

Museum Shops: Experiences Gained from Developing Electronic and Mobile Commerce Solutions

¹Zafeiri Konstantina, ²Gavalas Damianos

Abstract

The phenomenal success of the web provides museum organizations an ideal medium for communication, documentation, promotion, advertisement, dissemination of cultural activities and marketing. Museum shops, which nowadays represent integral parts of the museums, have also a lot to benefit from a successful presence on the web arena. In addition to traditional web sites, carefully designed electronic commerce (e-commerce) sites may increase the potential of museum shops offering possibilities for on-line shopping and other commercial functions, such online ticketing and digital image libraries organization. In parallel, the recent convergence of the traditionally separate technologies of the Internet and mobile telephony has brought the concept of 'wireless Internet' into the spotlight. Within wireless Internet, 'mobile commerce' (m-commerce) is a relatively new trend that represents a natural extension of e-commerce into the wireless world. M-commerce refers to electronic business transactions and differentiates from e-commerce since it involves the use of mobile devices and wireless medium rather than wired. The unique characteristics of mobile computing bring forward new challenges and opportunities for museum shops, among other businesses. This article presents the design and implementation of an e-commerce and an m-commerce museum shop application. The aim is to evaluate and compare the two applications in terms of several parameters, such as available technologies, strengths and limitations, design requirements, usability, interaction speed, usage cost, etc and also to identify ways for enhancing the potential of such applications and designing successful and profitable business models.

Keywords

Museum shop, e-commerce, m-commerce, wireless Internet, WAP.

1. INTRODUCTION

Museums comprise heterogeneous institutions whose twofold functions of education and leisure may be significantly promoted from the usage of digital technologies (Economou, 2004, Hawkey, 2005). Such technologies encompass a wide variety of media, including multimedia, simulations and presentations as well as the internet. The usage of new technologies reveals new potentials for museums, such as digital documentation of exhibits or e-management and e-presentation of collections to the public.

Museums, at the most basic level, provide homes for objects. The range is vast, yet each object is linked by a conscious decision made on its behalf to be preserved, classified and displayed. Museum souvenirs solidify and materialize the experience of the visit. In turn, the museum store often features as souvenirs representative 'star exhibits' to immortalize and summarize the experience for the visitor. The visitor in the museum store, like the tourist, "is a consumer away from home" (Butler, 2005). Museum shops are integral parts of modern museums and in fact have become a destination within museums. As opposed to the often monolithic, overtly didactic and somewhat threatening impression given by the museum itself, museum shops offer

¹ Teacher of Computers, BSc in Informatics, MSc in Cultural Informatics.

² Assistant Professor in the Department of Cultural Technology & Communication, University of Aegean, Greece. BSc in Informatics, MSc & PhD in Electronic Engineering.

space for marketing and commercial exploitation. Shops' exhibits represent the contents of the museum, but in a manner that is accessible. The products of a museum shop have a different meaning and importance from any other shop product and represent an attempt to substitute cultural objects (Butler, 2005).

The success and popularity of the Internet and the web provides museum organizations an ideal medium for communication, documentation, promotion, advertisement and marketing. Museum shops have also a lot to benefit from a successful presence on the web ground. In addition to traditional web sites, carefully designed electronic commerce (e-commerce) sites may increase the potential of museum shops. The term e-commerce refers to any commercial exchange (delivery or transaction) of information, goods, services, and payments between entities (physical or not) over telecommunications networks (Turban et al, 2005). Usually, e-commerce is connected with shopping and sale of information, products or services. E-commerce activities include establishing and maintaining online relationships between an organization and its suppliers, dealers, customers and other agents related to (or in support of) traditional delivery channels. Other activities include product searches and comparisons by consumers, product information presentation and promotion by manufacturers and retailers, post-purchase customer support, communication between seller and shippers or banks and other activities that are not directly related to the transaction itself.

In the context of museums, the possibilities of on-line shopping and other commercial ventures, such a ticketing and digital image libraries organization, reveal new commercial potentials for museum shops. In particular with new technologies, the space of the museum shop has extended beyond that of a physical and tangible realm. With the Internet, the world's most pervasive and gratuitous consumer marketplace, the museum shop has found itself an electronic home in several incarnations. Almost all museum web pages have links to their own private online shops and for many of that, with these online resources, it is no longer necessary to even visit the actual museum.

