Winter 12-10-2002

Evaluation of M-Sites Using PDAs

HY Sonya Hsu

Gordon C. Bruner II

Evaluation of M-Sites Using PDAs

HY Sonya Hsu
Department of Management
Southern Illinois University
Carbondale, Illinois, USA
Sonyah@siu.edu

Gordon C. Bruner II
Associate Professor of Marketing
Director, Office of Scale Research
Southern Illinois University
Carbondale, Illinois, USA
gcbii@siu.edu

Abstract

As mobile sites (m-sites) are introduced a very relevant question to ask is "How should these sites be different from the typical websites developed for desktop PCs?" This paper presents an initial, exploratory attempt to address some issues related to m-sites. This evaluation of sites was conducted using wireless PDAs in a WLAN environment. The results indicated that regular sites and m-sites differed significantly in perceived search engine functionality. The evaluated m-sites showed little differences across various industries. A discussion of these results as well as recommendations for managers and academic researchers are provided.

1. Introduction

According to the forecast of PriceWaterHouse Cooper [17], more users are expected to access the Internet in the future on mobile devices rather than on desktop computers. The report went on to predict that by 2005 the penetration of mobile data services in Western Europe will still lead the world (91% of its total population), followed by Japan (90%) [17]. United States, coming in third, will have increased its mobile data consumption up to about 83% while the worldwide penetration rate will be 20%[17].

As of September 2001, according to the National Telecommunications and Information administration [18], the vast majority of Internet users in the United States accessed the Internet through a desktop or laptop computer. Only 1.8 percent of households had an Internet accessible personal digital assistant (PDA) or other handheld device. The other devices capable of accessing the Internet such as cell phones and pagers were only owned by 4.8 percent of households. Virtually, all of these households with mobile devices also had computers [18].

Mobile communication, since the 90s, has been evolving from voice only transmission to simple data transmission, followed by Enhanced Message Service (EMS) and then Multimedia Messaging Service (MMS) (See Table 1). MMS is classified as third generation (3G) cellular technology. Nippon Telephone and Telegram (NTT') DoCoMo system in Japan has successfully employed 3G technologies. The success of DoCoMo not only relied on its rollout of the infrastructure layers but its quality of service (QoS) in handhelds and content services – i-Mode which offers mobile websites and i-Appli offers more interactive applications [11]. Nationwide deployment of 3G in the U.S. was conducted by Sprint during the summer of 2002 tied with the release of ***Men in Black II***, in which the company's service was featured.

When discussing wireless research, the technical issues, such as the interoperability, have been the primary topics. However, there have been few known scholarly studies examining how website contents appear on the mobile devices. As m-sites are introduced a very relevant question to ask is how should these sites be different from the typical websites developed for desktop PCs? As shown in Table 2, accessing the Internet with m-devices is likely to be a very different experience for users compared to the experience with desktop computers.

Table 1: Evolution from Text to Multimedia

	1990s	2001	2002
Characteristics	100-200 characters	Text messages, sound Picture, text formatting	Multiple rich media formats
Content reformatting for mobile necessary	Yes	Yes	No
Application	Simple person-to-person messaging	Person-to-person messaging	Person-to-person messaging with visual feel
Multimedia Messaging	All phones	EMS standard expected to be Widely adopted	MMS standard expected to be Widely adopted

Table content extracted from Lewis [15].

Further, although use of an m-device has one big advantage over PCs (mobility), it also has several disadvantages. Compared to desktop modem access, data transfer via mobile devices is more expensive. Compared to the rest of world, the majority of U.S. population still prefers the desktops over mobile devices to access information via Internet. Theoretically, regular Web and the mobile Web have distinct audiences, purposes and characteristics that supposedly warrant different features and content. In reality, how do sites compare at this point?

This paper presents an initial, exploratory attempt to address some issues related to mobile sites. How successfully are these changes from regular to "mobile" sites currently being made? How are users reacting to these mobile sites? What improvements appear to be needed? This paper will report on the analysis of over seventy sites and discuss managerial implications as well as recommendations for future studies.

