Mobile Information Access in the Real World: A Story of Three Wireless Devices

ABSTRACT

The importance of the user perspective to the wireless information access experience cannot be understated: simply put, users will not indulge in devices that are perceived to be difficult to use and in technologies that do not offer quality infotainment – combined information and entertainment – content. In this paper, we investigate the impact that mobile devices have on the user wireless infotainment access experience in practice. To this end, we have undertaken an empirical study placed in a 'real-world' setting, in which participants undertook typical infotainment access tasks on three different wireless-enabled mobile devices: a laptop, a Personal Digital Assistant and a Head Mounted Display device. Results show that, with the exception of participants' level of self-consciousness when using such devices in public environments, the user wireless information access experience is generally unaffected by device type. Location was shown, though, to be a significant factor when users engage in tasks such as listening to online music or navigation. Whilst the interaction between device and environment was found to influence entertainment-related tasks in our experiments, the informational ones were not affected. However, the interaction effects between device and user type was found to affect both types of tasks. Lastly, a user's particular computing experience was shown to influence the perceived ease of wireless information access only in the case of online searching, irrespective of whether this is done for primarily informational purposes or entertainment ones.

KEYWORDS

Personal Digital Assistant, Head Mounted Device Wireless information access, Context-dependent searching

1. INTRODUCTION

Portability, convenience and affordability are all factors behind the increase in take-up of wireless devices. Improvements in technology, especially in respect of computational processing capabilities, together with the homologation of the IEEE 802.11 family of wireless networking standards have pushed the barriers of anywhere / anytime information access.

While the allure of ubiquitous information access still has novelty appeal, it is unlikely that appeal *per se* will still be enough in the future to sway customers to adopt such technologies if the expected *infotainment* (i.e. combined information and entertainment) return is not going to justify the initial outlay. However, whilst research in the area has focused on themes such as usability, multimodal interaction and haptics (Buyukkokten et al., 2000; Fulk, 2001; MacKay, 2003; Waycott and Kukulska-Hulme, 2003; Yue et al., 2006), the field of context aware computing has primarily concentrated on application-centred issues (Nylander et al., 2004), as well as personalisation (Chandrasekaran and Joshi, 2002; Hinz, Fiala and Wehner, 2004) and adaptation based on location and device (Hodes and Katz, 1999; Satyanarayanan M, 1996; Zhang and Ma, 2004). Nonetheless, comparatively little work has been done examining the user mobile infotainment access experience when this is mediated by different devices – which is the precise issue we address in this paper. Moreover, we adopt a “real-world” approach in our study, in that the experiments on which it is based employ people in realistic contexts engaged in everyday infotainment access tasks. The “real-world” experience is one which has been overlooked by researchers; by making it the focus of our study, we hope to offer new insights into what it actually means to access mobile infotainment content in practice, and not in artificial, unrealistic settings, as is the case with prevailing research. At the end of the day, the overwhelming majority of infotainment access does take place in such “real-world” contexts, and it is the user experience of such access that must be explored in order to ensure that it is one which is perceived as enjoyable/useful and, thus, capable of enduring when the novelty appeal of mobile infotainment access wears off.

The structure of this paper is as follows: Section 2 presents an overview of mobile information access devices, while Section 3 reviews work done with respect to user experiences of mobile computing. Such work provides the foundation for our project, whose experimental method is described in detail in Section 4. Whilst Section 5 presents the results and implications of our study, Section 6 draws conclusions and identifies possibilities for future work.

2. MOBILE INFORMATION ACCESS DEVICES

Although there are a plethora of available mobile devices, in this paper we shall concentrate our attention on those that can access the World Wide Web wirelessly. As the Web is the largest repository of networked information, it is no surprise that we view “accessing information” and “accessing Web information” synonymously in this paper. Accordingly, we give an overview of such devices, with an emphasis on the ones considered in our study.

2.1 Laptops

Laptop technology emerged in the late 1980s and hit mainstream computing in the 1990s. Initially, similar to the case of other mobile devices, laptops were beset by issues of bulk and weight, and had comparatively less resources – from memory and processing power viewpoints– than their standalone counterparts.

It is only relatively recently, however, with the advent of 3G and WiFi technology that laptops have been able to harness the full potential of the Web wirelessly. Thus, a study on evaluation of clinical response to wireless technology by Seckman, Romano and Marden (2001) focuses on measuring perceived usefulness, easy of use and impact of wireless technologies. Their results show that the nurses were the most frequent users of the wireless laptops, with 86.9 percent, and staff feedback show that the new technology is easy to use with no interference with medical devices. From another viewpoint, Rodriguez et al (2003) compared PDA and laptop based versions of a nursing documentation application. In the study, both of the devices were wirelessly connected to the hospital mainframe system to enable collecting and entering patient's data at the point of care. 18 staff nurses participated in the study, selected from local teaching hospitals. They had no prior PDA experience, and their computer literacy ranged between 0.1 and 20 years. The results of the experiment showed that it took nurses less time to look for vital signs measurement and acknowledge a pending medical order on a PDA. However it took them less time to read text and enter the vital sings measurements on a laptop.

On the other hand, from an applied computing aspect, Chu and Ganz (2004) examined a portable teletrauma system that assists health-care centres in pre-hospital trauma care. In this study, simultaneous transmission of patient's video, medical images and electrocardiogram signals, which is required though the pre-hospital procedure, is demonstrated by coupling a laptop computer with a commercially available 3G wireless cellular data service. The evaluation of the system revealed that the tool has the potential in reducing patient mortality when it is used by emergency services personnel to provide immediate care to the patient. However, the quality of the images and video transferred is reduced significantly due to the jitter and the delays caused by 3G wireless network (CDMA) limitations.