Beyond the "traditional" e-commerce, a new type of commerce is growing in the last decade, the mobile commerce (m-commerce). Taking into consideration the tremendous growth in mobile telephony and the evolution of the handheld devices, technologies and applications are beginning to focus more on mobile computing and the wireless web. With the 'wireless internet' becoming reality, the idea of bridging the traditional e-commerce with mobile devices has naturally shaped up. M-commerce brings forth many advantages like: ubiquity (the use of wireless device enables the user to receive information and conduct transactions anytime, anywhere); flexibility (mobile devices enable users to be contacted at virtually anytime and place); dissemination (most wireless networks support the option of synchronized information transmission to the users); personalization (customized information is enabled, meeting users preferences, followed by payment mechanisms that allow for personal information to be stored, eliminating the need to enter credit card information for each transaction) (Keng et al, 2001).

Particularly in the context of museum shops, wireless technologies offer another option in the context of ticketing and on-line shopping. With the advent of these technologies, a museum shop provides more opportunities to its customers, especially to frequent travelers. The prospect of a family, on their way from the airport to a town, receiving information about the most intriguing museum exhibitions in town and buying tickets through a mobile device is a possible scenario of an m-commerce transaction.

The main objective of this article is to describe an e-commerce and an m-commerce museum shop application, in order to evaluate and compare the strengths and weaknesses of the two worlds in terms of several parameters: technologies involved, limitations, design, usability, speed interaction, cost, etc. To the best of our knowledge such qualitative comparison does not exist in the literature; furthermore,

although many e-commerce sites have been designed for promoting the products of museum shops, no such m-commerce application currently exists.

The basic research questions the paper attempts to address are the following:

- investigation of the feasibility of developing electronic commerce solutions in the context of museum environments for both PCs and portable devices users using state-of-the-art ICT technologies
- development and evaluation of two e-commerce and m-commerce prototypes using as a case-study a Greek Natural History museum
- comparison of the two prototypes in terms of several parameters, such as available, technologies, strengths and limitations, design requirements, usability, interaction speed, usage cost, etc
- identification of ways for enhancing the potential of such applications and designing successful and profitable business models.

2. THE USE OF INFORMATION & COMMUNICATION TECHNOLOGIES IN MUSEUMS

In the last few years there has been massive growth in the use of information & communication technologies (ICTs) technologies in museum environments, both onsite in the form of digital interactives, and online via the creation of ever-more popular websites.

Some applications such as databases and search engines make more accessible and more rapid tasks that were hitherto slow and tedious. Many replace previous earlier alternative or analogue versions – animation, audio, film, graphics, photography, television, video etc. Others facilitate essentially new activities that would otherwise be impossible; this is especially true of applications that create material on demand (Hawkey, 2005). ICTs have been widely used for educational purposes, to enhance the museum visitors experience or provide distant access to real or virtual artifacts:

- The world wide web provides access to a range of digital resources including online libraries, journals, databases and datasets through the internet.
- Multimedia materials may include graphics, pictures, photographs, animations, film, video, and sound in addition to text and can potentially support a variety of learning styles (Economou, 2004).
- Streaming digital audio and video delivered via the web can give access to real-life situations.
- Visualisation tools can represent complex sets of data in a visual way.
- Simulations and models allow interaction with and manipulation of real world environments. They permit field trips, experiments and other activities associated with a museum's collection and research that are otherwise impracticable for reasons of time, locality, safety or expense (Tsichritzis and Gibbs, 1991).
- Microworlds and games provide an extension of the simulation by incorporating a case study scenario. In these kinds of games, the learner participates directly as a virtual persona (an avatar) rather than as a mere observer.

The research work presented herein relates to the use of the web and wireless network technologies as means for communicating, documenting, promoting and advertising museum shops.

3. E-COMMERCE MUSEUM SHOP APPLICATION

The shop of the Natural History Museum of Vrisa (Lesvos Island, Greece) has been chosen as a case study to evaluate the characteristics and requirements of museum stores e-commerce sites. The target-group of the e-shop includes experts (e.g. scientists or students of geology and paleontology), individuals interested in

scientific books and the general public that wishes to learn more about the museum and its collection and purchase books, posters, cards or souvenirs.

The e-shop has been developed using osCommerce (osCommerce, 2006), an open-source platform for online e-commerce. osCommerce is a platform-independent tool that allows administrators of electronic businesses to easily install and maintain the e-shop with minimal effort and free of charge. osCommerce encompasses the following web technologies:

- the HTML (HyperText Markup Language), a markup language used to create documents on the web,
- CSS (Cascading Style Sheets), a technology that allows homogenous formatting of HTML documents,
- the PHP server-side web programming language (PHP, 2006), which enables the creation of web pages with dynamic content retrieved from a database,
- the MySQL Database Management System (MySQL, 2006), which stores data related to the e-shop's products, customers, orders, etc.
- the Apache web server (Apache Server, 2006).

