessary. Any other secondary navigation elements, non-essential links, and marginal content may be placed at the bottom of the page if really needed, with a simple link to these selections at the top of the page. ✓ • Users should be able to see the page content once it is loaded without scrolling and they should not have to scroll significantly to find the main content of the page. ✓ • Placing distinguishing information at the beginning of pages, headings, paragraphs, lists, etc, can help the user contextualize when using devices with limited screen size, and when interaction periods with these devices is small and fragmented. • Users generally look at the top center of a page first, then look left, then right, and finally begin systematically moving down the total web page. • All critical content and navigation options should be toward the top of the page. Particularly on navigation pages, most major choices should be visible with no, or a minimum of, scrolling. ✓ • Important information should appear higher on the page so users can locate it quickly. The least used information should appear toward the bottom of the page. ✓

Table 2: Page Layout Guidelines (Cont'd)

Guidelines# 10	**Avoid using wide elements**
Sources	(Budiu & Nielsen, 2011); (Zamzami U. A., 2010)
Description or justification	• Designing mobile websites using one column layout is preferred for every thing, including data entry and wide elements, which requires horizontal srolling, should be avoided. ✓ • The designer must always try to fit the contents within the small screen width. ✓
Guidelines# 11	**Minimize white spaces on the page**
Sources	(U.S. Dept., 2006); (Zamzami U. A., 2010)
Description or justification	• If there were large areas with no contnet on the page, the user may stop scrolling, as he may think that he reached the bottom of the page and there is no more contents below. ✓ • Separating paragraphs using white spaces increases readability and information recognition and thus the user can distinguish important information from those less important. ✓ • Empty lines and blank spaces between interface elements should be minimized and each screen should be filled with usefull meterials to avoid the need for frequent scrolling of the page. ✓
Guidelines# 12	**Elements of mobile interfaces such as names, colour schemes and dialogs appearances should be the same as their desktop counterparts.**
Sources	(Budiu & Nielsen, 2011)
Description or justification	• The cosistency between the desktop and the mobile version, by using the same name of the buttons and the services, let the user to find the information that s/he needs in less time.

Table 2: Page Layout Guidelines (Cont'd)

Guidelines# 13	**Place a logo(s) in a consistent place on every page to ensure users are fully aware they are on your website.**
Sources	(Kärkkäinen & Laarni, 2002); (Dubai eGovernment, 2011); (Budiu & Nielsen, 2011); (NSW, 2013)
Description or justification	• Including the logo on every page assures the user that s/he is still on the website while browsing the website pages. • Let the user know the site is part of a cohesive set of government services by presenting a clear identity of the governemnt agency logo

Table 3: Guidelines for Using Colors

Guidelines# 14	**Limit the number of different colors used on a page**
Sources	(Zamzami U. A., 2010)
Description or justification	• Using too many colors may reduce the legibility of a presentation. • To ensure that different colours can be clearly distinguished, the coloured area must be of a sufficient size. • Smaller objects need to be more saturated to be visible • The smaller the area that is to be highlighted, the clearer the colour must be in the colour code, which means that the number of available colours for use in small screens is lower than larger screens. ✓
Guidelines# 15	**Use colors meaningfully**
Sources	(Zamzami U. A., 2010)

Table 3: Guidelines for Using Colors (Cont'd)

Description or justification	• The fact that small-screen devices are used for shorter periods, with less user concentration than full-sized screens, means that the designer must primarily use colours as a means to make the operation of the device as simple as possible. ✓ • Colors should be used to direct the user's attention that they distinguish what is important and what is not, and so helping users in making their ineraction decisions, e.g., colors can be used to distinguish clickable links from normal text. ✓ • Since mobile devices often do not have good color contrast and are often used in less-than-ideal lightening conditions, information highlighted in color may not be visible to users. ✓

Table 4: Simplicity Guidelines

Guidelines# 16	**Avoid visual noise and clutter**
Sources	(U.S. Dept., 2006); (Zamzami U. A., 2010)
Description or justification	• The page design must be simple, and not cluttered. • Visual noise distracts users from completing tasks. Visual noise may be created by misaligned controls or redundant borders of neighboring controls. • Because it is important for mobile users to gain an idea about the content of the page on the initial view, there should be minimal amount of clutter that is not central to the user's experience of the page. • Avoid using blinking text as this decreases readbility and make it harder for the user to focus on the surrounding contnet. • Reduce features as much as possible. • Only the most needed features should be included. • It should always be clear for what purpose a function is designed and how it can be used. If there is no specific need for that functionality, it should not be implemented.

Table 5: Consistency Guidelines

Guideline# 17	**Maintain consistency with the platform of use**
Sources	(U.S. Dept., 2006); (Zamzami U. A., 2010); (NSW, 2013)
Description or Justification	• Providing a consistent global interface that is compatible with the mobile platform in use is necessary, as the properties of the platform interface elements have been optimized for that particular platform. ✓ • Using the same properties of the mobile platform interface elements guarantees its usability. For example, mobile devices differ in the types and sizes of fonts that they support, using the default font type, and sizes should be consistent with individual devices' standard font types and sizes. ✓ • Due to the varied resolutions of small-screen devices, it is important to carry out carefull research into the technical specifications of the device and take this into acount when selecting the font type and size to be displayed. ✓ • Tasks performed on more consistent interfaces resulted in: o A reduction in task completion times; o A reduction in errors; o An increase in user satisfaction; o A reduction in learning time. ✓
Guideline # 18	**Apply consistent design and layout throughout the site**
Sources	(Zamzami U. A., 2010); (NSW, 2013)

Table 5: Consistency Guidelines (Cont'd)

Description or Justification	• Consistency is applied to the visual presentation of information, placement of user interface elements, and format. ✓ • Similar information, features, and functions such as navigation should be located at the same place within the interface, to ensure a consistent global interface and ease of recognition. ✓ • The localization of functions on the screens makes it easier to find them, and thus help the user to be accustomed with using the system. ✓ • The human spatial memory should be exploited on small-screens interfaces by subdividing the screen space into specific functional zones and areas, and placing tools and navigation aids at the edges of the screen. Assigning certain functions to a fixed place on the screen works, even if these functions are temporarily pushed off the screen. ✓ • Keep action buttons positioned in a set sequence. This helps the user develop familiarity and confidence, and avoid errors and frustration. • Be consistent with where you place repeated blocks, links or sections of information.

Table 6: Content Selection Guidelines

Guideline # 19	**Ensure that content is suitable for use in a mobile context**
Sources	(Zamzami U. A., 2010)
Description or Justification	• Mobile users typically have different interests and they have more immediate and goal-directed intentions than desktop users. • Users in a mobile context are often looking for specific pieces of information that is relevant to their context, rather than browsing. As an example, a user may be requiring a specific information while he is walking to a class or they may want to fill their wasted time on the bus or while waiting. • Sometimes, the users need important information and the time is very critical such as the urgent situations.
Guideline # 20	**Provide content that is engaging, relevant, and appropriate to the audience**
Sources	(U.S. Dept., 2006)
Description or Justification	• Content is the information provided on a website. Do not waste resources providing easy access and good usability to the wrong content. One study found that content is the most critical element of a website. Other studies have reported that content is more important than navigation, visual design, functionality, and interactivity. ✓
Guideline # 21	**Only the most relevant and essential information should be shown**
Sources	(Zamzami U. A., 2010); (Budiu & Nielsen, 2011)

Table 6: Content Selection Guidelines (Cont'd)

Description or Justification	• Limit content to what the user has requested and only the most important information should be displayed on mobile devices. Otherwise, important contnet might be pushed down or difficult to find among other contents. • Irrelevant information diminishes the visibility and comprehensibility of important information. • Considering the mobile use context, the user may not appreciate being distracted by excessive media objects, or unnecessary information. • The nature of user interactions in the mobile context is fragmented, and mobile users become frustrated, if they have to read a large page of contents to find the desired information.
Guideline # 22	**Use clear and simple language**
Sources	(Zamzami U. A., 2010)
Description or Justification	• Use clear terminology and as few word as possible to convey information, without losing the meaning. • This is particularly important for mobile delivery, where brevity and directness are generally more desirable than a discursive style. ✓
Guideline # 23	**Provide a short but descriptive page titles**
Sources	(Zamzami U. A., 2010)

Table 6: Content Selection Guidelines (Cont'd)

Description or Justification	• Provide a descriptive title for the page to allow easy identification of the contents, and thus to prompt the navigation efficiency. • Keep the title short, to reduce page weight. • The title of the page should be the same as the text of the link leading to it. • Titles should be unique and clearly tell about the content of the page rather than suing generic titles. ✓

Table 7: Visual and Interaction Design Guidelines

Guideline # 24	**Select the font and background color that provide sufficient contrast and would not hamper the visibility of text or links**
Sources	(Shrestha, 2007); (Seward, 2011); (NSW, 2013); (Qian & WenDao, 2012)
Description or Justification	• The use of typography, colour, contrast and font size can affect the user's ability to read comfortably, which is affected by eyesight, lighting conditions, or contrast. It becomes really important to overstate visual contrast between site elements. • Consider the devices that users may be reading the content on, with smaller interfaces, and high-glare screens such as those on smartphones and tablets. • The contrast values on smaller screens should be at least 50% to ensure good legibility in all situations. wheras a brigthness contrast of 30% is clearly legible for displaying text on larger screens. • Maintianing sufficient forground and background contrast is specially essential for important information.

Table 7: Visual and Interaction Design Guidelines (Cont'd)

Description or Justification	• With smaller text sizes, greater contrast values should be selected. • Using images or complex screen backgrounds that do not offer a sufficient constant should be avoided as it reduces the legibility of the learning material too much. • Single-color backgrounds with a high contrast ratio between the background and the foreground color are easiest for readers • Cold colors like green and blue can be used for the background, while warmer colors like red and orange can be used for foreground. • Grey is another option that can provide sufficient contrast. • Black is the most suitable font color with any background. • The use of colored text is suitable for small screens to a limited extent, because the low number of colors makes color detection more difficult, and partly because no other colour combination can achieve the same brightness as black and white. • The choice of colors can be used on different lightness, such as black, white and grey, with low saturation and high purity of the green, yellow, blue or red can give the elderly users comfort and a sense of fluency, while the low saturation and high purity of color ensure the elderly users' long time viewing without visual fatigue.
Guideline # 25	**Keep fonts large to optimize the reading process** ✓
Sources	(Seward, 2011); (Zamzami U. A., 2010); (U.S. Dept., 2006)

Table 7: Visual and Interaction Design Guidelines (Cont'd)

Description or Justification	• Due to poor resolutions of PDAs and the variable lighting conditions in a mobile context, smaller font sizes may worsen the reading process. • The impairment caused by the effect of shaking while walking also requires bigger font for better readability. • The smaller the text, the more the font should be adapted to the special features of the screen. • Text should be as clear, large, and visible as possible. • Sizing of text should be consistnet with individual devices' standard font sizes. • The selection of the font size depends on the screen resolution. The better the resolution, the smaller the font size is appropriate • The display quality and legibility of most fonts suffer below font size of 14 pt. • On larger screens, font sizes of 12 pt or bigger are preferred for extended reading. • Users preferences indicated that a font size between 10 pt and 12 pt is preferred for reading text on PDAs • A large font size of 12 pt cater the needs of most users and it has been suitable for eledery people and thus it may be suitable for walking users • The font size choice should consider the amount of text that will be presented on the screen at once
Guideline # 26	**Organize text using sub-headings and links** ✓
Sources	(Zamzami U. A., 2010)

Table 7: Visual and Interaction Design Guidelines (Cont'd)

Description or Justification	• Using sub-headings can assist users determining whether information is of interest to them, and allow them to skip it more easily if not. • Using links can assist users in determining the degree of details they want to get about the content, and thus they can contextualize their information searching
Guideline # 27	**Minimize margins** ✓
Sources	(Zamzami U. A., 2010)
Description or Justification	• Margins are determinal to good handheld display. • Reading text without margins is less preferred as it requires more cognitive load. • A wide margin will reduce the line length of the screen. • Minimizing margins may be recommended, because it will not reduce the line length of the small screen too much while requiring less cognitive load.
Guideline # 28	**Avoid having too many text styles and sizes on the same page** ✓
Sources	(Zamzami U. A., 2010)

Table 7: Visual and Interaction Design Guidelines (Cont'd)

Description or Justification	• Mobile devices often have few fonts and limited support of font sizes and styling (bold, italic etc). As a result, using any of these effects may not achieve the desired effect. • Implemetning too many different text sizes and the overuse of text highlighting styles such as italics and underlining may hinder readability. • Using blinking text should be avoided as it hinders readability and make it harder for the user to focus on the other contents • It is appropriate to use only 2 to 3 kinds of font styling • As a suggestion, the adequate use of the Bold font style is for importnat information or sub-headings, bigger font size for main-headings, and regular font for additional information.
Guideline # 29	**Organize documents so they are readable without requiring an associated style sheet** ✓
Sources	(U.S. Dept., 2006)
Description or Justification	• Style sheets are commonly used to control webpage layout and appearance. • Style sheets should not hamper the ability of assistive devices to read and logically portray information
Guideline # 30	**Ensure that text highlighting techniques are not confusable with static contents and links** ✓
Sources	(Zamzami U. A., 2010)

Table 7: Visual and Interaction Design Guidelines (Cont'd)

Description or Justification	• Choosing a specific font size and font characterstics to represent certainn types of information is usefull, to increase readability. • The varieties of colors, bold style and italicas must not cause confusion betweeen links and static contents. • Do not use color to emphasize a word or phrase within a block of text, especially blue or purple, as this may be confused with hyperlinks. • Do not use underlining except for links only. • The use of italic style is unsuitable for small screens because the slanting strokes of the characters collide with the orthogonal pixel grid of the screen, which makes the font display very irregular. • The use of bold style is suitable for small screens as long as the letter spacing is sufficient enough to ensure that the characters do not run into each other.

Table 8: Guidelines for Using Images and Icons

Guideline # 31	**Minimize the use of images** ✓
Sources	(Jung, 2005); (Budiu & Nielsen, 2011); (Kärkkäinen & Laarni, 2002); (Hassan, Jaber, & Hamdan, 2009); (UTexas, 2013); (Craig, 2010)
Description or Justification	• Reduce the number of the graphical content in the interfaces because it will increase the time that are needed to download the content and it will take a large space of the small mobile devices' screens. • If you must use images in a mobile site, make them relevant and supply meaningful ALT text so that mobile devices can use the text descriptions.

Table 8: Guidelines for Using Images and Icons (Cont'd)

Description or Justification	• Use basic, small file size images or none at all. • Picture files are usually quite large and may require too much processing capacity. Furthermore, the low resolution decreases the information value of very small images. • If you use too many kinds of colors or images, the consistency and concentration is becoming lack and the speed could be getting slow. • Don't use background images on your mobile pages.
Guideline # 32	**Avoid using large or high resolution images** ✓
Sources	(Zamzami U. A., 2010)
Description or Justification	• Use images with appropriate quality rather than filling the screen with tiny icons**.** • Make images smaller than 100 pixels and specify the image height and width in the source code. • Avoid large or high resolution images that are not displayable on the mobile device. • Large and high resolution images require too much processing capacity, and cannot be displayed without horizontal scrolling. • However, if such images are necessary to be used, their resolutions must be reduced, but not so much as to decrease their information value or to make them incomprehensible.
Guideline # 33	**Handheld mobile device's icon design should be as direct, simple and unique as possible**
Sources	(Qian & WenDao, 2012); (Jung, 2005)

Table 8: Guidelines for Using Images and Icons (Cont'd)

Description or Justification	• Icon in the interface design should be balanced and stable • Icon design must clearly distinguish from background, allowing older users to easily understand. • Button and Icon should be designed simply because when they are complicated, the content to be intended to provide is not clear.
Guideline # 34	**Icon color design cannot use more than 5 kinds of colors**
Sources	(Qian & WenDao, 2012)
Description or Justification	• We can choose gray, in order to build a concise, plain and simple visual effect. The choice of colors can be used on different lightness, such as black, white and grey, with low saturation and high purity of the green, yellow, blue or red can give the elderly users comfort and a sense of fluency, while the low saturation and high purity of color ensure the elderly users' long time viewing without visual fatigue.
Guideline # 35	**For touch phones, leave generous amounts of space around widgets such as radio buttons, arrows for dropdown boxes, checkboxes, scrollbars, and links.**
Sources	(Budiu & Nielsen, 2011); (MSDN, 2009)
Description or Justification	• The space around the widgets must be enough for the fingertip of the user. The thumb is the most common finger that used by the users in clicking. • The size of the user interface elements should be optimized for a touch screen and that can be done by leave enough spaces around the elements to make them clickable by the user finger.

Table 9: Guidelines for Using Tables

Guideline # 36	**Do not use tables unless the device is known to support them** ✓
Sources	(Zamzami U. A., 2010)
Description or Justification	• Not all mobile devices support the use of tables. • Tables do not work well on limited size screens and may result in the user having to scroll horizontally to read them. • Don't use nested tables. • Where possible, use an alternative to tabular presentation. • Do not use tables for layout: putting navigational links into tables may result in the user having both to scroll horizontally and vertically to see possible navigational choices. • Use tables for extensive numerical data
Guideline # 37	**The table width and height should not exceed the display width and height** ✓
Sources	(Zamzami U. A., 2010)
Description or Justification	• The table height should not exceed the screen size, because the column titles will not be visible after scrolling down the table. • Horizontal scrolling is not supported in all handheld devices, and so the table width should not exceed the display width. • If the presentation of a table with a height that exceed the display size cannot be avoided, then scrolling of the table should retain the headlines of the table.

Table 10: Site Navigation Design Guidelines

Guideline # 38	**Provide a consistent navigation mechanisms**
Sources	(Zamzami U. A., 2010)
Description or Justification	• Using the same navigation mechanisms across a service helps users orient themselves and to identify navigation mechanisms more easily. • Make sure that navigation button labels and positions are consistent across the website • Consistency in navigation is important as changing the navigation logic causes user insecurity feeling and frustration • As the main way to navigate forward in many mobile applications is using links, the application must be very consistent in forward navigating with links. If the navigation was not consistent, users will not be sure how to proceed in the application. • The backward navigation must be also consistent.
Guideline # 39	**Keep the number of levels in a hierarchical structure few in number (Use a flat hierarchy)** ✓
Sources	(Zamzami U. A., 2010); (Ma, 2011)
Description or Justification	• Time is critical to mobile users, and so mobile users' tasks should be fulfilled as quickly as possible. • Mobile users do not tend to navigate deep, thus, it is important that they need not to follow long link paths in order to reach the desired information. • Since every step takes longer on handheld devices, a flat (shallow) hierarchical structure of the information with fewer steps is preferred rather than the deep hierarchy. Shallow structure will support the walking user's limited attention.

Table 10: Site Navigation Design Guidelines (Cont'd)

Description or Justification	• Using simple hierarchies which are similar to the phone menus that users are already familiar with is preferred. • Simple and fast interaction should be favored as the user may interact with the device while moving or doing something else • Decreasing the amount of navigation required throughout the application is necessary to avoid the user disorientation. • The user become frustrated if it takes more than four page retrievals to reach their objective. Therefore, the structure should be kept shallow in 3-4 levels.
Guideline # 40	**Use links to the main screen and don't repeat the navigation on every page** ✓
Sources	(Zamzami U. A., 2010); (Rabin & McCathieNevile, 2008); (Lobo, Kaskaloglu, Kim, & Herbert, 2011)
Description or Justification	• It is recommended to display navigation on the main page only and to include on other pages links back to the home page. • Each screen should ideally contain a link to the main screen of the program. This is especially important since it is difficult to include all of the navigation structure on every page. • On mobile devices, the screen real state is precious, and navigtion can push contents down the screen, so users have to scroll down far on every page to get the main content. • Linking the text using hypermedia should be avoided because it requires excessive clicking for navigation which is impractical and cognitively overloading. Thus when links are to be used for navigation, they should be indicated clearly.
Guideline # 41	**Use 'back' command** ✓
Sources	(Zamzami U. A., 2010); (Fidgeon, 2012)

Table 10: Site Navigation Design Guidelines (Cont'd)

Description or Justification	• It should be easy to return to previous page using text or icons. • To move back upwards through a hierarchical structure, a 'back' or 'up' command is needed in every screen other than the main screen of the program. • To allow the user to jump to the previous section, providing 'back' function is very useful especially on those devices that do not support 'back' as a soft key, such as touch screen devices.
Guideline # 42	**Balance the choice between scrolling and paging** ✓
Sources	(Zamzami U. A., 2010)
Description or Justification	• Mobile devices typically have restrictions on the largest page they can accommodate. Devices with severe memory restrictions can only have small pages delivered to them. Equally some devices offer a poor scrolling experience and a better page retrieval experience. • Use scrolling when presenting closely related information that makes little sense to split up, and when rapid movement between different parts may be required. • Scrolling should be avoided when it moves critical information off the bottom of the screen, or when the information is not worth the effort of scrolling. • Dividing pages into usable but limited size portion is recommended. • If pages are too big they may take long time to load. • If pages are too short, then the user will be required to make multiple requests to read the relevant information. This can also lead to an unnecessary delay since each request typically takes a measurable time.

Table 10: Site Navigation Design Guidelines (Cont'd)

Description or Justification	• Take into account the trade-off between having too many links on a page and asking the user to follow too many links to reach what they are looking for. • Page scrolling if there are many links is awkward. On the other hand, each retrieval of a navigation page takes time and adds cost, so the number of links on a page should not be minimized at the expense of adding page retrievals.
Guideline # 43	**Limit scrolling to one direction** ✓
Sources	(Seward, 2011); (Zamzami U. A., 2010); (Lobo, Kaskaloglu, Kim, & Herbert, 2011); (Hassan, Jaber, & Hamdan, 2009)
Description or Justification	• Vertical scrolling is the primary scrolling direction. • Vertical scrolling is easy on most devices, while horizontal scrolling is not. • The combination of vertical and horizontal scrollbars should be avoided on small screens because it makes the navigation of complex document difficult and awkward. • Horizontal scrolling should be avoided but it may be needed to view wide elements. • If it is not possible to avoid presenting elements such as images and tables that are larger than the screen size, then consider providing these elements on a separate page with a link back to the main content instead of using vertical and horizontal scrolling together. • The advanced orientation-awareness feature available on current mobile devices could then be exploited to view the entire image in landscape format by rotating the device without the need for horizontal scrolling.

Table 10: Site Navigation Design Guidelines (Cont'd)

	• Governmental services provided in a specific web interface must be presented to the user as a menu of hyperlinks to minimize the user need to scroll the content horizontally as much as possible.
Guideline # 44	**Minimize the amount of scrolling** ✓
Sources	(Seward, 2011); (Zamzami U. A., 2010); (U.S. Dept., 2006); (Roberts, 2012)
Description or Justification	• The page should be designed so that simple repeated scrolling in the same direction (axis) allows the user to experience all its content. • Some vertical scroll is acceptable, but must be appropriate. • Each screen should be filled with useful objects and materials to avoid the need for frequent scrolling of the page. • Reducing the amount of vertical scrolling can be done by simplifying the text to be displayed using summarization and avoiding wordy messages. • Information that is over three to four screens long is often better split up into pages. • Users become frustrated if they click a link and wait for a page to be loaded that is 2 to 3 lines of text, even if the previous page was 4 screens of text. • Use an appropriate page layout to eliminate the need for users to scroll horizontally
Guideline # 45	**Limit navigation options, and keep them direct** ✓
Sources	(Seward, 2011)
Description or Justification	• Limit the navigation items to just a few • If the mobile site has many pages, consider how important most of those pages are to users in the mobile context

Table 11: Guidelines for Managing Hyperlinks

Guideline # 46	**Using text for links rather than images where possible** ✓
Sources	(Shrestha, 2007); (Kärkkäinen & Laarni, 2002); (UTexas, 2013); (U.S. Dept., 2006)
Description or Justification	• Using images for links may increase the size of the page and thus longer time to download, and in small-screen images are sometimes difficult to interpret, especially if users are not familiar with those pages • The structure of the device's navigation levels will often determine the appropriateness of using icon. At the top level the categories can be represented by icons, but at the secondary levels the selection choices are too specific to be unambiguously represented by icons. • Image links may be hard to detect. Therefore, using text instead of images for navigation labels is recommended, but textual descriptions should be as short as possible. • Using mouse-over techniques to indicate links are not preferred on mobile devices.
Guideline # 47	**Clearly identify the target of each link**
Sources	(Zamzami U. A., 2010)
Description or Justification	• It is important for mobile users to indicate clearly where a link will lead the user, by using clear, concise, descriptive link text to help users decide whether following it will be of interest for him. • Textual descriptions of links should be as short, simple, meaningful, and easy to understand as possible to ensure navigation efficiency. • The link text should be simple, informative, clearly describe the content behind it, and not more than one line as much as possible.

Table 11: Guidelines for Managing Hyperlinks (Cont'd)

	• Keeping the navigation and labeling as clear descriptive and action-oriented as possible, help simplify and direct the user towards task completion. This can be accomplished by associating each link with a given task during the design. • The use of links for text organization provides scaffolding by making the overall information structure visible and provides functionality for moving between the contents
Guideline # 48	**Provide large target size and padding**
Sources	(Seward, 2011); (Zamzami U. A., 2010)
Description or Justification	• Targets should be big enough to allow people to fudge their aim just a bit. • Targets should be far enough apart from each other to allow for a bit of error in accuracy. • Use large selectable targets whenever possible. • The icon's size is directly connected to the type of the user's interaction with the device. If input is done with a stylus, then the element of selection can be displayed at a very small size of 9×9. Using fingertip, with a touch-screen is the most space consuming technique as the options on the screen must be large enough to be selected by a fingertip, about 15×15, which is larger than an icon would need for visualization • Design buttons large enough so they can be pushed with a finger or the back of a pen (user don't always use the stylus). • When designing icons the design should always be optimized for a specific size in pixels, which will be determined by the device. The exact size at which the icons are to be displayed should be checked very carefully. • For walking users, target sizes should be at least 16×16 and preferably 20 × 20

Table 12: Input Guidelines

Guideline # 49	**Reduce or completely eliminate the need for data input especially text input**
Sources	(Seward, 2011); (Zamzami U. A., 2010); (U.S. Dept., 2006)
Description or Justification	• Given the typical input limitation of a mobile device, the interface must as far as possible minimize user input, and particularly avoid free text entry whenever possible. • The total number of user's interactions with the system should be kept low. • Reduce the use of icons whenever possible. • Interactive pages on mobile devices should be short and informative since users may not be sure that they have filled every field in a long form. • Reducing the number of keystrokes made by the user can be done by simplifying the navigation and by replacing text input with other types of interactions method such as using selection.
Guideline # 50	**Replace text input with list selection**
Sources	(Zamzami U. A., 2010); (Budiu & Nielsen, 2011); (U.S. Dept., 2006); (Lentz, 2011); (Tarasewich, Gong, & Nah, 2007)
Description or Justification	• Entering text on mobile devices can be very slow and error-prone. • Make user input as simple as possible by providing word selection instead of requiring free text input. • Selection can be provided by offering choices using numbers, list boxes, radio buttons, combo box, link lists, default values, and any other control that do not require typing. • The strings that you suggest may be based on site analytics and may reflect what your site's users typically fill in those boxes (if there are more common values). • Where possible, compute field values rather than asking the users to enter them.

Table 12: Input Guidelines (Cont'd)

Guideline # 51	**Place (automatically) a blinking cursor at the beginning of the first data entry field when a data entry form is displayed on a page** ✓
Sources	(U.S. Dept., 2006)
Description or Justification	• Users should not be required to move the mouse pointer to the first data entry field and click on the mouse button to activate the field. Designers should consider, however, that programming this automatic cursor placement might negatively impact the performance of screen reader software

Table 13: Feedback Guidelines

Guideline # 52	**Indicate visited and unvisited links** ✓
Sources	(Zamzami U. A., 2010); (U.S. Dept., 2006)
Description or Justification	• Indicating visited and unvisited links is usefull for annotating the content which is necessary to give the user the satisfaction of accomplishment and completion.
Guideline # 53	**Provide an informative error message**
Sources	(Zamzami U. A., 2010); (U.S. Dept., 2006)
Description or Justification	• When the user error is within the control of the contnet provider, the user should be provided with clear information regarding the fault they have experienced. • Error messages should concisely explain a problem and contain meaningful suggestions for resolving the problem. • This should help users understand whether the fault was temporary or permanent, whether they should retry the attempt to access the content and how they may be able to solve the problem.

Table 14: Mobile Context Guidelines

Guideline # 54	**Ensure that the user interface elements are clearly visible in low light** ✓
Sources	(MSDN, 2009); (UN, 2012)
Description or Justification	• Since the mobile website can be used by the users in bad lighting conditions because the users are on the move and the context of use is not fixed, the elements of the interface must be clear and visible in the different environment that surrounding the users by using a good contrast color and a suitable font size. • Ensure effective and easy-to-read color combinations
Guideline # 55	**Take advantage of inbuilt functionality**
Sources	(Warsi, 2007); (Budiu & Nielsen, 2011)
Description or Justification	Mobile Phones come with lots of inbuilt functionality that most PCs don't have: • *Make calls*: Allow users to automatically ring a number when they tap or click a phone number. This is useful for 'Contact us' or 'Store finder' pages. • *See an address on a map*: it's possible to give the user the option to select an address and automatically open the mobile phone's map application. • *Find the nearest...:* Since many mobile phones come with inbuilt location-detection capability (e.g. GPS) you can ask a user to share their current location. High street retailers, for example, can make it easy for customers to detect their nearest stores on a map. • *Input information in innovative ways*: There are innovative ways to allow users to input information that are both fun and useful.

Table 14: Mobile Context Guidelines (Cont'd)

Guideline # 56	**Take into account the impact of the social context**
Sources	(Häkkilä, 2006); (Tarasewich, Gong, & Nah, 2007); (Kaikkonen, Kaasinen, & Ketola, 2009)
Description or Justification	• Consider possible effects of social context in relation to the application. In some social context, certain device or user behavior may be considered awkward or even unacceptable. Social context has also effect on interruptability. For example, a volume alert may be considered as inappropriate device behavior in some social context • Utilize context awareness to ease or even to automate access to situationally relevant content and services • Environmental conditions (e.g., brightness, noise levels, weather) can change depending on location, time of day, and season. The usability or appropriateness of an application can change based on these different context factors.
Guideline # 57	**Design for limited and split attention**
Sources	(Tarasewich, Gong, & Nah, 2007)
Description or Justification	• Mobile devices that demand too much attention may distract users from more important tasks because Users of mobile devices often need to focus on more than one task • Interfaces for mobile devices should be designed to require as little of the user's attention as possible
Guideline # 58	**Allow for single or no handed operation**
Sources	(Tarasewich, Gong, & Nah, 2007)

Table 14: Mobile Context Guidelines (Cont'd)

Description or Justification	• The context of use of the mobile devices is not fixed, so the user may use the website with one or no handed. • The interface elements must be designed will and be clear and clickable to let the user to interact with them by using one or no hand because he/she is moving.
Guideline # 59	**Make sure there is option for large font** ✓
Sources	(Kaikkonen, Kaasinen, & Ketola, 2009)
Description or Justification	• The font size of the text in the mobile websites must be clear to increase the readability of the users. In addition, the option for large font is preferred to make the text readable for the elder people or when the user in bad surrounding environment.

Table 15 points to the guidelines from the previous guidelines tables that are concerned with contexts of use addressed in this research.

Table 15: The Context of Use That Addressed and the Guiedlines Belong to Them

Context of use	Related guidelines
User Personal Characteristics Context	GL#1: Know your users. GL#2: Determine the purpose of the site / service and identify the primary goals of the website before beginning the design process. GL#6: Provide a functional bilingual website. GL#20: Provide content that is engaging, relevant, and appropriate to the audience. GL#22: Use clear and simple language. GL#25: Keep fonts large to optimize the reading process. GL#59: Make sure there is option for large font.

Table 15: The Context of Use That Addressed and the Guidelines Belong to Them (Cont'd)

Context of use	Related guidelines
Small Screen Context	GL#7: Design for portrait layout. GL#8: Divide the screen area into title, contnet, and navigation from top to bottom. GL#9: The main content of the screen and the most important information should be shown at the top. GL#10: Avoid using wide elements. GL#11: Minimize white spaces on the page. GL#14: Limit the number of different colors used on a page, GL#16: Avoid Visual noise and clutter, GL#23: Provide a short but descriptive page titles. GL#24: Select the font and background color that provide sufficient contrast and would not hamper the visibility of text or links. GL#27: Minimize margins. GL#28: Avoid having too many text styles and sizes on the same page. GL#31: Minimize the use of images. GL#33: Handheld mobile device's icon design should be as direct, simple and unique as possible. GL#37: The table width and height should not exceed the display width and height. GL#40: Use links to the main screen and don't repeat the navigation on every page. GL#42: Balance the choice between scrolling and paging. GL#43: Limit scrolling to one direction. GL#44: Minimize the amount of scrolling. GL#45: Limit navigation options, and keep them direct.

Table 15: The Context of Use That Addressed and the Guidelines Belong to Them (Cont'd)

Context of use	Related guidelines
	GL#46: Using text for links rather than images where possible. GL#49: Reduce or completely eliminate the need for data input especially text input.
Mobile Device Characteristics Context (different screen size, supporting font type, different resolution of the mobile devices, memory size)	GL#15: Use colors meaningfully. GL#17: Maintain consistency with the platform of use. GL#24: Select the font and background color that provide sufficient contrast and would not hamper the visibility of text or links. GL#32: Avoid using large or high resolution images. GL#33: Handheld mobile device's icon design should be as direct, simple and unique as possible. GL#34: Icon color design cannot use more than 5 kinds of colors. GL#36: Do not use tables unless the device is known to support them, GL#37: The table width and height should not exceed the display width and height, GL#41: Use 'back' command. GL#46: Using text for links rather than images where possible.
Content Context	GL#29: Organize documents so they are readable without requiring an associated style sheet. GL#39: Keep the number of levels in a hierarchical structure few in number (Use a flat hierarchy). GL#42: Balance the choice between scrolling and paging. GL#44: Minimize the amount of scrolling. GL#47: Clearly identify the target of each link. GL#52: Indicate visited and unvisited links.

Table 15: The Context of Use That Addressed and the Guidelines Belong to Them (Cont'd)

Context of use	Related guidelines
Lighting Conditions Context	GL#15: Use colors meaningfully. GL#24: Select the font and background color that provide sufficient contrast and would not hamper the visibility of text or links. GL#25: Keep fonts large to optimize the reading process. GL#34: Icon color design cannot use more than 5 kinds of colors. GL#46: Using text for links rather than images where possible. GL#54: Ensure that the user interface elements are clearly visible in low light. GL#59: Make sure there is option for large font.
Mobility Context (context of use the mobile such as using mobile while walking and moving, waiting in a queue, urgent situations, ...etc)	GL#9: The main content of the screen and the most important information should be shown at the top. GL#15: Use colors meaningfully. GL#19: Ensure that content is suitable for use in a mobile context. GL#20: Provide content that is engaging, relevant, and appropriate to the audience. GL#21: Only the most relevant and essential information should be shown. GL#23: Provide a short but descriptive page titles. GL#33: Handheld mobile device's icon design should be as direct, simple and unique as possible. GL#35: For touch phones, leave generous amounts of space around widgets such as radio buttons, arrows for dropdown boxes, checkboxes, scrollbars, and links, GL#39: Keep the number of levels in a hierarchical structure few in number (Use a flat hierarchy).