2.2 Personal Digital Assistant

Personal digital assistants (PDAs) probably exhibit one of the most popular and easily recognisable showcases of portable computing, manifesting a 28% market growth in Western Europe in the second quarter of 2004 (IDC, 2004). Nonetheless, they do inherit issues typical of mobile devices, such as small screen size, slow input facilities, low bandwidth, small storage capacity, limited battery lifetime and relatively slow CPU speed (Buyukkokten et al., 2000; Fox et al., 1998; Fulk, 2001)

The apparent contradiction between the increasing popularity of PDAs and the above enumeration of problems have made PDAs a popular area of research. For instance, the Power Browser (Buyukkokten, et al., 2000) was created to provide easy navigation in complex web sites using small screen mobile devices. Here, a proof-of-concept application implemented on a Palm operating system PDA uses an HTTP proxy that receives the requests from the mobile user and, based on the request fetches of the user, dynamically generates a summary view to be transmitted back to the client. These summary web pages contain both link structure as well as the contents of the set of web pages being accessed. Top Gun Wingman (Fox et al., 1998) is another transcoder targeted for the Palm operating system PDAs. Although similar to the Power Browser, this application not only provides ease of navigation but instead also converts the pages, images, and files (Zip / PalmDoc) to a browser-specific suitable format.

In a more recent study, Dong, Waters and Duffy (2005) compared two one-hand access methods on a PDA. The experiment conducted with 20 participants asked users to navigate through three types of map (road map, subway map and street map) using tilting and tapping method and evaluate the effectiveness, efficiency and preference of the users. The results of this study indicated that neither method was significantly more effective, efficient, or preferred by the evaluators.

From different perspective, Duh, Tan and Chen (2006) compared laboratory and field mobile usability tests effectiveness by employing 10 participants per setting. The findings of this study shows that the field tests reveals much more types of usability problems that the ones conducted in an laboratory environment. The study also shows that users' behaviour is more negative and takes longer time to perform a task in the field environment, which causes dissatisfaction and unveils the real usability problems encountered in practice, thus providing further support for field studies – the approach adopted in our work.

Another field based study was undertaken by Knoche and McCarthy (2005), who examined the interaction and delivery requirements for Mobile TV. This study compared the traditional TV feature with the Mobile TV service that was implemented as part of this study. The comparative study was conducted on four participants in a real world environment using Digital Video Broadcasting for Handhelds (DVB-H) technology. Three out of four users of this service were happy with the features of digital TV and they would watch live TV on their handsets. Importantly, the findings also showed that all of the participants were willing to pay for such a service.

TV-Anytime (TV-Anytime, 2003) applications allow users to access their profiles remotely with a wireless-enabled PDA (Kazasis et al., 2003). Here logged in users can search an online database for relevant television programmes, documentaries and movies and download to their home appliances. Using the application, previews of programmes can be watched online. Moreover, the user can set the length of the clip according to the network bandwidth and battery lifetime of the particular personal digital assistant employed.

2.3 Head Mounted Devices

Head mounted displays (HMDs) are a sub-set of wearable computer technology, which aim to allow hands free access to computer functionality. They consist of two canonical displays, and usually comprise either two liquid crystal display (LCD) or cathode-ray tube (CRT) screens that are either mounted on a helmet or on a glasses-frame structure.

HMDs can be either binocular, showing the same image to both eyes, or stereoscopic in nature, showing different images to each eye. The choice between binocular or stereoscopic depends on whether three-dimensional interaction or presentation is required. Moreover, HMDs use a range of display resolutions. It is important to remark, however, that a trade off exists between the resolution used and the field of view, which in turn impacts the perceived level of experienced immersion. A low field of view decreases the experienced level of user immersion, yet a higher field of view involves spreading the available pixels, which can cause distortion on the picture.

It should also be noted that ergonomic and usability factors vary considerably between different devices, with issues such as display size, weight and adjustability of physical and visual settings all affecting the usability of a particular head-mounted display for any specific task (Bowman et al., 2002). Additionally, the large and encumbering size of CRT-based HMDs is also an identified obstacle towards their adoption (Lantz, 1997), as is the current high cost of HMDs that display both high resolution and a wide field of view. Indeed, the fact that HMDs afford the user the experience a high degree of visual immersion, yet in everyday life a user's field of view is limited, has been shown to be an inhibitor in their popularity, rather than a contributing factor. Moreover, from a medical perspective, the weight of HMDs has possibly detrimental implications on the supporting muscles and even on the eyes, with issues of hygiene also being singled out as possible deterrents to the proliferation of HMDs.

Nonetheless, despite the computational costs and usability drawbacks of the head-mounted displays, they are widely used in current research, ranging from virtual environments to wearable Internet applications. Thus, the Smart Spaces (Pablo Research Group, 2002) project promises to implement anywhere / anytime automatic customisable, dynamically adaptable collaboration tools. In order to achieve these goals HMDs, smart spaces, augmented reality and ubiquitous information access devices are being used. The main driving force of this research is information access anytime / anywhere, whilst the user is engaged in other tasks.

Hitachi is also involved in the implementation of wearable Internet appliances, targeting both industrial users and consumers. The aim of the WIA (Wearable Internet Appliance) project is to provide mobile Internet and resource access using HMDs (Ebina et al., 2002). Here, industrial users can employ HMDs to communicate between colleagues as well as to access company databases and other centrally stored information (diagrams, equipment explanations) relating to their work.

Whilst such application-oriented research is attractive, the emphasis of our study, though, is on the user experience of mobile information access, when it is being mediated by different access devices. Accordingly, in the next section we provide an overview of work in the area.

3. MOBILE INFORMATION ACCESS AND THE USER EXPERIENCE

Since the first GSM (Global System for Mobile Communications) system started operating in 1991, mobile information access and mobile services have represented one of the most vibrant research areas in telecommunications (Collesei et al., 1994; Peersman et al., 2000). Today, GSM-based information access services are already being used for medical (de Azevedo et al., 2003), business (Friel and Kilmartin, 1998) and entertainment (TheRegister, 2004) purposes. However, the latest advances in hardware and networking technologies have pushed researchers in the direction of seamless and pervasive information access, a direction ultimately affecting the way of life of the individual and resetting industry standards.