Table 2: Contrast of Alternative Means of Accessing Internet

Attribute	*Desktop Computer*	*Handheld devices*
Connection speed	fast	Slow/moderate
Connection expense	cheap	expensive
Monitor size	large	small
Visual quality	great	poor
Sound quality	great	poor
Navigation ease	good	poor
Mobility	poor	good

2. Literature Review

Mobile websites (referred to here as the Mobile Internet) involve the use of wireless communications technologies to access network-based information and applications from mobile devices [17]. Customers engaged in m-commerce use wireless communication technologies to access network-based information and applications from mobile devices. Excluding laptops, there are currently two principal classes of mobile devices: mobile phone handsets and handheld computing devices (e.g., Personal Digital Assistants, PDAs). As shown in Table 2, analysts cited a number of obstacles to the development of the mobile Internet in the United States, such as minimal screens, low data rates (less than 20 Kbps), and cumbersome text input mechanisms [14][15].

In transition from regular web sites to presenting the content on the wireless platforms, such as Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), and Global System Mobile Communications (GSM), the service providers have developed different ways to modify the presentation. Typically, regular web sites provide the same information to the mobile sites. Sometimes, you may click through the mobile site via regular Web sites, for example, CNN, The Wall Street Journal (which is hard to navigate through). Some regular sites have distinctly different mobile sites to show their unique presentations on the wireless platforms.

There are several ways to develop wireless e-business applications (See Table 3), such as:

1. Create regular Web pages that users view from the small displays on mobile devices.
2. Using the Wireless Application Protocol (WAP) to connect to the Internet.
3. Build applications optimized for handheld devices using Web clipping.
4. Build a Native application that can incorporate on-line and off-line components and are available when network connections are not.

Table 3: Wireless Development Option Comparison

Capabilities / application	Web pages	WAP	Web clipping	Native
Data transfer				
Multiple modes	No	No	Limited	Yes
Intelligent selection	No	No	No	Yes
Data access				
Local databases	No	No	No	Yes
Local processing	No	No	No	Yes
Data interactivity				
Rich display	No	No	Yes	Yes
Flexible input	No	No	Yes	Yes
Mobile computing	No	Yes	Yes	Yes
Intl coverage	Yes	Yes	Yes	Yes

Table content extracted from [16].

No matter what type the application is, there are different characteristics to define QoS. In terms of technology, QoS parameters may include timeliness, bandwidth, and reliability [5]. From the user's point of view, QoS requirements may become a perceived QoS. Depending on the type of data transmission application, the priority can be defined among different flows in multimedia stream by picture resolution, color accuracy, video rate, video smoothness, audio quality, video/audio synchronization, cost and security [12].

Buchanan et al. [3], in their usability research of WAP phones, identified design guidelines which: 1) provide direct, simple access to focused valuable content, 2) use simple hierarchies, 3) reduce the amount of vertical scrolling, and 4) reduce the number of keystrokes. The study resembled issues identified during the early stage of website development for desktop computers.

Followed by Chan et al. [6] using cognitive walkthrough and heuristic evaluation methods, they evaluated the usability of ten wireless sites in three platforms: WAP-enabled mobile phones, Palm OS based wireless PDAs, and Pocket PCs running Windows CE operating systems. Their usability findings pertained to user tasks, content presentation, search, navigation

systems, and the design constraints imposed by form factors impacted on usability [6].

The research objective of Chan et al. [6] was to assess the usability of wireless sites of the most popular e-commerce companies as well as to provide the examination of wireless interface design. In defining wireless sites, their definition of tasks focused on transactional, and information retrieval. They found that all ten sites accessed using mobile devices were designed with steps similar to their counterparts designed for PC-based access [6]. However, in mobile environment, there was neither enough time nor content for users to perform such tasks. As insightful as this study was, only ten sites were evaluated. The very small number of sites could have greatly biased their evaluations. Further, it precluded their ability to make comparisons across industries.

Cellmania.com launched a free directory of 10,000 of the most "effective" WAP sites [2]. As a third party from the Web industry and consumers, Cellmania reviewed mobile sites with four criteria: overall usefulness to the mobile consumer, content, ease of use and navigation, interactivity and robustness of site. Thirteen categories were evaluated by the experts and users. Those categories are communications, travel, reference, news, games, financial/business, directory services, weather/traffic, sports, portals/search, m-commerce, food and entertainment [10]. Unfortunately, very little information about the analysis made by Cellmania.com was publicly released. Thus, we still do not know how sites optimized for mobile devices compare to those optimized for desktop PCs or what differences may exist across industries.

Given the previous work that has been conducted, two research questions were addressed in this research. First, what differences are there between the typical websites constructed for the desktop experience and those sites designed with mobile devices in mind? The second question has to do with the possibility that some industries may be more innovative than others in preparing for this new form of Internet access. Thus, what differences are there between industries in terms of the ways their sites appear on a mobile device?