Table 15: The Context of Use That Addressed and the Guidelines Belong to Them (Cont'd)

Context of use	Related guidelines
	GL#40: Use links to the main screen and don't repeat the navigation on every page. GL#42: Balance the choice between scrolling and paging. GL#45: Limit navigation options, and keep them direct. GL#47: Clearly identify the target of each link. GL#48: Provide large target size and padding, GL#49: Reduce or completely eliminate the need for data input especially text input. GL#50: Replace text input with list selection. GL#51: Place (automatically) a blinking cursor at the beginning of the first data entry field when a data entry form is displayed on a page. GL#54: Ensure that the user interface elements are clearly visible in low light. GL#57: Design for limited and split attention. GL#58: Allow for single or no handed operation.
Network Connectivity Context	GL#31: Minimize the use of images. GL#32: Avoid using large or high resolution images. GL#46: Using text for links rather than images where possible.
Social Situations Context (Such as noise level, limit attention)	GL#9: The main content of the screen and the most important information should be shown at the top, GL#15: Use colors meaningfully, GL#21: Only the most relevant and essential information should be shown,

Table 15: The Context of Use That Addressed and the Guidelines Belong to Them (Cont'd)

Context of use	Related guidelines
	GL#39: Keep the number of levels in a hierarchical structure few in number (Use a flat hierarchy), GL#56: Take into account the impact of the social context, GL#57: Design for Limited and Split Attention
Interface Elements Consistency Context	GL#12: Elements of mobile interfaces such as names, colour schemes and dialogs appearances should be the same as their desktop counterparts. GL#13: Place a logo(s) in a consistent place on every page to ensure users are fully aware they are on your website. GL#17: Maintain consistency with the platform of use. GL#18: Apply consistent design and layout throughout the site. GL#31: Minimize the use of images. GL#38: Provide a consistent navigation mechanisms.
Critical Time Context	GL#39: Keep the number of levels in a hierarchical structure few in number (Use a flat hierarchy). GL#49: Reduce or completely eliminate the need for data input especially text input. GL#50: Replace text input with list selection. GL#51: Place (automatically) a blinking cursor at the beginning of the first data entry field when a data entry form is displayed on a page.

Chapter IV

Mobile Web Builder Tools

Due to sudden heavy rains or sever changing of weather conditions on certain regions that may result in death and destruction due to lack of citizens' knowledge in what to do to stay safe, the Presidency of Meteorology and Environmental (PME) desktop website was chosen for its importance for the citizens of Saudi Arabia for the following technical reasons:

- It doesn't have mobile version.
- It contains updated information compared to other e-Government websites.
- It has an early warning system and the weather forecast features that can be used for emergency situations.

The PME desktop website contains an English version but all the important links in the English version are not activated. It contains a vertical and horizontal navigation bars. The most important services on this website which can be used for emergency situations can be included in the mobile version are in the horizontal bar as shown in Figure 5 and Figure 6, and they are as follows:

- Early Warning: It contains information about the areas that are exposed or could be exposed to environmental disasters and its level of urgency.
- Weather: It contains information about the weather forecast for the current day and the next five days.
- Emergency Call: It contains contact numbers that can be used by citizens to inform them about emergency situations.
- E-Services: Used for sending the three types of notifications about cases of pollution incidents using one of three ways:
    - Notification by Email.
    - Notification by Phone.
    - Notification by SMS: not currently implemented.

Figure 5: The home page of the PME desktop website (the Arabic version)

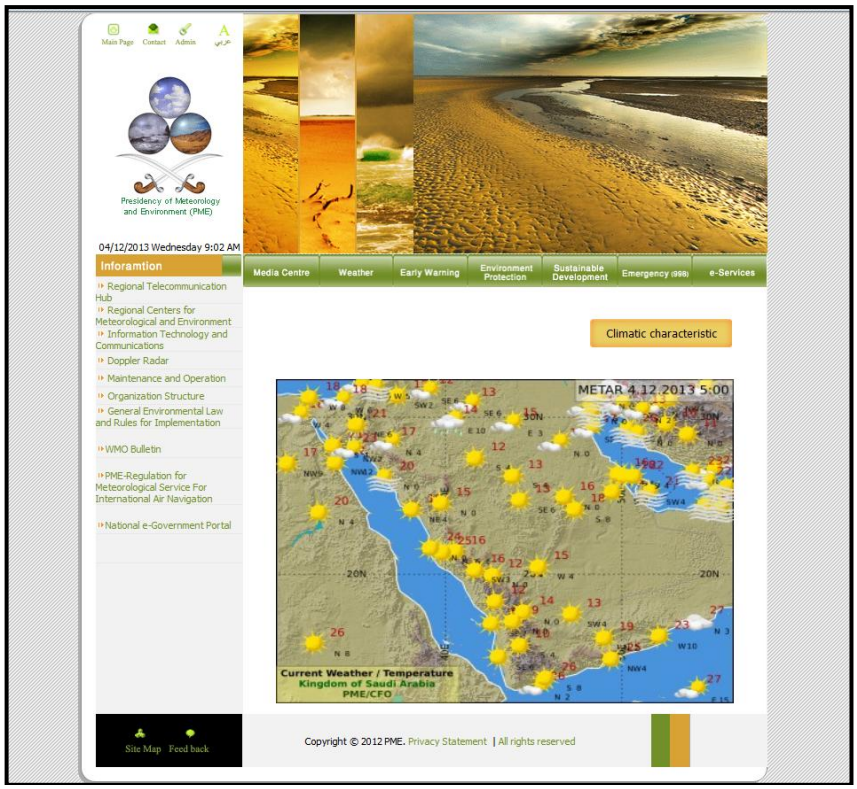

Figure 6: The home page of the PME desktop website (the English version)

4.1. Mobile Web Builder Tools

Mobile Web builders are online tools and advertised to develop a professional looking websites to be hosted instantly. They are useful tools for users without programming knowledge. There is no software to buy, no code to learn; all the developer needs is to have simple Internet knowledge (webcandy, 2013).

Many of the mobile web builder tools give the website developers templates to choose from that can match the developer's mobile web purpose.

The claimed advantages of using mobile web builder tools are (webcandy, 2013):

- A professional quality website.
- Instantly up and running.

- A user friendly and easily customizable interface that gives a complete website with all its features with an attractive design.

The obvious disadvantages are that the website developers are limited to the look and functions of the tool and the templates or designs they provide (webcandy, 2013). Resulting layouts need editing, which can't be possible sometimes or take a long time, because they might contain extra information which the user doesn't need within the mobile version. These layouts are suitable for business and marketing mobile websites not for websites in emergency situations. However, one of the advantages of a customized website design, which is built by the developer by using codes, is that the website will look and function exactly as the developer wants (webcandy, 2013).

4.1.1. Categories of Mobile Web Builder Tools

During comparative analysis of mobile builder tools, this research found that they can be divided into three categories.

- **Category One**

  This group allows the user to choose certain interface widgets, navigations of elements and the content from the desktop website by opening it to the user so he/she can choose from the desktop website and then add it directly to the mobile version.

- **Category Two**

  This group allows the user to build the mobile version by choosing the style, certain interface widgets, colors, buttons and the content without using the desktop version.

This group gives the developer the ability to build the mobile version while adding html code to manipulate the content.

- **Category Three**

This group can convert the desktop website to a mobile version without changing the content or the links. It keeps all the website components as they are, then it gives the user the ability to change the design by adding or removing anything such as pages and widgets.

4.1.2. Testing the Efficiency of Mobile Builder Tools

To be able to test the efficiency of mobile builder tools, an appropriate test website was needed. Most of the government websites do not have mobile versions in Saudi Arabia. This research is concerned with taking a Saudi government website which citizens need to use in an emergency situation. The assumption was that Civil Defense website has the most important and updated information citizens can use if they face a natural disaster. But unfortunately it was not updated and it contained only static information. For this reason search continued for a government website outside Saudi Arabia to be used to demonstrate but we found that most of the important services for their citizens were not applicable and not familiar to Saudi citizens, so the PME website was chosen. One mobile builder tool of each category was used on the tested website.

- **Example of Category One: Mobify**

Mobify is a web-based platform that helps the user adapt the desktop website for mobile and tablet devices. It allows the user to create a mobile version of the website through an intuitive and user-friendly graphical user interface (GUI). The following figures represent the interface of this tool.

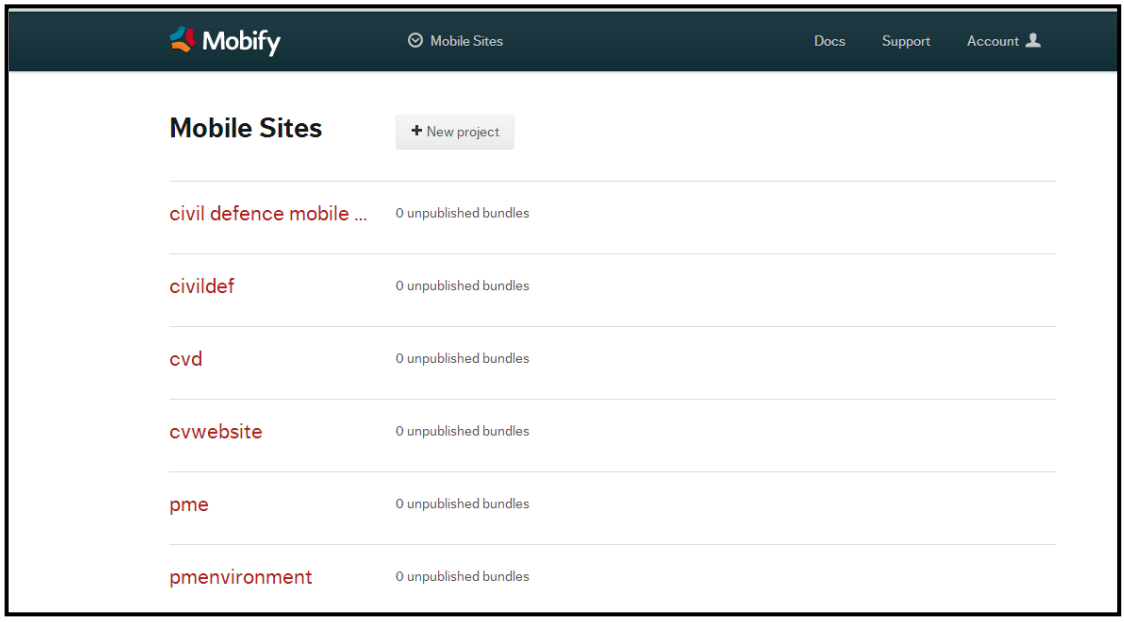

Figure 7: The main interface of the Mobify tool after login

The main interface of the Mobify tool after login contains all the websites that the developer built in his/her Mobify account (Figure 7). The developer can edit any one of these websites by clicking on the website to start the editing or to continue building the website.

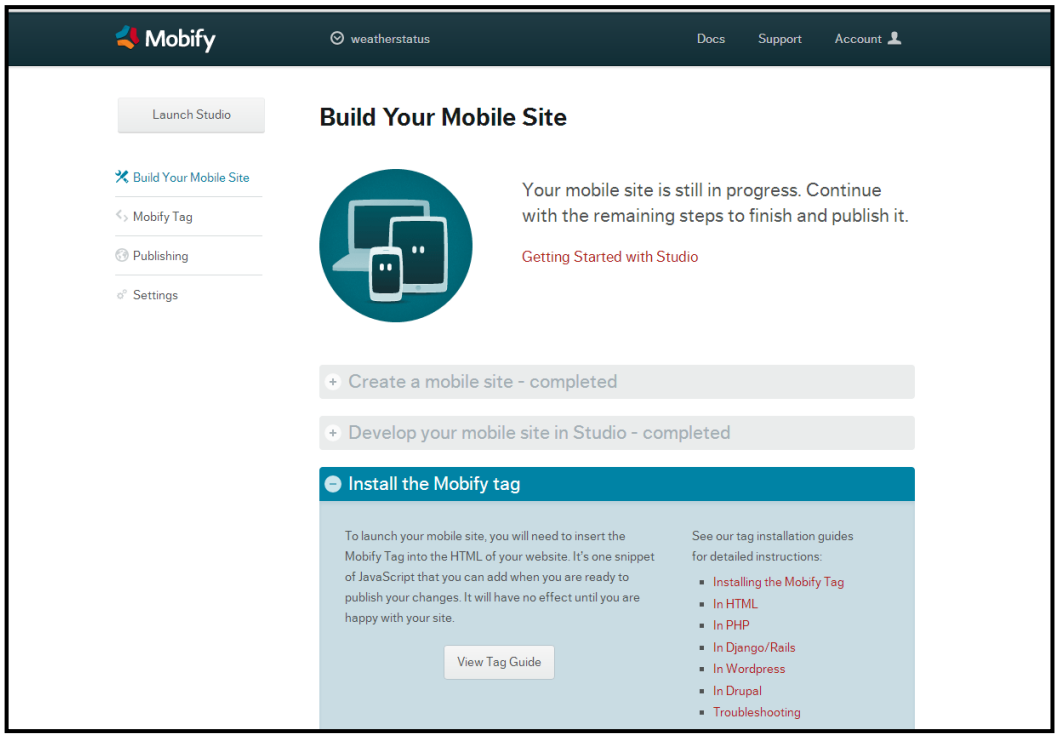

Figure 8: The interface of building the mobile site in the Mobify tool

The Mobify tool offers four steps to build and publish the mobile version (Figure 8), they are:

1. For creating the mobile site by determining its name and the desktop site it belongs to.
2. For launching the studio to start building the mobile site
3. For installing the tag of the Mobify tool in the mobile site version.
4. For publishing the mobile site version.

The Mobify tool allows the developer to edit the mobile site version by launching the studio and using the tools available for it. Sometimes there is a delay to launch the studio and sometimes it does not open if the connection is slow because it is a web-based application.

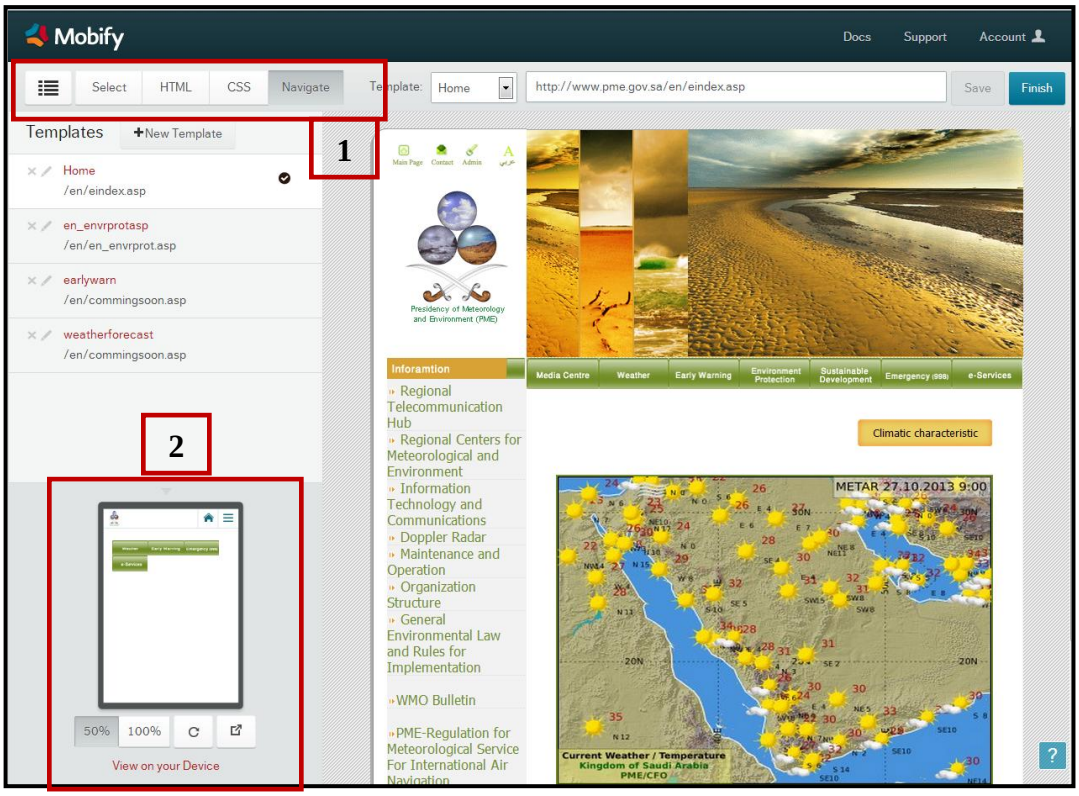

Figure 9: The interface of the studio in the Mobify tool

The interface of the studio contains different parts (Figure 9). The desktop website is opened inside the studio to allow the developer to select different parts from it to be included in the mobile site version: the logo, navigation bar, parts of the content or buttons. It also contains a menu in the left upper corner (part 1 in Figure 9) which allows the developer to select certain interface widgets from the desktop website the navigation bar. Also, it contains a small window on the left bottom corner (part 2 in Figure 9) where the developer can see how the mobile version will be look like after adding certain interface widgets from the desktop website.

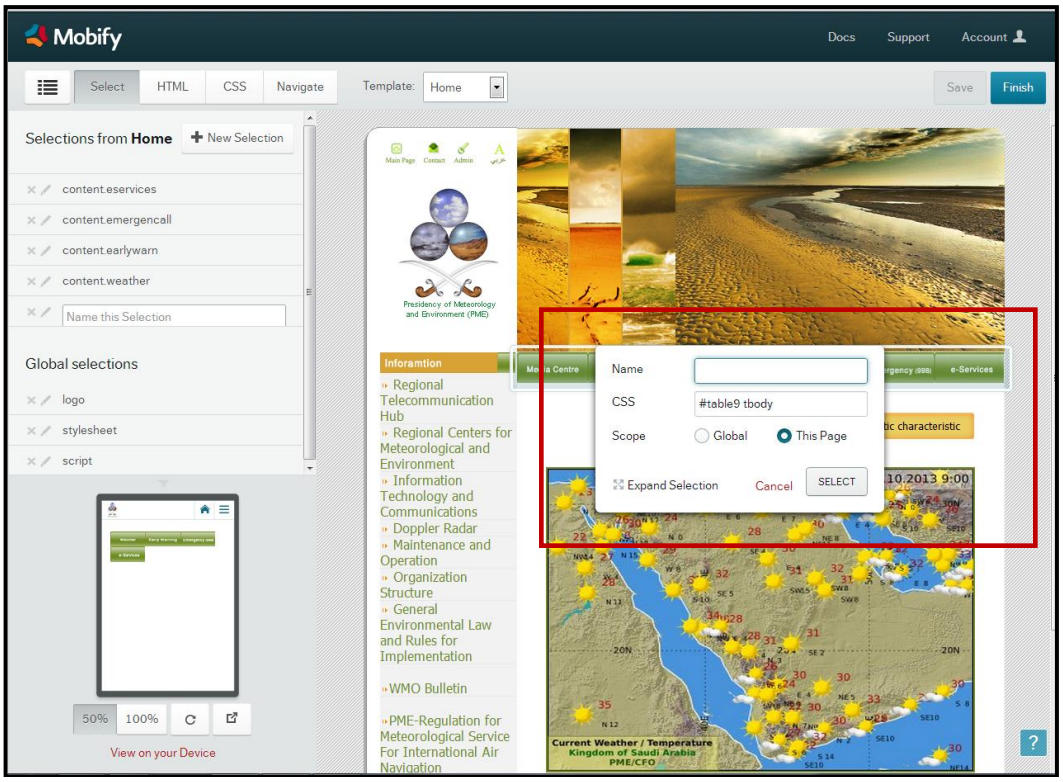

Figure 10: Continuation of the studio interface in the Mobify tool

The developer can select any interface widget or navigation bar from the desktop website to add it to the mobile version as shown in Figure 10 where the navigation bar was selected.

Advantages

Mobify has some advantages in that:

- It creates a link to the desktop website version.
- The generated mobile website size is compatible with the most popular phone devices, iOS and android.

Disadvantages

Mobify has some disadvantages:

- Because it is a web-based application, it takes a long time to launch the studio to start building the website, reaching up an hour then being unresponsive.

- It was not easy to use with the government website sample even after watching the tutorial. The place or the size of the navigation bar could not be changed. The following figures (Figure 11 and Figure 12) represent two different mobile versions for two different desktop websites, the PME website and the Civil Defense website. In the two mobile versions, the navigation bar was not arranged properly.

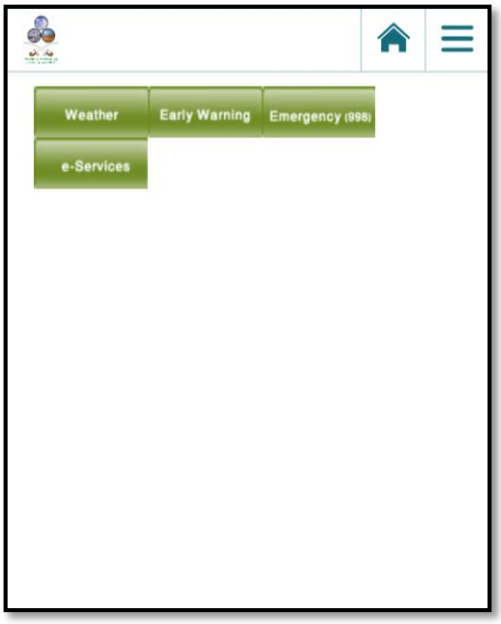

Figure 11: Screen shot of the home page of mobile version for PME (English version) using Mobify

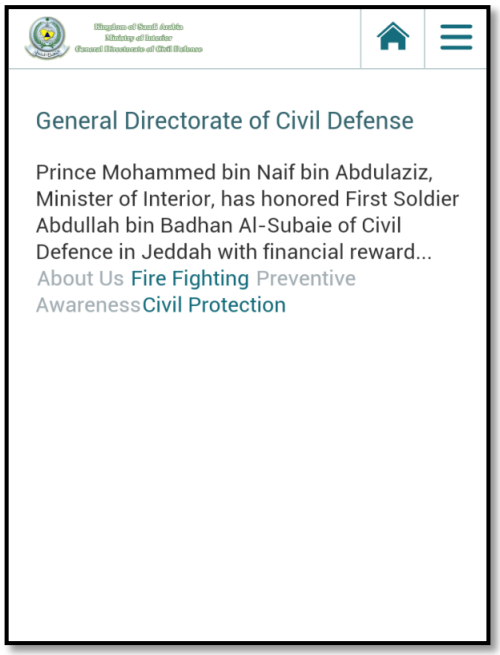

Figure 12: Screen shot of the home page of mobile version for Civil Defense website using Mobify

- It takes the button, the links or the navigation bar from the desktop website and puts them as they are in the mobile version. It keeps the size of the buttons without adapting them to be compatible with the mobile interface as shown in Figures 11 and 12.

- It didn't work with the Arabic version of the website as shown in Figure 13. It doesn't support Arabic characters; the characters appearing as question marks.

- It doesn't support Internet explorer so the user has to use Google Chrome as mentioned in their website as a condition.

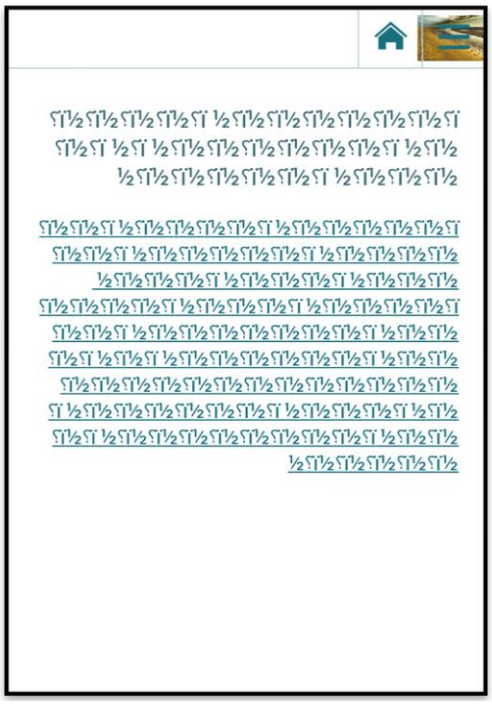

Figure 13: Screen shot of the home page of mobile version for PME website (Arabic version) using Mobify

- There is no form builder which is needed to build a form for sending notification as one of the services applied by PME in the desktop site.

This tool will be examined in this research due to the following reasons:

- The difficulty of use especially for novices.
- This tool works only with the English version of the desktop websites and all the important links in the English version are not activated.

- ## Example One From Category Two: MoFuse

MoFuse has a large set of features for building and managing the developer's mobile site.

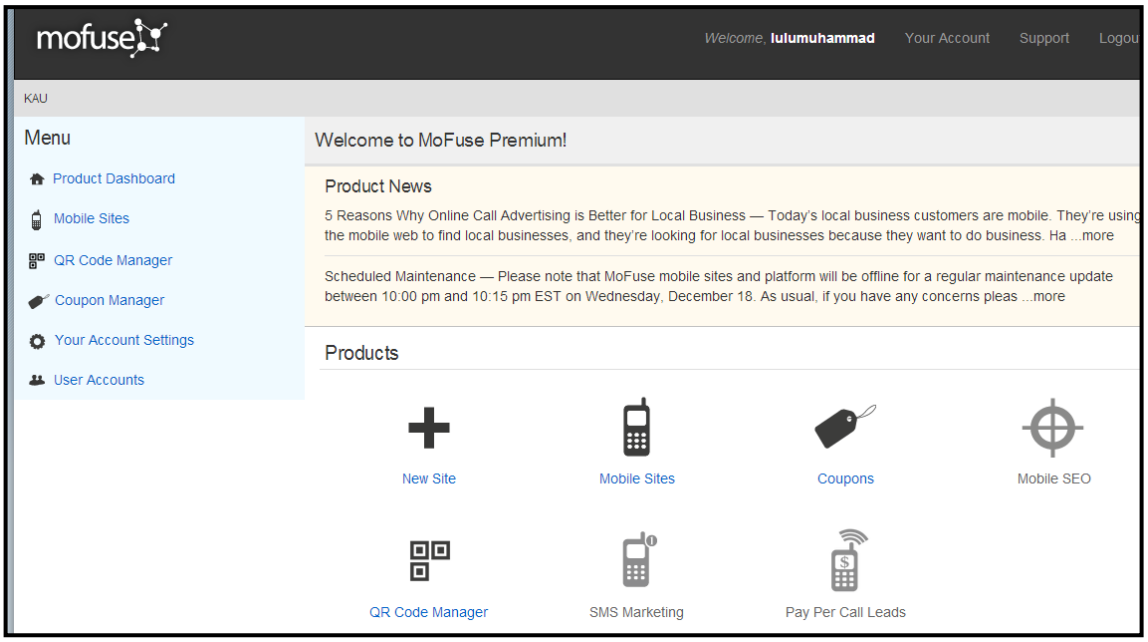

Figure 14: The main page of MoFuse tool after login

The main interface of the MoFuse tool after login contains the option of creating a new mobile website or previewing the mobile website the developer created before using this tool (Figure 14).

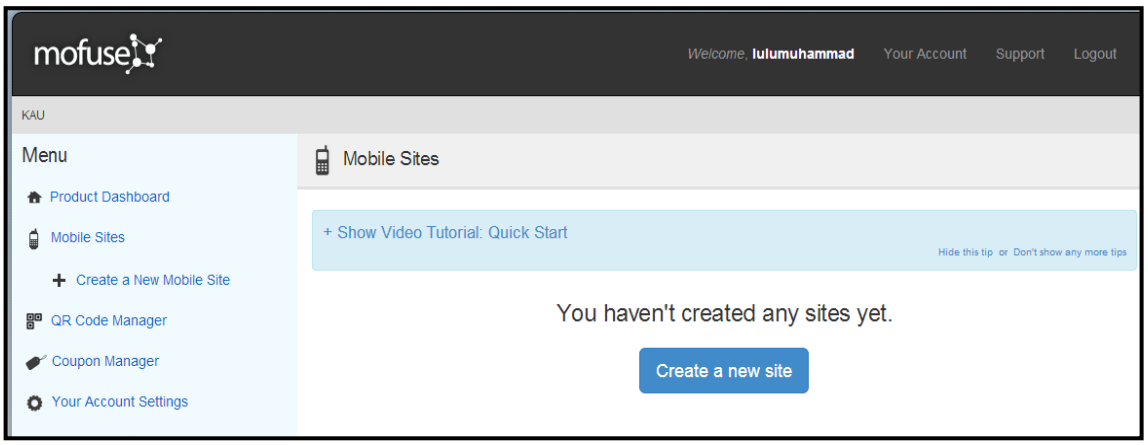

Figure 15: Create a new mobile website

To create a new mobile site (Figure 15), there are two options that can help the developer as shown in (Figure 16). The first option is using a guided wizard that helps the developer create a mobile site in five steps as shown in (Figure 17).

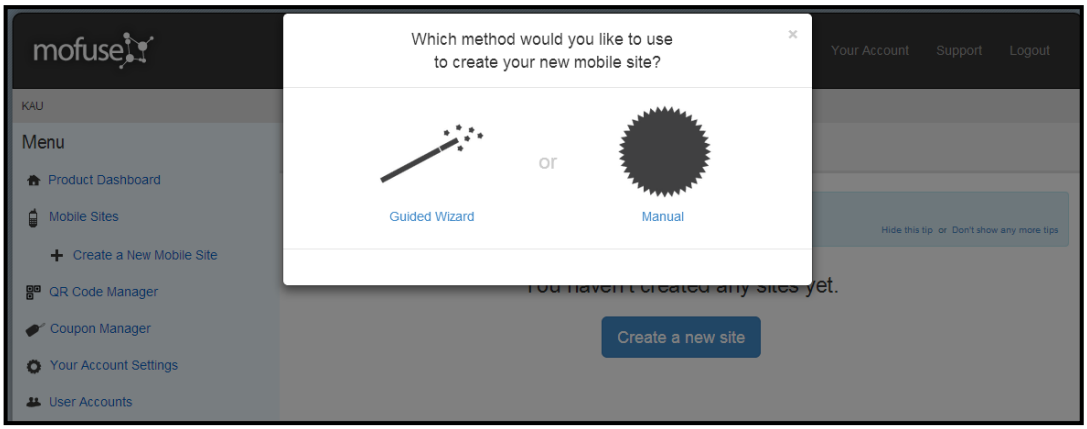

Figure 16: Options for creating a new mobile site

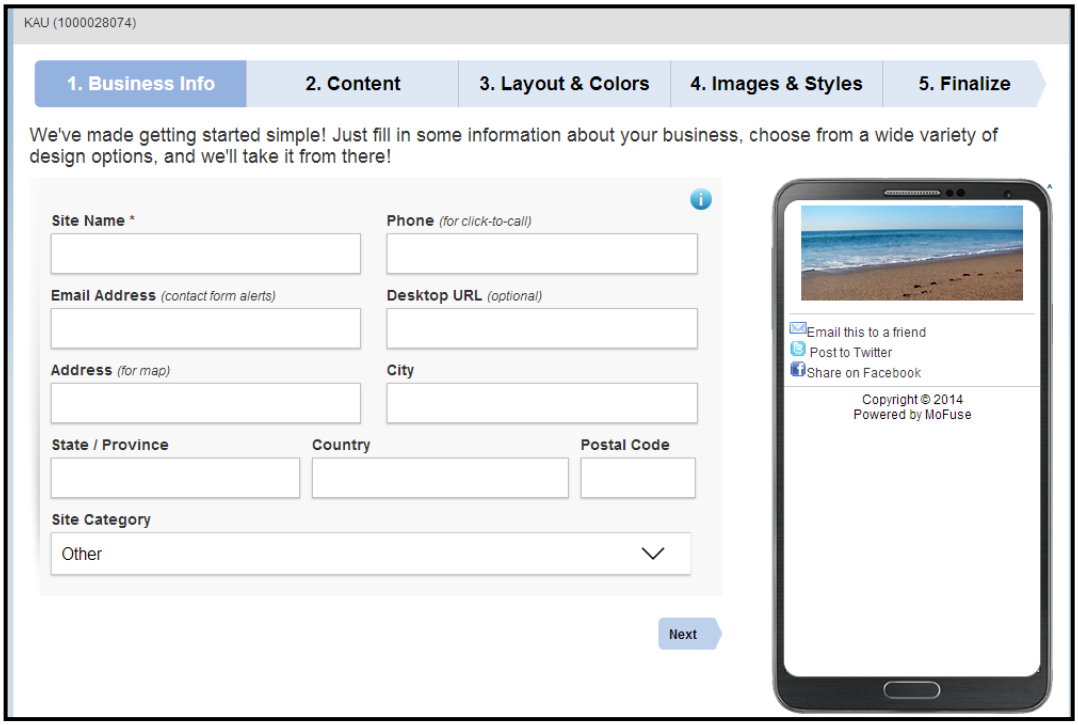

Figure 17: Guided wizard for creating a mobile site

The second option is creating the mobile site manually as shown in the following figure (Figure 18)

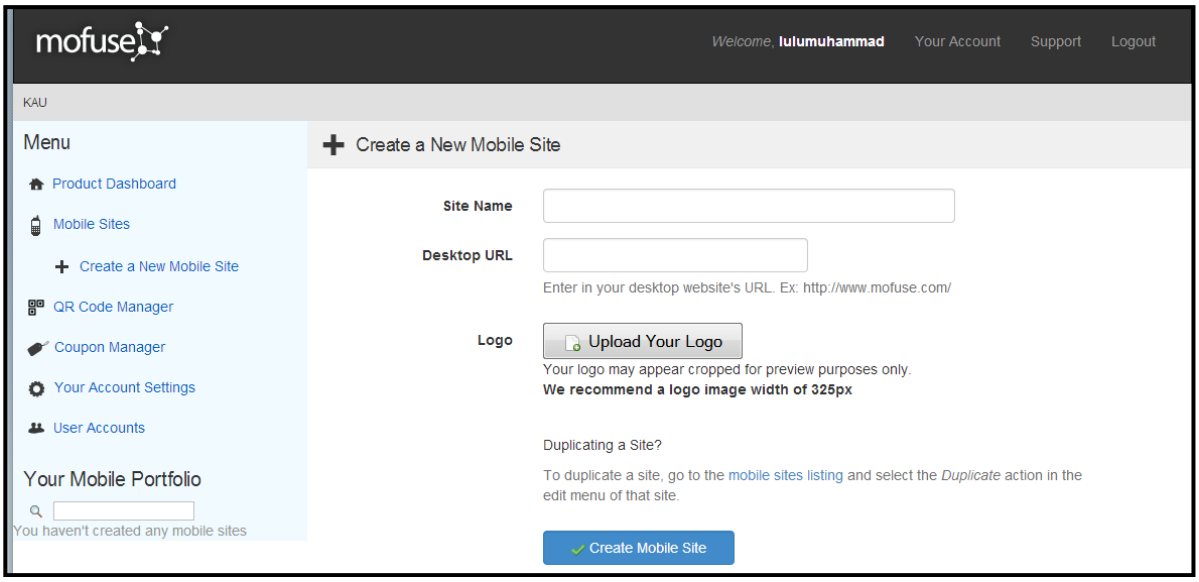

Figure 18: creating a mobile site manually

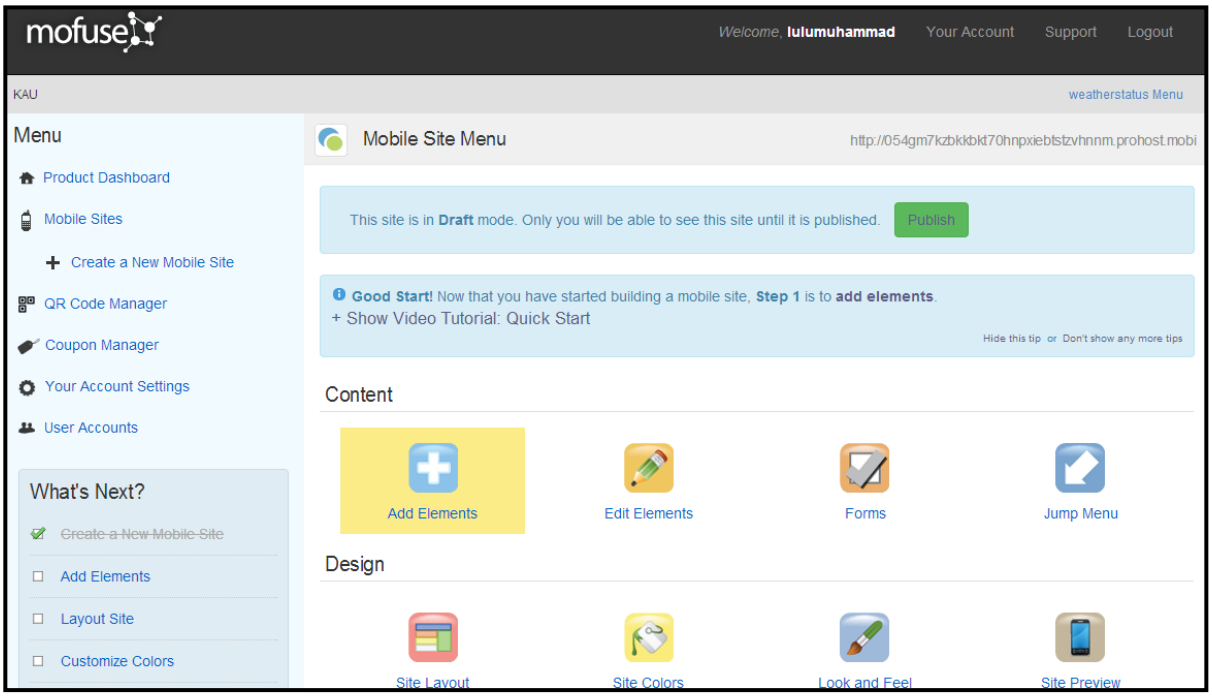

Figure 19: The mobile site building tools menu

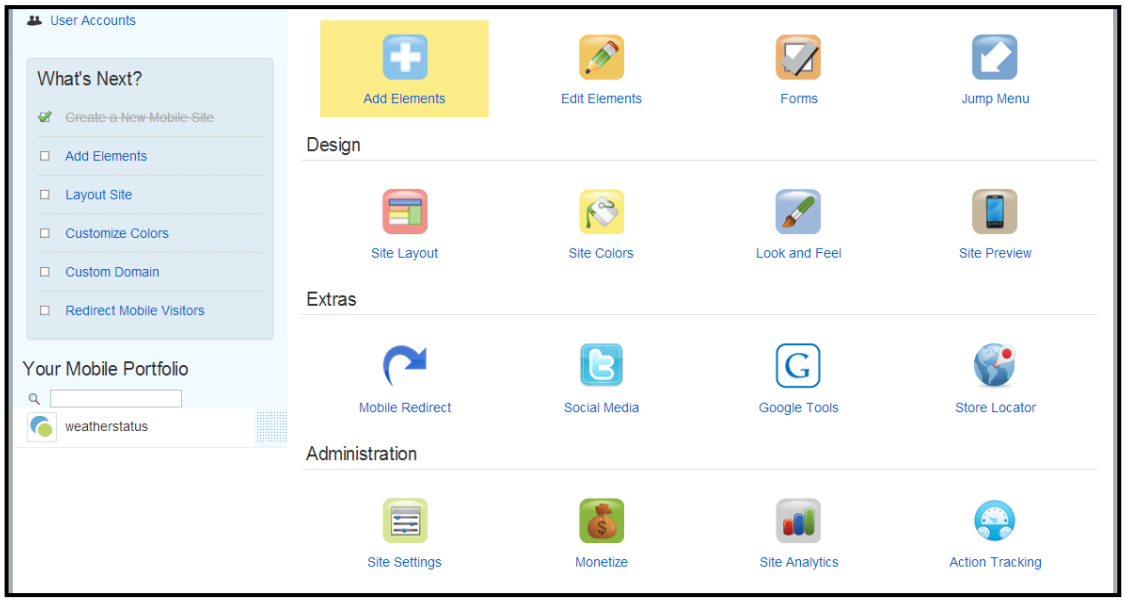

Figure 20: Continuation of mobile site building tools menu

The MoFuse tool offers different building tools and widgets that can help the developer edit the content and the design of the mobile site version (Figures 19 and 20). The developer can add or edit elements in the mobile site and choose the site layout and the colors of the interface elements.