One of the main issues in mobile information access is content tailoring. Work done in this area includes that of Freire et al. (2001), who developed WebViews, an application which performs transcoding of traditional web content so that it could be accessed via mobile devices. Here, the user creates views of any web content that (s)he would like to access on-the-move and saves them into his/her profile. The WebViews server then reformats the profile contents and sends the data to the requesting mobile device (PDA, WAP-enabled phone or mobile phone) accordingly. Similarly, in MobileIQ, Chandrasekaran and Joshi (2002) also used profile-based transcoders to look into issues like mobility management, disconnection management, content personalization, bandwidth utilization, download latencies and user privacy. Their findings highlight that the use of transcoders for mobile information access purposes is generally expensive to implement for multiple users and inefficient in most cases due to malformed code which requires manual parsing of the HTML data.

From a different perspective, Pospischil, Umlauft and Michlmayr (2002) designed a mobile tourist guide for Universal Mobile Telecommunications System (UMTS) technology. The implemented application provides a map of the inner city of Vienna in two zoom levels. Popular sights and tourist attractions are identified on the map as points of interest (PoI) and each one of them are linked with further textual and multimedia presentations. There are three scenarios that this system can be useful in: information retrieval about the sights, city guide, tour diary compiler. In the first scenario, prior to actually walking through the city, a user may plan the sightseeing tour using the map and the PoIs provided. In the second scenario, the system identifies the location of the user and guides him/her to the next location using multi-model (audio/video) interaction methods. Thirdly and finally, the application compiles a tour diary in daily bases so that the users can share their experiences with others.

Similarly, Amendola et al. (2004) implemented an agent-based expert tourist guide for mobile device users. The prototype provides accurate information to the user by filtering it based on four different factors: the current *location* of the user; the *device type* that the user interacts with; user preferences and interests, saved on his/her *profile*; and the real-time *context* information (e.g. current time, current day, static/on the move). In a real life scenario, the user requesting information from this system receives information based on his/her location, device type and preferences (e.g. the restaurants listed according to their distance the user's current location and ordered within based on his/her choice of cuisine).

Another important issue in mobile information access is the associated user experience. From this aspect, Muñoz et al. (2004) studied the use of context-aware handheld systems in hospitals. The implemented system attempts to manage the hospital information flow using Internet messenger (IM) paradigm and by getting the support of context. The contextual elements used by the system are location, delivery timing, role reliance and artefact location and state. Using this system, with the support of IM-like approach on a handheld device, the doctors, nurses and support staff can share information about the patients between their colleagues in the same shift or other shifts. The evaluation of the system, by 28 hospital staff members, showed that 91 percent of the participants would use the system. Additionally 84 percent believed that using the system would enhance their job performance and 78 percent perceived that the system would be easy to use.

In related work, the user experience of mobile presence was explored in the PePe Field study (Lehikoinen and Kaikkonen, 2006), in which twelve users were asked to name, share and use location information. Results revealed that automatically updated location information was, from a user perspective, the most important presence attribute.

The impact of different mobile information access devices on the user experience was explored by Buranatrived and Vickers (2004), and by Gulliver et al. (2004). Whilst the former focused on the impact of tasks in a simulated wireless environment, the latter study explored the perceptual impact of variable multimedia quality when it is being mediated by different access devices. Interestingly, both studies concluded that the ease-of-use and perceived multimedia quality, respectively, are not affected by device type.

To the best of our knowledge, however, no work has been done exploring how a user's experience of mobile infotainment access is affected by the different access devices that (s)he is utilising when this takes place in a real world setting. By undertaking such practical research, it is our intention to gain a better understanding of factors that actually affect mobile infotainment access in a realistic context and, in so doing, paint a clearer picture of the user experience in such settings. We now proceed to detail the methodological approach adopted.

4. EXPERIMENTAL METHOD

4.1 Participants

Participants in our experimental study were aged between 18 – 53 years old and were drawn from blue and white-collar professionals, as well as from the UK higher education bodies. A total of 144 people volunteered to participate in the study. None received any remuneration for participating; however they all were offered a cup of coffee of their choice, as part of the experiment.

Participants were grouped according to their computer knowledge in 3 main groups – *novice, intermediate,* and *advanced* (Table 1). This categorisation was based on the participants completing a short questionnaire (prior to beginning the experiment proper) that assessed their computer abilities and expertise.

Computer knowledge		
Do you regularly use electronic mail (e-mail)?	Yes ☐	No ☐
Do you regularly use search engines (Google, AltaVista)?	Yes ☐	No ☐
Do you regularly use word processing applications (Ms Word, WordPerfect)?	Yes ☐	No ☐
Do you regularly use spreadsheet applications (Ms Excel, Lotus)?	Yes ☐	No ☐
Have you ever successfully installed software on a computer?	Yes ☐	No ☐
Have you ever written and successfully run a computer program?	Yes ☐	No ☐
Do you know how much RAM your computer has? (amount orally)	Yes ☐	No ☐
Do you know what a USB port is? (mention orally)	Yes ☐	No ☐

Table 1: Computer knowledge questionnaire

Here, participants who only answered 'yes' to either of the first two questions were deemed to be novices, whilst those who answered affirmatively to the first two questions and at least one of the following two were considered to be of intermediate expertise. Users who were of intermediate status were ‘upgraded’ to advanced expertise only if they answered positively to the last four questions (and gave correct oral answers to the last two; oral answers were solicited for the last two questions in order to ascertain participants’ understanding of computer technology).

4.2 Experimental Variables

Experimental variables in our study included: device type, computer expertise, user location, and task group type. Accordingly, our study incorporated three different types of mobile access devices – a laptop, a PDA, and a head mounted device – all of which boasted varying information display capabilities, as shall be described in section 4.3 and varying degrees of portability (these range from a relatively bulky laptop, to a handheld PDA, to a wearable HMD). As mentioned above, three levels of computer expertise were considered in our study. The experiment took place in two different settings – one was an ‘on-the-street’ setting, in which participants accessed information whilst physically being on a busy high street bench; the other was a ‘coffee shop’ setting in which participants accessed the Web from a café. Lastly, as part of the experiments, users were asked to perform two groups of tasks, each of which reflected one of the main reasons behind users’ wishes to access Web material– accordingly, one group of tasks was mainly informational in nature, whilst the other was entertainment-related, both of which will be described in more detail in section 4.4.