When installed, osCommerce creates a default e-shop with pre-defined configuration, layout, design and functionality. Post installation, the user may modify this default e-shop either through an administrator tool or through modifying the HTML/CSS and PHP code to alter or enhance the e-commerce site's functionality. The administrator tool that accompanies osCommerce platform allows the administrator to:

- regulate parameters relative to the presentation of pages,
- add, erase or modify the products categories or individual products,
- specify what kind of information is presented for each product (such as weight, size, description, manufacturer, picture, etc.),
- insert special offers for some products,
- specify the available alternatives of payment,
- administer the records of clients that have signed in as customers of the e-shop,
- administer the catalogues of orders that have been conducted by customers,
- determine the languages in which the messages will be presented (the platform supports English, German and Spanish, however support for other languages may be added),
- view reports about what products have been purchased (and in which quantity) and who are the customers that have completed purchases.

Our e-commerce application has been implemented by taking advantage of the functionality offered by the osCommerce platform along with some modifications to the appearance and the context. The most important modifications made upon the default e-shop created through the platform's installation process are the following:

- addition of new categories, products and special offers,
- offer support for displaying messages and products information in the Greek language,
- changes on the design and layout of the pages,
- changes on the appearance of the header & footer of every page,
- changes on the title of every page,
- creation of a new logo,
- changes to the existing 'chromatic pallet' (to suit to the theme of a natural history museum), the layout of the headings and the links,
- changes to the left and right column that appear on every page, as well as the boxes included within them.

The abovementioned modifications have been performed either through using an HTML/CSS authoring tool (Macromedia Dreamweaver MX) or through altering the service functionality offered by osCommerce (addition / modification of PHP code).

The products of the museum shop have been classified in four categories: books, posters, souvenirs and cards. For each product, we have entered into the platform's database information that includes the product's name (in Greek and English), price, description, thumbnail photo and full-resolution photo. Special attention has been paid on maintaining low to moderate picture sizes (up to 12 KB for thumbnails, up to 300 KB for enlarged photos) to reduce pages download times. In addition, the original layout of the left and right column has been modified. Already existing categories (boxes) have been replaced by new ones that correspond to the requirements of a museum shop. Finally, a visual effect (animation) has been incorporated on the first page, created in Macromedia Flash MX 2004. The museum e-hop is accessible at (Vrysa's Natural History Museum, 2006).

Having loaded the first page of the application, the customer notices the functionality and services offered by the museum shop. At startup, the visitor may choose a language to continue the navigation. Below the box with languages, there are the boxes with main categories, new products, advanced search, and finally the box with information about payment and delivery method (see Figure 1).

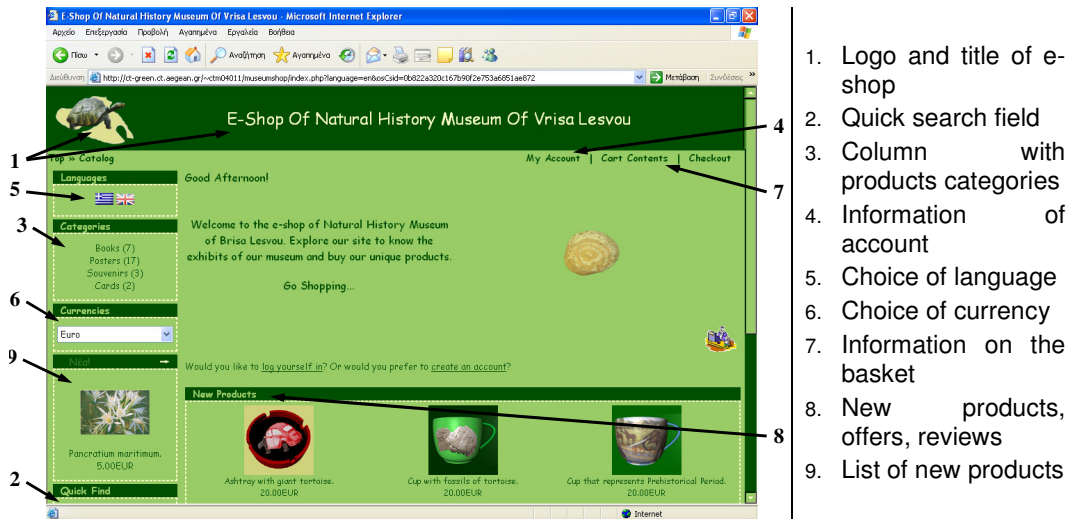


Figure 1: The main page of the e-shop

After selecting any product category, the corresponding list of products is retrieved and displayed. Having selected a product, the visitor may view the product's image, description, reviews, price, and orders that have been made from other customers. In case that the visitor desires to purchase a product, the site guides the customer until the order is completed. Some screenshot's of representative e-shop pages are shown in Figure 2.