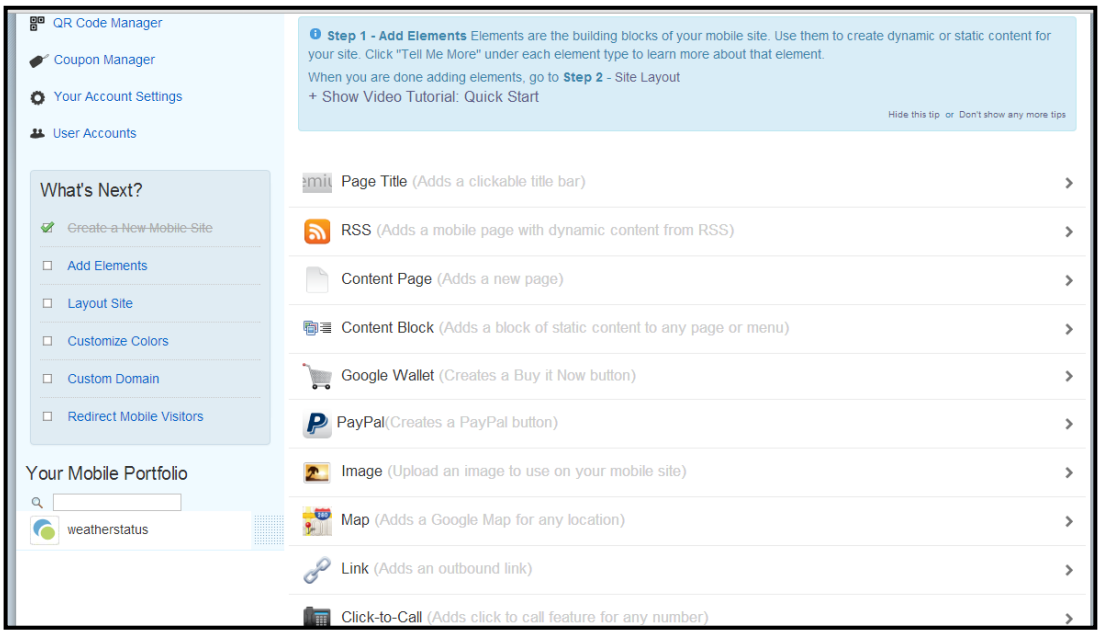

Figure 21: The interface for adding new elements

The MoFuse tool offers different types of elements that can be added to the mobile version (Figure 21). These elements allow the developer to add contents, links, images or maps to the mobile site pages.

Advantages

Use of this tool has some advantages:

- It is easy to use and easy to learn not requiring long steps in adding the elements to the mobile site.
- It allows the user to build a mobile website that contains only the content that the developer wants to include in the mobile version. This tool did not import any object from the desktop website; it allows the user to build the mobile site by using default elements such as buttons and widgets that are available as shown in Figure 22.

Figure 22: The home page of the PME mobile version build using MoFuse

- It creates a link to the desktop version as shown in Figure 22 (GL# 4).
- The result website is compatible with the most popular phone devices, iOS and Android (GL#17) (Mobile Device Characteristics Context, Interface Consistency Context).
- It creates Home, Back links at the bottom of the website pages (GL# 41) (Mobile Device Characteristics Context).
- It contains a form builder so developers can build their own form as shown in Figure 23 and 24.
- The developer can use an HTML editor inside the page to add and adjust specific features of the page content such as tables, font size and color, determine the subheading inside the page. Figure 25 shows the HTML editor.

Figure 23: The form build in the PME mobile version using MoFuse tool

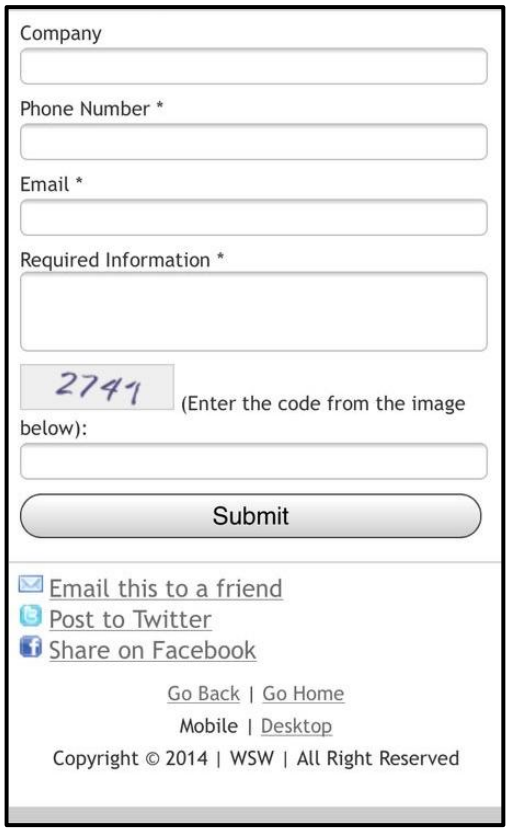

Figure 24: Continuation of the form

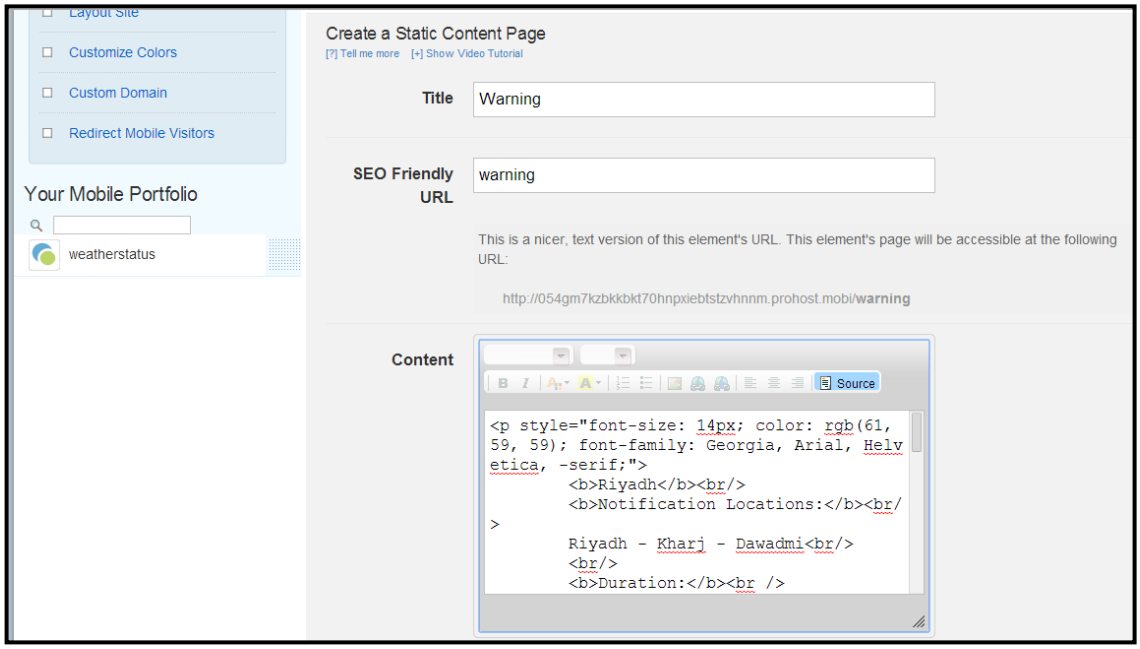

Figure 25: Using HTML editor to create a content page

- It does not create a complete breadcrumbs to let the users to know where he/she is while browsing the website. It just provide the user with the name of the last page. As shown in figure 23, it provide the user with the last page "Send Notification by Email" and does not give him/her the name of the main menu "E-Services".
- The logo and the website name are included on all the pages and in the same place to address the where am I navigation guideline (GL#8) (Small Screen Context) (GL#13) (Interface Elements Consistency Context).

Disadvantages.

The disadvantages of Mofuse are as follow:

- It did not include a link to the Arabic version of the website.
- Each link on the page that opens another page on the website must be a button and it couldn’t be used as a hyperlink which makes the page full of buttons.
- The form doesn't have a reset button to clear the text boxes that allows the user to refill the form again as shown in (Figure 24).
- It does not provide a functional bilingual website because it does not create Arabic version of the mobile website.
- It took long time to load the result mobile version.

From the previous advantages of the Mofuse website mobile version and according to Section 3.2, the following context of use were covered:

- Mobile Device Characteristics Context
- Interface Consistency Context

- **Example Two of Category Two: Mobile Website Builder**

This builder tool is similar to the MoFuse builder tool but with a few different features. The following figures represent a screen shot of Mobile Website Builder Tool.

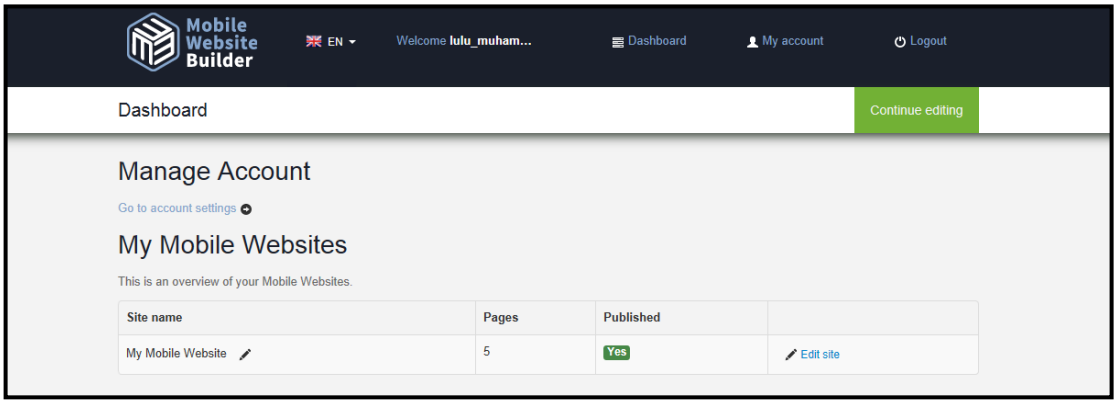

Figure 26: The main interface of Mobile Website Builder tool after login

The main interface of Mobile Website Builder after login contains the mobile websites created in Mobile Website Builder with the ability to edit any of them (Figure 26). The Mobile Website Builder allows the developer to edit the mobile site by offering different widgets that can be added to the mobile site version (Figures 27, 28, and 29).

Figure 27: The interface of the editing page of the Mobile Website Builder

In the edit step, the Mobile Website Builder tool offers a preview of the selected page of the mobile site version in the right side of the editing interface (Figure 27). It also allows the developer to add different widgets to each page of the mobile version by selecting the page then selecting the widget and it will be added directly.

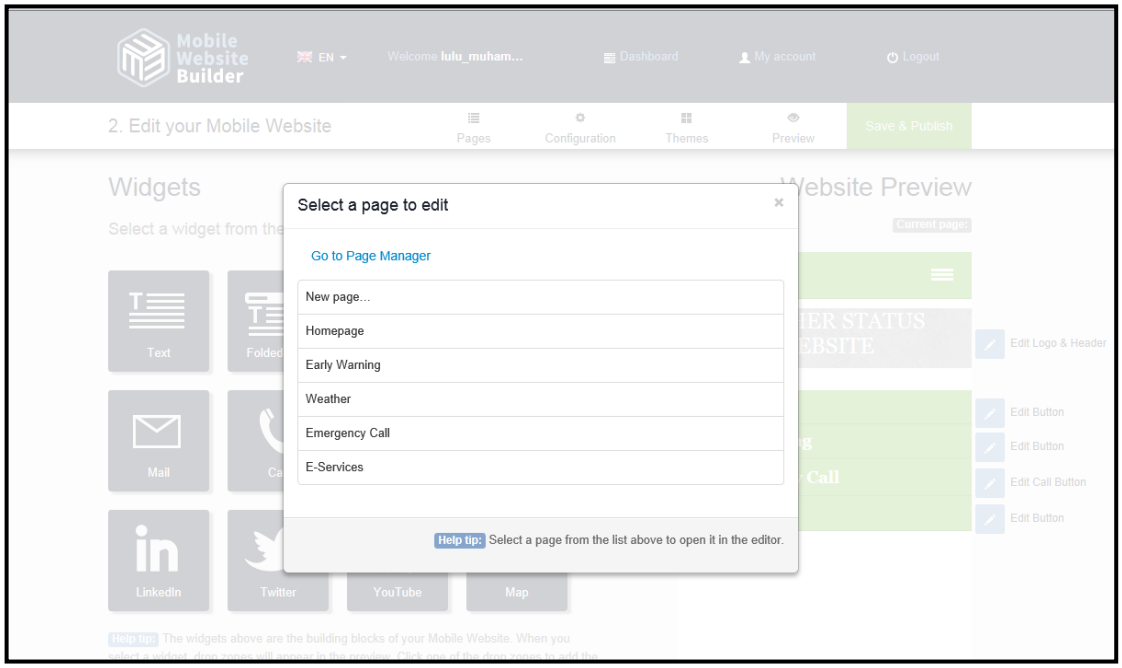

Figure 28: The page manager in the Mobile Website Builder tool

This tool also offers a page manager that allows the developer to create or edit the page and rearrange the order of the mobile site pages (Figure 28). The developer can open the page from page manager and add, edit or delete widgets on this page.

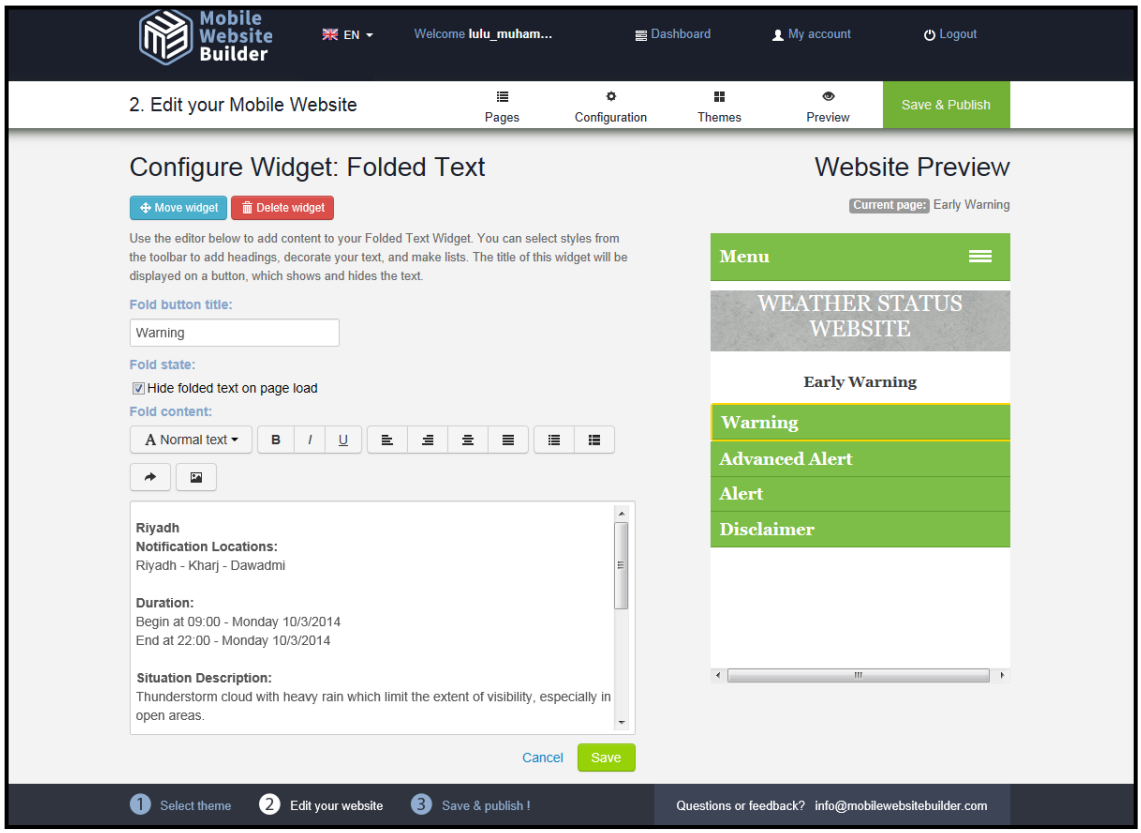

Figure 29: The interface of editing a widget in the Mobile Website Builder tool

The developer can edit any widgets added to the mobile site by clicking on the edit button beside the widget as shown in Figure 29. After the developer finishes editing on the mobile version, the Mobile Website Builder offers two steps to publish the mobile site (Figures 30 and 31).

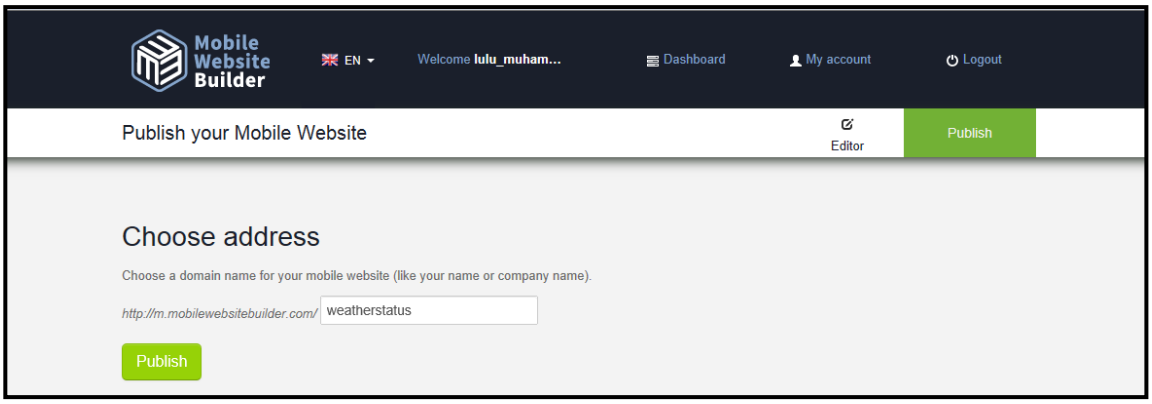

Figure 30: The interface of publishing the Mobile Website

The tool either gives the developer the address of the mobile site version (Figure 30), or it gives the developer a script that can be added to the desktop website of the mobile site version (Figure 31) to redirect the users to the mobile site when they open it from their mobile devices.

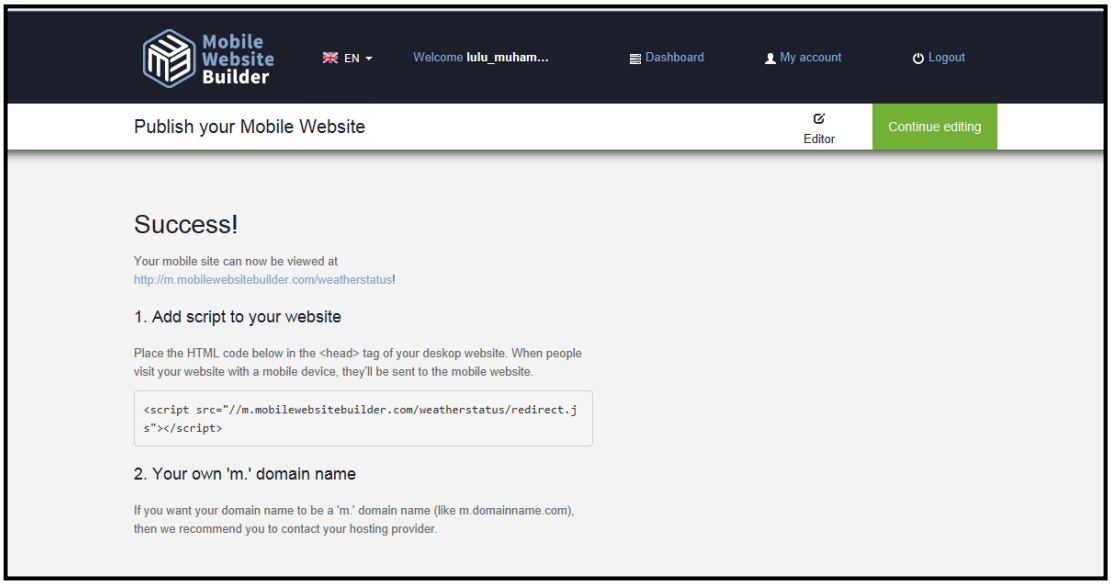

Figure 31: Continuation of the interface of publishing the Mobile Website

Advantages

- The Mobile Builder tool is simple and easy to use.
- It supports the Arabic language.

- It gives the user a code that can be added to the full site to redirect the users to the mobile version.
- It also has a feature called folded text which can be used instead of creating many pages like what was done inside the Early Warning, Weather and E-Services buttons. By clicking the folded text, the text area is expanded on the same page and by clicking again the page is collapsed. This feature used on many pages of the website such as Early Warning page (Figure 32 and Figure 33), Weather page (Figure 34 and Figure 35) and E-Services page (Figure 36 and Figure 37).

Figure 32: Early warning page of the mobile version of PME using Mobile Website Builder tool

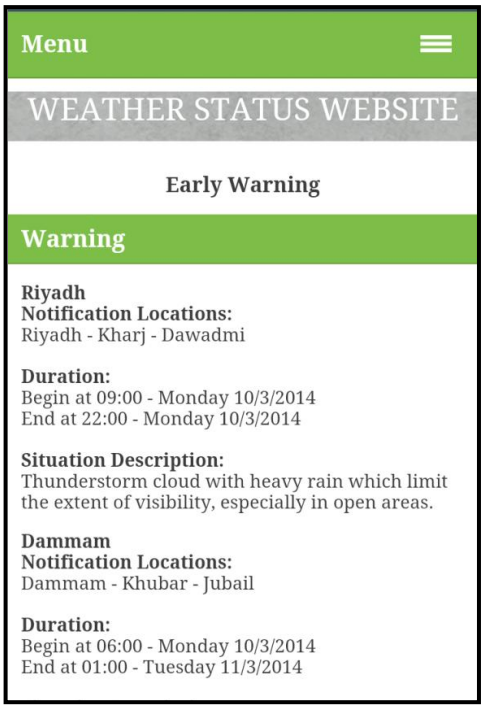

Figure 33: Early warning page

Figure 34: The weather page of the mobile version of PME Using Mobile Website Builder tool

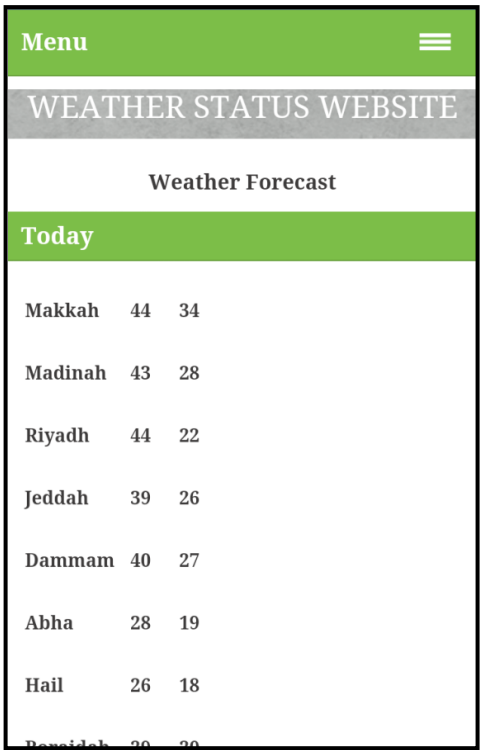

Figure 35: The today weather page of the mobile version of PME using Mobile Website Builder tool

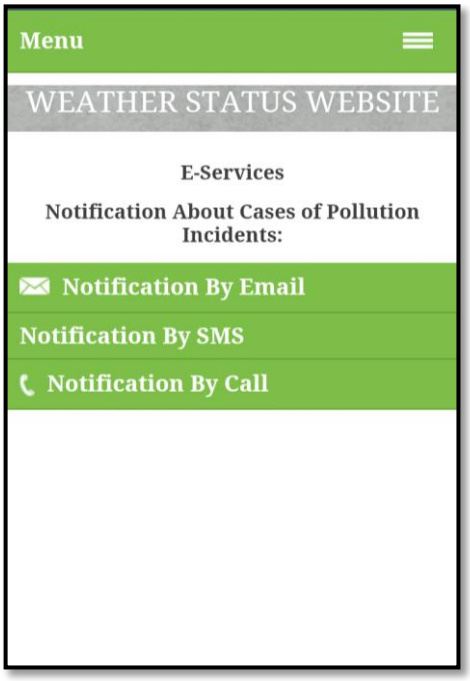

Figure 36: E-services page of the mobile version of PME using Mobile Website Builder tool

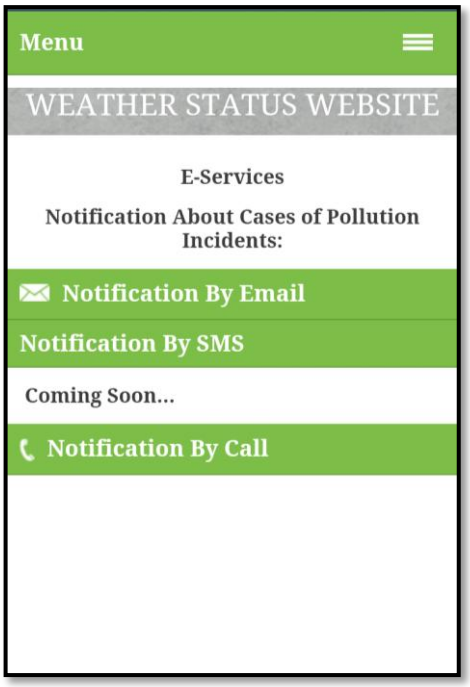

Figure 37: Send notification by SMS

- The resulting website is compatible with the most popular phone devices, iOS and Android.

Disadvantages

- It doesn't contain a form builder so the user can't build a form and instead of the form a mail widget was used to send notification by Email as shown in (Figure 38).
- The home link is in a dropdown menu (Figure 40) not on the main menu of the home page as shown in Figure 39.
- There is no link to the previous page.
- There is no link to the full site.
- The developer can't upload the logo from his/her computer.

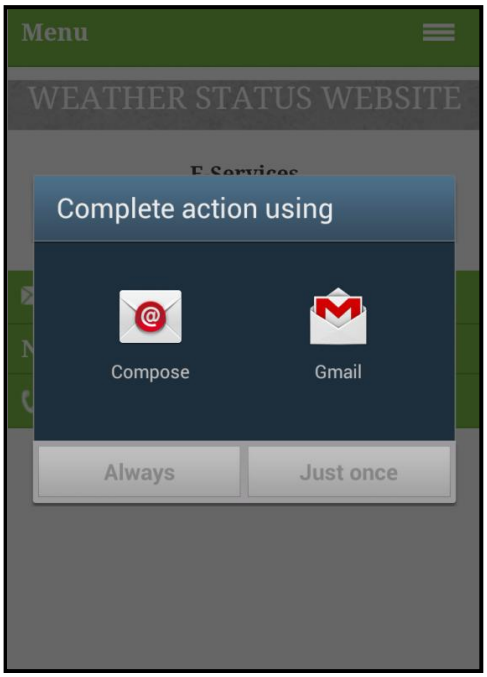

Figure 38: Send notification by email

Figure 39: The home page of the mobile version of PME using Mobile Website Builder tool

Figure 40: Menu items of the home page

- **Example of Category Three: Dudamobile**

The main interface of Dudamobile after login contains the mobile websites that was created usig this tool and the ability to edit any one of them (Figure 41). Dudamobile creates a mobile version of the desktop website by taking everything in the desktop website and inserting them directly into the mobile site version. The developer can then publish the site directly if editing is not needed. The Dudamobile tool also allows the developer to edit the pages of the developed mobile site by offering some layouts and widgets.

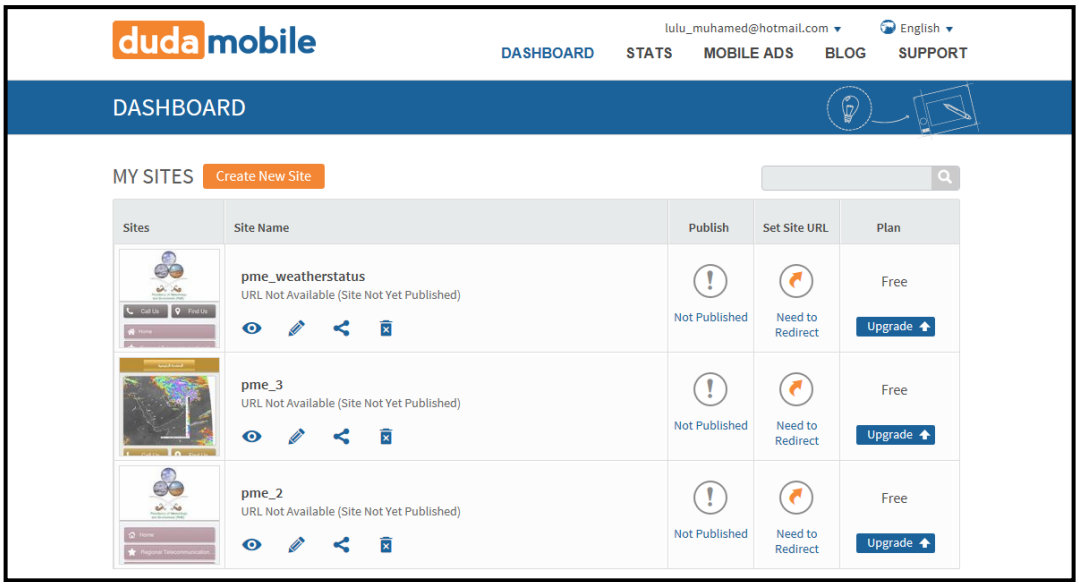

Figure 41: The main interface of Dudamobile tool after login

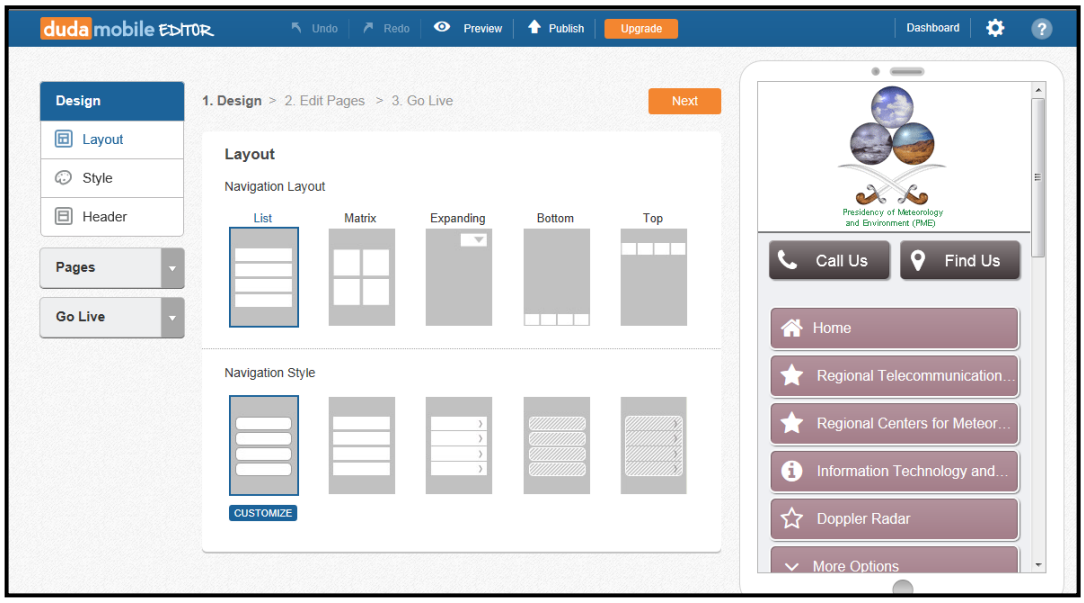

Figure 42: The interface of the design page of Dudamobile

The interface of the design page of Dudamobile contains three steps for designing the mobile site version that help the developer to change the design of the mobile site or change the pages. These steps are shown in (Figure 42) and they are for selecting the pages layout, the pages style and the header of the mobile site version. The edit step is

shown in (Figure 43) which enables the developer to edit the mobile site pages by adding, editing or deleting the pages and the contents.