Data was analysed with the Statistical Package for the Social Sciences (SPSS) for Windows version (release 11.5.0). A Multiple ANalysis Of VAriance (MANOVA), suitable to test the significant differences of three or more categories, and the t-test, suitable to identify the differences between two categories (Stephen and Hornby, 1997), were applied to analyse participants' responses. A significance level of $p < .05$ was adopted for the study.

4.3 Experimental Material

Three different types of devices were used in our experiments. The first was a Hewlett Packard laptop equipped with a 54Mbps Netgear PCMCIA wireless network card. The laptop ran the Microsoft Windows XP operating system, and was equipped with 128MB RAM, a 15-inch screen transflective thin film translator (TFT) screen and a 910 MHz Mobile AMD Athlon XP 2000+ processor (Figure 1a). In our experiments, the laptop represented mature technology.

The second device, a representative of 'contemporary' technology, was an HP iPAQ 5450 PDA with a 16-bit touch-sensitive TFT LCD that supports 65,536 colour. The display pixel pitch of the PDA device employed is 0.24 mm and its viewable image size is 2.26 inch wide and 3.02 inch tall. The device incorporates WiFi 802.11b connectivity as standard and runs the Microsoft Windows for Pocket PC 2003 operating system on an Intel 400Mhz XSCALE processor.

The third and last device employed in our study was an Olympus Eye-Trek FMD 200 head-mounted display, and was considered as a representative of technology of the future, due to its relative novelty, incipient take-up and easily availability through high street electronics shops. Accordingly, the HMD employed in our study used two LCD displays, each one of which contains 180.000 pixels with a viewing angle of 30.0° horizontal and 27.0° vertical. It supports PAL video format and has a display weight of 85g (Figure 1b). Although the HMD by itself is not wireless enabled, it was interfaced via a Lifeview Fly Jacket with the PDA employed in our study, and thus connectivity was ensured.

4.4 Experimental Set-up

Our study involved real participants engaged in real-life tasks in realistic scenarios. Accordingly, as previously mentioned, participants undertook two main tasks, the first of which was mainly informational in nature and involved a mixture of physical and digital searching. This involved users searching for their nearest shopping centre on the Web, and then locating sports stores in the centre, also via the Web. Once this was done, participants had to physically go to the identified sports stores (there were two) and had to obtain price information on a specific good (a sports shoe, in our case), Once this was done, participants had to find the corresponding price for the good over the Web and e-mail the cheapest price found to a friend via e-mail.

The second task was mainly entertainment-related. This comprised users listening to a mainstream online radio station, noting down the details of the track currently being played and then searching for the album cover of the respective track on the Web. Once this was done, users were asked to download the cover on their device for future reference in a music store.

These two tasks were undertaken in two different real world environments, reflecting situational contexts that users might find themselves in during their everyday activities. The first involved users accessing the required information needed to fulfil their tasks on a busy high street bench, whilst the second involved users undertaking the same set of tasks in a comparatively secluded café. Both locations were covered by WiFi blankets.

a) b)

Figure 1 a) On-the-street scenario using a laptop; b) Coffee-shop scenario using an HMD

The 144 participants involved in our study were evenly assigned to one of the two environments (‘on-the-street’ and ‘coffee-shop’) in which our experimental study took place. Moreover, participants were also evenly distributed as far as the use of the three experimental devices is concerned, with 48 participants being allocated for the laptop, PDA and HMD, respectively. Lastly, care was taken that each device should be used by an equal number of novice, intermediate and advanced computer users.

4.5 Experimental Process

Before undertaking the experiment, all participants were verbally explained that the experiment consisted of two main groups of tasks (Figure 2 and Figure 3), which they should accomplish at their own pace. Once this was done, they were given the respective experimental devices they were to use towards the accomplishment of the tasks. Although users did not need to log on to any of the devices, they were given the user name and password needed to log on to the wireless internet service provider employed in the study.

Participants were then asked if they would like to order a coffee. For participants in the ‘on-the-street’ scenario a ‘to-go’ coffee was ordered in the nearest café and brought to them, whilst for those in the ‘coffee-shop’ setting the order was delivered at the participants’ respective table.

Inf1: ***Connect to the Internet using the device provided.*** *Inf2:* ***Go to the* www.askjeeves.co.uk *website and search for shopping centres in the area.*** *Inf3:* ***Open a shopping centre’s web page and find its interior map and identify the sports shops within.*** *Inf4:* ***Find the cheapest price for* Adidas Tuscany *from the local shops.*** *Inf5:* ***Search on the Internet and compare the online prices with the prices in hand.*** *Inf6:* ***Send the cheapest price available to a friend via email***

Figure 2: Group of information-related tasks

Ent1: ***Logon to*** www.virginradio.co.uk ***web site.*** *Ent2:* ***Tap on the appropriate button on the website and start listening to the stream.*** *Ent3:* ***Listen to online radio.*** *Ent4:* ***Note down the singer and the title of the song that is currently playing.*** *Ent5:* ***Use the details to search for the album cover on a music market web site of your choice*** *Ent6:* ***After finding the album cover, download the image file to the mobile device for future use in the music store.***

Figure 3: Group of entertainment-related tasks

For each of the tasks involved, participants were asked to indicate their opinions on a 5-point Likert scale (*strongly agree, agree, neutral, disagree, strongly disagree*) to a series of seven statements concerning the tasks at hand (Figures 4 and 5). Once this was accomplished, users could indicate in writing any further comments that they had about their experience. Lastly, participants were thanked for their time and effort.