3. Methodology

The study was conducted with students in a MBA course at a large university in the Midwestern United States. The students were put into groups and provided some instruction on using the m-devices. They were each assigned seventy-four sites to evaluate and they were not told specifically whether the sites were regular or mobile sites. Reports in the popular press as well as the researchers' experiences with the devices provided insight into the key problems that users could encounter at websites.

Thirty-four (See Table 4) out of over 600 mobile sites were filtered from Palm.net Web clipping services [9]. Forty regular websites in addition to the mobile sites were evaluated in this research (a total of 74). Five industries were chosen from Palm.net, whose sites were presented with average users' ratings. Evidently, there were more regular websites than the mobile sites. Originally, the researchers selected more than 74 sites; however, some mobile sites were deleted because of their loading difficulty and/or unavailability when this research was conducted. Those sites may have been temporally out of service or simply out of business because of economic downturn.

Table 4: The Evaluations of Websites and Mobile Sites in Five Industries

Industries	Entertainment	Finance	News	Shopping	Travel
Regular Websites	Dodgeball	Ameritrad	CNN	GapCo	eLocal
	Dorcino	BigCharts	ESPN	Amazon	Fodors
	Egolfscore	CBSMarketWatch	LATimes	InternetGroceries	Freightgate
	Fandango	NewYorkFed	AllLotto	BarnesNobles	HotelDiscounts
	Gorm	Forbes	CBS1	DealTime	NWAirline
	InterBUG	MasterCard	USAToday	eBay	OAG
	Moviefone	Quicken	VegasInsider	Godiva	PizzaOnline
		WellsFargo		BlueBook	Travelocity
		FreeRealTime		Oreilly	
Mobile Sites	Banywhere	NewYorkFed	ABCNews	Amazon	CoTimetable
	Beamshop	Fidelity	AllLotto	Barnes&Noble	Freightgate
	booksbtc	Forbes	CNN	Buy.com	HotelDiscounts
	Dodgeball	MarketWatch	ESPN	eBay	NWAirline
	Dorcino	Quicken	InfoBrand	GoAmerica	OAG
	Egolfscore	WellsFargo	Chronical	Oreilly	
	Moviefone		CBS		
	InterBUG		VegasInsider		
	Airguitar				

The evaluations made by the judges addressed several issues. First, how well did the page fit within the screen when the respondents looked for a particular function like a "search engine?" Did the respondents need to scroll around on the minimized PDA to find the function? While meeting the task of "looking for a search function" on the sites, the respondents were asked to evaluate if the text was readable, and if the graphics were presented right. Finally, the respondents assessed how easily they found a search function. The rationale behind this procedure was that by completing a task - find a search engine, the respondents gave their quick responses to what was presented in a particular Web site, regular or mobile.

The m-devices used in the study were PDAs. Specifically, they were a top-of-the-line color version running *Pocket PC* with *Microsoft CE* including *Internet Explorer*. The devices connected to the web via "Wi-Fi" (802.11b) network. The screen size was approximately 3" x 2". Although it would have been valuable to use 3G cell phones, at the time the study was conducted cell phones with Internet services were still rare in the U.S., not to mention the difficulty and expense of obtaining enough handsets and service to use in the exercise.

The URLs for the sites were put in the *Favorites* folder of each device ahead of time by the researchers. The procedure was for each site to be accessed using Internet Explorer and then for the questions to be answered. To make the job as simple as possible yet remain in the mobile domain, students used an Excel form created by the researchers running simultaneously on the PDA. By using programmable function buttons on the front of the devices, students could easily switch between a view of a website and the spreadsheet upon which they entered their assessments.

Once a group had finished judging all of the sites they e-mailed their Excel file to an address provided. The researchers then merged the data from each of the groups into one file and analyzed the data. T-tests were utilized to analyze the differences between the mobile sites and the regular sites. ANOVA was used to analyze the differences among the various industries. This study was not concerned about potential differences in group or individual evaluations but instead focused on differences between sites as judged by the groups.

4. Results

The assessments of the five groups of judges of the seventy-four sites were analyzed to address the research questions. The findings with respect to each question are presented below.

Research Question 1: Mobile vs. Regular Websites

Surprisingly, there were few significant differences found between mobile and regular Websites. Among the site characteristics tested, we found that only the presence of a search engine showed a significant difference ($t = 2.117$, $P < .05$). In other words, the regular websites (mean = 3.35) provided easier access to search engines than m-sites (mean = 2.96). The other criteria, adequacy of fit to the screen, degree of graphic distortion, and readability of text, did not show a significant level of difference between regular websites and mobile sites (See Table 5).