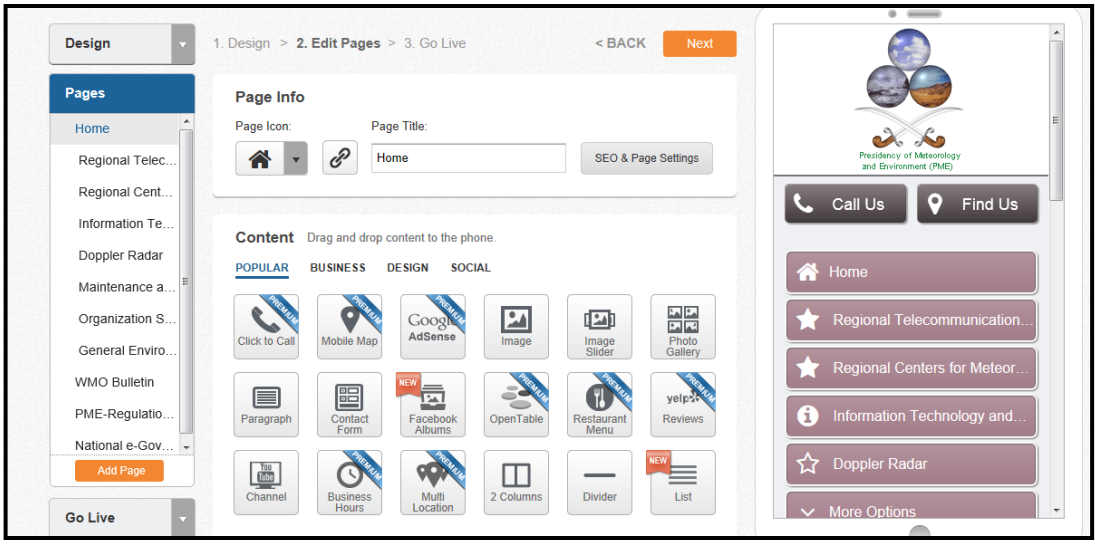

Figure 43: The interface of editing the pages of the mobile site in Dudamobile

The design edit process in Dudamobile includes changing the layout navigation, the style or the header. This tool also allows the developer to add or remove pages or widgets from the mobile site. The developer can add or remove pages from the mobile version then see how the mobile site will look like within the preview.

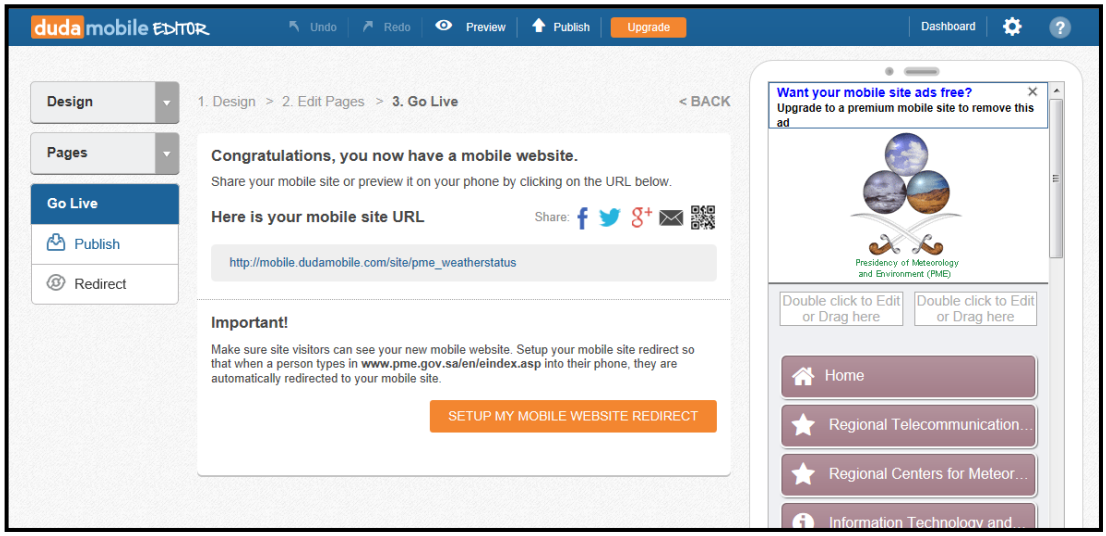

Figure 44: The interface of the publish page of Dudamobile

The interface of the published page of Dudamobile, where the mobile site can be published, gives the developer the address of the mobile site and then the resulting mobile site version can be seen on the mobile device (Figures 44).

Advantages

This tool has some features that give the developer advanced flexibility such as:

- DudaMobile is an easy builder tool requiring low learning time.
- It also has many layouts for the navigation and the style that the developer can use it to organize the page elements as shown in Figure 42.
- The developer can convert an existing website or create a new mobile version from existing templates.
- The logo and the website name are included on all the pages and in the same place to address the where am I navigation guideline (GL#8) (Small Screen Context) (GL#13) (Interface Elements Consistency Context).
- The developer can change the logo of the mobile site.
- The developer can add or remove any buttons or pages from the mobile version. It also allows the developer to add or remove widgets for the mobile site as shown in Figure 43.
- It supports the Arabic language of the site as shown in the following figures (Figures 45, 46 and 47) (GL# 6) (User Personal Characteristics Context).
- It creates link to the full site with name classic (GL# 4).

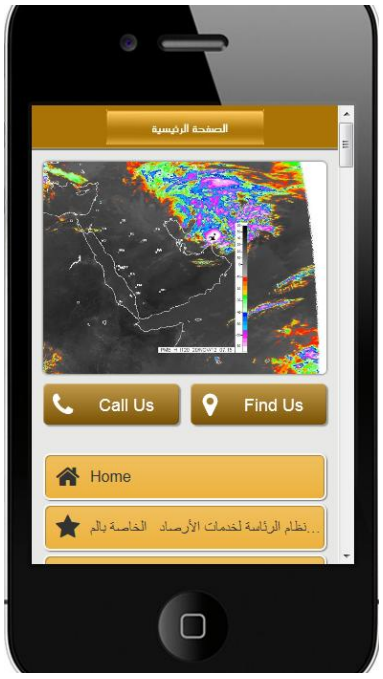

Figure 45: Home page of the Arabic mobile version of PME using Dudamobile tool

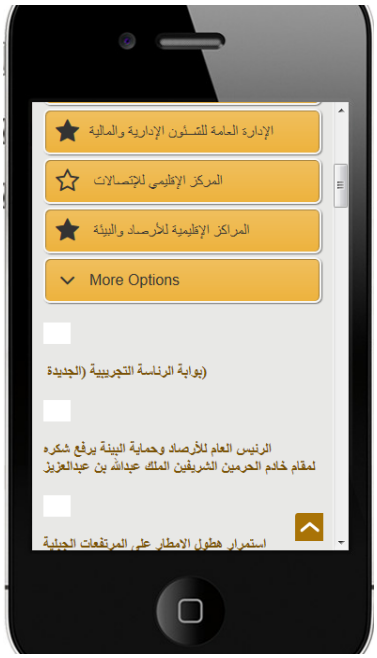

Figure 46: Continuation of The home page of the Arabic mobile version

Figure 47: Continuation of the home page of the Arabic mobile version

Disadvantages

This tool has some disadvantages:

- It takes all the buttons, links and content from the desktop website and puts them in the mobile version as they are.
- It does not create Home, Back links at the bottom of the website pages.
- If the image is too large on the desktop website, it doesn't customize it to be compatible with the mobile version of the site as shown in (Figures 48, 49, 50 and 51)

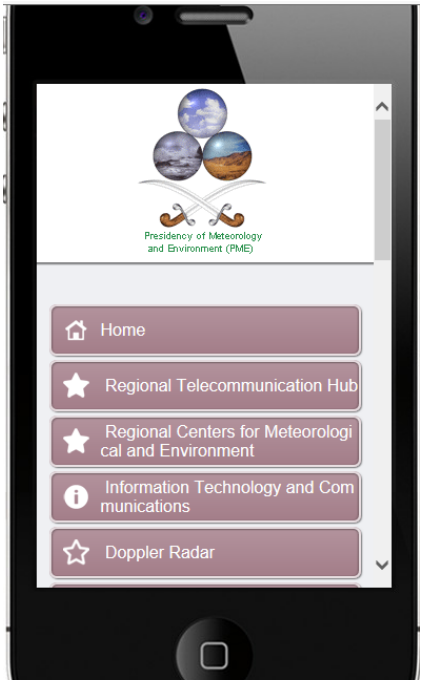

Figure 48: Home page of the English mobile version of PME desktop website

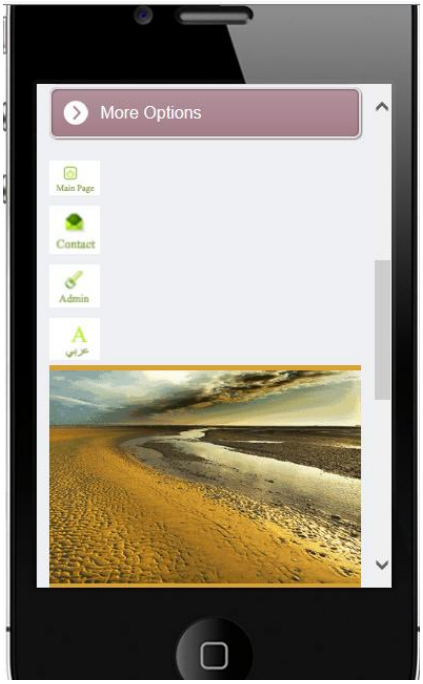

Figure 49: Continuation of the English mobile version

Figure 50: Continuation of the English mobile version

Figure 51: Continuation of the English mobile version

- This tool doesn't take long time to convert the desktop site to a mobile version but the result is not compatible with the context of the mobile device because

there is scrolling which is more than three screens and the user will take a long time to find the information especially if the desktop website contains many functions and services.

- It does not create breadcrumbs to let the users to know where he/she is while browsing the website.

From the previous advantages of Dudamobile website version and according to Section 3.2, the context of use addressed was User Personal Characteristics Context.

4.1.3. Conclusion

After using the three mobile web builder tools in building mobile versions of the PME desktop website, the following conclusions were found:

- Mobile web builder tools from category one and three are not suitable for building a mobile site that has limited amount of information because they take everything existing in a desktop version and puts them as they are in the mobile version unless the developer changes them manually.
- Mobile web builder tools from category two are more suitable for developing a website that can be appropriates to open with mobile devices than category one and three because they give the user the ability to build his/her mobile version as needed although they contain some obstacles such as limitation of the templates used for interface design.
- Mobile web builder tools are more appropriate for business websites because they have layouts and template categorized by the purpose of the mobile site.

Chapter V

Developing the PME Mobile Website

There are three principles that need to be followed in designing mobile user interfaces (Zamzami & Mahmud, 2012):

- Let the users be in control of the interface
- Reduce user's memory load
- Make the user interface consistent

The PME desktop site was chosen for this research as the example website to convert to a mobile version.

5.1. HTML5 Definition

HTML5 is a World Wide Web Consortium (W3C) specification that defines the fifth major revision of the Hypertext Markup Language (HTML) which is the core technology markup language of the internet used for structuring and presenting content for world wide web (Wikipedia, 2014) (Webopedia, 2014). One of the major changes in HTML5 is in respect to how HTML addresses Web applications for mobile devices. Other new

features in HTML5 include specific functions for embedding graphics, audio, video, and interactive documents.

The program used to develop the mobile version of the proposed mobile government website for PME was Adobe Dreamweaver CS6. It was chosen for two reasons:

- It contains an HTML5 editor as shown in figure 52.
- It allows the developer to choose the size of the mobile interface as shown in figure 53.

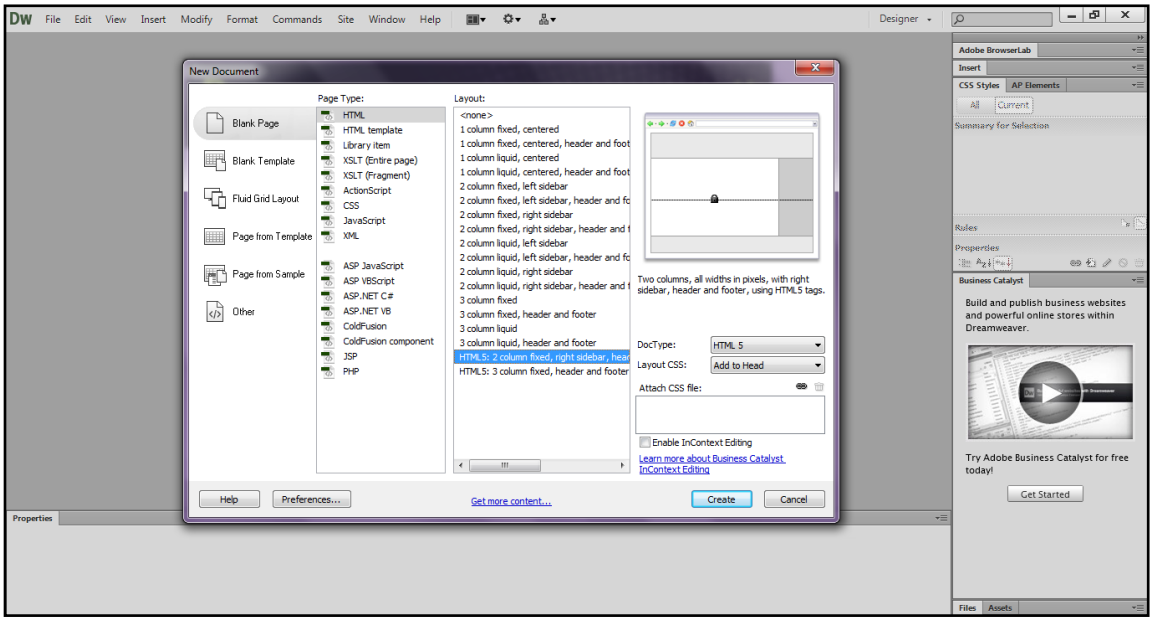

Figure 52: Adobe Dreamweaver CS6 interface for HTML5 editor

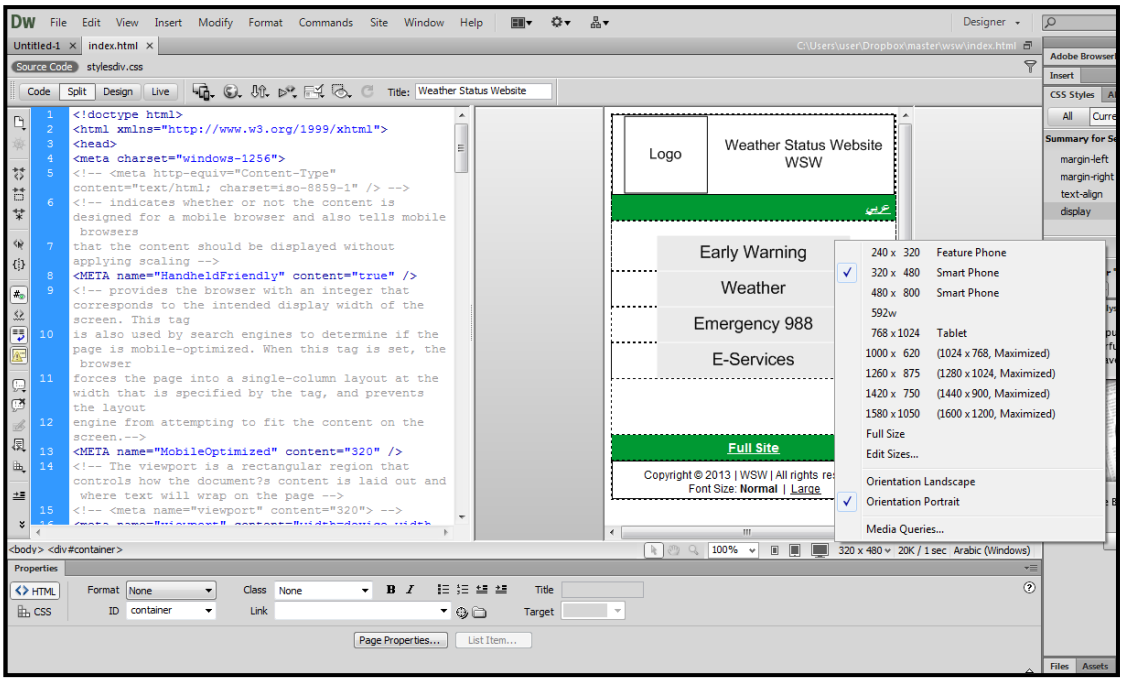

Figure 53: Choosing the Size of mobile interface in Adobe Dreamweaver CS6

At the first stage, the mobile version built was in the English language because one of the mobile builder tools used in developing the mobile version (Mobify) did not have Arabic support. The Arabic version of it was later developed.

The mobile website is built to be compatible with iOS iPhone5 mobile devices. Although the website is designed for iOS iPhone5, it can be used for Android mobile devices.

5.2. The Proposed Mobile Version of PME

The interface of the proposed mobile version that was developed for PME website has the following features:

- It is very simple because the more attention an interface requires, the more difficult it will be for the mobile user to maintain awareness of the surrounding environment (Chittaro, 2010).
- It contains only the important information the citizen needs in an urgent situation while the user is moving.
- It has 4 buttons that present the most important services for citizens.
- It includes the copyright information of the website.
- It includes a link to the Arabic version of the website and a link to the full site and vice versa.
- It offers two sizes for the font: normal (default size) and large.

The main interface layout of the proposed mobile version of the PME website has the following services in the home page as shown in (Figure 54):

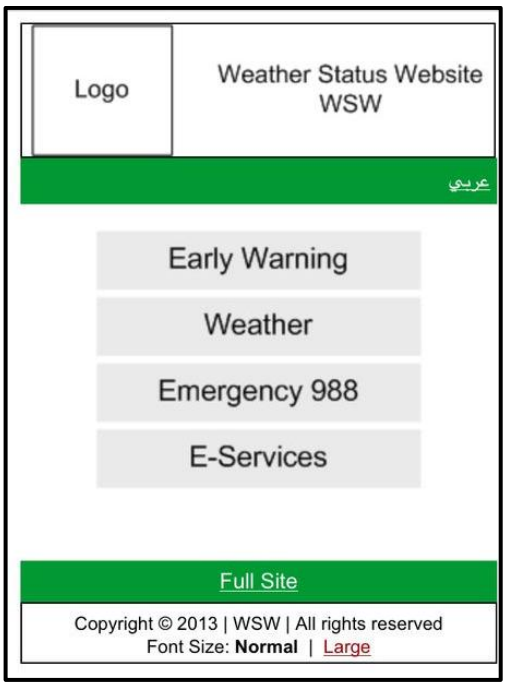

Figure 54: Home page of the proposed mobile version of the PME website

1. Early Warning: It contains information about the areas that have been or could be exposed to natural disasters (Figure 55). In the full site, this service opens the map of Saudi Arabia and identifies warning levels areas on the map in four colors, green, yellow, orange and red which means disclaimer region, alert region, advanced alert region and warning region, respectively. Then a user can click on the colored circle on the map to open an explanation about the area's situation.

Figure 55: Early warning page

In the mobile version, the image of the map was eliminated dividing the region into four categories:

- Disclaimer regions: it displays information about the regions that may be exposed to a natural disaster.

- Alert regions: means an alert about the possibility of an area affected by the climate phenomenon of air.
- Advanced alert regions: it means advanced alert about the impact of the phenomenon of air and to take caution
- Warning regions: it means severe meteorological phenomena or floods to take caution and commitment to civil defense instructions, guidance and directives (Figure 56).

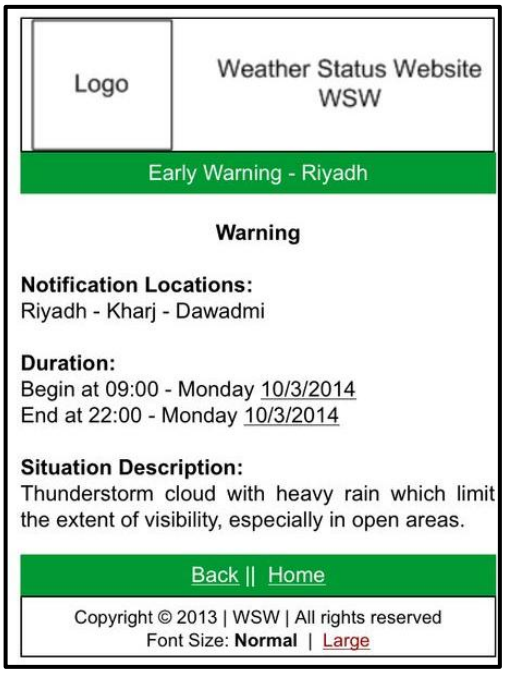

Figure 56: Warning page of Riyadh

2. Weather: it contains information about the weather forecast which is divided into three links (Figure 57):
    - Today's Weather
    - Tomorrow's Weather
    - 5 Days Weather

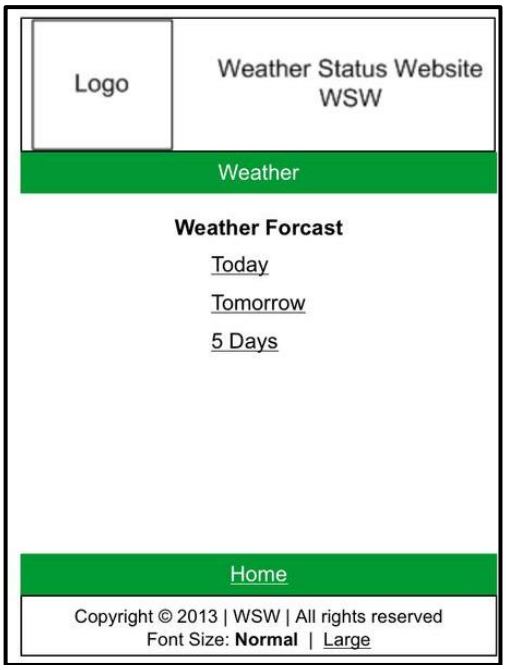

Figure 57: Weather page

3. Emergency 988: It contains the number of the emergency services (Figure 58).

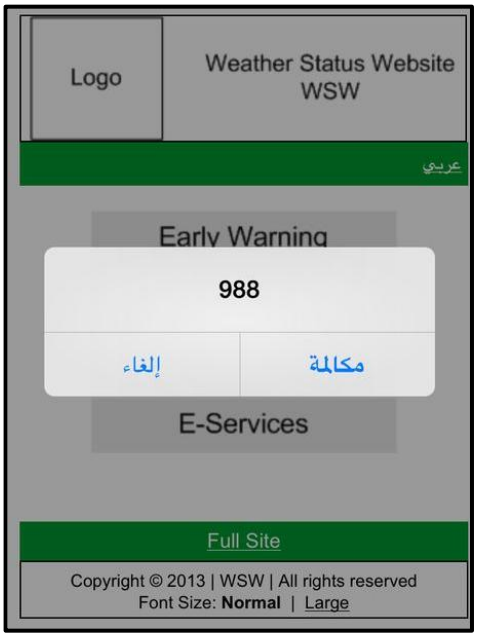

Figure 58: Call emergency 988 from the main menu

4. E-Services: it contains three links that can be used for sending notifications about cases of pollution incidents. These links are as follow (Figure 59):

- Notification by Email: send an email to notify about cases of pollution incidents.
- Notification by Phone: call numbers to notify about cases of pollution incidents.
- Notification by SMS: send SMS to notify about cases of pollution incidents seems to be yet provided by PME as stated on their website as "Coming Soon".

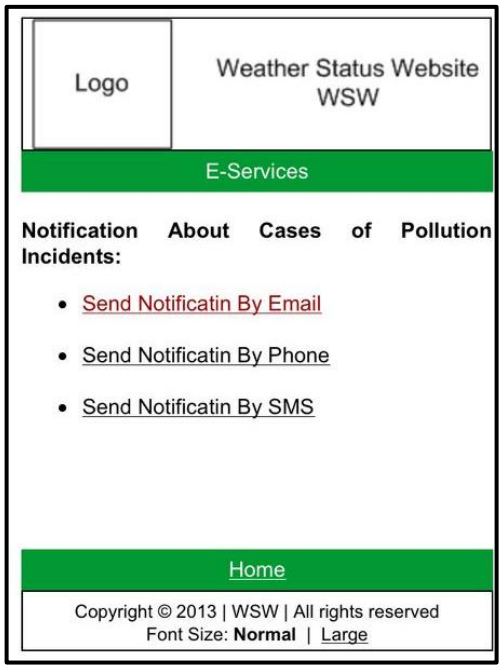

Figure 59: E-services page

The pages of the mobile version was designed with specific properties according to the proposed guidelines and the context of use addressed in Section 3.2 and during the prototype design, the following user interface design decisions were made:

1. The logo and the website name are included on all the pages and in the same place to address the where am I navigation guideline (GL#8) (Small Screen Context) (GL#13) (Interface Elements Consistency Context).
2. The ability to change the language to the Arabic language is included on the home page (GL#6) (User Personal Characteristics Context).
3. The main navigation menu is on the home page only and they are not repeated on every page (GL#40) (Small Screen Context, Mobility Context).
4. A link to the full site is on the home page (GL#4).
5. The copy right of the website is included on every page of the proposed mobile version.
6. Each page contains breadcrumbs to allow users to keep track of their locations within the website to address where I have been navigation guideline (GL#8) (Small Screen Context).
7. Links to go back or go home on all the pages (GL#40) (Small Screen Context, Mobility Context) (GL#41) (Mobile Device Characteristics Context).
8. The page size is 320 width X 480 heights which is the size of iPhone screen size (GL#1) (User Personal Characteristics Context).
9. The menu buttons on the home page were arranged vertically from the most important button for users and all of them are visible at once. The vertical arrangement of the elements in a mobile device is more suitable because the height of the mobile device screen is bigger than the width, so that will prevent horizontal scrolling which is not preferred by users (GL#9) (Small Screen Context, Mobility Context, Social Situations Context) (GL#21) (Mobility Context).

10. The grey color was chosen for the buttons on the home page with black font color on it to insure the contrast and minimize the number of colors used on the icons (GL#34) (Mobile Device Characteristics Context, Lighting Conditions Context).
11. The maximum number of pages depth is less than 3 pages to minimize the number of clicks (GL#39) (Content Context, Mobility Context, Social Situations Context, Critical Time Context).
12. The interface was optimized for the portrait presentation format (GL#7) (Small Screen Context).
13. The font size is 14 which can make the text readable for the users (GL#25) (User Personal Characteristics Context, Lighting Conditions Context).
14. The ability to enlarge the font size to 16 to insure the readability in bad conditions as shown in the following figure (Figure 60) (GL#59) (User Personal Characteristics Context, Lighting Conditions Context).
15. The bold was used for the headings or subheadings only and the italic style was not used (GL#28) (Small Screen Context).
16. The font color is black with white background to be sure there is a good contrast between the font color and the background color and to limit the number of colors used (GL#14) (Small Screen Context), (GL#24) (Small Screen Context, Mobile Device Characteristics Context, Lighting Conditions Context).
17. The underline style was used for links only (GL#15) (Mobile Device Characteristics Context, Lighting Conditions Context, Mobility Context, Social Situations Context), (GL#30).

Figure 60: Using large font in warning page of Riyadh

18. Using a drop down menu on the page of 5 days forecast to select the city instead of using a table with scrolling as done on the page of today and tomorrow weather forecast in order to balance the choices between scrolling and paging as shown in (Figure61) (GL#42) (Small Screen Context, Content Context, Mobility Context).
19. Using underlined text for the links (GL#46) (Small Screen Context, Mobile Device Characteristics Context, Lighting Conditions Context, Network Connectivity Context).
20. The visited links are indicated with a red color (GL#52) (Content Context).
21. The font family is Arial, Helvetica, sans-serif. Arial is chosen because it is supported by the mobile devices and it has less character spacing which makes Arial more suitable for the limited screen size, on mobile devices.

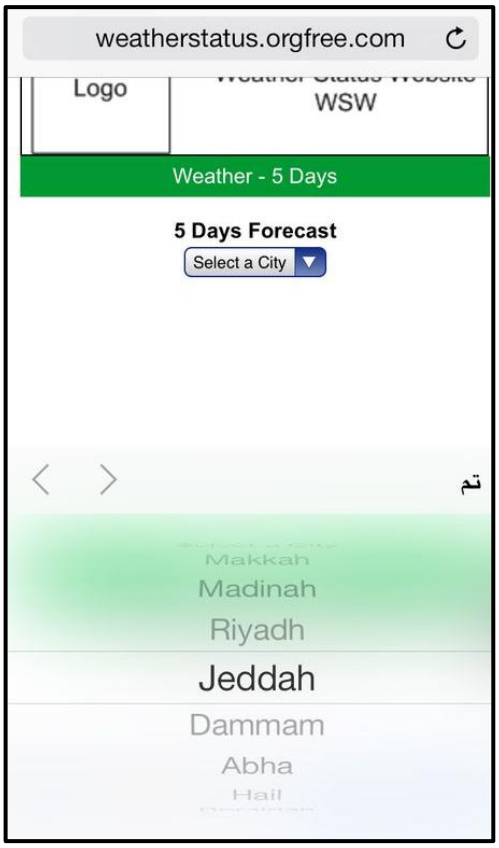

Figure 61: Using drop down menu in 5 days weather forecast

22. The images were not used except for the logo and the main menu on the home page to minimize the loading time of the website from the mobile devices (GL#31) (Small Screen Context, Network Connectivity Context, Interface Elements Consistency Context).
23. The scrolling was used instead of paging and the maximum scrolling was about less than 3 screens because paging is always used in presenting content in steps but in this case the user needs the information by doing the least number of clicks (GL#42) (Small Screen Context, Content Context, Mobility Context).
24. The scrolling that was used is only vertical as shown in (Figure 62) (GL#34) (Mobile Device Characteristics Context, Lighting Conditions Context).

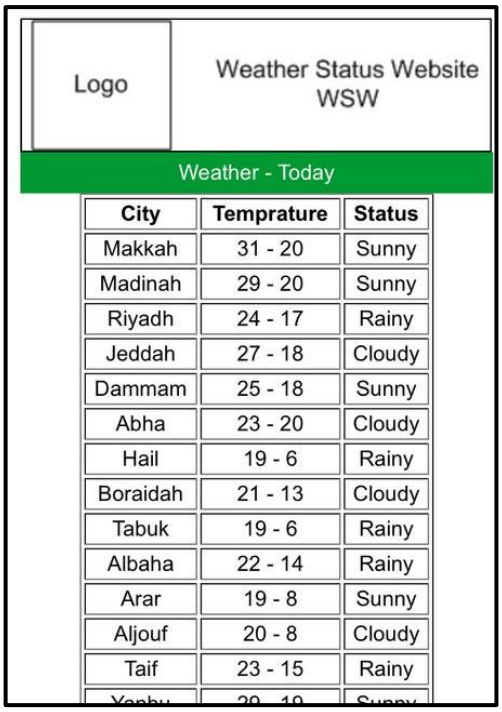

Figure 62: Using vertical scrolling in today weather forecast

25. The place of the links, logos, navigation and contents are consistent in the proposed mobile version to minimize the time needed by the user to find the information. This is also applied for the font size and color (GL#17) (Mobile Device Characteristics Context, Interface Elements Consistency Context), (GL#38) (Interface Elements Consistency Context).
26. Using the in-built function for making 988 Emergency call button on the home page as shown in (Figure 58) (GL#55).

According to the previous decision that made in designing the proposed mobile version, the following context of uses from section 3.2 were covered:

- User Personal Characteristics Context
- Small Screen Context
- Mobile Device Characteristics Context

- Content Context
- Lighting Conditions Context
- Mobility Context
- Network Connectivity Context
- Social Situations Context
- Interface Elements Consistency Context
- Critical Time Context

5.3. Additional HTML5 Coding

While developing the mobile version of the PME website, a few tags are needed in the <head> section of the web page to let the browser know that the page is ready to be viewed in a mobile browser and to fix the size and the orientation of the interface. These tags are:

1. **<META name="HandheldFriendly" content="true" />**

   provides the browser with an integer that corresponds to the intended display width of the screen. This tag is also used by search engines to determine if the page is mobile-optimized. When this tag is set, the browser forces the page into a single-column layout at the width that is specified by the tag, and prevents the layout engine from attempting to fit the content on the screen.

2. **<META name="MobileOptimized" content="320" />**

   The viewport is a rectangular region that controls how the documents content is laid out and where text will wrap on the page.

3. **@media all and (orientation: portrait){...}**

   This tag is used for optimizing the interface for portrait presentation.

4. **@media all and (max-width: 320px) {...}**

   This tag is used for determining the screen size.

5. **Viewport**

   The viewport is a rectangular region that controls how the document's content is laid out and where text will wrap on the page. The default display width for Internet Explorer Mobile is 1024 pixels, so if the web page width is less than 1024 pixels, it should set the viewport width accordingly.

   <meta name=”viewport” content=”width=320”/>

6. **Initial-sale=1**

   This code is used in viewport to determine the exact size of the page that must be displayed on the screen. When the initial scale is set to 1, only 320 pixels of the total width are displayed. This is because the width of the iPhone device is 320 pixels and 320/1 = 320. When the initial scale is doubled, to 2, only 180 pixels are displayed at first and so on.

Also special tags that were used in HTML5 are:

- The <header>: tag defines a header for a document or section.
- The <section>: tag defines a section in a document.
- The <nav>: tag defines navigation links.

For the interface elements such as the logo, screen size and navigation links on the home page and other elements to be fixed on the same place across the website pages, Cascading Style Sheets (CSS) were used.

Chapter VI

Usability Testing

According to the definition of context from chapter two, context may be anything which describes the situation of the user (Butter, Aleksy, Bostan, & Schader, 2007). Context can be used to adapt a user interface to the user's current needs, situation and device capabilities to improve its usability (Butter, Aleksy, Bostan, & Schader, 2007). As a result, the device capabilities are relevant to the interaction between the user and the application and can be seen as context attributes (Butter, Aleksy, Bostan, & Schader, 2007).

6.1. Guidelines Measurement

The proposed guidelines were divided into three groups based on the measurement type:

- The first group is guidelines that do not need user evaluation in the proposed mobile government version. Such guidelines only need a yes/no or not applicable answer and can be evaluated by the researcher.