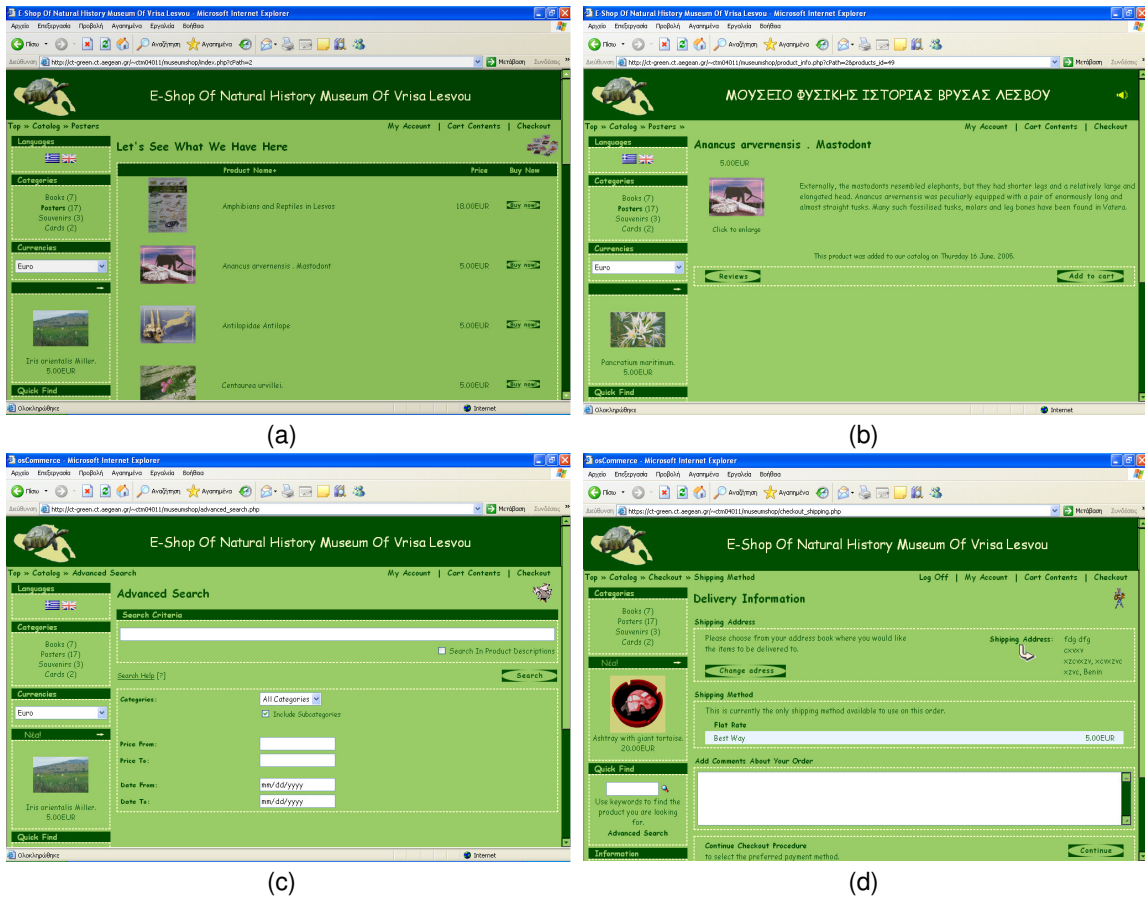


Figure 2. Screenshot from the museum shop's e-commerce application: (a) list of products for the posters category; (b) detailed information about a product, (c) products' search page; (d) delivery information for a specific order.

4. M-COMMERCE MUSEUM SHOP APPLICATION

The increasingly high penetration rate of mobile phones and the consequent exposure of subscribers to mobile technology raise high expectations for the adoption of mobile commerce. Today's available mobile devices cover a broad range and include mobile phones, laptops / notebooks, Personal Digital Assistants (PDAs), palmtops, tablet PCs, pagers, etc. M-commerce (also called mobile commerce or mobile e-commerce) is defined as a special type of e-commerce still performed over the Internet, however using mobile terminals and a wireless network interface (either a wireless LAN or a network provided by a mobile operator) (Keng et al, 2001, Lehner & Watson, 2001).

Among others, m-commerce offers the following services (Lehner & Watson, 2001): information and data access (news, city guides, maps, traffic, weather, etc.); transactions (banking, brokering, shopping, auctions, betting, booking & reservation, mobile wallet); entertainment (music, games, graphics, video); communication / interaction (short messaging, unified messaging, e-mail, chat rooms, video-conferencing).