Table 5: The Differences between Regular & Mobile

	*Web/ Mobile	Mean	Std. Dev	t	df	Sig. (2-tailed)
Fit	Web	2.61	1.265	.065	365	.948
	Mobile	2.60	1.202			
Readable	Web	3.88	1.109	-.502	365	.616
	Mobile	3.94	1.056			
Distorted Graphics	Web	2.77	1.423	-.249	365	.803
	Mobile	2.81	1.488			
Search Engine	Web	3.35	1.782	2.117	365	.035
	Mobile	2.96	1.781			

Web N = 198; Mobile N = 169

Research Question 2: Differences among Industries

The sites were grouped into five industries: entertainment, finance, news, shopping, and travel. In Fit, Readable, Distorted Graphic, and Search Engine criteria, there were no differences among five industries using ANOVA (See Table 6). The researchers further ran the t-test on 14 paired industries to see if there were any differences. It turned out that, only two industries, finance (mean = 3.14) and shopping (mean = 2.40), showed significant differences ($t = 2.184$, $P < .05$). Specifically, typical websites were viewed as different from m-sites in their degree of distorted graphics (See Table 7). Therefore, among those sites we evaluated, the sites in finance industry were more likely to present distorted pictures than those in shopping industry.

Table 6: The Differences between Industries

		Sum of Squares	df	Mean Square	F	Sig.
Fit	Between Groups	2.900	4	.725	.496	.739
	Within Groups	239.739	164	1.462		
	Total	242.639	168			
Readable	Between Groups	1.558	4	.390	.344	.848
	Within Groups	185.850	164	1.133		
	Total	187.408	168			
Distorted Graphic	Between Groups	12.080	4	3.020	1.376	.244
	Within Groups	359.861	164	2.194		
	Total	371.941	168			
Search Engine	Between Groups	10.277	4	2.569	.807	.523
	Within Groups	522.433	164	3.186		
	Total	532.710	168			

Table 7: The Differences between Finance and Shopping Industries

	Industry	Mean	Std. Dev	t	df	Sig. (2-tailed)
Fit	Finance	2.72	1.162			
	Shopping	2.37	1.159	1.183	57	.242
Readable	Finance	3.97	.981			
	Shopping	3.77	1.278	.669	57	.506
Distorted Graphic	Finance	3.14	1.529			
	Shopping	2.30	1.418	2.184	57	.033
Search Engine	Finance	3.31	1.775			
	Shopping	3.17	1.840	.305	57	.761

Finance N = 29; Shopping N = 30

5. Discussion

As more people begin to connect to the web using mobile devices than PCs the sites themselves will have to change. Chief among the changes noted in this study was ease of finding a search engine. It appears that right now it is much more likely to find a search engine at a normal site than at an m-site. Having an easy to find search engine is important even for those who access the web with desktop computers. But, for those using m-devices they are likely to be critical. That is because navigating around a site to locate something of interest is so difficult when the screen is small and the keyboard is limited or non-existent. When a search engine is not prominent upon reaching the front page of a site visitors could quickly become frustrated and go elsewhere.

Because of its distinct characteristics compared to regular websites, mobile sites will need to define further on QoS when the research related to content analysis, usability and websites development. The constantly changing mobile industries have several ways to create their m-sites. However, while Web clipping service providers offer a unique setting for the handheld optimization which utilizes synchronization function of PDAs, there are more disappointments on mobile devices than satisfaction. At least, our study made less dramatic evaluations. Different protocols and mobile applications appear to have made great differences in results.

No matter what type of application is used, there are different characteristics to define QoS. For example, in transferring an image file, the picture quality and the response time could be considered as appropriate factors [12]. In terms of technology, QoS parameters may include timeliness, bandwidth, and reliability [5]. From the user's point of view, QoS requirements may become a perceived QoS. Depending on which type of data transmission application is used, the priority can be defined among different flows in multimedia stream, e.g., picture resolution, color accuracy, video rate, video smoothness, audio quality, video/audio synchronization, cost and security [12]. For content delivery, a new breed of Mobile Internet Providers (MIPs) is filling the gaps over the airways until the new data networks are in place.