Q1: It is easy to logon to the Internet.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q2: It is easy to navigate through search results on the device.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q3: It is easy to find sports shops in the malls near to you.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q4: It is easy to read maps on my device.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q5: It easy to find online prices of the product and make a comparison.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q6: It is easy to send e-mails.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q7:I am comfortable using the device in a public place	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

Figure 4: Information-related tasks questionnaire

Q1: It is easy to navigate through the *Virgin Radio* website.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q2: It is easy to listen to online radio.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q3: It is easy to identify the track that is playing.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q4: It is easy to interact with the device.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q5: It is easy to do searches on the Web.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q6: It is easy to access information and save it on my device.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Q7:I am comfortable using the device in a public place	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

Figure 5: Entertainment-related tasks questionnaire

5. RESULTS

5.1. Device Impact

The MANOVA performed as part of our study revealed that, with the exception of four tasks, across the two scenarios of our study, the particular device type does not have a significant impact on the user information access experience. This observation holds true, even though, as Figures 6 and 7 show participant mean opinions scores for the HMD were (with only one exception) consistently lower than that of the other two devices considered in our investigation. The one exception to this trend is users' ability to identify the currently playing track on the visited online radio station – in the case of the HMD this was facilitated by three factors: the first is that the online radio site had a lite version tailored for PDA browsers (the HMD accessed the web through the PDA, as previously mentioned); moreover, in this version the details of the current track being played were placed on top of the page, in an instantly viewable location. Lastly, when the relatively small screen of the PDA was blown up to near full immersion size quality, the HMD users felt that they were actually being "hit" (actual words of three participants) with this particular information.

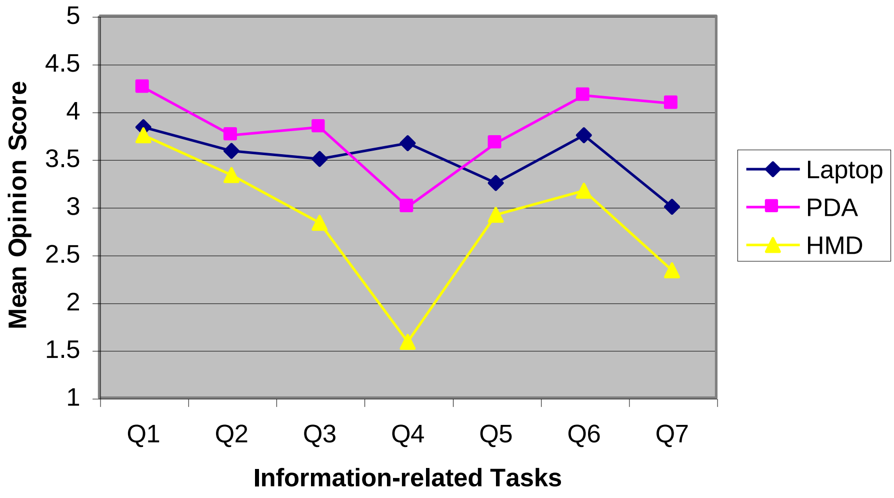

Figure 6: Device Type Impact on Participant Mean Opinion Scores for Information-related Tasks

The particular type of device employed was shown to have a significant impact on the user information access experience in the case of reading maps from the screens of the device ($F=9.420$, $p<.01$), and users' comfort factor with respect to using a mobile information access device in a public place ($F=6.492$, $p<.01$). We believe that reasons for the first finding is that most maps that people found online had virtually unreadable labels – this problem was exacerbated in the case of the small screen PDA, whilst in the case of the HMD, which did provide full immersion, this was done so at the expense of resolution. As far as the second observation goes, it should come as no surprise that participants who wore HMDs should feel particularly self-conscious in public places, as would those accessing information via relatively bulky laptops – people were most comfortable with using the PDA as an information access device in a public context, which might be one of the main drivers behind their popularity.

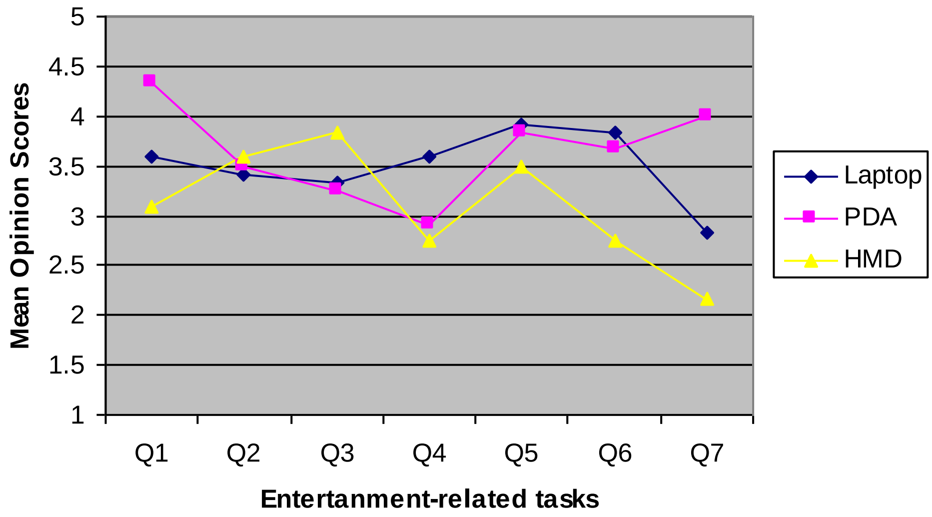

Figure 7: Device Type Impact on Participant Mean Opinion Scores for Entertainment-related Tasks

In the case of entertainment-related tasks, type of device was found to have a significant effect on users' navigation on the online radio website ($F = 4.295$, $p < .05$) and, again, on their comfort factor associated with using a wireless access device in public ($F = 7.869$, $p < .01$). Whilst we have already elaborated upon what we believe are the reasons behind the latter (and we can additionally remark that the relative ordering of comfort levels associated with the respective devices is the same in the case of entertainment-related tasks as in for the information-related ones), we believe that the reason for the former observation lies in the fact that many users found it difficult to navigate through a website using the point-and-tap functionality of the stylus whilst wearing the HMD – this contrasts markedly to the case where the same (adapted, lite) website was accessed by the PDA alone, for which users gave the highest ratings of all devices employed in our study.