Mobile and wireless network technologies witnessed exciting innovations in recent years and will continue to represent a rapidly growing sector in the foreseeable future. The increasing demand for mobile data communications has led to the deployment of 3G mobile networks, offering higher throughput and basic multimedia services together with voice capabilities. In addition, wireless Local Area

Networks (LANs) have also evolved rapidly, complementing the wireless networking landscape (Shim, 2006). Mobile and wireless network technologies offer the necessary network infrastructure for the growth of m-commerce technologies and applications.

In order to guide the global development of the new wireless applications, the leaders of the telecommunications industry formed the Wireless Application Protocol Forum (WAP Forum) (WAP Forum, 2006). In particular, WAP is an open, global specification that allows users to access Internet-type content via thin-client devices³, such as cell phones, pagers, PDAs, etc. The most common WAP-enabled devices are the so-called “WAP Phones”. The most recently approved specification is WAP 1.2.1 (June 2000), but WAP 2.0 is now available in and is under active review and validation by the Open Mobile Alliance (OMA) (Open Mobile Alliance, 2006).

The markup language used for WAP services is the Wireless Markup Language (WML) (Wireless Markup Language, 2006) which is similar to HTML. WML has been designed having resource-constrained handheld devices in mind (e.g. small displays and one-hand navigation without a keyboard or mouse). WML has a smaller set of markup tags than HTML. Unlike the flat structure of HTML documents, WML documents are divided into separate units of user interaction (termed “cards”) that are easily navigable with a micro-browser⁴. Figure 3 shows a WML page with dynamic content as it appears when loaded on the Openwave Phone Simulator (Openwave Phone Simulator, 2006).

```
<?php
// send wml headers
header ("Content-type: text/vnd.wap.wml");
echo "<?xml version='1.0'?>";
echo "<!DOCTYPE wml PUBLIC '-//WAPFORUM//DTD WML 1.1//EN' ""
. "'http://www.wapforum.org/DTD/wml_1.1.xml'">";
?>
<wml>
<card id="card1" title="Example 1"> <p>
  <?php
  // format and output date
  $the_date = date("M d Y");
  print $the_date;
  print "<br/>Welcome to a PHP-enabled site!";
  ?>
</p> </card>
</wml>
```



Figure 3: A WML page with dynamic content as displayed through the Openwave Phone Simulator

Despite consumers’ expectations, WAP has not yet met the adverts promise for a truly “mobile Internet”. However, WAP has gained remarkable acceptance mainly in Europe, but also in Japan. Some of the advantages of WAP are the following: WAP is an open, global specification; WAP is designed for thin-client devices; when compared to devices used for mobile Internet services, WAP enabled devices are smaller, less cumbersome, consume less power, and are usually less expensive.

However, WAP is considered a commercial failure, which is a direct consequence of its inherent weaknesses (Gavalas et al, 2006): most mobile devices are typically equipped with small display screens and require data entry by

³ Thin-clients are lightweight portable devices with limited computational, processing and display capabilities.

⁴ Similarly to the well-known Internet browsers which are compatible with the HTML standard, micro-browsers are lightweight browser applications, optimized for thin-client devices. WAP micro-browsers are those that «speak» (i.e. are compatible with) WML.

alphanumeric keypad strokes; WML supports limited text formatting and imaging; not many content providers offer content tailored to WAP phones, although the numbers are growing; WAP 1.x has been mainly operated over wireless systems wherein charges apply on connection duration basis. That has proved a major counterincentive since users were not keen on surfing the net with a tiny screen over unacceptably slow and overrated wireless connections (Kumar, 2003).

In addition to technological issues, usability issues appear in WAP applications due to the limitations of mobile devices. The current state of wireless technology poses many constraints for designing effective user interfaces for m-commerce applications. Small screen display, limited bandwidth and the simplistic, yet, diverse functionality of wireless handheld devices certainly affect usability. Considering all the above, the following solutions have been proposed to address these problems (Chittaro & Cin, 2001, Tarasewich, 2002):

- avoidance of scrolling, especially horizontal scrolling; scrolling, which can severely hinder users browsing behavior,
- usage of flat hierarchies (since every step takes longer on handheld devices, a flat hierarchical structure with fewer steps is preferred),
- design of a navigation system consistent with a regular web browser; this consistency enables users familiar with web browsers to transfer their browsing experience to mobile applications,
- provision of a "Back" button with the same function in a regular browser,
- provision of a history list that records the order in which hyperlinks have been traversed; the history list should present previously visited sites as a stack,
- design of an appropriate navigation system that brings users back to the data entry page after reviewing the codes, or provision of a help screen without leaving the data entry screen,
- search facilities; improvement on search precision by intelligent query support and predefined search options.