- The second group is guidelines that can be measured using performance tasks given to users and post task questionnaires.
- The third group is guidelines that can be measured using post test interface user subjective evaluation questionnaires.

Recalling Section 3.2, the guidelines that will be evaluated and addressing the context of use are marked with * in Tables 16, 17 and 18.

The following table (Table 16) determines 15 guidelines that do not need to be measured in the proposed version and the reasons. It also determines if these guidelines need to be measured in the two mobile versions developed using Mofuse and Dudamobile mobile web builder tools.

Table 16: Guidelines That Do Not Need to be Measured and the Reasons

Guidelines that do not need to be measured in the proposed mobile version	**Context**	**Reasons**	**Mobile web builder tools websites**
GL#1: Know your users. GL#2: Determine the purpose of the site / service and identify the primary goals of the website before beginning the design process.	*	These guidelines are from the analysis phase and they must be decided by the developer before the development of the website.	Did not need an evaluation for the other mobile versions.

Table 16: Guidelines That Do Not Need to be Measured and the Reasons (Cont'd)

Guidelines that do not need to be measured in the proposed mobile version	Context	Reasons	Mobile web builder tools websites
GL#3: Decide whether you need more than 1 mobile site.		This guideline is from the analysis phase and it must be decided by the developer before the development of the website.	Did not need an evaluation for the other mobile versions.
GL#4: Quick access to the full site and back.		This guideline cannot be evaluated because the desktop website did not connect to the mobile site.	Did not need an evaluation for the other mobile versions.
GL#5: Ensure the site information is up-to-date.		The websites that have important information which can be used for emergency situations must be up to date.	Did not need an evaluation for the other mobile versions.

Table 16: Guidelines That Do Not Need to be Measured and the Reasons (Cont'd)

Guidelines that do not need to be measured in the proposed mobile version	Context	Reasons	Mobile web builder tools websites
GL#7: Design for portrait layout	*	The portrait layout is used on all the pages of the proposed mobile version and the other mobile websites built by using the builder tools. There is no need to evaluate this guideline because the landscape layout was not used.	They did not need an evaluation for the other mobile versions.
GL#10: Avoid using wide elements.	*	This guideline is applied because there is no wide element used in the proposed version.	Needs to be evaluated using subjective measurements.
GL#13: Place a logo(s) in a consistent place on every page to ensure users are fully aware they are on your website.	*	This guideline is applied and the logo is included on each page at the same place.	Did not need an evaluation for the other mobile versions.

Table 16: Guidelines That Do Not Need to be Measured and the Reasons (Cont'd)

Guidelines that do not need to be measured in the proposed mobile version	Context	Reasons	Mobile web builder tools websites
GL#15: Use colors meaningfully.	*	The colors used in the proposed version are black for the fonts and white for the background. Also green is used for the bar and white is used for font the static links on the page such as "Back" and "Home".	Needs to be evaluated in the Dudamobile website using subjective measurements.
GL#28: Avoid having too many text styles and sizes on the same page.	*	The font type that was used in the proposed mobile version is Arial size 14. Bold was used only for the heading and sub-heading and the under lined style was used for links. The italic style was not used.	Needs to be evaluated in the Dudamobile website using subjective measurement.
GL#29: Organize documents so they are readable without requiring an associated style sheet.	*	This guideline was tested and the proposed mobile version will be readable without requiring style sheets.	Did not need an evaluation for the other mobile websites because there are no style sheets for them.

Table 16: Guidelines That Do Not Need to be Measured and the Reasons (Cont'd)

Guidelines that do not need to be measured in the proposed mobile version	Context	Reasons	Mobile web builder tools websites
GL#30: Ensure that text highlighting techniques are not confusable with static contents and links.		The highlighting technique was not used in the proposed mobile version and in the other websites	Did not need an evaluation for the other mobile versions.
GL#32: Avoid using large or high resolution images.	*	The images were not used in the proposed mobile version	Needs to be evaluated in the Dudamobile website using subjective measurements.
GL#34: Icon color design cannot use more than 5 kinds of colors.	*	The icons were used only on the main menu at the home page. The color used was light grey for the background and black for the foreground.	Needs to be evaluated in the Dudamobile website using subjective measurements.
GL#43: Limit scrolling to one direction.	*	The scrolling was avoided on most pages but some pages that included tables have vertical scrolling only which was less than three screens.	Did not need an evaluation for the other mobile versions.

The guidelines that needed performance measurement are 24 guidelines and they are presented in Table 17 as follow:

Table 17: Guidelines That Need Performance Measurements

	Guidelines	Context
1	GL#6: Provide a functional bilingual website.	*
2	GL#8: Divide the screen area into title, content, and navigation from top to bottom.	*
3	GL#9: The main content of the screen and the most important information should be shown at the top.	*
4	GL#12: Elements of mobile interfaces such as names, colour schemes and dialogs appearances should be the same as their desktop counterparts.	*
5	GL#20: Provide content that is engaging, relevant, and appropriate to the audience.	*
6	GL#21: Only the most relevant and essential information should be shown.	*
7	GL#23: Provide a short but descriptive page titles.	*
8	GL#26: Organize text using sub-headings and links.	
9	GL#33: Handheld mobile device's icon design should be as direct, simple and unique as possible.	*
10	GL#36: Do not use tables unless the device is known to support them.	*
11	GL#37: The table width and height should not exceed the display width and height.	*
12	GL#39: Keep the number of levels in a hierarchical structure few in number (Use a flat hierarchy).	*
13	GL#40: Use links to the main screen and don’t repeat the navigation on every page.	*

Table 17: Guidelines That Need Performance Measurements (Cont'd)

	Guidelines	Context
14	GL#41: Use 'back' command.	*
15	GL#42: Balance the choice between scrolling and paging.	*
16	GL#49: Reduce or completely eliminate the need for data input especially text input.	*
17	GL#50: Replace text input with list selection.	*
18	GL#51: Place (automatically) a blinking cursor at the beginning of the first data entry field when a data entry form is displayed on a page.	*
19	GL#53: Provide an informative error message.	
20	GL#54: Ensure that the user interface elements are clearly visible in low light.	*
21	GL#55: Take advantage of inbuilt functionality.	
22	GL#56: Take into account the impact of the social context.	*
23	GL#57: Design for Limited and Split Attention.	*
24	GL#59: Make sure there is option for large font.	*

The guidelines that needed subjective measurements by allowing users to fill post-test questionnaire for each website after he/she finishes the test to evaluate the interface elements. These guidelines are 20 guidelines and they are presented in Table 18 as follow:

Table 18: Guidelines That Need Subjective Measurements

	Guidelines	Context
1	GL#11: Minimize white spaces on the page.	*
2	GL#14: Limit the number of different colors used on a page.	*
3	GL#16: Avoid Visual noise and clutter.	*
4	GL#17: Maintain consistency with the platform of use.	*
5	GL#18: Apply consistent design and layout throughout the site.	*
6	GL#19: Ensure that content is suitable for use in a mobile context.	*
7	GL#22: Use clear and simple language.	*
8	GL#24: Select the font and background color that provide sufficient contrast and would not hamper the visibility of text or links.	*
9	GL#25: Keep fonts large to optimize the reading process.	*
10	GL#27: Minimize margins.	*
11	GL#31: Minimize the use of images.	*
12	GL#35: For touch phones, leave generous amounts of space around widgets such as radio buttons, arrows for dropdown boxes, checkboxes, scrollbars, and links.	*
13	GL#38: Provide a consistent navigation mechanism.	*
14	GL#44: Minimize the amount of scrolling.	*
15	GL#45: Limit navigation options, and keep them direct.	*
16	GL#46: Using text for links rather than images where possible.	*

Table 18: Guidelines That Need Subjective Measurements (Cont'd)

	Guidelines	Context
17	GL#47: Clearly identify the target of each link.	*
18	GL#48: Provide large target size and padding.	*
19	GL#52: Indicate visited and unvisited links.	*
20	GL#58: Allow for single or no handed operation.	*

6.2. Usability Testing Approach

The usability testing methodology was based on the methodology of Dumas and Redish (Dumas & Redish, 1999). The textbook used for CPCS381 "Human Computer Interaction" within the Computer Science (CS) department curriculum in King Abdulaziz University KAU.

6.3. Goals and Concerns

The proposed guidelines were used to design the proposed mobile version of the PME website. To evaluate the usability of the proposed mobile version, testing with potential users was conducted.

- **General Goal:**

Are the proposed context of use guidelines efficient and effective in the designed PME mobile site providing a good user experience.

Table 19 addresses the general concerns of this research and their quantitative goals. Each general concern has specific concerns for some of the proposed guidelines which can be measured by user performance of specific task(s).

It must be mentioned that the time compared was different for each sample of the mobile versions and designated by (time) in Table 19.

Table 19: Goals and Concerns

General concerns	Quantitative goals	Specific concerns	Tasks
Can users find a city or a region that has an urgent situation easily and quickly	The users will be able to find the information about a city or a region that has an urgent situation in less than (time) with no more than 1 click the first time they need it.	GL#8: Divide the screen area into title, content, and navigation from top to bottom. GL# 20: Provide content that is engaging, relevant, and appropriate to the audience GL# 21: Only the most relevant and essential information should be shown GL#26: Organize text using sub-headings and links GL#39: Keep the number of levels in a hierarchical structure few in number (Use a flat hierarchy)	Task1: Find all the cities that have early warning.

Table 19: Goals and Concerns (Cont'd)

General concerns	Quantitative goals	Specific concerns	Tasks
	The users will be able to find the information about a specific city or region that has urgent situations in less than (time) with no more than 2 clicks the first time they need it.	GL#8: Divide the screen area into title, content, and navigation from top to bottom. GL#9: The main content of the screen and the most important information should be shown at the top GL# 20: Provide content that is engaging, relevant, and appropriate to the audience GL# 21: Only the most relevant and essential information should be shown GL#26: Organize text using sub-headings and links GL#39: Keep the number of levels in a hierarchical structure few in number (Use a flat hierarchy)	Task2: Find the duration and the situation description of the urgent situation in Dammam city.

Table 19: Goals and Concerns (Cont'd)

General Concerns	Quantitative Goals	Specific Concerns	Tasks
Can users find the number to call in an emergency easily and quickly	The users will be able to call the emergency number in less than (time) with no more than 1 click the first time they need it	GL# 39: Keep the number of levels in a hierarchical structure few in number (Use a flat hierarchy)	Task1: Make an emergency call by using the number for emergency provided
		GL# 40: Use links to the main screen and don't repeat the navigation on every page	
		GL# 55: Take advantage of inbuilt functionality	
Can users send notification by email to notify about incident cases	The users will be able to fill the form using the mobile device virtual keyboard with no more than 2 wrong entries (include wrong typing)	GL# 39: Keep the number of levels in a hierarchical structure few in number (Use a flat hierarchy)	Task1: Send an email to notify about an incident.
		GL# 49: Reduce or completely eliminate the need for data input especially text input	
		GL# 50: Replace text input with list selection	

Table 19: Goals and Concerns (Cont'd)

General concerns	General concerns	General concerns	General concerns
		GL# 51: Place (automatically) a blinking cursor at the beginning of the first data entry field when a data entry form is displayed on a page	
		GL# 53: Provide an informative error message	
Can users find the weather forecast of a specific city easily and quickly	The users will be able to find the weather forecast for a specific city today in less than (time) with no more than 2 clicks	GL#8: Divide the screen area into title, content, and navigation from top to bottom. GL# 20: Provide content that is engaging, relevant, and appropriate to the audience GL# 21: Only the most relevant and essential information should be shown	Task1: Find the weather forecast for Jeddah city today.

Table 19: Goals and Concerns (Cont'd)

General concerns	General concerns	General concerns	General concerns
	The users will be able to find the future weather forecast for a specific city in less than (time) with no more than 5 clicks	GL#8: Divide the screen area into title, content, and navigation from top to bottom. GL# 20: Provide content that is engaging, relevant, and appropriate to the audience GL# 21: Only the most relevant and essential information should be shown	Task1: Find the weather forecast for Arar city tomorrow then find the forecast for next 5 days
Can users read important information from a table easily and quickly	The users will be able to find the weather forecast for a specific city today in less than (time) with no more than 2 clicks	GL# 36: Do not use tables unless the device is known to support them GL# 37: The table width and height should not exceed the display width and height	Task1: Find the weather forecast for Jeddah city today.
	The users will be able to find the future weather forecast for a specific city in less than (time) with no more than 5 clicks	GL# 42: Balance the choice between scrolling and paging	Task1: Find the weather forecast for Arar city tomorrow then find the forecast for next 5 days

Table 19: Goals and Concerns (Cont'd)

General concerns	General concerns	General concerns	General concerns
Can users use the interface elements, icons and links to find the information quickly	The users will be able to use the links and icons to find specific information with no more than 2 clicks	GL# 6: Provide a functional bilingual website	Task1: Open the Arabic version of the site and then back to the English version
	The users will be able to use the links and icons to find specific information with no more than 1 click	GL# 12: Elements of mobile interfaces such as names, color schemes and dialogs appearances should be the same as their desktop counterparts.	Task2: Open the full website
	The users will be able to use the links and icons to find specific information about the warning cities with no more than 1 click	GL# 20: Provide content that is engaging, relevant, and appropriate to the audience GL# 23: Provide a short but descriptive page titles GL# 33: Handheld mobile device's icon design should be as direct, simple and unique as possible	Task1: Find all the cities that have early warning.

Table 19: Goals and Concerns (Cont'd)

General concerns	General concerns	General concerns	General concerns
	The users will be able to use the links and icons to find specific information with no more than 2 click	GL# 20: Provide content that is engaging, relevant, and appropriate to the audience GL# 23: Provide a short but descriptive page titles GL# 33: Handheld mobile device's icon design should be as direct, simple and unique as possible	Task2: Find the duration and the situation description of the urgent situation in Dammam city. Task3: Find the weather forecast for Jeddah city today.
	The users will be able to use the links and icons to find specific information with no more than 1 click	GL# 12: Elements of mobile interfaces such as names, color schemes and dialogs appearances should be the same as their desktop counterparts. GL# 33: Handheld mobile device's icon design should be as direct, simple and unique as possible GL# 40: Use links to the main screen and don't repeat the navigation on every page	Task1: Make an emergency call by using the number for emergency provided

Table 19: Goals and Concerns (Cont'd)

General concerns	General concerns	General concerns	General concerns
	The users will be able to use the links and icons to find specific information with no more than 5 click	GL# 41: Use 'back' command	Task1: Find the weather forecast for Arar city tomorrow then find the forecast for next 5 days
	The users will be able to use the links and icons to find specific information with no more than 1 click	GL# 59: Make sure there is option for large font	Task1: Enlarge the website font size

Chapter VII

Usability Testing Results and Discussion

A pilot evaluation on the three sample websites (proposed version, Mofuse version and Dudamobile version) was performed by a mobile user expert with a Computer Science graduate degree. To determine the base time for each task, the expert did the tasks and the time was calculated for each task on each website using a stopwatch. The base times were used to compare with the performance times for each task by each user. The following table (Table 20) represents the base time measured in seconds:

Table 20: Base Time for Each Task

Tasks	Mobile versions		
	Proposed version	**Mofuse version**	**Dudamobile version**
1	4.3	12	10.1
2	8	17	11.78
3	1.3	3.5	5.33
4	1.5	2	38.5
5	6.8	8.89	39.75
6	10	8.1	42.28
7	1.3	2.5	12.45
8	1.9		4
9	3.86		

Some of the tasks were not applicable in the Mofuse and the Dudamobile versions, so there is no times calculated for them. These tasks are highlighted in grey in Table 20.

The usability testing was done on three groups of users. Each user examined and evaluated the three websites but each group has different websites order as follow:

- Group One: The users of this group examined first the proposed version built using the government mobile website guidelines mentioned in Section 3.2 then examined the Mofuse version then the Dudamobile version.
- Group Two: The users of this group examined the Mofuse version first, the Dudamobile version second then the proposed version.
- Group Three: The users of this group examined the Dudamobile version first, the proposed version second then the Mofuse version**.**

Each group had 5 users. According to Jakob Nielsen, 5 users is enough for usability testing as it lets you find almost as many usability problems as you would find using many more test participants (Nielsen, 2012).

According to Nielsen (Nielsen, Usability Engineering, 1993), there are five parameters for usability which will be covered in this research discussed in detail in section 2.4:

- Efficiency of use
- Subjective Satisfaction
- Learnability
- Memorability
- Low Errors Rate

To avoid copyright infringement during testing with citizens of Jeddah, all the mobile versions developed did not include the logo nor the copyright information of the PME website.

7.1. Users' Profile

The usability test was conducted with 15 users. Participants were local Jeddah citizens and employees from King Abdulaziz University, female campus.

A demographic questionnaire (pre-test questionnaire) was given to each user prior to testing (Appindex A). The following tables (Table 21 to Table 24) show the demographic of the users.

Table 21: Gender Percentage

Gender	Percentage (Number)
Male	20% (3)
Female	80% (12)

Table 22: Age Range Percentage

Age range	Group 1	Group 2	Group 3	Percentage (Number)
20 - 25	1	2	-	20% (3)
26 - 30	2	1	-	20% (3)
31 - 35	2	1	3	40% (6)
36 - 40	-	1	2	20% (3)

Table 23: Mobile Type of the Participants

Mobile type	Percentage (Number)
iPhone	60% (9)
Samsung	26.7% (4)
HTC	13.3% (2)

Table 24: Services Used By the Participants

Services	Percentage (Number)
Text messaging	100% (15)
Check weather	80% (12)
Playing games	80% (12)
Go online	100% (15)
Check your email	100% (15)
Searching for specific information on the Web	100% (15)
Reading text	73.3% (11)
Using the PME website	26.7% (4)

7.2. Task Analysis

To evaluate the guidelines that need performance measurements, times was calculated from the users performance after doing each task using a stop watch. All the tasks were read to the users because they were walking while performing some tasks and the calculation of the time was started after they finished reading each task. The following explains the statistical analysis performed on the usage times.

7.2.1. Hypothesis H1

Recalling H1 from Section 1.6, there are statistically significant differences between the mobile version of the PME website developed by using mobile design guidelines taking into account the context of use and the websites that are developed by using mobile website builder tools for each task given to users during usability testing. Task 9 is only applicable in the proposed version, so it does not need to be compared between the three websites.

To address this hypothesis, A T-Test and ANOVA were applied for the mobile versions websites: "the proposed mobile version, the Mofuse mobile version, the Dudamobile mobile version" in tasks "1-8". The results are presented in Tables 25 to 39.

- **Task1**

Table 25 : The Variance Analysis for Degrees of Mobile Versions: "Proposed Version, Mofuse Version, Dudamobile Version" in Task 1

Task 1	Sum of Squares	Mean Square	df	F	Sig
Between Groups	6399.994	3199.997	2	33.520	0.01 Sig
Within Groups	4009.561	95.466	42		
Total	10409.555		44		

Table 25 shows that the value (F) was (33.520), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between the mobile versions: "proposed version, Mofuse version, Dudamobile version " in Task 1. To find

out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 26).

Table 26 : LSD Test for Multiple Comparisons

Task 1	Proposed version M = 5.744	Mofuse version M = 30.879	Dudamobile version M = 31.202
Proposed version	-		
Mofuse version	25.135**	-	
Dudamobile version	25.458**	0.322	-

Note: without * has not significance (0.05)* (0.01)**

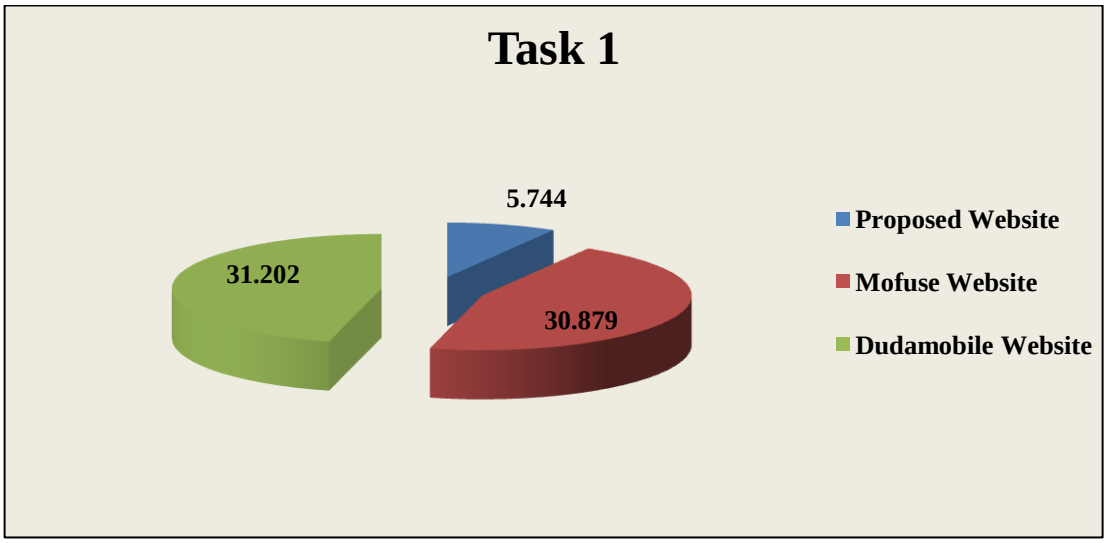

Figure 63: Differences of degrees of mobile versions: "proposed version, Mofuse version, Dudamobile version" in task1

Table 26 and Figure 63 show that there are no differences in mobile websites in Task 1 between the Dudamobile version and the Mofuse version, while there are differences between the Dudamobile version and the proposed version compared to the Dudamobile version at significance level (0.01), also there are differences between the Mofuse

version and the proposed version compared to the Mofuse version at significance level (0.01), where the time average for both of the Dudamobile version and the Mofuse version reached respectively (30.879), (31.202), followed by the proposed version with an average (5.744).

- **Task2**

Table 27 : The Variance Analysis for Degrees of Mobile Versions: "Proposed Version, Mofuse Version, Dudamobile Version" in Task 2

Task 2	Sum of Squares	Mean Square	df	F	Sig
Between Groups	3560.767	1780.383	2	14.661	0.01 Sig
Within Groups	5100.450	121.439	42		
Total	8661.217		44		

Table 27 shows that the value (F) was (14.661), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between the mobile versions: "proposed version, Mofuse version, Dudamobile version" in Task 2. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 28).

Table 28 : LSD Test for Multiple Comparisons

Task 2	Proposed version M = 6.071	Mofuse version M = 15.692	Dudamobile version M = 27.812
Proposed version	-		
Mofuse version	9.620**	-	
Dudamobile version	21.741**	12.120**	-

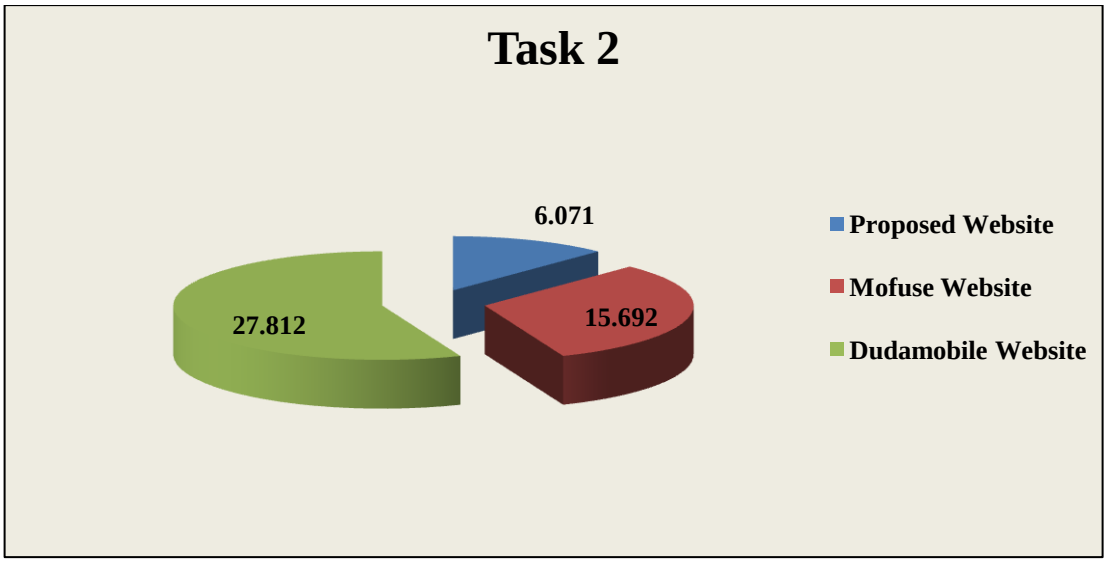

Figure 64: Differences of degrees of mobile versions: "proposed version, Mofuse version, Dudamobile version" in task2

Table 28 and Figure 64 show that there are differences in the mobile versions in "Task 2" between the Dudamobile version and both of "the Mofuse version, the proposed version" compared to the Dudamobile version at significance level (0.01), also there are differences between the Mofuse version and the proposed version compared to the Mofuse version at significance level (0.01), where the time average for the Dudamobile version reached (27.812), followed by the Mofuse version with an average time (15.692), followed by the proposed version with an average time (6.071).

- **Task3**

Table 29 : The Variance Analysis for Degrees of Mobile Versions: "Proposed Version, Mofuse Version, Dudamobile Version" in Task 3

Task 3	Sum of Squares	Mean Square	df	F	Sig
Between Groups	354.614	177.307	2	7.037	0.01 Sig
Within Groups	1058.253	25.197	42		
Total	1412.867		44		

Table 29 shows that the value (F) was (7.037), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between the mobile versions: "proposed version, Mofuse version, Dudamobile version" in Task 3. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 30)

Table 30 : LSD Test for Multiple Comparisons

Task 3	Proposed version M = 2.488	Mofuse version M = 4.983	Dudamobile version M = 9.284
Proposed version	-		
Mofuse version	2.495*	-	
Dudamobile version	6.796**	4.301**	-

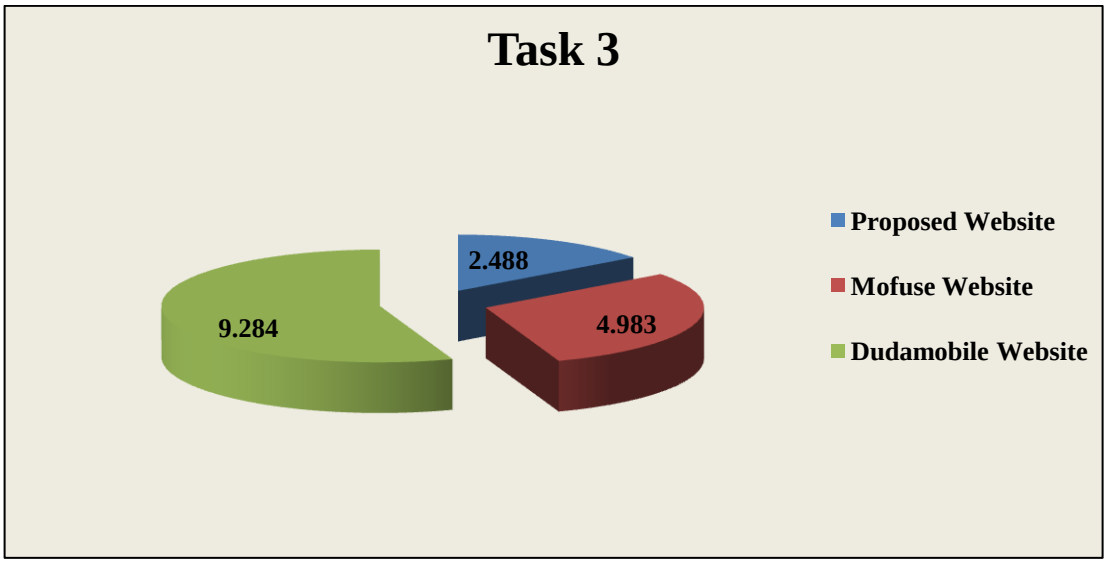

Figure 65: Differences of degrees of mobile versions: "proposed version, Mofuse version, Dudamobile version" in task 3

Table 30 and Figure 65 show that there are differences in the mobile versions in "Task 3" between the Dudamobile version and both of "Mofuse version, proposed

version " compared to the Dudamobile version at significance level (0.01), while there are differences between the Mofuse version and the proposed version compared to the Mofuse version at significance level (0.05), where the time average for the Dudamobile version reached (9.284), followed by the Mofuse version with an average time (4.983), followed by the proposed version with an average time (2.488).

- **Task4**

Table 31 : The Variance Analysis for Degrees of Mobile Versions: "Proposed Version, Mofuse Version, Dudamobile Version" in Task 4

Task 4	Sum of Squares	Mean Square	df	F	Sig
Between Groups	28311.817	14155.909	2	37.196	0.01 Sig
Within Groups	15984.143	380.575	42		
Total	44295.960		44		

Table 31 shows that the value (F) was (37.196), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between the Mobile versions: "Dudamobile version, Mofuse version, proposed version" in Task 4. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 32).

Table 32 : LSD Test for Multiple Comparisons

Task 4	Proposed version M = 5.857	Mofuse version M = 8.462	Dudamobile version M = 68.012
Proposed version	-		
Mofuse version	2.604*	-	
Dudamobile version	62.155**	59.550**	-

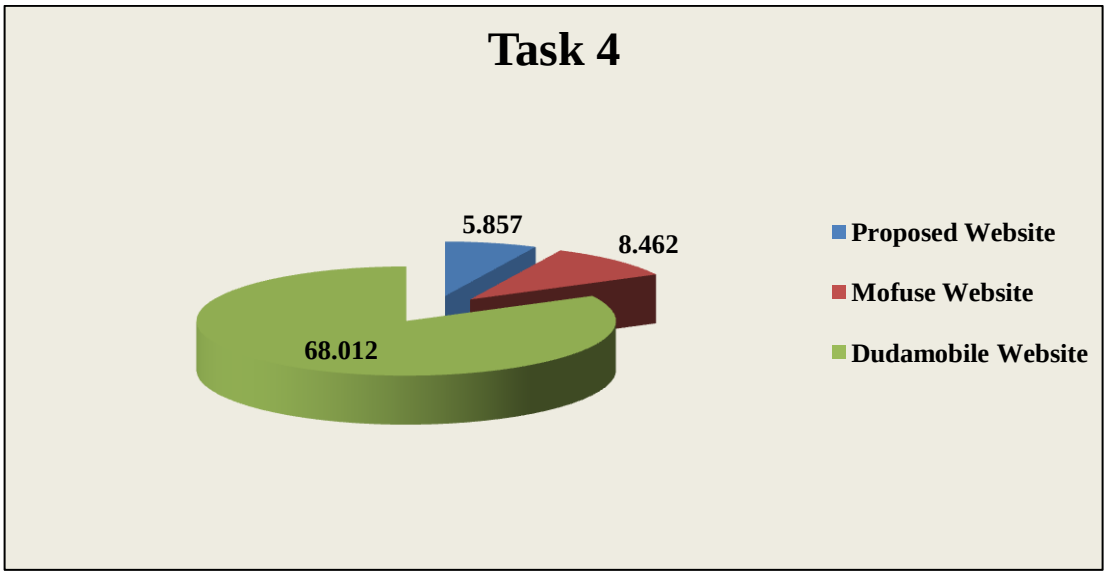

Figure 66: Differences of degrees of mobile versions: "proposed version, Mofuse version, Dudamobile version" in task 4

Table 32 and Figure 66 show that there are differences in the mobile versions in "Task 4" between the Dudamobile version and both of "Mofuse version, proposed version " compared to the Dudamobile version at significance level (0.01), while there are differences between the Mofuse version and the proposed version compared to the Mofuse version at significance level (0.05), where the time average for the Dudamobile version reached (68.012), followed by the Mofuse version with an average time (8.462), followed by the proposed version with an average time (5.857).

- **Task5**

Table 33 : The Variance Analysis for Degrees of Mobile Versions: "Proposed Version, Mofuse Version, Dudamobile Version" in Task 5

Task 5	Sum of Squares	Mean Square	df	F	Sig
Between Groups	5651.041	2825.521	2	24.602	0.01 Sig
Within Groups	4823.644	114.849	42		
Total	10474.685		44		

Table 33 shows that the value (F) was (24.602), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between the mobile versions: "Dudamobile version, Mofuse version, proposed version" in Tasks 5. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 34)

Table 34 : LSD Test for Multiple Comparisons

Task 5	Proposed version M = 7.453	Mofuse version M = 10.226	Dudamobile version M = 34.650
Proposed version	-		
Mofuse version	2.773*	-	
Dudamobile version	27.196**	24.423**	-

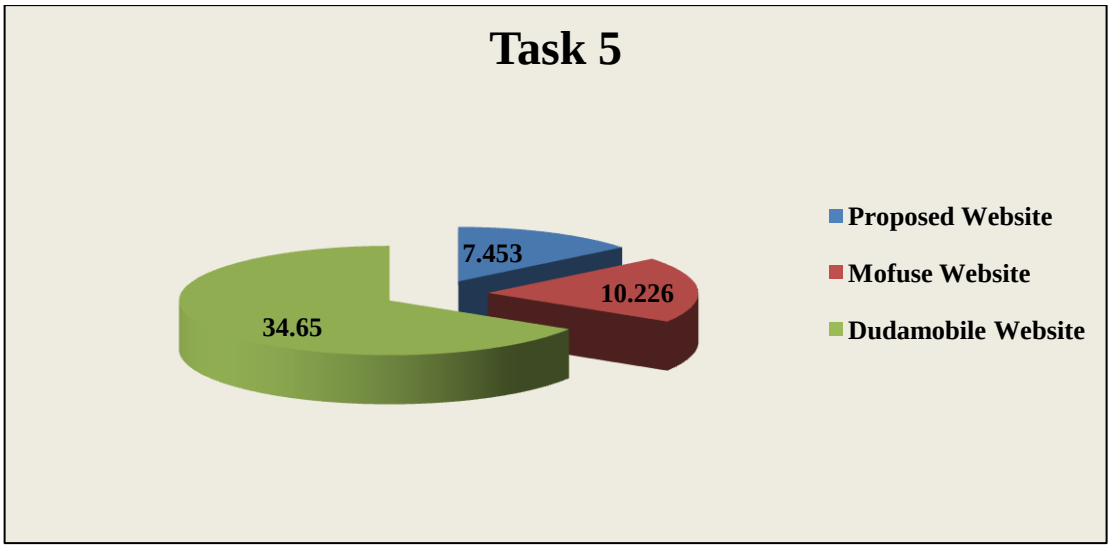

Figure 67: Differences of degrees of mobile versions: "proposed version, Mofuse version, Dudamobile version" in task 5

Table 34 and Figure 67 show that there are differences in the mobile versions in "Task 5" between the Dudamobile version and both of "Mofuse version, proposed version" compared to the Dudamobile version at significance level (0.01), while there are differences between the Mofuse version and the proposed version compared to the Mofuse version at significance level (0.05), where the time average for the Dudamobile version reached (34.650), followed by the Mofuse version with an average time (10.226), followed by the proposed version with an average time (7.453).