Lastly, we remark that the finding that device type does not have a significant impact on most of the tasks used to characterise the user information access experience in our study is not totally unexpected. Indeed, it confirms and extends similar results obtained by Buranatrived and Vickers (2004) – in the case of only two mobile devices (a PDA and mobile phone), when users are engaged in purely informational tasks, accessed from a single location (a laboratory)

5.2. User Type Impact

Surprisingly, user computing knowledge has, with two notable exceptions, no significant impact on the mobile information access experience (Figures 8 and 9). The only exceptions to this observation were, in both the information-related group of tasks as well as the entertainment one, respectively, the users' perception of ease of conducting searches for pricing information ($F= 8.007$, $p<.01$) and on the Web, generally ($F=4.915$, $p<.05$).

Interestingly, it is *intermediate* users who perceive that Web-based searches are quite easy to accomplish, whilst, as expected, *novice* users encountered the most difficulties in searching for information, and rated the experience accordingly. Whilst the fact that *advanced* users found Web searching to be comparatively more difficult that their *intermediate* counterparts might appear at first sight to be counter- intuitive, our

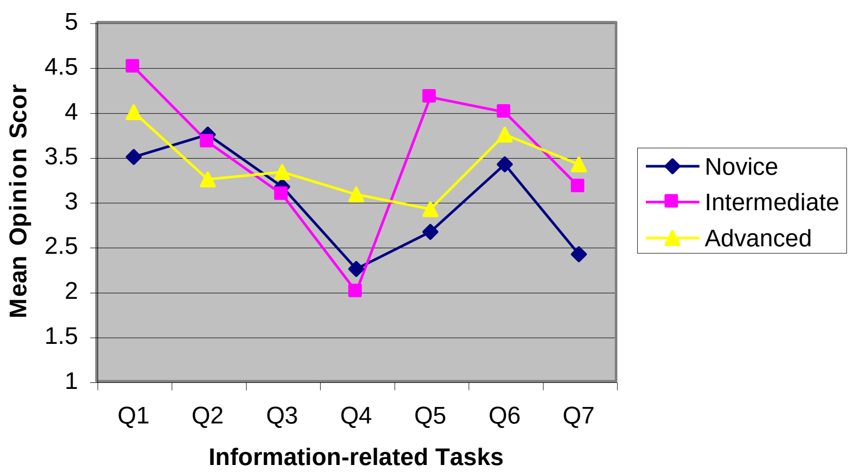

Figure 8: User Type Impact on Participant Mean Opinion Scores for Information-related Tasks

observations of the experiments highlighted that *intermediate* users were more flexible and prepared to experiment with different types of devices; this is in contrast to *advanced* users, who seemed to be constrained by their everyday searching idiosyncrasies, and seemed to regard their adaptation to different devices as an imposition.

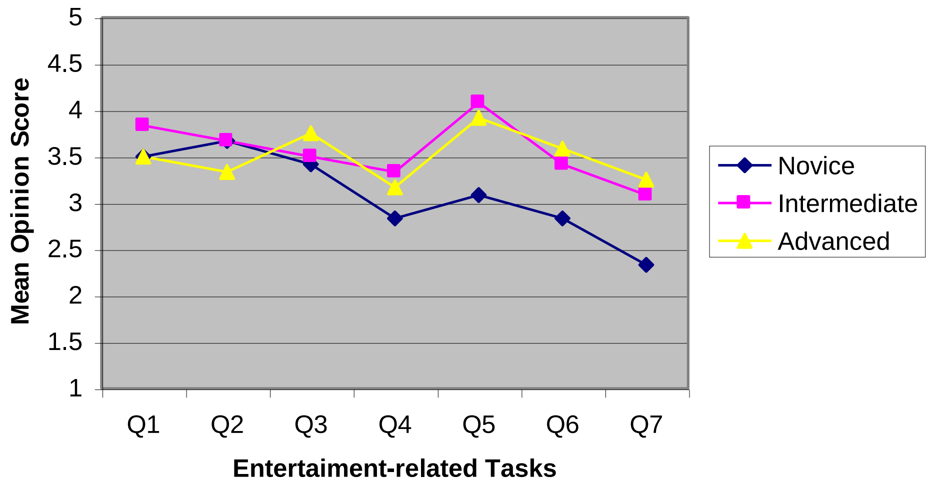

Figure 9: User Type Impact on Participant Mean Opinion Scores for Entertainment-related Tasks

Nonetheless, the particular computing knowledge of the user was found not to affect his/her perception of the mobile information access experience in the overwhelming majority of the tasks that our study comprised. This, in our opinion, reflects the success of Web designers in suitably tailoring content to a range of access devices, so that the experience of interacting with them is perceived to be relatively simple (most of the average scores for tasks are above the mid-level value of 3) and similar by different categories of users.

5.3. Location Impact

Our analysis revealed that, in the case of entertainment-related tasks, navigation ($F=14.331$, $p<.01$) and ease of listening to online radio ($F=11.824$, $p<.01$) were found to be significantly affected by user location (Figure 10). However, as far as the group of information-related tasks is concerned, no significant effects were found when taking the particular location of the user into consideration (Figure 11).