Regarding the design of a WAP application, the application should:

- be tested on different mobile devices, in order to ensure that the characteristics and functions are device-independent,
- incorporate small-sized graphics.

In order to gain in-depth understanding of the potentials that wireless networks offer to museum organizations, we have implemented a dynamic m-commerce application, 'parallel' to the e-commerce application introduced in Section 2 (i.e. the museum shop of the Natural History Museum of Vrisa has been used once again as a case-study). The application's content combines the usage of WML markup language and PHP technology. In the following paragraphs, we introduce and examine the application in terms of its implementation details, usability, services offered to the user, security, architecture, structure and data modelling aspects.

The technologies involved in the m-commerce application are the following: the WAP 1.1 protocol for accessing the e-shop's content through mobile terminals; the WML standard for formatting the e-shop's content; the PHP server-side programming language to enable dynamic creation of WML pages; the MySQL database management system to store data related to the e-shop's products, customers, orders, etc; the Apache web server.

The WAP site of the museum shop has been designed according to the usability guidelines listed above. The main usability features of the WAP application are:

- easy reading and browsing of information,
- multiple links that provide the user with alternative routes for locating the same information, thereby making the navigation easy and fast,
- limited number of pages with vertical scrolling,
- inclusion of a numbered list to the navigation menu items,
- small-size pages (up to 9.2 KB, including graphics),

- limited use of graphics to decrease download delays,
- inclusion of a “Back” button on every page with the same function as in regular browsers.

The main functions and characteristics of the WAP site are the following: provision of information for every product such as its title, description and price; implementation of a search engine for products search by title; display of the last five products added in the database of e-shop; user authentication (log in) page; implementation of a shopping cart, a personal area for users to store selected products; design of an order process whereby the customer, after confirming the shopping cart contents, chooses a payment method (snail mail / courier) and completes the order; offer of a help page and report for previous orders; administrator authentication (log in); design of pages used by the administrator to insert new products or update the information of existing ones, through a WAP phone or a desktop PC.

For the ordering process, user authentication is absolutely necessarily. The reason that this solution was preferred is that micro-browsers do not fully support cookies (a technology used in ‘traditional’ web interactions to identify the user that issued a request).

The interaction between the user and the WAP site goes as follows: the user of a WAP device enters the e-shop’s URL (web address) in the WAP device’s micro-browser. The micro-browser then posts requests to the WAP gateway. The gateway locates the site on the wired web, retrieves the requested page, encodes, compiles and forwards it to the user. The received data are then rendered for display by the mobile device’s micro-browser.

Regarding data modeling, we have designed a relational MySQL database system following a similar approach to the e-commerce application. Namely the WAP site’s database basically stores the same kind of data and includes information about products, product categories, customers, shopping cart contents, orders, etc.