- **Task6**

Table 35 : The Variance Analysis for Degrees of Mobile Versions: "Proposed Version, Mofuse Version, Dudamobile Version" in Task 6

Task 6	Sum of Squares	Mean Square	df	F	Sig
Between Groups	4759.468	2379.734	2	44.542	0.01 Sig
Within Groups	2243.903	53.426	42		
Total	7003.371		44		

Table 35 shows that the value (F) was (44.542), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between mobile versions: "Dudamobile version, Mofuse version, proposed version" in Tasks 6. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 36)

Table 36 : LSD Test for Multiple Comparisons

Task 6	Proposed version M = 17.912	Mofuse version M = 23.798	Dudamobile version M = 42.068
Proposed version	-		
Mofuse version	5.886**	-	
Dudamobile version	24.155**	18.269**	-

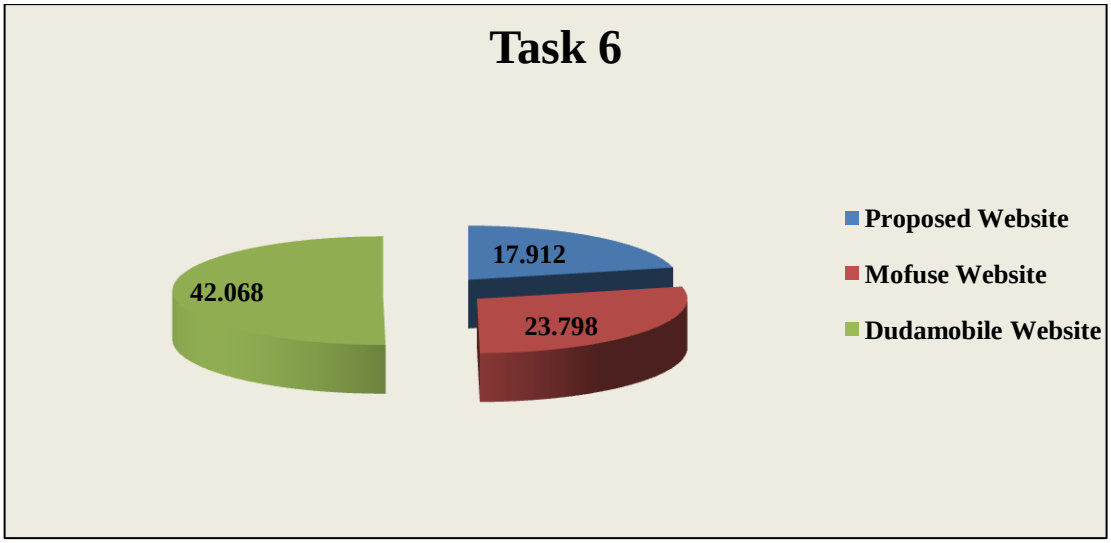

Figure 68: Differences of degrees of mobile versions: "proposed version, Mofuse version, Dudamobile version" in task 6

Table 36 and Figure 67 show that there are differences in the mobile versions in "Tasks 6" between the Dudamobile version and both of "Mofuse version, proposed version " compared to the Dudamobile version at significance level (0.01), also there are

differences between the Mofuse version and the proposed version compared to the Mofuse version at significance level (0.01), where the time average for the Dudamobile version reached (42.068), followed by the Mofuse version with an average time (23.798), followed by the proposed version with an average time (17.912).

- **Task7**

Table 37 : The Variance Analysis for Degrees of Mobile Versions: "Proposed Version, Mofuse Version, Dudamobile Version" in Task 7

Task 7	Sum of Squares	Mean Square	df	F	Sig
Between Groups	3016.760	1508.380	2	13.914	0.01 Sig
Within Groups	4553.155	108.408	42		
Total	7569.915		44		

Table 37 shows that the value (F) was (13.914), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between the mobile versions: "proposed version, Mofuse version, Dudamobile version" in Task 7. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 38)

Table 38: LSD Test for Multiple Comparisons

Task 7	Proposed version M = 4.151	Mofuse version M = 13.691	Dudamobile version M = 24.199
Proposed version	-		
Mofuse version	9.540**	-	
Dudamobile version	20.048**	10.508**	-

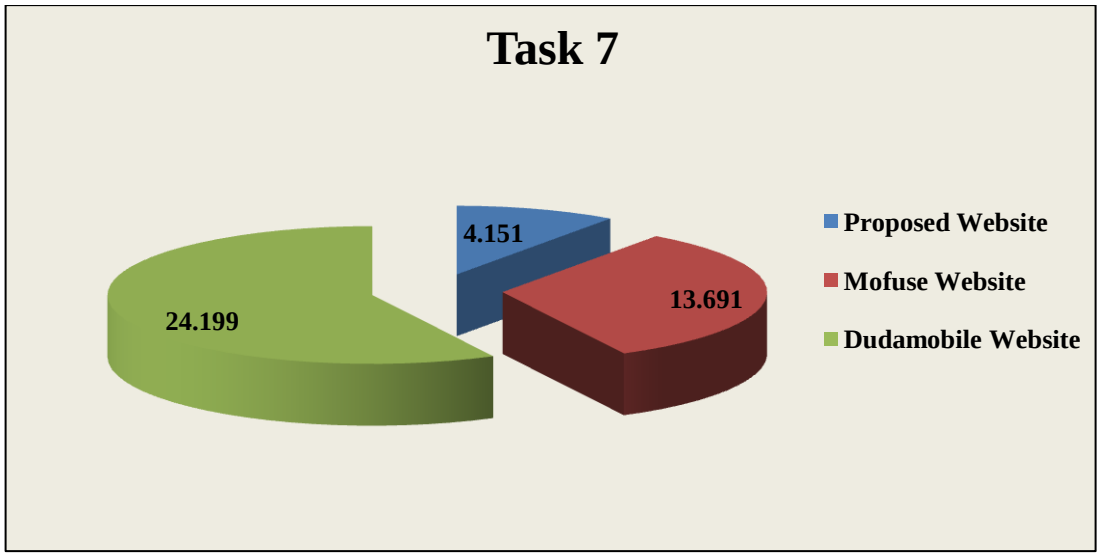

Figure 69: Differences of degrees of mobile versions: "proposed version, Mofuse version, Dudamobile version" in task 7

Table 38 and Figure 69 show that there are differences in the mobile versions in "Task 7" between the Dudamobile version and both of Mofuse version and proposed version compared to the Dudamobile version at significance level (0.01), also there are differences between the Mofuse version and the proposed version compared to the Mofuse version at significance level (0.01), where the time average for the Dudamobile version reached (24.199), followed by the Mofuse version with an average time (13.691), followed by the proposed version with an average time (4.151).

- **Task8**

Table 39 : The Differences in Degrees Average of Mobile Versions: "Proposed Version, Dudamobile Version" in Task 8

Task 8	Mean	Std. Deviation	N	df	t	Sig
Proposed version	5.072	2.939	15	14	9.543	0.01 Dudamobile version
Dudamobile version	12.730	6.575	15			

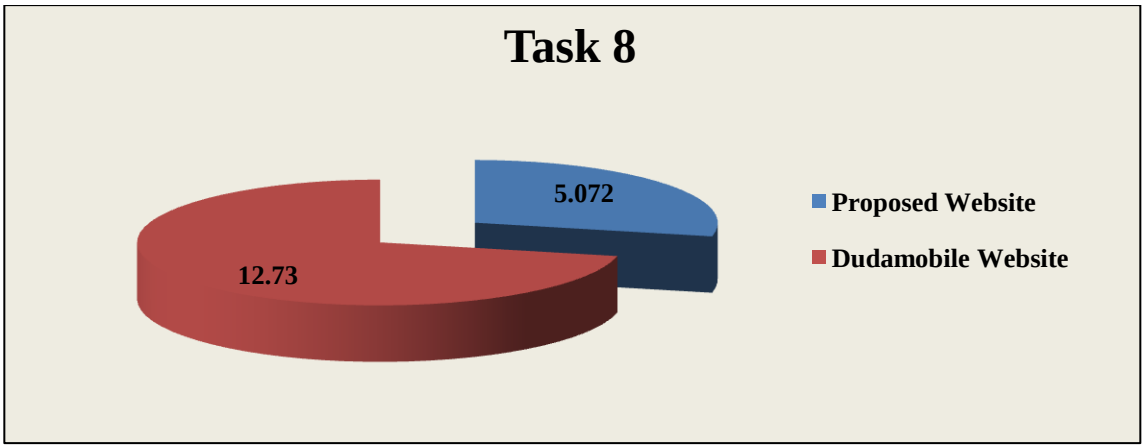

Figure 70: The differences in degrees average of mobile versions: "proposed version, Dudamobile version" in task 8

Table 39 and Figure 68 show that the value (t) was (9.543), and it is a statistically significant value at a level (0.01) where the time average for the Dudamobile version reached (12.730), while the time average for the proposed version was (5.072).

The following figure (Figure 71) shows the overall time average for the three mobile versions: proposed version, Mofuse version and Dudamobile version in task 1 to task 8.

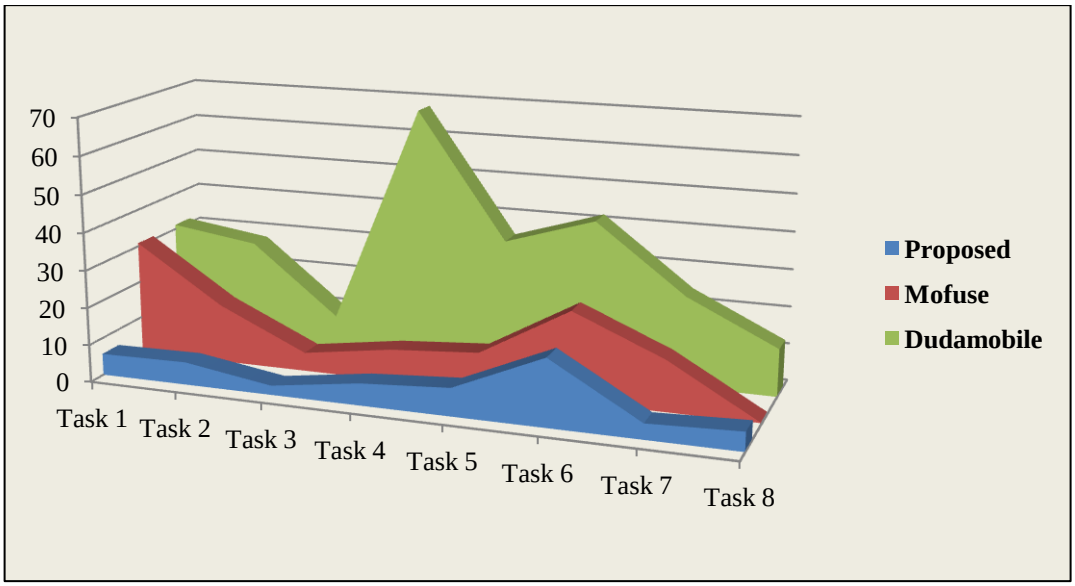

Figure 71: Overall average time for the three mobile versions in task 1 to task 8

According to Table 74 to Table 76 in Appendix B, the calculated times for the proposed version for all the users has the least time for all the tasks that performed by 15 users. This means that the performance on the proposed version was better than the Mofuse and the Dudamobile versions.

According to the previous results from Table 25 to Table 39, there are statistically significant differences between the mobile version of the PME website developed by using mobile design guidelines taking into account the context of use and the websites that are produced by using mobile website builder tools for each task given to user during usability testing. So, hypothesis 1 (H1) is addressed.

Based on the results, hypothesis (H1) achieved two parameters of the five of Nielsen's usability parameters. The two parameters achieved for the proposed version are Efficiency and Low errors rate. Efficiency of the proposed version means that all the users could achieve the goal and complete that tasks accurately in the least amount of tome compared to the Mofuse and Dudamobile versions while Low errors rate means that the proposed version has the least error rate between the three websites.

7.2.2. Hypothesis H2

Recalling H2 from Section 1.6, there are statistically significant differences between the users performance on the proposed version of the PME website in each group compared when the order of testing was changed for each group who examined the three mobile versions of the PME website.

To address this hypothesis, a T-Test and ANOVA applied for "Group1, Group 2, Group 3" in the proposed version in tasks "1-9". The following tables (Table 40 to Table 57) show the results.

- **Task1**

Table 40 : The Variance Analysis for Degrees of "Group1, Group 2, Group 3" in Proposed version" Task 1

Task 1	Sum of Squares	Mean Square	df	F	Sig
Between Groups	52.750	26.375	2	6.640	0.01 Sig
Within Groups	47.666	3.972	12		
Total	100.416		14		

Table 40 shows that the value (F) was (6.640), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between "Group1, Group 2, Group 3" in the proposed version "Task 1". To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 41)

Table 41 : LSD Test for Multiple Comparisons

Task 1	Group 1 M = 6.464	Group 2 M = 4.468	Group 3 M = 6.300
Group 1	-		
Group 2	1.996*	-	
Group 3	0.164	1.832*	-

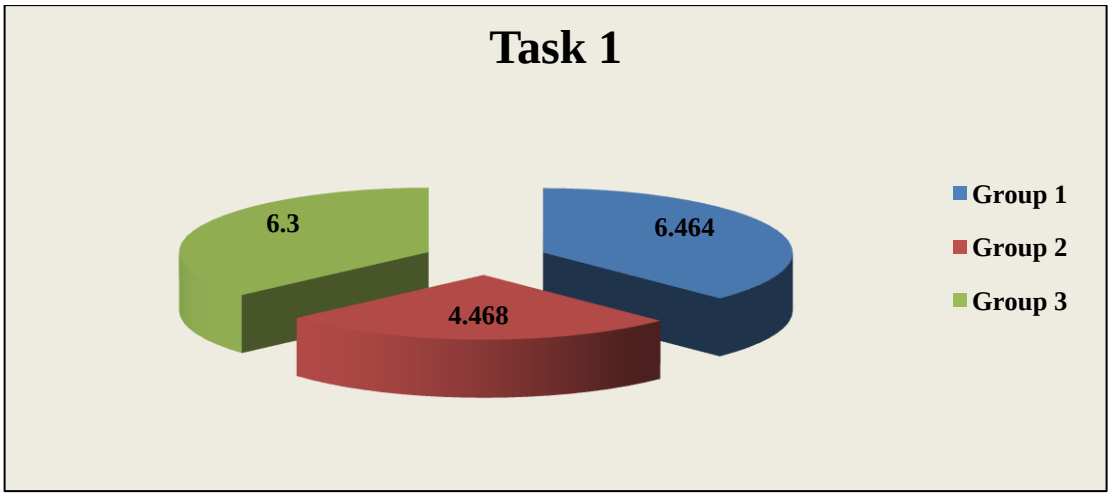

Figure 72: Differences of degrees of " Group1, Group 2, Group 3" in the proposed version "task 1"

Table 41 and Figure 72 show that there are no differences in the proposed version in "Task 1" between Group 1 and Group 3, while there are differences between Group 1 and Group 2 compared to Group 1 at significance level (0.05), also there are differences between Group 3 and Group 2 compared to Group 3 at significance level (0.05), where the time average for both of Group 1 and Group 3 reached respectively were (6,464), (6,300), followed by Group 2 with an average (4.468).

- **Task2**

Table 42 : The Variance Analysis for Degrees of "Group1, Group 2, Group 3" in Proposed version Task 2

Task 2	Sum of Squares	Mean Square	df	F	Sig
Between Groups	105.654	52.827	2	7.450	0.01 Sig
Within Groups	85.090	7.091	12		
Total	190.744		14		

Table 42 shows that the value (F) was (7.450), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between "Group1, Group 2, Group 3" in the proposed version Task 2. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 43)

Table 43 : LSD Test for Multiple Comparisons

Task 2	Group 1 M = 7.236	Group 2 M = 4.500	Group 3 M = 6.478
Group 1	-		
Group 2	2.736**	-	
Group 3	0.758	1.978*	-

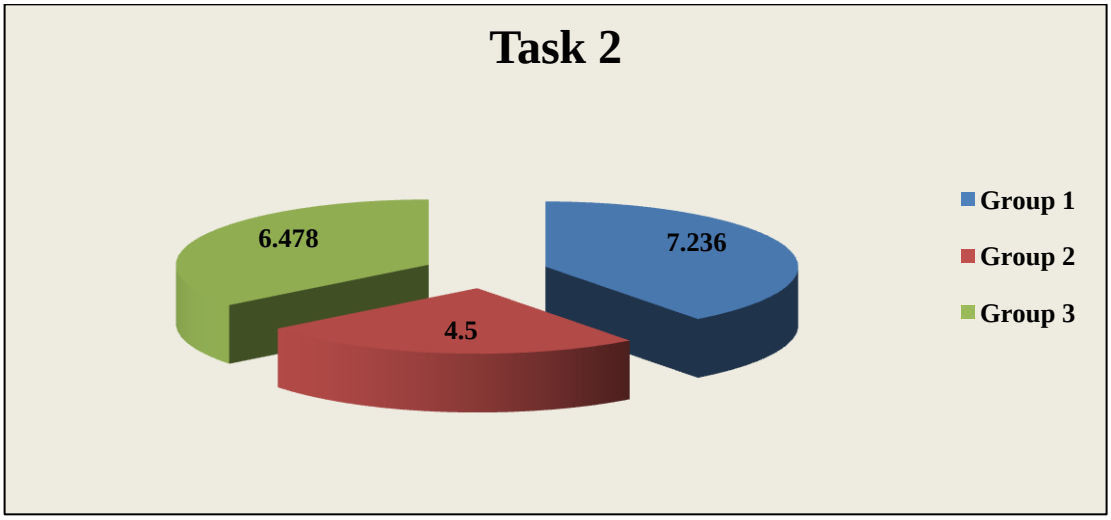

Figure 73: Differences of Degrees of " Group1, Group 2, Group 3" in the proposed version Task 2

Table 43 and Figure 73 showed that there are no differences in the proposed version "Tasks 2" between Group 1 and Group 3, while there are differences between Group 1 and Group 2 compared to Group 1 at significance level (0.01), also there are differences between Group 3 and Group 2 compared to Group 3 at significance level (0.05), where

the time average for both of Group 1 and Group 3 reached respectively were (7.236), (6.478), followed by Group 2 with an average (4.500).

- **Task3**

Table 44 : The Variance Analysis for Degrees of "Group1, Group 2, Group 3" in the proposed version Task 3

Tasks 3	Sum of Squares	Mean Square	df	F	Sig
Between Groups	47.846	23.923	2	5.819	0.01 Sig
Within Groups	49.338	4.112	12		
Total	97.184		14		

Table 44 shows that the value (F) was (5.819), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between "Group1, Group 2, Group 3" in the proposed version Task 3. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 45)

Table 45 : LSD Test for Multiple Comparisons

Task 3	Group 1 M = 3.426	Group 2 M = 1.880	Group 3 M = 2.158
Group 1	-		
Group 2	1.546*	-	
Group 3	1.268*	0.278	-

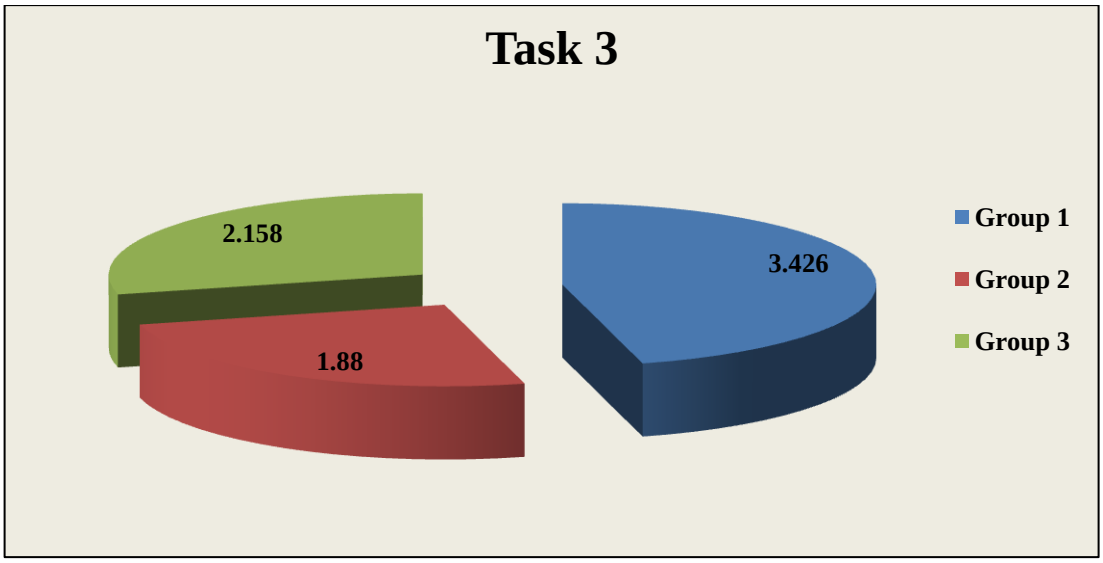

Figure 74: Differences of degrees of "Group1, Group 2, Group 3" in the proposed version task 3

Table 45 and Figure 74 showed that there are differences in the proposed version in Task 3 between Group 1 and both of "Group 2, Group 3" compared to Group 1 at significance level (0.05), while there are no differences between Group 2 and Group 3, where the time average for Group 1 reached (3.426), followed by the time average for both of Group 2 and Group 3 reached respectively was (1.880), (2.158).

- **Task4**

Table 46 : The Variance Analysis for Degrees of "Group1, Group 2, Group 3" in the proposed version Task 4

Task 4	Sum of Squares	Mean Square	df	F	Sig
Between Groups	64.199	32.100	2	6.211	0.01
Within Groups	62.014	5.168	12		Sig
Total	126.213		14		

Table 46 shows that the value (F) was (6.211), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between "Group1, Group 2, Group 3 "in the proposed version Task 4. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 47):

Table 47 : LSD Test for Multiple Comparisons

Task 4	Group 1 M = 4.344	Group 2 M = 5.676	Group 3 M = 7.552
Group 1	-		
Group 2	1.332*	-	
Group 3	3.208**	1.876*	-

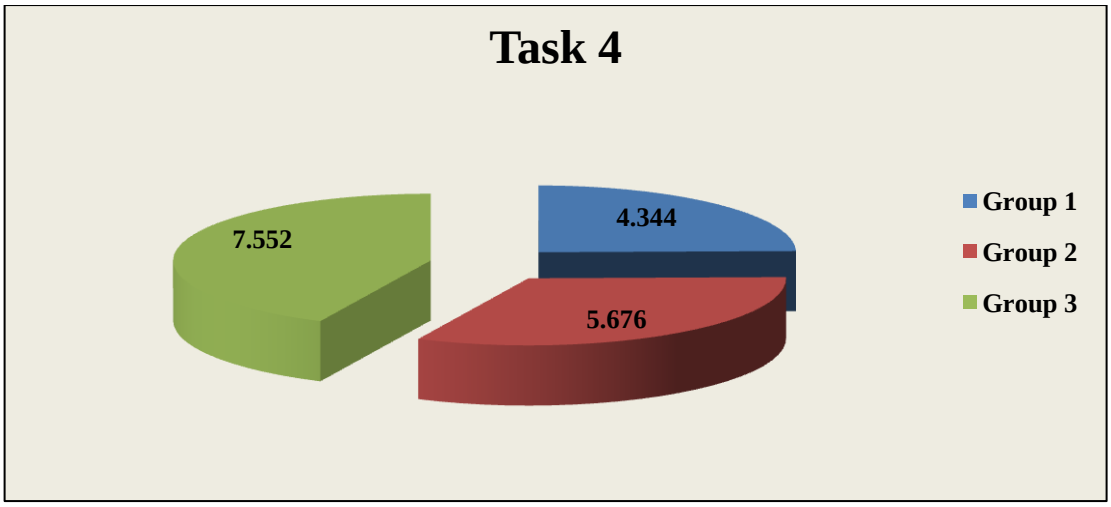

Figure 75: Differences of degrees of "Group1, Group 2, Group 3" in the proposed version task 4

Table 47 and Figure 75 show that there are differences in the proposed version Task 4 between Group 2 and Group 3 compared to Group 3 at significance level (0.05), while there are differences between Group 1 and Group 3 compared to Group 3 at significance level (0.01), also there are differences between Group 1 and Group 2 compared to Group 2 at significance level (0.05),where the time average for Group 3 reached (7.552),

followed by Group 2 with an average (5.676), followed by Group 1 with an average (4.344).

- **Task5**

Table 48 : The Variance Analysis for Degrees of "Group1, Group 2, Group 3" in the proposed version Task 5

Task 5	Sum of Squares	Mean Square	df	F	Sig
Between Groups	71.652	35.826	2	12.185	0.01 Sig
Within Groups	35.281	2.940	12		
Total	106.933		14		

Table 48 shows that the value (F) was (12.185), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between " Group1, Group 2, Group 3 "in the proposed version Task 5. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 49)

Table 49 : LSD Test for Multiple Comparisons

Task 5	Group 1 M = 9.832	Group 2 M = 5.694	Group 3 M = 6.834
Group 1	-		
Group 2	4.138**	-	
Group 3	2.998**	1.140*	-

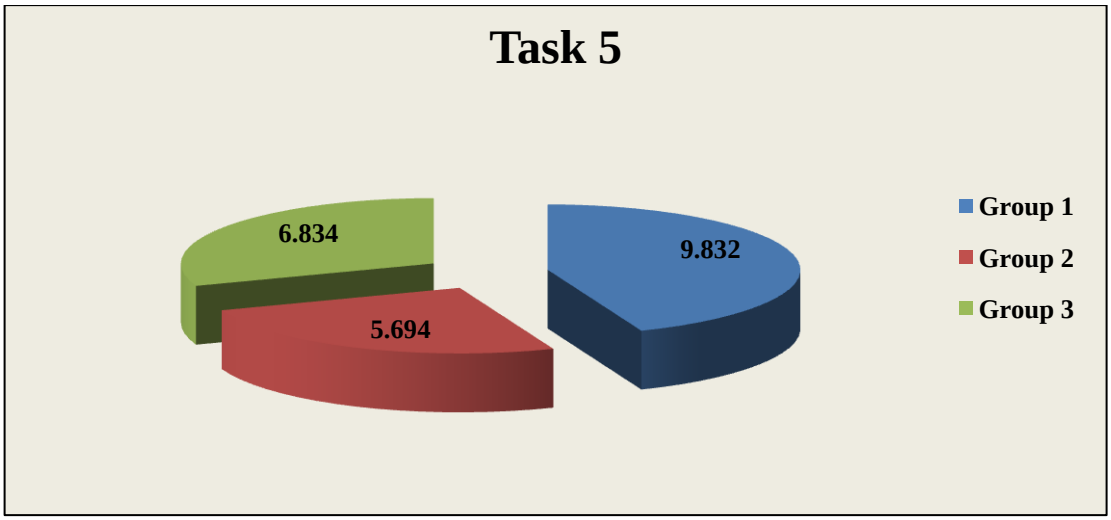

Figure 76: Differences of degrees of "Group1, Group 2, Group 3" in the proposed version in task 5

Table 49 and Figure 76 show that there are differences in the proposed version in Task 5 between Group 1 and both of "Group 2, Group 3" compared to Group 1 at significance level (0.01), while there are differences between Group 2 and Group 3 compared to Group 3 at significance level (0.05), where the time average for Group 1 reached (9.832), followed by Group 3 with an average (6.834), followed by Group 2 with an average (5.694).

- **Task6**

Table 50 : The Variance Analysis for Degrees of "Group1, Group 2, Group 3" in the proposed version in Task 6

Tasks 6	Sum of Squares	Mean Square	df	F	Sig
Between Groups	291.928	145.964	2	10.860	0.01 Sig
Within Groups	161.289	13.441	12		
Total	453.217		14		

Table 50 show that the value (F) was (10.860), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between " Group1, Group 2, Group 3 "in the proposed version in "Task 6". To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 51)

Table 51 : LSD Test for Multiple Comparisons

Tasks 6	Group 1 M = 18.658	Group 2 M = 15.886	Group 3 M = 19.194
Group 1	-		
Group 2	2.772**	-	
Group 3	0.536	3.308**	-

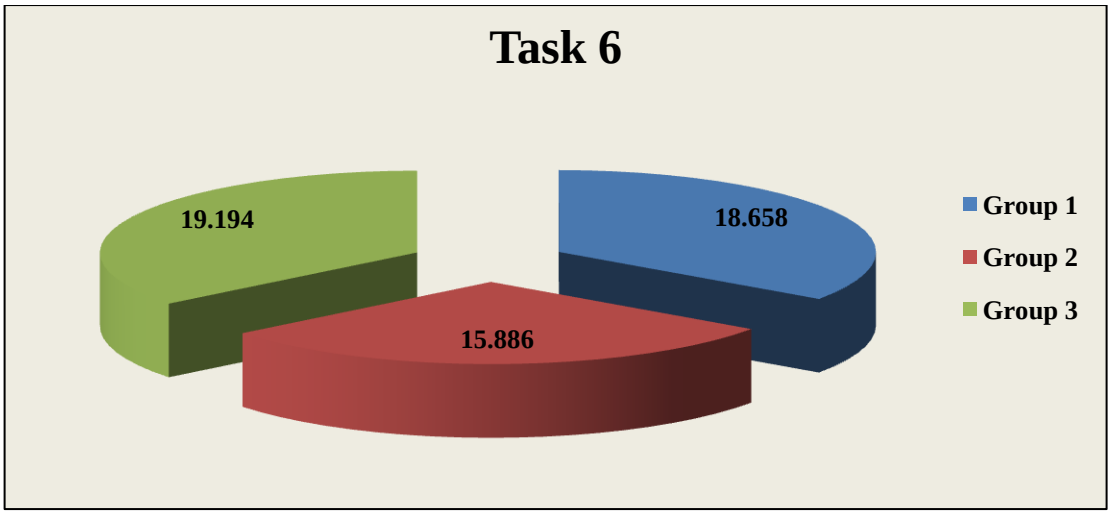

Figure 77: Differences of degrees of "Group1, Group 2, Group 3" in the proposed version task 6

Table 51 and Figure 77 show that there are no differences in the proposed version in "Task 6" between Group 1 and Group 3, while there are differences between Group 2 and Group 3 compared to Group 3 at significance level (0.01), also there are differences between Group 1 and Group 2 compared to Group 1 at significance level (0.01),where

the time average for both of Group 1 and Group 3 reached respectively was (18.658), (19.194), followed by Group 2 with an average (15.886).

- **Task7**

Table 52 : The Variance Analysis for Degrees of "Group1, Group 2, Group 3" in the proposed version in Task 7

Tasks 7	Sum of Squares	Mean Square	df	F	Sig
Between Groups	59.449	29.724	2	3.268	0.01 Sig
Within Groups	109.145	9.095	12		
Total	168.594		14		

Table 52 show that the value (F) was (3.268), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between "Group1, Group 2, Group 3" in the proposed version in Task 7. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 53)

Table 53 : LSD Test for Multiple Comparisons

Tasks 7	Group 1 M = 3.440	Group 2 M = 4.758	Group 3 M = 4.256
Group 1	-		
Group 2	1.318*	-	
Group 3	0.816	0.502	-

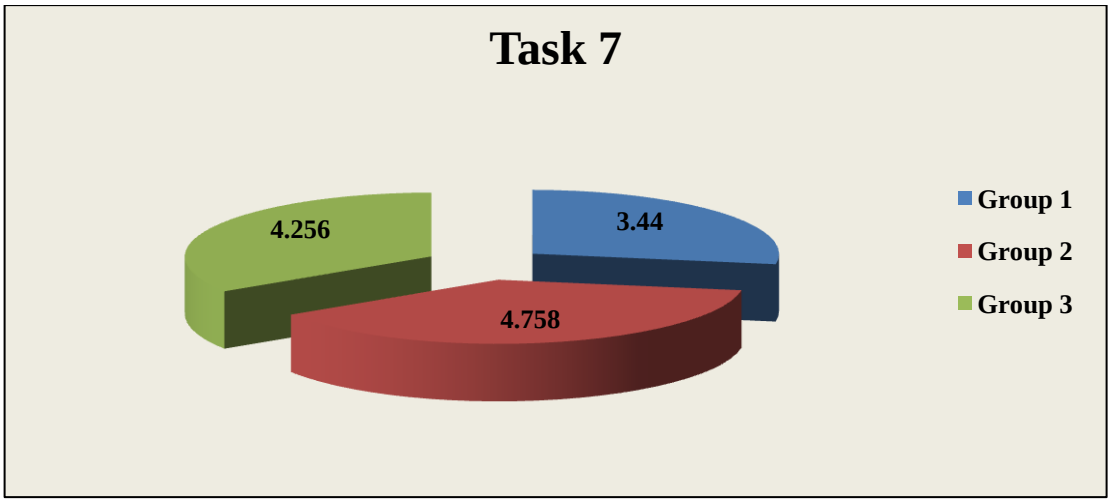

Figure 78: Differences of degrees of "Group1, Group 2, Group 3" in the proposed version in task 7

Table 53 and Figure 78 show that there are no differences in the proposed version in Task 7 between Group 2 and Group 3, while there are differences between Group 1 and Group 2 compared to Group 2 at significance level (0.05), while there are no differences between Group 1 and Group 3, where the time average for both of Group 2 and Group 3 reached respectively was (4.758), (4.256), followed by Group 1 with an average (3.440).

- **Task8**

Table 54 : The Variance Analysis for Degrees of "Group1, Group 2, Group 3" in the proposed version in Task 8

Task 8	Sum of Squares	Mean Square	df	F	Sig
Between Groups	56.198	28.099	2	7.110	0.01 Sig
Within Groups	47.425	3.952	12		
Total	103.623		14		

Table 54 shows that the value (F) was (7.110), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between "Group1,

Group 2, Group 3" in the proposed version in Task 8. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 55)

Table 55 : LSD Test for Multiple Comparisons

Task 8	Group 1 M = 3.736	Group 2 M = 4.878	Group 3 M = 6.602
Group 1	-		
Group 2	1.142*	-	
Group 3	2.866**	1.724*	-

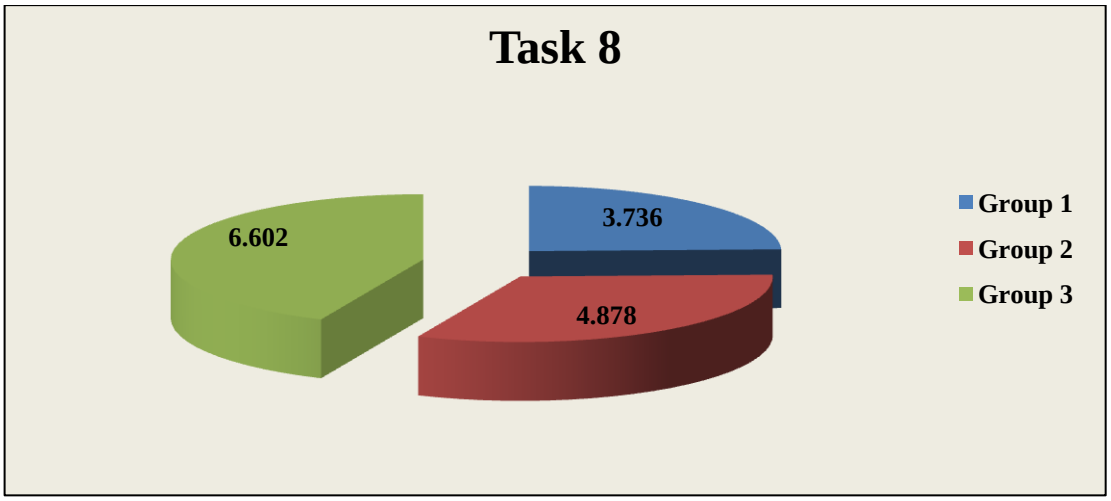

Figure 79: Differences of degrees of "Group1, Group 2, Group 3" in the proposed version task 8

Table 55 and Figure 79 show that there are differences in the proposed version in Task 8 between Group 2 and Group 3 compared to Group 3 at significance level (0.05), while there are differences between Group 1 and Group 3 compared to Group 3 at significance level (0.01), also there are differences between Group 1 and Group 2 compared to Group 2 at significance level (0.05), where the time average for Group 3 reached was (6.602), followed by Group 2 with an average (4.878), followed by Group 1 with an average (3.736).