It has to do with the fact that users are unfamiliar with using the devices for data purposes and the devices are inferior to the desktop experience in many ways (as shown in Table 2). For those consumers who have alternatives, they may just continue surfing the Web using desktops until mobile devices overcome the barriers of human usability and technical difficulty. In addition, most websites are not constructed with m-devices in mind. Thus, this study examines some ways in which "good" and "bad" sites differ.

In general, most users expect a wireless website to be somewhere between the level of sophistication of an interactive voice response (IVR) system and a Web site [1]. Mobile devices, PDA, cell phone or pagers, have their limitations to the screen size and their cumbersome text input mechanisms. Despite the convenience, most U.S. consumers will probably continue using the easier and faster interface on their home computer until mobile devices overcome the current problems. Gillick et al. [7] suggested a speech recognition technology for text input on a very small mobile device. Cellmania [4], however, just introduced WebNum to the market that consumers can simply use numeric shortcuts associate with the Internet site's domain name to overcome cumbersome Web surfing by keying different sites.

Businesses servicing websites should develop their mobile Internet sites in both WML (wireless mark-up language) and HDML (handheld device mark-up language) to ensure their customers can access them despite the sort of mobile device they have. Moreover, marrying the company's website to the mobile one may

be useful in some cases so that some interactions can start on the desktop and finish on the phone and vice versa [1]. Meanwhile, the voice interface may be used to enhance the Internet access experience for speaking with a customer service representative but not loosing their data processing. VoIP (Voice over IP) should be anticipated to provide data and voice messaging via mobile devices in the near future.

References

.

[1] Berry, Neerav. Retooling for the Wireless Web: Is Your Business Ready for the Wireless Web? White Papers, *Cellmania*. 2000.

[2] Braue, David. Cellmania Aims To Remove WAP Blockade In Telcos, Enterprises. February 09, 2001. http://www.wirelessauthority.com.au/r/article/jsp/sid/979490

[3] Buchanan, G., S. Farrant, M. Jones, H. Thimbleby, G. Marsden, and M. Pazzani, "Improving Mobile Internet Usability," Proceedings of the Tenth International World Wide Web Conference, New York, NY: ACM, 2001.

[4] Canada News Wire. Cellmania's mFinder(TM) Wireless Search Engine and Directory is Now Available to Rogers AT&T Wireless Customers Across Canada. http://www1.newswire.ca/releases/February2002/04/c8295.html

[5] Chalmers, D., Sloman, M. "A Survey of Quality of Service in Mobile Computing Environments," *IEEE Communication Surveys*, 1999. 2nd Quarter.

[6] Chan, Susy S., Fang, Xiaowen, Brzezinski, Jack, Zhou, Yanzan, Xu, Shuang, and Lam, Jean. "Usability for Mobile Commerce Across Multiple Form Factors," *Journal of Electronic Commerce Research*, 2002, Vol. 3: 3.

[7] Gillick, Kevin, Vanderhoof, Randy. Mobile E-Commerce (m-commerce) "Market Place Enablers and Inhibitors" A White Paper for the *Smart Card Forum Annual Meeting*. September 2000.

[8] https://ami.avantgo.com/channels/index.html

[9] http://applications.palmsource.com/Software/index.asp

[10] http://mfinder.cellmania.com/Jsp/web/home.jsp

[11] http://www.nttdocomo.com

[12] Jamalipour, Abbas. "Wireless Broadband Multimedia and IP Applications Via Mobile ATM Satellites," In Sirin Tekinay (ed.) *Next Generation Wireless Networks*. MA: Kluwer Academic Publishers. 2001.

[13] Kukitz, Jeff. Online Initiatives of Top Business Schools: Best Practices. PA: *Penn State Publication*. 2001. http://www.ebrc.psu.edu/publications/researchpapers.html

[14] Lawton, George. "Waiting for wireless apps." *ZDNet News*. November 1, 2001. http://techupdate.zdnet.com/techupdate/stories/main/0,14179,2821554-4,00.html

[15] Lewis, Valerie "Sensory Overload." *America's Network*, Sep 1, 2001, 105, 63-8.

[16] Palm Inc. Wireless Enterprise Applications for Mobile Information Management: Development Options and Business Decisions. 2000. http://www.palm.com/pr/palmvii/7whitepaper.pdf

[17] PowerWaterHouseCoopers. *Technology Forecast: 2001-2003*. CA: PowerWaterHouseCoopers Technology Center. 2001.

[18] Victory, Nancy, & Cooper, Kathleen. A Nation Online: How Americans Are Expanding Their Use of the Internet. U.S. Department of Commerce/National Telecommunications and Information Administration. 2002.