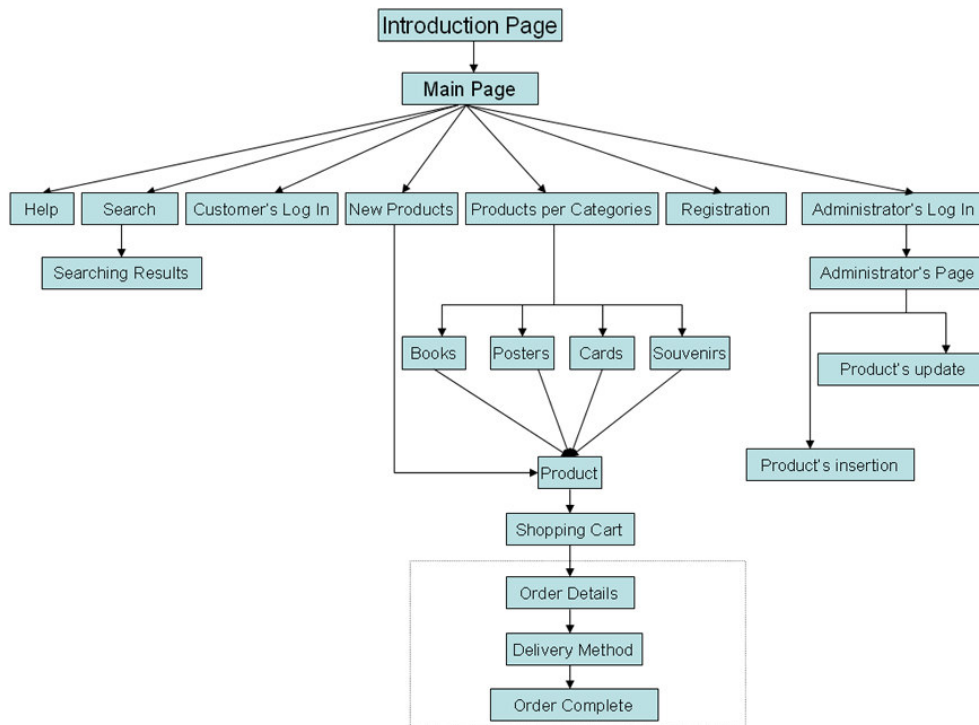


Figure 4: The structure of the WAP site

The following paragraphs describe different ways of user navigation in the WAP site of the museum shop. The Openwave Phone Simulator has been used to test and debug the application. The way a customer may navigate through the WAP site is illustrated in Figure 4. When a customer enters the WAP site, the introduction page appears that includes the logo of the museum (see Figure 5a,b). When selecting the 'ENTER' key, the customer retrieves the first page with the main navigation menu (see Figure 5c), through which he/she may choose to:

- enter as an authorized customer,
- register as a new customer to obtain username and password,
- get the last five products inserted into the database,
- browse products by category,
- search for products by title,
- ask for help.

The same navigation menu appears when user selects the "Options" key from the keyboard (see Figure 5d).

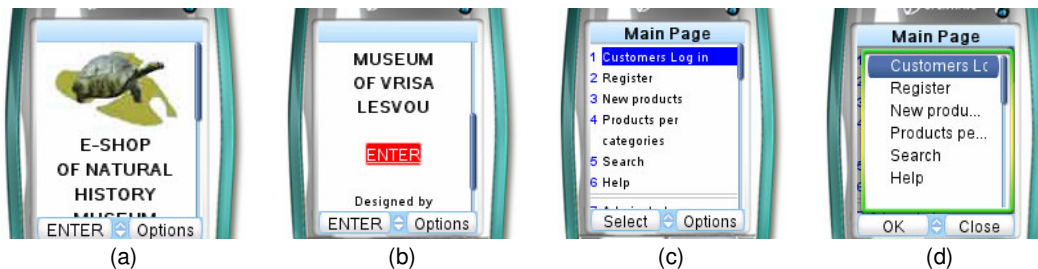


Figure 5: (a), (b) The introduction page, (c) the main page with the navigation menu, (d) selecting the 'Options' key through the keypad.

The user that wishes to enter the site as a customer is authenticated and needs to fill in his/her credentials in a login form (see Figure 6). Potential customers may sign-in through a registration page wherein they need to fill in their desired username / password pair and also their personal data (surname, name, address, etc).

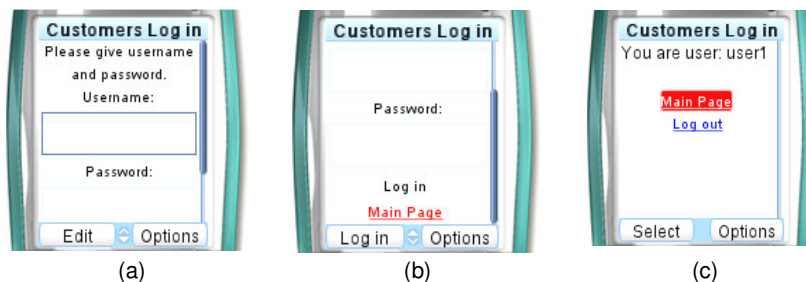


Figure 6: The log in process.

Thereafter, the user may: view the last five products added to the database (Figure 7a); view the main product categories (Figure 7b); select one of the main categories (books, posters, souvenirs or cards) to retrieve the corresponding products list (Figure 7c); obtain detailed information for a specific product (Figure 7d). Having loaded a product's card, the user may choose to add this product to his/her personal shopping cart (for customers only), or go back to the main page. If the user has not logged in, he/she is directed either to the log in or the registration page.

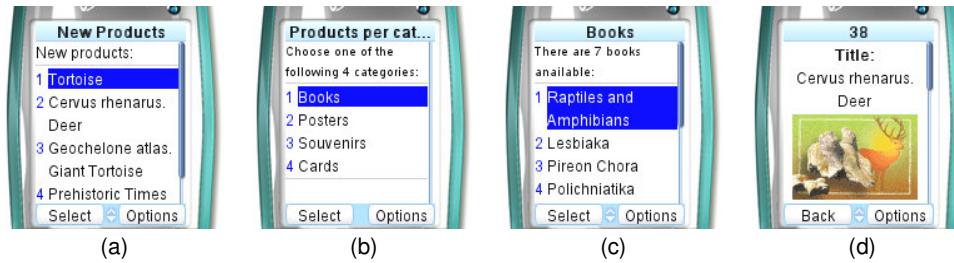


Figure 7: (a) The page with new product arrivals, (b) main product categories, (c) list of products in the 'books' category, (d) detailed information about a product.