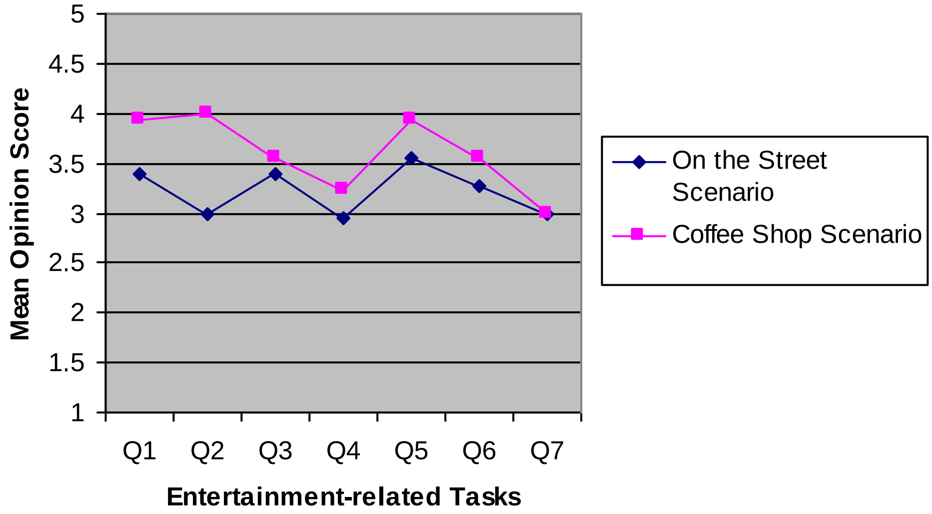

Figure 10: Impact of Location on Entertainment-related tasks

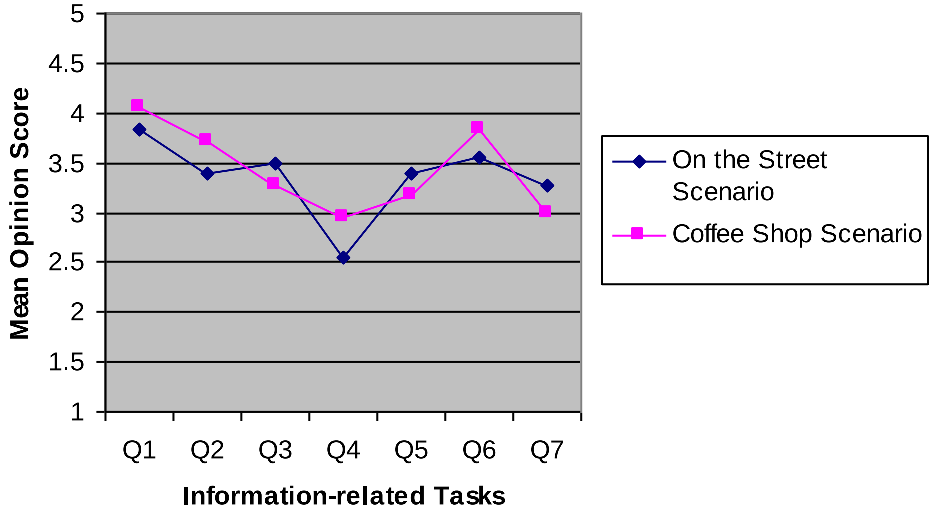

Figure 11: Impact of Location on Information-related tasks

These results highlight that when a user is engaged in accessing content for informational purposes, (s)he is prepared to disregard possibly detrimental environmental factors such as noise and lighting levels, as well as the proximity, in inevitably crowded shopping centres and high streets, to fellow consumers. However, when accessing entertainment related material, levels of lighting (brighter and sunnier in the 'on-the-street' scenario) affect the glare of the device being used, and, as such, negatively impact upon the user experience. Similar considerations apply to the case of listening to online radio – in the relative seclusion of a café the experience is perceived to be more enjoyable than when attempted in a busy and noisy outdoors environment.

5.4. Infotainment Impact

Most Web users access content comprised somewhere on the infotainment spectrum – and in this empirical study we wanted to investigate whether a user's perception of ease of information access varied significantly between situations in which one was engaged in primarily informational-related tasks and those where wireless Web access was done for predominantly entertainment purposes.

Analysis of our results revealed, however, that there were no significant differences in users' perceived ease of information access between the two main categories of tasks considered in the study (Figure 12). Although we are surprised at this finding – for we were expecting user tolerance levels to be higher in the informational-related tasks – we believe it highlights the fact that users have equally stringent expectations for both information- and entertainment-related tasks. Whilst in the former case, emphasis might be put on the quality of information retrieved, in the latter the focus might be on the quality of the playback media – whilst the emphasis might be different in the two scenarios, expectations are certainly not.

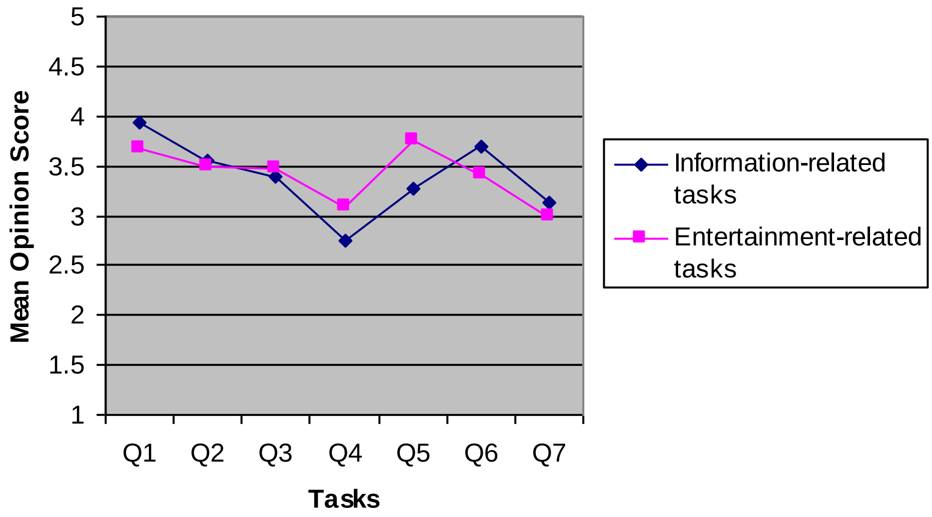

Figure 12: Information vs. Entertainment – the Impact on User Mean Opinion Scores

5.5 Interaction Effects

The MANOVA also revealed that there are significant interaction effects between the particular device used and the user type, with this combination of variables influencing user navigation and searching in both the information and entertainment related tasks of our study (Table 2).