- **Task9**

Table 56 : The Variance Analysis for Degrees of "Group1, Group 2, Group 3" in the proposed version Task 9

Task 9	Sum of Squares	Mean Square	df	F	Sig
Between Groups	75.122	37.561	2	8.158	0.01
Within Groups	55.249	4.604	12		Sig
Total	130.371		14		

Table 56 shows that the value (F) was (8.158), and it is a statistically significant value at a level (0.01), which indicates the existence of differences between "Group1, Group 2, Group 3" in the proposed version Task 9. To find out the direction of significance, an LSD test had been applied for multiple comparisons. (Table 57)

Table 57 : LSD Test for Multiple Comparisons

Task 9	Group 1 M = 3.538	Group 2 M = 7.458	Group 3 M = 3.918
Group 1	-		
Group 2	3.920**	-	
Group 3	0.380	3.540**	-

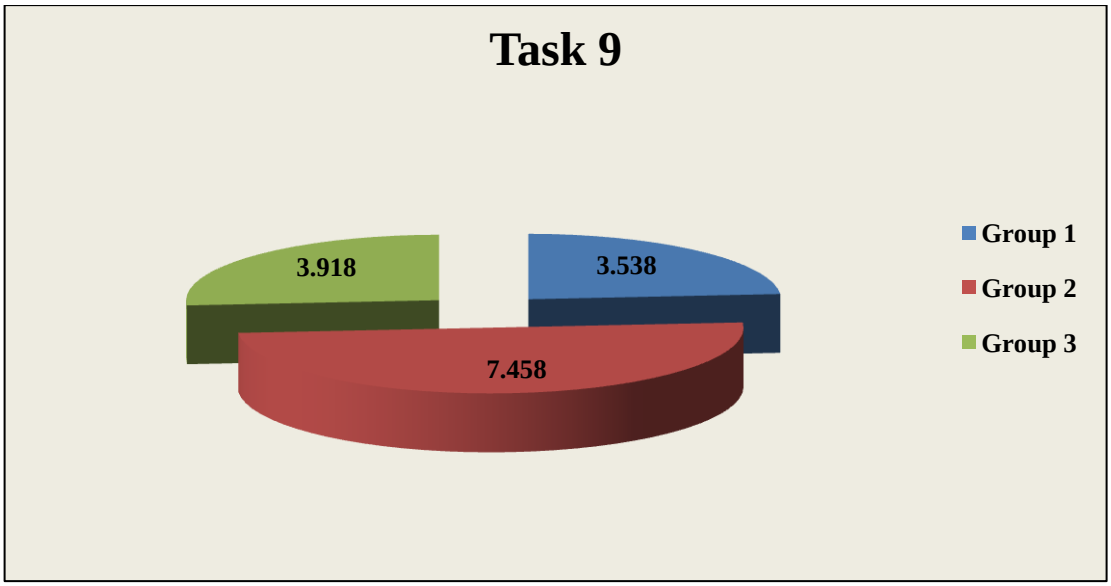

Figure 80: Differences of degrees of "Group1, Group 2, Group 3" in the proposed version task 9

Table 57 and Figure 80 show that there are differences for the proposed version in Task 9 between Group 2 and both of "Group 1 and Group 3" compared to Group 2 at a significance level of (0.01), while there are no differences between Group 1 and Group 3. The time average for Group 2 reached was (7.458), followed by both Group1 and Group 3, where their averages reached respectively were (3.538), (3.918).

The following figure (figure 81) shows the overall time average for proposed version in group 1, group 2 and group 3 for task 1 to task 9.

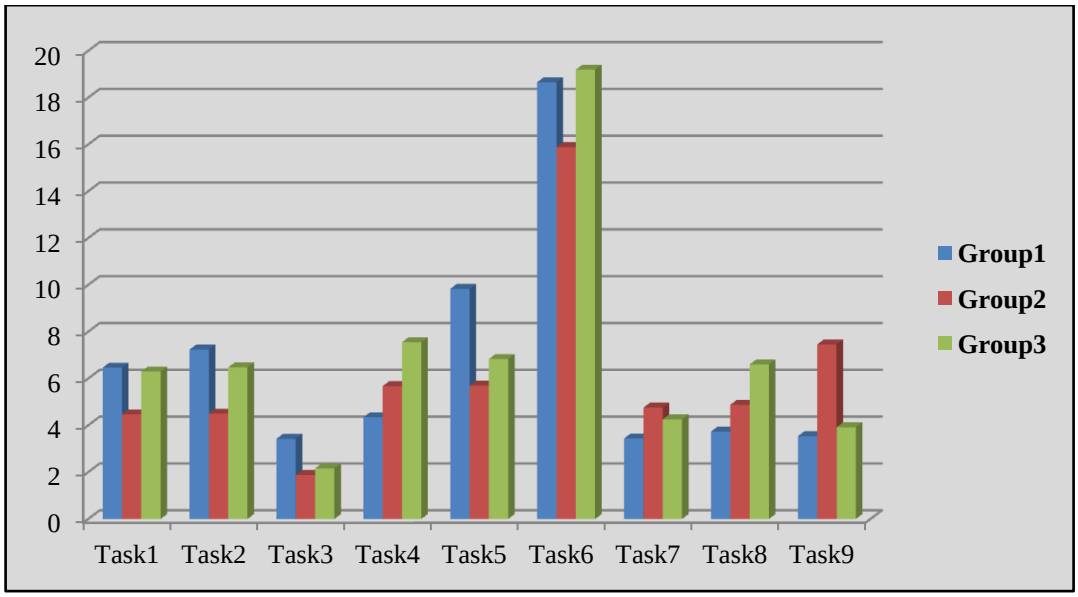

Figure 81: Overall average time for proposed version in the three groups

According to the results from Table 40 to Table 57, **t**here are statistically significant differences between the users performance on the proposed version of the PME website and the websites that were developed by using mobile website builder tools when the order of testing of the three versions was interchanged. So, hypothesis 2 (H2) is addressed.

From H1, we concluded that the proposed version has the least usage time among the three mobile versions of the PME website, but it was important to assess if the order of the evaluation had an effect on users due to learnability. From Table 77 to Table 79 in Appendix-B that have the results of the calculated time for each group of all the three mobile versions, we found that the proposed version has the least time between the three mobile versions in each group. Based on the previous results of H2, we found that tasks 4, 7, 8 and 9 has the minimum time in group 1 while tasks 1, 2, 3, 5, and 6 has the minimum time in group2. The order of the proposed version in group1 and group2 was

the first and last to be evaluated, respectively. Although the proposed version was the last website to be evaluated in group2 where the users suffered from fatigue, it still had the least usage time. Also the users age group in group1 and group2 was less than 35 while there are 2 users in group3 whose age were between 35 and 40 years. Besides, there were some users in group1 and group2 who had background experience in the PME website.

According to the results, analysis hypothesis (H2) addressed another two parameters of Nielsen's five usability parameters: Learnability and Memorability. Learnability means the proposed version is easy to learn for first time users and they could rapidly start working with it while memorability means that the proposed version is easy to remember for the casual user.

7.3. Users Comments

The following table (Table 58) displays the comments of the users for each task in the post-task questionnaire. From Table 54, we can see that all the users rated 8 tasks out of 9 as very easy in the proposed version. On the Mofuse version, all the users rated 4 tasks out of 7 as very easy while their rating for the Dudamobile version were different and some of the tasks on Dudamobile were rated as difficult and very difficult.

Table 58: Users Comments in Post-Task Questionnaire

Tasks	Proposed version	Mofuse version	Dudamobile version
1	100% of users rate this task as very easy. The majority of written or verbal users comment on the reason of their response was that they can find all the cities that have early warning after one click.	73.3% of users rate this task as very easy while 26.7% as easy. All the written or verbal users comment on the reason of their response was that they have to click all the warning levels buttons (4 buttons) to find the cities that have early warning.	20% of users rate this task as easy, 60% as neutral and 20% as difficult. The majority of written or verbal users comment on the reason of their response was that they the cities places were marked on KSA map with different color circles according to their warning level without mention the city name and these circles did not seem clickable. Also the map need time to be loaded.

Table 58: Users Comments in Post-Task Questionnaire (Cont'd)

Tasks	Proposed version	Mofuse version	Dudamobile version
2	100% of users rate this task as very easy. The majority of written or verbal users comment on the reason of their response was that they can find a specific city.	80% of users rate this task as very easy while 20% as easy. The majority of written or verbal users comment on the reason of their response was that they need time to find a specific city while they have to click all the warning levels.	86.7% of users rate this task as very easy while 13.3% as easy because the users have to find the city from a map according to its location.
3	100% of users rate this task as very easy.	100% of users rate this task as very easy.	80% of users rate this task as very easy while 20% as easy. The majority of written or verbal users comment on the reason of their response was that they need to zoom on the web page to find the number.

Table 58: Users Comments in Post-Task Questionnaire (Cont'd)

Tasks	Proposed version	Mofuse version	Dudamobile version
4	100% of users rate this task as very easy. The majority of written or verbal users comment on the reason of their response was that they can find the mailing service after one click and also they found that filling the form was easy and the message appears after submitting the form was clear and appropriate.	100% of users rate this task as very easy. The majority of written or verbal users comment on the reason of their response was that they can find the mailing service after one click and also filling the form was easy but the security code in the form was annoying for the users and the message appears after submitting the form was not very clear as it seems as a link.	26.7% of users rate this task as difficult while 73.3% as very difficult. All the written or verbal users comment on the reason of their response was that they could not find the link of the mailing service because they had to scroll down many pages and the link was not seem as a link. It seemed as a normal text and written with small font size.

Table 58: Users Comments in Post-Task Questionnaire (Cont'd)

Tasks	Proposed version	Mofuse version	Dudamobile version
5	100% of users rate this task as very easy.	100% of users rate this task as very easy.	26.7% of users rate this task as easy, 40% as neutral and 33.3% as difficult. The majority of written or verbal users comment on the reason of their response was that they had to scroll down many page to find the forecast of a specific city. Also the buttons used did not seem clickable and not appropriate form mobile screens.
6	100% of users rate this task as very easy. All the written or verbal users comment on the reason of their response was that the using of dropdown menu to find a specific city minimize the searching time.	100% of users rate this task as very easy.	46.7% of users rate this task as easy, 26.7% as neutral and 26.7% as difficult. The majority of written or verbal users comment on the reason of their response was that they had to scroll down many page to find the forecast of a specific city. Also the buttons used did not seem as clickable.

Table 58: Users Comments in Post-Task Questionnaire (Cont'd)

Tasks	Proposed version	Mofuse version	Dudamobile version
7	100% of users rate this task as very easy.	66.7% of users rate this task as very easy, 26.7% as easy and 6.7% as neutral. The majority of written or verbal users comment on the reason of their response was that the position of the full site link did not clear and the text is small. Also the using of Desktop term was not meaningful.	66.7% of users rate this task as neutral, 33.3% as difficult. The majority of written or verbal users comment on the reason of their response was that the position of the full site link did not clear as they need to scroll down many pages. Also the using of Classic term was not meaningful.
8	100% of users rate this task as very easy.	This task did not applicable in this website because it did not provide a multilingual website.	93.3% of users rate this task as very easy while 6.7%.
9	73.3% of users rate this task as very easy while 26.7% as easy.	This task did not applicable in this website because it did not provide an enlarge feature.	This task did not applicable in this website because it did not provide an enlarge feature.

7.4. Analysis of User Interface Evaluation

The following tables (Table 21 to Table 35) represents the interface elements design evaluation of the three mobile versions of the PME website using post-test interface evaluation questionnaires after completing the tasks of each mobile version. It is important to note that some of the questions were not given to respondents of the questionnaires after testing each mobile version since the features mentioned in the questionnaire are not available in that version.

Table 59, Table 60 and Table 61 represent the users rating of interface design elements in terms of its effect on the text legibility in the three mobile versions of the PME website. The total number of the users was 15.

Table 59: Rating the proposed version Interface Design Elements in Terms of its Text Legibility

Proposed version					
	Questions	**Legible**	**Neutral**	**Illegible**	**Comments**
1	**Font type makes the text**	100%	0%	0%	-----
2	**Font size makes the text**	93.3%	6.7%	0%	-----
3	**Font style (Bold) makes the text**	86.7%	13.3%	0%	-----
4	**The background-foreground (black and white) color combination used in the website pages makes the text**	93.3%	6.7%	0%	-----

Table 59: Rating the proposed version Interface Design Elements in Terms of its Text Legibility (Cont'd)

Proposed version					
	Questions	**Legible**	**Neutral**	**Illegible**	**Comments**
5	**The background-foreground (used in "Back" and "Home" links) color combination makes the text**	100%	0%	0%	-----
6	**Spaces between characters makes the text**	100%	0%	0%	-----
7	**Spaces between lines makes the text**	93.3%	6.7%	0%	-----
8	**The tables width makes the text**	100%	0%	0%	-----

Table 60: Rating the Mofuse version Interface Design Elements in Terms of its Text Legibility

Mofuse version					
	Questions	**Legible**	**Neutral**	**Illegible**	**Comments**
1	**Font type makes the text**	80%	20%	0%	-----
2	**Font size makes the text**	86.7%	13.3%	0%	-----
3	**Font style (Bold) makes the text**	73.3%	26.7%	0%	-----

Table 60: Rating the Mofuse version Interface Design Elements in Terms of its Text Legibility (Cont'd)

Mofuse version					
	Questions	**Legible**	**Neutral**	**Illegible**	**Comments**
4	**The background-foreground (black and white) color combination used in the website pages makes the text**	66.7%	33.3%	0%	-----
5	**The background-foreground (used in "Back" and "Home" links) color combination makes the text**	40%	40%	20%	-----
6	**Spaces between characters makes the text**	60%	40%	0%	-----
7	**Spaces between lines makes the text**	53.3%	46.7%	0%	-----
8	**The tables width makes the text**	46.7%(8)	40%(6)	13.3%	The table width of the 5 days forecast is not appropriate to the mobile device.

Table 61: Rating the Dudamobile version Interface Design Elements in Terms of its Text Legibility

Dudamobile version					
	Questions	**Legible**	**Neutral**	**Illegible**	**Comments**
1	**Font type makes the text**	6.7%	33.3%	60%	-----
2	**Font size makes the text**	6.7%	46.7%	46.7%	-----
3	**Font style (Bold) makes the text**	6.7%	53.3%	40%	-----
4	**The background-foreground (black and white) color combination used in the website pages makes the text**	13.3%	40%	46.7%	-----
5	**Spaces between characters makes the text**	0%	26.7%	73.3%	-----
6	**Spaces between lines makes the text**	6.7%	6.7%	86.7%	-----
7	**The tables width makes the text**	0%	26.7%	73.3%	-----

The previous tables Table 59 to Table 61 show that 4 questions out of 8 rating the proposed version as 100% legible and the other questions were more than 86% for text legibility and no question was rating as illegible while the text legibility on the Mofuse version was more than 40% and no question was rating as a 100% legible. Some of the respondents were rating some questions on Mofuse as illegible such as the color of the Home, Back links and the table width. For Dudamobile, most of the respondents were rating the questions as illegible.

Table 62, Table 63 and Table 64 represent the users answers of the yes/no questions to evaluate the three mobile versions.

Table 62: Users Answers of Yes/No Questions to Evaluate the Proposed Version

Proposed version				
	Questions	**Yes**	**No**	**Comments**
1	**The amount of contents placed on each screen was appropriate**	100%	0%	-----
2	**The amount of white spaces between screen elements was appropriate**	100%	0%	-----
3	**You were able to identify the main headings clearly.**	100%	0%	It was centered and bold
4	**The main headings provide an appropriate feedback on your current location on the website**	100%	0%	-----
5	**You were able to identify sub-headings clearly**	100%	0%	They were bold
6	**You were able to differentiate between normal text and links**	100%	0%	They were underlined
7	**You were able to differentiate visited links**	100%	0%	They were in red color.

Table 62: Users Answers of Yes/No Questions to Evaluate the Proposed Version (Cont'd)

Proposed version				
	Questions	**Yes**	**No**	**Comments**
8	**The website layout design was consistent**	100%	0%	-----
9	**There are generous amount of spaces around the links**	80%	20%	-----
10	**There are generous amount of spaces around the form elements**	100%	0%	-----
11	**The message provided after fill the form were suitable and informative**	100%	0%	-----
12	**The number of colors used on the website pages is appropriate**	100%	0%	
13	**The places of the repeated navigation elements ("Home", "Back" links) on the website pages are consistent**	100%	0%	-----
14	**The information was written in a simple language**	100%	0%	-----
15	**The number of navigation links on the pages is appropriate**	100%	0%	-----

Table 62: Users Answers of Yes/No Questions to Evaluate the Proposed Version (Cont'd)

Proposed version				
	Questions	**Yes**	**No**	**Comments**
16	**There are generous amount of the spaces around the buttons and icons on the website pages**	100%	0%	-----
17	**The number of font styles used on the website pages were appropriate**	100%	0%	-----
18	**Using text for links is better than images**	100%	0%	Did not need time to load
19	**Do you need to zoom on the website pages**	13.3%	86.7%	On the page of cities weather forecast for today and tomorrow

Table 63: Users Answers of Yes/No Questions to Evaluate the Mofuse Version

Mofuse version				
	Questions	**Yes**	**No**	**Comments**
1	**The amount of contents placed on each screen was appropriate**	93.3%	6.7%	-----
2	**The amount of white spaces between screen elements was appropriate**	66.7%	33.3%	-----
3	**You were able to identify the main headings clearly.**	80%	20%	They were left aligned with grey color

Table 63: Users Answers of Yes/No Questions to Evaluate the Mofuse Version (Cont'd)

Mofuse version				
	Questions	**Yes**	**No**	**Comments**
4	**The main headings provide an appropriate feedback on your current location in the website**	86.7%	13.3%	-----
5	**You were able to identify sub-headings clearly**	60%	40%	They were left aligned with grey color in the same place of the main headings.
6	**You were able to differentiate between normal text and links**	66.7%	33.3%	Underlined
7	**You were able to differentiate visited links**	13.3%	86.7%	The color of the visited links did not change
8	**The website layout design was consistent**	73.3%	26.7%	-----
9	**There are generous amount of spaces around the links**	46.7%	53.3%	-----
10	**There are generous amount of spaces around the form elements**	60%	40%	-----
11	**The message provided after fill the form were suitable and informative**	60%	40%	The message appear as a link
12	**The number of colors used on the website pages is appropriate**	26.7%	73.3%	The color used is not saturated

Table 63: Users Answers of Yes/No Questions to Evaluate the Mofuse Version (Cont'd)

Mofuse version				
	Questions	**Yes**	**No**	**Comments**
13	**The places of the repeated navigation elements ("Home", "Back" links) on the website pages are consistent**	60%	40%	They were not clear and the font size is small
14	**The information was written in a simple language**	100%	0%	-----
15	**The number of navigation links on the pages is appropriate**	100%	0%	-----
16	**There are generous amount of the spaces around the buttons and icons on the website pages**	100%	0%	-----
17	**The number of font styles used on the website pages were appropriate**	100%	0%	-----
18	**Using text for links is better than images**	60%	40%	The image need more load time than the text
19	**Do you need to zoom on the website pages**	26.7%	73.3%	On the pages of the cities forecast for today, tomorrow and 5 days

Table 64: Users Answers of Yes/No Questions to Evaluate the Dudamobile Version

Dudamobile version				
	Questions	**Yes**	**No**	**Comments**
1	**The amount of contents placed on each screen was appropriate**	6.7%	93.3%	The contents on the page is too much and it did not appropriate with the mobile device screen.
2	**The amount of white spaces between screen elements was appropriate**	13.3%	86.7%	-----
3	**You were able to identify the main headings clearly.**	26.7%	73.3%	There are no main headings
4	**The main headings provide an appropriate feedback on your current location in the website**	6.7%	93.3%	There are no main headings
5	**You were able to identify sub-headings clearly**	13.3%	86.7%	There are no sub-headings
6	**You were able to differentiate between normal text and links**	20%	80%	-----
7	**You were able to differentiate visited links**	13.3%	86.7%	-----
8	**The website layout design was consistent**	13.3%	86.7%	The design layout was not appropriate with the mobile device screen because there were horizontal and vertical menu
9	**There are generous amount of spaces around the links**	6.7%	93.3%	The links need to be zoomed in to be clear

Table 64: Users Answers of Yes/No Questions to Evaluate the Dudamobile Version (Cont'd)

Dudamobile version				
	Questions	**Yes**	**No**	**Comments**
10	**There are generous amount of spaces around the form elements**	20%	80%	-----
11	**The number of colors used on the website pages is appropriate**	26.7%	73.3%	The number of colors used is too much
12	**The information was written in a simple language**	66.7%	33.3%	-----
13	**The number of navigation links on the pages is appropriate**	13.3%	86.7%	There were too much navigation links on the page
14	**There are generous amount of the spaces around the buttons and icons on the website pages**	33.3%	66.7%	The buttons need to be zoomed in to be clear
15	**The number of font styles used on the website pages were appropriate**	33.3%	66.7%	-----
16	**The images used in the website were meaningful**	6.7%	93%	-----
17	**Using text for links is better than images**	73.3%	26.7%	-----
18	**Do you need to zoom on the website pages**	100%	0%	The zooming was needed all the time because the size is too small

The previous tables Table 62 to Table 64 show the opinion of the respondents about the amount of the information, the heading clarity, the ability to differentiate the links, the need of zooming on the pages and other things. For the proposed version, 100% of the respondents were satisfy with 18 questions out of 19. In contrast, all the users were satisfy with only 4 questions. For Dudamobile, most of the respondents were not satisfy with the website.

Table 65, Table 66 and Table 67 represent the users rating of the interface design elements for the three mobile versions in terms of their effect on the content readability.

Table 65: Rating the Interface Design Elements for the proposed version in terms of its Effect on the Content Readability

Proposed version					
	Questions	**Readable**	**Neutral**	**Not readable**	**Comments**
1	**The amount of margins makes the content**	100%	0%	0%	-----
2	**The amount of white spaces between the content elements makes the content**	100%	0%	0%	-----
3	**The use of sub-headings makes the content**	100%	0%	0%	-----
4	**Vertical scrolling makes the content**	80%	20%	0%	-----
5	**The number of words per line makes the content**	93.3%	6.7%	0%	-----
6	**The number of lines per screen makes the content**	100%	0%	0%	-----

Table 66: Rating the Interface Design Elements for the Mofuse version in terms of its Effect on the Content Readability

Mofuse version					
	Questions	**Readable**	**Neutral**	**Not readable**	**Comments**
1	**The amount of margins makes the content**	66.7%	33.3%	0%	-----
2	**The amount of white spaces between the content elements makes the content**	60%	40%	0%	-----
3	**The use of sub-headings makes the content**	60%	40%	0%	-----
4	**Vertical scrolling makes the content**	73.3%	26.7%	0%	-----
5	**The number of words per line makes the content**	80%	20%	0%	-----
6	**The number of lines per screen makes the content**	66.7%	33.3%	0%	-----

Table 67: Rating the Interface Design Elements for the Dudamobile version in terms of its Effect on the Content Readability

Dudamobile version					
	Questions	**Readable**	**Neutral**	**Not readable**	**Comments**
1	**The amount of margins makes the content**	13.3%	20%	66.7%	-----
2	**The amount of white spaces between the content elements makes the content**	6.7%	26.7%	66.7%	-----
3	**The use of sub-headings makes the content**	13.3%	20%	66.7%	-----
4	**Vertical scrolling makes the content**	6.7%	26.7%	66.7%	-----
5	**The number of words per line makes the content**	0%	40%	60%	-----
6	**The number of lines per screen makes the content**	0%	33.3%	66.7%	-----

From Table 64 to Table 67, 100% respondents rating 4 questions out of 6 as readable for the proposed version and question was rated as not readable for the proposed and the Mofuse version. For Dudamobile version, more than 60% of the respondents were rating the questions as not readable.

Table 68, Table 69 and Table 70 represent the users rating of the interface design elements for the three mobile versions in terms of their clarity.

Table 68: Rating of the Interface Design Elements for the proposed version in Terms of its Clarity

Proposed version							
	Questions	**Very Clear**	**Clear**	**Neutral**	**unclear**	**Very unclear**	**Comments**
1	**The white background makes screen elements**	86.7%	16.3%	0%	0%	0%	-----
2	**Links meaning about destination page content were**	80%	20%	0%	0%	0%	-----
3	**Navigation links (Back, and Home Page) position was**	93.3%	6.7%	0%	0%	0%	-----

Table 69: Rating of the Interface Design Elements for the Mofuse version in Terms of its Clarity

Mofuse version							
	Questions	**Very Clear**	**Clear**	**Neutral**	**unclear**	**Very unclear**	**Comments**
1	**The white background makes screen elements**	66.7%	20%	13.3%	0%	0%	-----
2	**Links meaning about destination page content were**	60%	26.7%	13.3%	0%	0%	-----
3	**Navigation links (Back, and Home Page) position was**	53.3%	26.7%	6.7%	6.7%	6.7%	-----

Table 70: Rating of the Interface Design Elements for the Dudamobile version in Terms of its Clarity

Dudamobile version							
	Questions	**Very Clear**	**Clear**	**Neutral**	**unclear**	**Very unclear**	**Comments**
1	**The white background makes screen elements**	13.3%	40%	46.7%	0%	0%	-----
2	**Links meaning about destination page content were**	0%	33.3%	40%	26.7%	0%	-----

Table 68 to Table 60 show the respondents rating in terms of the clarity of the three mobile versions interface elements. The majority of the respondents rating the questions as very clear for the proposed and Mofuse versions with more than 80% and 60%, respectively. Some of the respondents were rating some questions for the Mofuse version as unclear such as the position of the Home, Back links. For Dudamobile, the minority of the respondents rating the questions as clear and very clear.

Table 71, Table 72 and Table 73 represent the users rating of the interface design elements for the three mobile versions in terms of their ease of use.

Table 71: Rating of the Interface Design Elements for the proposed version in Terms of its Ease of Use

Proposed version							
	Questions	**Very easy**	**Easy**	**Neutral**	**Difficult**	**Very difficult**	**comments**
1	**Using 'Back' and 'Home' primary navigation links to navigate through the website pages were**	80%	20%	0%	0%	0%	-----
2	**Reading the information that do not require scrolling were**	93.3%	6.7%	0%	0%	0%	-----
3	**Understand the hierarchical structure was**	93.3%	6.7%	0%	0%	0%	-----
4	**Using vertical scrolling while finding information was**	80%	20%	0%	0%	0%	-----

Table 71: Rating of the Interface Design Elements for the proposed version in Terms of its Ease of Use (Cont'd)

Proposed version							
	Questions	**Very easy**	**Easy**	**Neutral**	**Difficult**	**Very difficult**	**comments**
5	**Using vertical scrolling while finding information from a table was**	86.7%	13.3%	0%	0%	0%	-----
6	**Clicking on the desired links was**	80%	20%	0%	0%	0%	-----
7	**Finding a specific information from the website pages was**	93.3%	6.7%	0%	0%	0%	-----
8	**Filing the form in the website was**	86.7%	13.3%	0%	0%	0%	-----
9	**Interaction with the interface elements while walking was**	93.3%	6.7%	0%	0%	0%	-----
10	**Interaction with the interface elements with one hand was**	86.7%	13.3%	0%	0%	0%	-----

Table 72: Rating the Interface Design Elements for the Mofuse version in Terms of its Ease of Use

Mofuse version							
	Questions	**Very easy**	**Easy**	**Neutral**	**Difficult**	**Very difficult**	**comments**
1	**Using 'Back' and 'Home' primary navigation links to navigate through the website pages were**	60%	20%	13.3%	6.7%	0%	-----
2	**Reading the information that do not require scrolling were**	46.7%	33.3%	13.3%	6.7%	0%	-----
3	**Understand the hierarchical structure was**	13.3%	73.3%	6.7%	6.7%	0%	-----
4	**Using vertical scrolling while finding information was**	40%	53.3%	0%	6.7%	0%	-----
5	**Using vertical scrolling while finding information from a table was**	33.3%	53.3%	0%	13.3%	0%	-----

Table 72: Rating the Interface Design Elements for the Mofuse version in Terms of its Ease of Use (Cont'd)

Mofuse version							
	Questions	**Very easy**	**Easy**	**Neutral**	**Difficult**	**Very difficult**	**comments**
6	**Clicking on the desired links was**	40%	46.7%	6.7%	6.7%	0%	-----
7	**Finding a specific information from the website pages was**	33.3%	40%	20%	6.7%	0%	-----
8	**Filing the form in the website was**	40%	40%	13.3%	6.7%	0%	-----
9	**Interaction with the interface elements while walking was**	53.3%	40%	0%	6.7%	0%	-----
10	**Interaction with the interface elements with one hand was**	40%	53.3%	0%	6.7%	0%	-----

Table 73: Rating the Interface Design Elements for the Dudamobile version in Terms of its Ease of Use

Dudamobile version							
	Questions	**Very easy**	**Easy**	**Neutral**	**Difficult**	**Very difficult**	**comments**
1	**Understand the hierarchical structure was**	6.7%	6.7%	33.3%	26.7%	26.7%	-----
2	**Using vertical scrolling while finding information was**	6.7%	13.3%	20%	33.3%	26.7%	-----
3	**Using vertical scrolling while finding information from a table was**	20%	0%	20%	33.3%	26.7%	-----
4	**Clicking on the desired links was**	0%	20%	20%	26.7%	33.3%	-----
5	**Finding a specific information from the website pages was**	0%	6.7%	20%	26.7%	46.7%	-----
6	**Filing the form on the website was**	0%	20%	40%	13.3%	26.7%	-----

Table 73: Rating the Interface Design Elements for the Dudamobile version in Terms of its Ease of Use (Cont'd)

Dudamobile version							
	Questions	**Very easy**	**Easy**	**Neutral**	**Difficult**	**Very difficult**	**comments**
7	**Interaction with the interface elements while walking was**	0%	6.7%	6.7%	53.3%	33.3%	-----
8	**Interaction with the interface elements with one hand was**	0%	26.7%	6.7%	33.3%	33.3%	-----

According to Table 71 to Table 73, most of the respondent's rating of the proposed version as very easy and none of them rated it as difficult or very difficult while some of respondents rated the Mofuse version as difficult. For Dudamobile, the majority of the respondents rates it as difficult and very difficult.

According to the results from Table 62 to Table 73, the fifth parameter of Nielsen's five usability parameters is achieved. These tables show the satisfaction and positive attitude of the users towards the proposed version compared to the Mofuse and Dudamobile versions.

7.5. Discussion

As mentioned before in Section 6.1, some of the guidelines did not need evaluation. The remaining guidelines were evaluated using either performance or subjective measurements.

The overall results from the performance evaluation showed that the proposed version had the less usage time than the Mofuse and the Dudamobile versions in all the three groups but there are differences in the calculated time of the proposed version among the three groups due to the users characteristics and experience in each group. A 100% (15 users) rated the tasks on the proposed website as very easy and based on the users comments, the proposed website was the most usable website compared to the other websites. Also from the subjective evaluation results, the proposed version interface was rated by the users as the most preferred website among the three websites in terms of website content readability, the effect of the interface elements on the text legibility and clarity, and the interface elements using ease of use.

Drawing on the methodology used for collecting the proposed guidelines and obtaining the results of evaluating these guidelines, the M-Government mobile version of the PME website developed by using mobile design guidelines taking into account the context of use produced a better user experience compared to the mobile versions of the PME website developed by using mobile web builder tools.

Results from the previous tables show that the proposed guidelines taking into account the different context of use can be successfully applied to the design of M-Government websites. As shown in this research, the proposed mobile version of the

PME website produced a better user experience than the mobile version that were developed using mobile web builder tools.

Chapter VIII

Conclusion, Recommendation and Future Work

8.1. Conclusion

Recent major developments and improvements in mobile devices and their features allowed users to use them in most of their transactional daily activities in many areas such as learning, e-services, security, banking...etc. However, one of the more important areas for users is using these devices for their safety in urgent situations.

A website designed for the desktop is not appropriate to be used on a small screen of a mobile device which prevents a mobile user in a critical situation from accessing important information from this website.

Due to the intensive use of mobile devices and variable context of use, a mobile website user interface with a good user experience is in urgent need. As mentioned in Chapter Two, there are challenges in designing mobile user interfaces, an important factor for the success of the mobile websites especially for time-critical government related e-service.

Based on the importance of designing a context-aware government mobile website and due to the lack of research in this field, this study explored the idea if designing government websites using this research's proposed M-Government guidelines taking into account the context of use will produce a better user experience than the websites developed using mobile builder tools.

Governments must not neglect developing their e-service websites required in real time by their citizens especially for services needed in urgent situations which cannot be postponed nor delayed. These websites are very important for citizens because any error in design leading to not finding the information in an appropriate time may cause harm or damages to lives and property. The design and development of government websites must follow user centred design approaches and methodologies, especially when it relates to human life. Due to these reasons, the human element in designing user interfaces, be it for the desktop or mobile, cannot be ignored nor automated.

The most important step in this research was collecting guidelines for designing the government mobile website version. The collecting process was challenging because the literature was lacking on research on designing M-Government websites taking into account context of use. After going through a process of review and filtration from all the guidelines collected, a set of fifty-nine guidelines in different categories corresponding to the most important requirements was identified.

For the purpose of this research, many popular mobile builder tools were analyzed and compared to find the most efficient tools on the market. Results show that there are three different categories of mobile builder tools as explained in Chapter 4. Some of the

mobile builder tools were not easy to use and require extensive programming knowledge and therefore were excluded from this research. Also, only free builder tools were considered because as we discussed in Chapter 1, governments have only limited budgets for their basics services and will probably use free and easy to use builder tools and to avoid copyright infringement laws for PME. Some of the builder tools have an HTML editor such as Mofuse to organize the website pages and make sure that the layout of the page are suitable for mobile devices' small screens, which is better than just dragging and dropping the website objects and elements into the mobile version of the website pages. This could mean it is better to build a mobile version of a website from the initial idea conception to completion using a user centered approach and programming languages as some builder tools need a programming language background anyway. Also, the loading time of the websites built using mobile builder tools was more than the load time of the hard coded website; and time is critical in urgent situations and makes a big life and death difference.

Three mobile versions of the PME website were developed for this study. The first was developed using an HTML5 programming code based on the mobile guidelines collected by this researcher. The other two versions were developed using two different mobile builder tools: Mofuse and Dudamobile. Two methods were used for evaluating the websites' usability: performance measures and subjective measures. Performance measures were done by giving a set of nine tasks to each of fifteen users to examine the three mobile versions and the times on task were calculated for each task for each user using each version. Subjective evaluations were conducted after users finished the tasks of each mobile version. They evaluated the mobile websites' interface by giving each

user post-task questionnaires and post-test interface evaluation questionnaires after completing all the tasks of each version.

This research found from the statistical analysis used on the calculated time for each task of the three websites, that the proposed version designed using the government mobile website version guidelines had the least usage time than the two mobile versions of the PME website built using mobile builder tools.

This research presented the applicability of the proposed guidelines mentioned in chapter three to the design of the three mobile versions of the PME government website. The results of the performance and subjective measures uncovered that interaction using the proposed mobile version of the PME website was overall very easy yielding a better user experience where users spent the least time performing tasks than the other two mobile version of the PME website developed using mobile builder tools. Thus, the proposed guidelines for designing a context aware mobile government website were useful for producing a good user experience.

The researcher, however, faced certain challenges leading to limitations for this research such as:

- While searching for a government website that can be appropriate for this research's purpose it was evident that most of the Saudi's government website were not updated and did not have timely broadcast of urgent information to citizens. Some of the Saudi government websites did not have an English version or the English version was not updated and some of the services did not work. Therefore, other country websites were considered but it was found that the services they provided were not familiar to Saudi citizens. Finally, the PME

website was chosen as the only possible sample website for this research since it has urgent information about the weather and natural disasters.

- The PME website has only a few services for urgent situations that can be put on a mobile version, which limits the depth of the pages.
- Some of the mobile builder tools did not support Arabic so only an English version of the mobile website versions was tested.
- The users suffered from fatigue because they had to test all the three mobile website versions. Each user had to perform 9 tasks in each mobile version and after finishing the tasks of each mobile version, they had to answer the evaluation questionnaire.

8.2. Recommendation and Future Work

During the research, we found that when the government website has few services, it's better for a developer to develop it using programming languages because the time for development will yield better results than using mobile builder tools which need to be learned producing user interfaces with limited usability attributes. The mobile builder tools are more suitable for commercial websites than government websites because the websites developed may be filled with unnecessary elements not needed by the citizens in urgent situations.

For future work, we recommend the following:

- Adding a GPS feature to the PME mobile version to identify the user's location to give the user the nearest safest place that he/she can go to in an urgent situation, where the user can send alerts to the authorities if he/she is in danger.
- Adapting the user interface according to the context of use. Although there have been several attempts to develop context-aware adaptation of mobile apps, it is not easy to develop systems that are adapted to single context of use, since none have a usable, well integrated and common solution fit for all users across many devices and platforms.

Chapter IX

References

Abowd, A. K. (2000). Towards a better understanding of context and context-awareness. *In proceeding of the 2000 conference on Human Factors Computing Systems.* Netherland.

Abramowicz, W., Olmstead, P. M., Wiśniewski, M., Karsenty, L., Peinel, G., & Tilsner, D. (2005). USE-ME.GOV (USability-drivEn open platform for MobilE GOVernment). *In The Proceedings of the First European Mobile Government Conference (Euro mGov 2005).* Brighton, UK.

Al-Hujran, O. (2012). Toward The Utilization Of M-Government Services In Developing Countries: A Qualitative Investigation. *International Journal of Business and Social Science, Vol. 3*(No. 5), 155-160.

Alijerban, M., & Saghafi, F. (2010). M-government Maturity Model with Technological Approach. *In New Trends in Information Science and Service Science (NISS), 2010 4th International Conference on, pp. 164-169. IEEE,.*

Al-Khalifa, H. S. (2011). Development of Mobile Government Websites: A Functional Design Approach. *Proceedings on the 13th International Conference on Information Integration and Web-based Application and Services iiWAS'11.* New York, USA.

Al-khamayseh, S., Lawrence, E., & Zmijewska, A. (2006). Towards Understanding Success Factors in Interactive Mobile Government.

Al-Nuaim, H. (2014). Context-Aware Mobile Interface Design fo M-government. In *User-Centrc Technology for Nonprofit and Civi Engagements* (pp. 171-186). Springer.

AlThunibat, A., Zin, N. A., & Sahari, N. (2010). Mobile Government Services in Malaysia: Challenges and Opportunities. *2010 International Symposium in Information Technology (ITSim).* Kuala Lumpur.

Antovski, L., & Gusev, M. (2005). M-Government Framework. *Proceedings EURO mGov.*

Avila, A. (2006). *Application of a Context Model in Context-Aware Mobile Government Services.*

Ayob, N. Z., Hussin, A. R., & Dahlan, H. M. (2009). Three Layers Design Guideline for Mobile Application. *International Conference on Information Management and Engineering ICIME '09.* Kuala Lumpur.

Bonnie MacKay, D. D. (2005). Walk 'n scroll: a comparison of software-based navigation techniques for different levels of mobility. *Proceedings of the 7th international conference on Human computer interaction with mobile devices & services* . Salzburg, Austria.

Budiu, R., & Nielsen, J. (2011). *Usability of Mobile Websites, 85 Design Guidelines for Improving Access to Web-Based Content and Services Through Mobile Devices.* Nielsen Norman Group.

Butter, T., Aleksy, M., Bostan, P., & Schader, M. (2007). Context-aware User Interface Framework for Mobile Applications. *27th International Conference on Distributed Computing Systems Workshops.*

Carroll, J. (2006). 'What's in It for Me?': Taking M-Government to the People. *19th Bled eConference.* Bled, Slovenia.

Cerejo, L. (2012). *Guidelines and Best Practices, The Elements Of The Mobile User Experience.* Retrieved December 7, 2013, from http://mobile.smashingmagazine.com/2012/07/12/elements-mobile-user-experience/#more-111967

Chittaro, L. (2010). Distinctive Aspects of Mobile Interaction and their Implications for the Design of Multimodal Interfaces. *Journal on Multimodal User Interfaces, Volume 3*(Issue 3), 157-165.

Clarke, A. (2012). *5 Mobile Website Usability Rules You Cannot Afford To Break.* usabilit ygeek.com.

Costa, P. D., Pires, L. F., Sinderen, M. v., & Filho, J. G. (2004). Towards a Services Platform for Mobile Context-Aware Applications. *IWUC.*

Craig, N. (2010, November 3). *Mobile Website design & development guidelines*. (The Dot Product) Retrieved December 7, 2013, from https://thedotproduct.org/mobile-website-deign-development-guidelines/

Cui, Y., & Roto, V. (2008). How People Use the Web on Mobile Devices. *WWW '08 Proceedings of the 17th international conference on World Wide Web.* Beijing, China.

Davies, J. D. (2007, March). *Improving the Usability of Mobile Applications Through Context-Awareness.*

Dubai eGovernment, D. (2011). *Dubai Government Website Guidelines, Version 3.* Dubai: Dubai eGovernment Department.

Dumas, J. S., & Redish, J. C. (1999). *A Practical Guide to Usability Testing.* USA: Intellect Books.

Dunlop, M., & Brewster, S. (2002). The Challenge of Mobile Devices for Human Computer Interaction. *Personal and Ubiquitous Computing, Volume 6*(Issue 4), 235 - 236.

Evanschitzky, H., & Iyer, R. G. (2007). *E-Services: Opportunities and Threats.* USA: Springer.

Fidgeon, T. (2012, April 26). *Mobile apps – some usability guidelines.* Retrieved December 7, 2013, from http://www.spotlessinteractive.com/articles/usability-research/mobile-app-guidelines.php

Gong, J., & Tarasewich, P. (2004). Guidelines for Handheld Mobile Device Interface Design. *Proceedings of DSI 2004 Annual Meeting.*

Grasso, A., & Roselli, T. (2005). Guidelines for Designing and Developing Contents for Mobile Learning. *Proceedings of the IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE 2205), 123-127.*

Häkkilä, J. (2006). *Usability With Context-Aware Mobile Application, Case studies and design guidelines.* Oulu, Finland.

Harrison, R., Flood, D., & Duce, D. (2013). Usability of Mobile Applications: Literature Review and Rationale for a New Usability Model. *Journal of Interaction Science*, 1-16.

Hassan, M., Jaber, T., & Hamdan, Z. (2009). Adaptive Mobile-Government Framework. *International Conference on Administrative Development: Towards Excellence in Public Sector Performance.* Riyadh.

Hassenzahl, M., & Tractinsky, N. (2006). User Experience – a Research Agenda. *Behaviour & Information Technology*, 91 – 97.

ICT, I. T. (2014). *ICT Indicator Report, End of Q1 2014.* Saudi Arabia.

Internet World, S. (2013, 12 31). *Internet World Stats*. (Mniwatts Marketing Group) Retrieved 11 2013, from http://www.internetworldstats.com/stats.htm

Jung, J. (2005). The Research of Mobile User Interface Design Components From the Standpoint of Universal Design for Learning. *IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'05).*

Kaikkonen, A. (2005). Usability Problems in Today's Mobile Internet Portals. *Proceedings of the 2nd IEE International Conference on Mobile Technology, Applications and Systems, 459- 464.* Guangzhou, Chine: IEEE.

Kaikkonen, A., Kaasinen, E., & Ketola, P. (2009). Handheld Devices and Mobile Phones. In *The Universal Access Handbook* (p. Chapter 11). CRC.

Kärkkäinen, L., & Laarni, J. (2002). Designing for Small Display Screens. *Proceedings of the second Nordic conference on Human-computer interaction, 31, 227-230, .* Aarhus, Denmark.

Kjeldskov, J., & Paay, J. (2006). Indexical Interaction Design for context-aware mobile computer systems. *OZCHI '06 Proceedings of the 18th Australia conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments* (pp. 71-78). sydney: ACM New York, NY, USA.

Kolari, J., Laakko, T., Heltunen, T., Ikonen, V., Kulju, M., Suihkonen, R., . . . Virtanen, T. (2004). *Context-Aware Services for Mobile Users, Technology and User Experience.* Finland: VIT Information Technology.

Kumar, M., & Sinha, O. P. (2007). M-Government – Mobile Technology for e-Government. *International conference on e-government.* India.

Lentz, J. L. (2011, 7 26). *User interface design for the mobile web - Best practices for designing applications for multiple device platforms - IBM.* IBM Corporation. Retrieved 10 2013, from http://www.ibm.com/developerworks/library/wa-interface/

Lin, M., Goldman, R., Price, K. J., Sears, A., & Jacko, J. (2007). How Do People Tap When Walking? An Empirical Investigation of Nomadic Data Entry. *International Journal of Human-Computer Studies, Volume 65*(Issue 9), 759–769.

Lobo, D., Kaskaloglu, K., Kim, C., & Herbert, S. (2011). Web Usability Guidelines For Smartphones: A Synergic Approach. *International Journal of Information and Electronics Engineering, Volume 1*(Issue 1), 33-37.

Lundahl, O. (2009, June). Göteborg, Sweden.

Ma, S. (2011, January 17). *Designing for the Mobile Web: Special Considerations*. (UX matters) Retrieved December 2013, 2013, from http://www.uxmatters.com/mt/archives/2011/01/designing-for-the-mobile-web-special-considerations.php

Mengistu, D., Zo, H., & Rho, J. J. (2009). M-government: Opportunities and Challenges to Deliver Mobile Government Services in Developing Countries. *Fourth International Conference on Computer Sciences and Convergence Information Technology.* Seoul.

MobiThinking. (2013). *Designing Usable Pocket Rockets: A Three Step Guide to Usability on the Mobile Web.* Retrieved November 2013, from http://mobithinking.com/sites/mobithinking.com/files/dotMobi_Mobile_Usability_Best_Practice.pdf

MSDN. (2009). *Pocket PC User Interface Guidelines.* Retrieved December 7, 2013, from http://msdn.microsoft.com/en-us/library/ms854763.aspx

Nielsen, J. (1993). *Usability Engineering.* San Francisco: Morgan Kaufmann.

Nielsen, J. (2012, June 4). *How Many Test Users in a Usability Study?* Retrieved June 15, 2014, from http://www.nngroup.com/articles/how-many-test-users/

NSW, G. (2013). *NSW Government Web Guidelines.* New South Wales, Australia: The NSW Department of Premier & Cabinet.

OECD/ITU, I. T. (2011). *M-Government Mobile Technologies for Responsive Governments And Connected Societies.* OECD Publishing.

Qian, W., & WenDao, W. (2012). Interface Design of Handheld Mobile Devices for the Older Users. *3rd International Conference on e-Education, e-Business, e-Management and e-Learning.* Singapore.

Rabin, J., & McCathieNevile, C. (2008, July). *Mobile Web Best Practices 1.0-Basic Guidelines, World Wide Web Consortium W3C, Recommendation REC-mobile-bp.* Retrieved December 7, 2013, from http://www.w3.org/TR/2008/REC-mobile-bp-20080729/

Rannu, R., Saksing, S., & Mahlakõiv, T. (2010). *Mobile Government: 2010 and Beyond.* Mobi Solutions Ltd.

Roberts, D. (2012, May 1). *Usability and Mobile Devices.* Retrieved December 7, 2013, from http://www.usability.gov/get-involved/blog/2010/05/mobile-device-usability.html

Sanou, B. (2013, February). *ICT Facts and Figures.* Geneva: International Telecommunication Union. Retrieved 2013

Sanou, B. (2013, February). *ICT Facts and Figures.* Geneva: International Telecommunication Union. Retrieved 2013

Seong, D. S. (October 25–27, 2006). Usability Guidelines for Designing Mobile Learning Portals. *Proceedings of the ACM 3rd international conference on Mobile technology, applications & systems.* Bangkok, Thailand.

Seward, D. (2011). *Designing Usable Mobile Websites.* Peak Usability.

Shrestha, S. (2007). Mobile Web Browsing: Usability Study. *Mobility '07 Proceedings of the 4th international conference on mobile technology, applications, and systems and the 1st international symposium on Computer human interaction in mobile technology* . Singapore.

Tarasewich, P., Gong, J., & Nah, F. (2007). Interface Design for Handheld Mobile Devices. *Proceedings of the Americas Conference on Information Systems AMCIS.* USA.

Trimi, S., & Sheng, H. (2008). Emerging Trends in M-Government. *Communications of the ACM, Volume 51*(Issue 5), 53-58 .

Tsiaousis, A., & Giaglis, G. (2008). Evaluating the Effects of the Environmental Context-of-Use on Mobile Website Usability. *7th International Conference on Mobile Business* . Barcelona.

U.S. Dept., o. H. (2006). *Research-Based Web Design & Usability Guidelines, Enlarged/Expanded edition.* Washington: U.S. Government Printing Office.

UAE, F. G. (2009). UAE Federal Government Web Guidelines. Dubai, UAE: Ministry of Cabinet Affairs.

UN, U. N. (2012). *E-Government Survey 2012, E-Government for the People.* New York: United Nation.

UTexas. (2013). *Mobile Web Site Guidelines*. (The University of Texas at Austin) Retrieved December 7, 2013, from http://www.utexas.edu/brand-guidelines/web-guidelines/mobile

Wang, C., Lu, Z., Feng, Y., & Fang, R. (2011). M-government Use: Technology,Context and Environment Determinants. *International Conference of Information Technology, Computer Engineering and Management Sciences.*

Wang, C., Lu, Z., Feng, Y., & Fang, R. (2011). M-government Use: Technology,Context and Environment Determinants. *International Conference of Information Technology, Computer Engineering and Management Sciences.* Nanjing, Jiangsu.

Warsi, A. (2007). *7 usability guidelines for websites on mobile devices.* Retrieved December 7, 2013, from http://www.webcredible.co.uk/user-friendly-resources/web-usability/mobile-guidelines.shtml

webcandy. (2013). *Advantages of a Custom Website versus using a Website Builder Tools*. (webcandy) Retrieved April 15, 2014, from http://www.webcandy.ca/resources/web-candy-blogs/11-web-design-blogs/74-advantages-of-a-custom-website-versus-using-a-website-builder-tool

Webopedia. (2014, 11 27). Retrieved from Webopedia: http://www.webopedia.com/TERM/H/HTML5.html

Wikipedia. (2014, 11 27). Retrieved from Wikipedia: http://en.wikipedia.org/wiki/HTML5

Yaiz, R. A., Selgert, F., & Hartog, F. d. (2006). On the Definition and Relevance of Context-Awareness in Personal Networks. *Third Annual International Conference on Mobile and Ubiquitous Systems: Networking & Services, pp. 1-6. IEEE.* California, USA.

Zamzami, I., & Mahmud, M. (2012). Mobile Interface for m-Government Services: A Framework for Information Quality Evaluation. *International Journal of Scientific & Engineering Research, Volume 3*(Issue 8), 1-5.

Zamzami, U. A. (2010, January). *Design of a Context-Aware User Interface in Mobile Learning.* Unpublished Dissertation.

Zefferer, T. (2011). *Mobile Government - E-Government for Mobile Societies, Stocking of Current Trends and Iintiatives.* Austria: Secure Information Technology Center.

Appendix-A

Questionnaires

Tasks Performance Measurements & Observation Form

Subgroup No.: User Name:

Website	Tasks	Time	Clicks	No. of wrong choices	Observation of user behavior and expressions					User Comments	Observer Comments
					F*	C*	A*	S*	H*		
Website 1	T1										
	T2										
	T3										
	T4										
	T5										
	T6										
	T7										
	T8										

Website	Tasks	Time	Clicks	No. of wrong choices	Observation of user behavior and expressions					User Comments	Observer Comments
					F*	C*	A*	S*	H*		
	T9										
Website 2	T1										
	T2										
	T3										
	T4										
	T5										
	T6										
	T7										
	T8										
	T9										
Website 3	T1										
	T2										
	T3										

Website	Tasks	Time	Clicks	No. of wrong choices	Observation of user behavior and expressions					User Comments	Observer Comments
					F*	C*	A*	S*	H*		
	T4										
	T5										
	T6										
	T7										
	T8										
	T9										

***Note:** F=Frustration, C=Confusion, A=Anger, S=Satisfaction, H=Face Happiness

Pre-Test Questionnaire

1. **Name:** …….
2. **Age:**
    a. 20-25 years
    b. 26-30 years
    c. 31-35 years
    d. 35-40 years
    e. 41-45 years
    f. 46-50 years
    g. more than 50 years
3. **Gender**
    a. Female
    b. Male
4. **Are you left-handed?**
    a. Yes
    b. No
5. **Do you have a smart phone?**
    a. Yes
    b. No

If your answer is yes, please answer the following questions:

6. **How many smart phones you have?**

    ……

7. **What types of smart phones are you using (Please specify brand and model)?**

    ……..

8. **Is it a touch-screen device?**
    a. Yes
    b. No
9. **What do you use your mobile device for?**

a. Phone calls
b. Text messaging
c. Check weather
d. Playing games
e. Go online
f. Check your email
g. Searching for specific information on the Web
h. Reading text
i. Others (name them): ……
……..

10. Does your mobile device change its orientation as the device is rotated?

a. Yes
b. No

11. Which page orientation do you prefer while you are working with your mobile device?

a. Portrait
b. Landscape

12. Which page orientation do you prefer if you go online to find specific information while you are moving?

a. Portrait
b. Landscape

13. Do you use your mobile device to do the government transactions?

a. Yes
b. No

14. Do you use the zoom in and zoom out features when you browse a website?

a. Yes
b. No

15. If you are using the zooming feature, when you use it?

……..……..……..
……..……..……..

16. **Do you think that mobile devices are suitable tools for doing government transactions?**
    a. Yes
    b. No
17. **Do you think that mobile devices can be used for finding information in urgent situations?**
    a. Yes
    b. No

Post-Task Questionnaire

Please, do the following tasks and rate each task after you finish it in terms of its easiness and write your comments if you have. Some tasks must be done under specific situations, these tasks are marked with **.

Group 1 Tasks

1. Find all the cities that have early warning. ……...
The task you just finished was 1 Very easy | 2 easy | 3 Neutral | 4 Difficult | 5 Very Difficult
Comments: ……..……

**** Note:** The tasks 2, 3 and 4 must be done while you are moving

2. ** Find the duration and the situation description of the early warning situation in Dammam city. …….....
The task you just finished was 1 Very easy | 2 Easy | 3 Neutral | 4 Difficult | 5 Very difficult
Comments: ……..……..

3. ** Make emergency call by using the number for emergency provided.				
…….....				
The task you just finished was				
1	2	3	4	5
Very easy	Easy	Neutral	Difficult	Very difficult
Comments:				
……..……..				

4. ** Send an email to notify about an incident.				
…….....				
The task you just finished was				
1	2	3	4	5
Very easy	Easy	Neutral	Difficult	Very difficult
Comments:				
……..……..				

Group 2 Tasks

**** Note:** These tasks must be done in low light and with one hand

1. ** Find the weather forecast for Jeddah city today. ……				
The task you just finished was				
1	2	3	4	5
Very easy	Easy	Neutral	Difficult	Very difficult
Comments: ……..				

2. ** Find the weather forecast for Arar city tomorrow then find the forecast for next 5 days. ……				
The task you just finished was				
1	2	3	4	5
Very easy	Easy	Neutral	Difficult	Very difficult
Comments: ……..				

Group 3 Tasks

1. Open the Full Site (Desktop website) and find the number to call in emergency. ……
The task you just finished was 1 2 3 4 5 Very easy Easy Neutral Difficult Very difficult
Comments: ……..

2. Open the Arabic version of the site and then back to the English version. ……
The task you just finished was 1 2 3 4 5 Very easy Easy Neutral Difficult Very difficult
Comments ……..

3. **Enlarge the website font size. ……				
The task you just finished was				
1	2	3	4	5
Very easy	Easy	Neutral	Difficult	Very difficult
Commnets: ……..				

Post-Test Interface Evaluation Questionnaire

After you finish all the tasks, please answer the following questions to evaluate the interface of the website that you use. If the evaluation question is not found on the website, please do not answer it and write a comment in the comment column.

1. **Please rate the following interface design elements in terms of its effect on the text legibility**

	Questions	Legible	Neutral	Illegible	Comments
1	**Font type makes the text**	☐	☐	☐	
2	**Font size makes the text**	☐	☐	☐	
3	**Font style (Bold) makes the text**	☐	☐	☐	
4	**The background-foreground (black and white) color combination used on the website pages makes the text**	☐	☐	☐	
5	**The background-foreground (used in "Back" and "Home" links) color combination makes the text**	☐	☐	☐	
6	**Spaces between characters makes the text**	☐	☐	☐	
7	**Spaces between lines makes the text**	☐	☐	☐	

8	**The tables width makes the text**	☐	☐	☐	

2. Please answer the following questions with yes or no then specify how or why if required

	Questions	Yes	No	Comments
1	**The amount of contents placed on each screen was appropriate**	☐	☐	
2	**The amount of white spaces between screen elements was appropriate**	☐	☐	
3	**You were able to identify the main headings clearly.**	☐	☐	**How?**
4	**The main headings provide an appropriate feedback on your current location in the website**	☐	☐	
5	**You were able to identify sub-headings clearly**	☐	☐	**How?**
6	**You were able to differentiate between normal text and links**	☐	☐	**How if yes and Why if no?**
7	**You were able to differentiate visited links**	☐	☐	**How?**
8	**The website layout design was consistent**	☐	☐	
9	**There are generous amount of spaces around the links**	☐	☐	
10	**There are generous amount of spaces around the form elements**	☐	☐	

11	**The message provided after fill the form were suitable and informative**	☐	☐	
12	**The number of colors used on the website pages is appropriate**	☐	☐	**If no, why?**
13	**The places of the repeated navigation elements ("Home", "Back" links) on the website pages are consistent**	☐	☐	
14	**The information was written in a simple language**	☐	☐	
15	**The number of navigation links on the pages is appropriate**	☐	☐	
16	**There are generous amount of the spaces around the buttons and icons on the website pages**	☐	☐	
17	**The number of font styles used on the website pages were appropriate**	☐	☐	
18	**The images used on the website were meaningful**	☐	☐	
19	**Using text for links is better than images**	☐	☐	**Why?**
20	**Do you need to zoom on the website pages**	☐	☐	**If yes, in which pages?**

3. **Please rate the following interface design elements in terms of its effect on the content readability**

	Questions	Readable	Neutral	Not readable	Comments
1	The amount of margins makes the content	☐	☐	☐	
2	The amount of white spaces between the content elements makes the content	☐	☐	☐	
3	The use of sub-headings makes the content	☐	☐	☐	
4	Vertical scrolling makes the content	☐	☐	☐	
5	The number of words per line makes the content	☐	☐	☐	
6	The number of lines per screen makes the content	☐	☐	☐	

4. **Please rate the following interface design elements in terms of its clarity**

	Questions	Very Clear	Clear	Neutral	unclear	Very unclear	Comments
1	The white background makes screen elements	☐	☐	☐	☐	☐	
2	Links meaning about destination page content were	☐	☐	☐	☐	☐	
3	Navigation links (Back, and Home Page) position was	☐	☐	☐	☐	☐	

5. Please rate the following interface design elements in terms of its easiness

	Questions	Very easy	Easy	Neutral	Difficult	Very Difficult	comments
1	Using 'Back' and 'Home' primary navigation links to navigate through the website pages were	☐	☐	☐	☐	☐	
2	Reading the information that do not require scrolling were	☐	☐	☐	☐	☐	
3	Understand the hierarchical structure was	☐	☐	☐	☐	☐	
4	Using vertical scrolling while finding information was	☐	☐	☐	☐	☐	
5	Using vertical scrolling while finding information from a table was	☐	☐	☐	☐	☐	
6	Clicking on the desired links was	☐	☐	☐	☐	☐	
7	Finding a specific information from the website pages was	☐	☐	☐	☐	☐	

8	**Filing the form in the website was**	☐	☐	☐	☐	☐	
9	**Interaction with the interface elements while walking was**	☐	☐	☐	☐	☐	
10	**Interaction with the interface elements with one hand was**	☐	☐	☐	☐	☐	

Appendix-B

Calculated Time

Table 74: Time Calculated for Proposed Mobile Version of All Groups

Proposed mobile version									
	Tasks								
Users	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	4.11	8.00	3.50	1.50	9.98	12.61	3.00	4.00	4.92
2	5.05	5.45	3.43	1.52	8.36	17.26	1.50	2.00	2.88
3	7.18	8.47	1.61	6.06	13.63	22.14	5.63	1.65	1.95
4	10.80	10.55	4.45	5.29	12.00	18.00	5.56	5.90	5.50
5	5.18	3.71	4.14	7.35	5.19	23.28	1.51	5.13	2.44
6	6.65	4.52	1.66	6.72	7.54	16.77	12.18	9.16	18.37
7	4.16	4.24	2.39	5.42	7.05	16.85	4.47	6.46	7.56
8	4.75	6.18	1.61	8.14	5.80	20.54	1.69	4.83	4.63
9	3.24	3.28	1.64	3.50	3.89	14.62	3.00	1.64	3.50
10	3.54	4.28	2.10	4.60	4.19	10.65	2.45	2.30	3.23
11	7.52	6.33	2.48	10.45	8.05	23.47	6.16	11.86	2.17
12	8.00	8.36	2.69	10.59	8.45	29.48	7.39	3.81	5.32
13	4.34	5.00	1.83	6.92	6.07	19.17	2.16	7.00	4.20
14	6.34	7.50	1.69	5.40	6.50	12.31	3.23	3.12	4.70
15	5.30	5.20	2.10	4.40	5.10	11.54	2.34	7.22	3.20

Table 75: Time Calculated for Mofuse Mobile Version of All Groups

Mofuse mobile version									
	Tasks								
Users	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	14.50	24.76	8.30	2.00	13.00	17.82	3.50		
2	15.68	17.63	4.50	2.00	11.34	23.03	2.00		
3	29.33	9.48	5.70	8.84	9.44	24.18	4.59		
4	30.80	12.50	4.50	5.00	12.50	22.00	6.43		
5	46.49	10.41	3.59	7.36	7.30	20.92	6.40		
6	40.58	13.13	3.71	11.02	14.18	17.36	35.16		
7	24.33	6.55	4.00	8.14	21.65	21.90	14.20		
8	35.88	12.43	2.45	9.14	8.19	23.80	17.69		
9	41.67	26.74	3.59	8.89	6.51	18.61	41.59		
10	38.67	24.74	4.19	9.19	7.34	20.21	38.44		
11	19.80	17.39	2.34	6.98	6.49	21.54	8.01		
12	32.60	16.63	2.60	6.56	9.09	41.01	6.63		
13	30.19	9.82	3.97	7.89	8.74	22.81	6.34		
14	27.80	15.39	4.60	7.32	7.54	21.78	7.61		
15	34.87	17.78	3.70	8.56	10.09	40.01	6.78		

Table 76: Time Calculated for Dudamobile Version of All Groups

Dudamobile mobile version									
	Tasks								
Users	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	28.71	17.42	6.08	35.00	47.01	50.60	13.65	13.00	
2	8.75	21.93	2.32	30.00	44.20	60.18	12.67	3.00	
3	46.81	43.32	15.35	76.69	25.30	38.17	13.21	9.00	
4	32.01	20.77	13.74	49.70	40.15	44.74	11.45	5.00	
5	26.68	38.40	5.74	60.62	27.70	45.08	13.79	16.82	
6	17.22	14.85	2.79	50.98	26.04	42.42	20.23	6.59	

Table 76: Time Calculated for Dudamobile Version of All Groups (Cont'd)

Dudamobile mobile version									
	Tasks								
Users	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
7	23.19	22.54	4.77	73.47	25.56	36.47	19.78	18.50	
8	24.41	23.69	5.15	84.52	35.29	44.68	18.65	22.56	
9	16.63	7.00	3.59	79.36	36.56	38.93	20.45	6.00	
10	19.30	7.50	3.40	81.12	37.16	40.93	21.23	7.50	
11	34.78	20.30	33.50	72.65	34.08	54.73	38.56	18.36	
12	60.00	69.84	10.94	100.73	35.03	40.69	37.39	23.77	
13	43.12	51.73	12.00	76.83	32.19	24.13	39.70	12.20	
14	41.12	45.20	16.50	65.40	36.32	28.34	40.67	17.56	
15	45.30	12.70	3.40	83.12	37.16	40.93	41.56	11.10	

Table 77: Time Calculated for Group 1 of All Websites Versions

User/Task	Proposed version	Mofuse version	Dudamobile version
U1/T1	4.11	14.50	28.71
U2/T1	5.05	15.68	8.75
U3/T1	7.18	29.33	46.81
U4/T1	10.80	30.80	32.01
U5/T1	5.18	46.49	26.68
U1/T2	8.00	24.76	17.42
U2/T2	5.45	17.63	21.93
U3/T2	8.47	9.48	43.32
U4/T2	10.55	12.50	20.77
U5/T2	3.71	10.41	38.40
U1/T3	3.50	8.30	6.08
U2/T3	3.43	4.50	2.32

Table 77: Time Calculated for Group 1 of All Websites Versions (Cont'd)

User/Task	Proposed version	Mofuse version	Dudamobile version
U3/T3	1.61	5.70	15.35
U4/T3	4.45	4.50	13.74
U5/T3	4.14	3.59	5.74
U1/T4	1.50	2.00	35.00
U2/T4	1.52	2.00	30.00
U3/T4	6.06	8.84	76.69
U4/T4	5.29	5.00	49.70
U5/T4	7.35	7.36	60.62
U1/T5	9.98	13.00	47.01
U2/T5	8.36	11.34	44.20
U3/T5	13.63	9.44	25.30
U4/T5	12.00	12.50	40.15
U5/T5	5.19	7.30	27.70
U1/T6	12.61	17.82	50.60
U2/T6	17.26	23.03	60.18
U3/T6	22.14	24.18	38.17
U4/T6	18.00	22.00	44.74
U5/T6	23.28	20.92	45.08
U1/T7	3.00	3.50	13.65
U2/T7	1.50	2.00	12.67
U3/T7	5.63	4.59	13.21
U4/T7	5.56	6.43	11.45
U5/T7	1.51	6.40	13.79
U1/T8	4.00		13.00
U2/T8	2.00		3.00
U3/T8	1.65		9.00
U4/T8	5.90		5.00

Table 77: Time Calculated for Group 1 of All Websites Versions (Cont'd)

User/Task	Proposed version	Mofuse version	Dudamobile version
U5/T8	5.13		16.82
U1/T9	4.92		
U2/T9	2.88		
U3/T9	1.95		
U4/T9	5.50		
U5/T9	2.44		

Table 78: Time Calculated for Group 2 of All Websites Versions

User/Task	Proposed version	Mofuse version	Dudamobile version
U1/T1	6.65	40.58	17.22
U2/T1	4.16	24.33	23.19
U3/T1	4.75	35.88	24.41
U4/T1	3.24	41.67	16.63
U5/T1	3.54	38.67	19.30
U1/T2	4.52	13.13	14.85
U2/T2	4.24	6.55	22.54
U3/T2	6.18	12.43	23.69
U4/T2	3.28	26.74	7.00
U5/T2	4.28	24.74	7.50
U1/T3	1.66	3.71	2.79
U2/T3	2.39	4.00	4.77
U3/T3	1.61	2.45	5.15
U4/T3	1.64	3.59	3.59
U5/T3	2.10	4.19	3.40
U1/T4	6.72	11.02	50.98
U2/T4	5.42	8.14	73.47

Table 78: Time Calculated for Group 2 of All Websites Versions (Cont'd)

User/Task	Proposed version	Mofuse version	Dudamobile version
U3/T4	8.14	9.14	84.52
U4/T4	3.50	8.89	79.36
U5/T4	4.60	9.19	81.12
U1/T5	7.54	14.18	26.04
U2/T5	7.05	21.65	25.56
U3/T5	5.80	8.19	35.29
U4/T5	3.89	6.51	36.56
U5/T5	4.19	7.34	37.16
U1/T6	16.77	17.36	42.42
U2/T6	16.85	21.90	36.47
U3/T6	20.54	23.80	44.68
U4/T6	14.62	18.61	38.93
U5/T6	10.65	20.21	40.93
U1/T7	12.18	35.16	20.23
U2/T7	4.47	14.20	19.78
U3/T7	1.69	17.69	18.65
U4/T7	3.00	41.59	20.45
U5/T7	2.45	38.44	21.23
U1/T8	9.16		6.59
U2/T8	6.46		18.50
U3/T8	4.83		22.56
U4/T8	1.64		6.00
U5/T8	2.30		7.50
U1/T9	18.37		
U2/T9	7.56		
U3/T9	4.63		
U4/T9	3.50		
U5/T9	3.23		

Table 79: Time Calculated for Group 3 of All Websites Versions

User/Task	Proposed version	Mofuse version	Dudamobile version
U1/T1	7.52	19.80	34.78
U2/T1	8.00	32.60	60.00
U3/T1	4.34	30.19	43.12
U4/T1	6.34	27.80	41.12
U5/T1	5.30	34.87	45.30
U1/T2	6.33	17.39	20.30
U2/T2	8.36	16.63	69.84
U3/T2	5.00	9.82	51.73
U4/T2	7.50	15.39	45.20
U5/T2	5.20	17.78	12.70
U1/T3	2.48	2.34	33.50
U2/T3	2.69	2.60	10.94
U3/T3	1.83	3.97	12.00
U4/T3	1.69	4.60	16.50
U5/T3	2.10	3.70	3.40
U1/T4	10.45	6.98	72.65
U2/T4	10.59	6.56	100.73
U3/T4	6.92	7.89	76.83
U4/T4	5.40	7.32	65.40
U5/T4	4.40	8.56	83.12
U1/T5	8.05	6.49	34.08
U2/T5	8.45	9.09	35.03
U3/T5	6.07	8.74	32.19
U4/T5	6.50	7.54	36.32
U5/T5	5.10	10.09	37.16
U1/T6	23.47	21.54	54.73
U2/T6	29.48	41.01	40.69

Table 79: Time Calculated for Group 3 of All Websites Versions (Cont'd)

User/Task	Proposed version	Mofuse version	Dudamobile version
U3/T6	19.17	22.81	24.13
U4/T6	12.31	21.78	28.34
U5/T6	11.54	40.01	40.93
U1/T7	6.16	8.01	38.56
U2/T7	7.39	6.63	37.39
U3/T7	2.16	6.34	39.70
U4/T7	3.23	7.61	40.67
U5/T7	2.34	6.78	41.56
U1/T8	11.86		18.36
U2/T8	3.81		23.77
U3/T8	7.00		12.20
U4/T8	3.12		17.56
U5/T8	7.22		11.10
U1/T9	2.17		
U2/T9	5.32		
U3/T9	4.20		
U4/T9	4.70		
U5/T9	3.20		