Task Type	Question Number	Significance
Information	2	F=19.496, p<.05
Information	3	F=21.824, p<.05
Information	5	F=26.328, p<.05
Entertainment	1	F=19.573, p<.05
Entertainment	4	F=23.094, p<.05
Entertainment	5	F=28.719, p<.05

Table 2: Significant Interaction Effects: Device and User Type

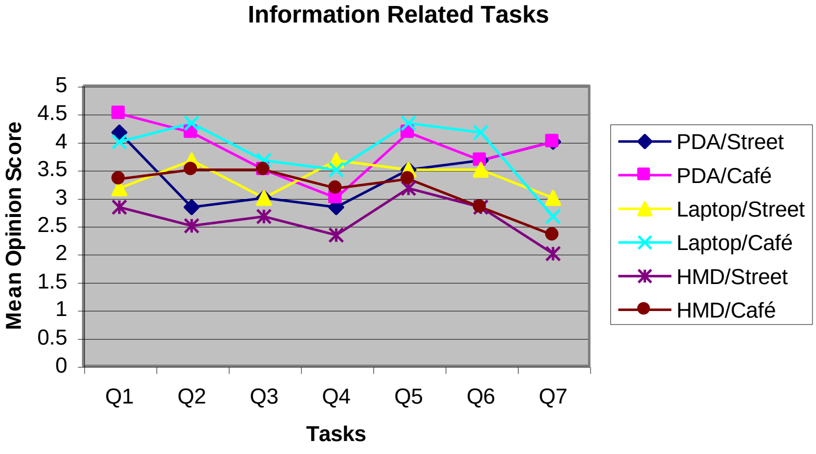

Figure 13: Information vs. Device/Environment – Combined Impact on User Mean Opinion Scores

Thus, our results, borne out by our observations, indicate that participants' experience in using computing metaphors and interpreting navigational and searching icons effectively can be severely tested when these are customised to particular devices. Whilst no significant effects were found when looking at the combined user type-environment impact, the MANOVA results highlighted that there was, for the majority of the entertainment-related tasks of our study, a significant effect on the user information access experience realised through the combined interaction between device type and environment (Table 3).

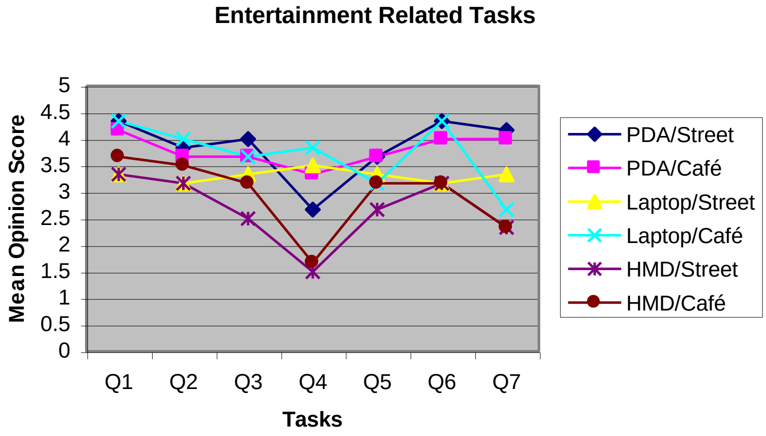

Figure 14: Entertainment vs. Device/Environment – Combined Impact on User Mean Opinion Scores

Thus, whilst, as expected, the lowest user ratings were given, across the board, in the case of the HMD used in the on-the-street setting (Figure 13 and 14), it is interesting to note that there is no significant device type-environment impact on the information-related tasks of our experiment, highlighting the discriminating nature of users when it comes to accessing entertainment material on the go.

Task Type	Question Number	Significance
Entertainment	2	F=22.108, p<.05
Entertainment	3	F=25.738, p<.05
Entertainment	5	F=23.667, p<.05
Entertainment	6	F=29.323, p<.05
Entertainment	7	F=25.426, p<.05

Table 3: Significant Interaction Effects: Device and Environment

6. CONCLUSIONS

The user experience of interacting with technologies and devices is an important driver behind their ultimate social acceptance and commercial uptake. In this paper, we have concentrated our attention on precisely this issue and explored the user wireless information access user experience, when this is mediated by three different access devices.

We have taken a field study approach to our work – an angle that is surprisingly often neglected by the main thrust of research in the area of mobile information access. Whilst related such studies have explored the user experience of mobile TV (Knoche and McCarthy, 2005), or the impact that one-handed use of a PDA has on map reading efficiency (Dong, Waters and Duffy, 2005) and the user experience of automatic location detection (Lehikoinen and Kaikkonen, 2006), we have investigated how this user experience is affected by the particular mobile access device employed.

Our results highlight that although mobile device types seem to heighten user levels of self-consciousness in public places – particularly if the device in question is a wearable one – generally the user information experience is unaffected by the type of wireless device responsible for it, a result in accordance with previous trends identified by Buranatrived and Vickers (2004) in their study of two mobile devices. Moreover, whilst user computing knowledge was found to influence searching activities in both an informational and entertainment context, this was an exception, rather than the norm. Ambient noise and light do impact on users' efforts to wirelessly access entertainment content; such factors, however, are ignored when informational content is sought, though.

We are aware of the limitations of our study – we sacrificed controlled laboratory conditions for ones in which the hustle and bustle of everyday life was all-encompassing; a larger sample size would certainly have been welcome, as would have a wider variety of infotainment tasks and wireless devices. Moreover, although we have explored real-world implications of physical context, other dimensions of context, such as the social angle, have remained unexplored in our work. All are certainly worthwhile avenues for future endeavours.

In concluding we note that, for the user, wireless information access holds both a promise and a challenge – a promise in that (s)he will be liberated from the tyranny of the wires; a challenge in that, in order to achieve this, future work will have to recognise that the user is not easily fooled: novelty appeal per se will not convince him/her to overlook deficiencies in the design of devices themselves nor of the content presented therein.

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