In case of choosing to add the product to the shopping cart, a confirmation page appears (Figure 8a). At that point, the user may choose either to continue shopping or to issue an order. In the latter case, a page with the contents of the user's shopping cart appears (Figure 8b). The user may then delete a product from the cart or alter the quantity of any product. Following that, the user's personal information and preferred payment method is confirmed and the process of ordering is completed (Figure 8c).

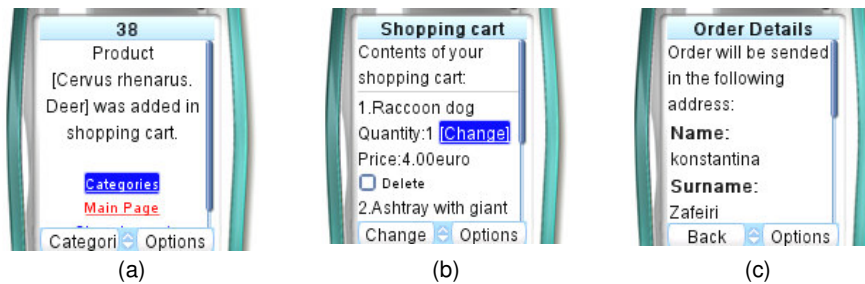


Figure 8. (a) Confirmation page of adding a product in the shopping cart; (b) the current contents of the shopping cart; (c) the order details.

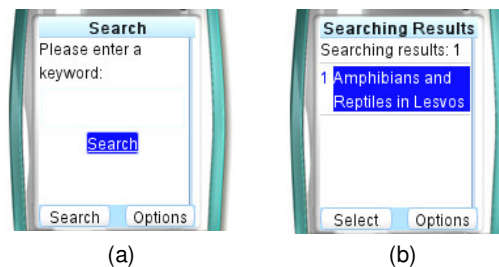


Figure 9: (a) The search page, (b) The page with searching results.

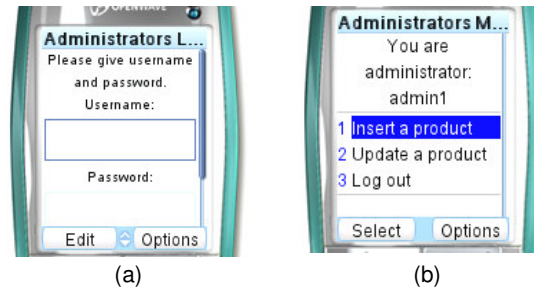


Figure 10: (a) The page with administrator's log in. (b) The main page for the administrators.

The user may also choose to search a product by title. After entering a keyword to search (Figure 9a), all relevant titles are displayed (Figure 9b). Finally, the administrator(s) of the museum shop, may login into the system (Figure 10a) and

load the administrator's page (Figure 10b), wherein they may choose among the following options:

- insert a new product to the database, along with the product's information;
- update the information of an existing product.

Summarizing, the design and implementation of the WAP site prototype has not been a straight-forward task. On the contrary, it proved more demanding and time-consuming compared to the e-commerce application. This is not only due to the lack of available integrated platforms (like osCommerce) that automate the development of m-commerce sites, but also due to the new programming challenges raised (e.g. lack of support for cookies) and the fact that application design requirements have been completely different thereby reducing the development speed even for experienced web developers.

In order to explain how the WAP site can be applicable, we mention the above scenario of use. A family on the way into town from the airport might not be certain about which of the city's attractions are likely to prove of the greatest interest. Through their mobile device and the portal operated by their WAP provider, they quickly come with a listing of museum exhibitions. It turns out that the most intriguing event is an exhibition that requires the advance booking of tickets. There is a separate allocation for out-of-town visitors. Since this requisite status is indicated by the phone number from which the WAP connection has been established, three tickets to the exhibition are bought, paid for, and stored in the telephone's memory a few minutes before the taxi pulls up to the museum door. The turnstile to the exhibition accepts the beamed tickets without further ado and beams back a voucher for the museum shop as thanks for having relieved museum personnel from handling the booking and admission process.

Another possible scenario would be the above: A palaeontologist who makes a research about the animals that lived in Alps might want to get information about a specific animal that lived also in Lesvos. For that reason, through a mobile device that holds, he attempts to buy on-line, through the WAP site, a book that gives all the information he needs.

5. EVALUATION AND COMPARISON OF THE E-COMMERCE AND M-COMMERCE SOLUTIONS

This section aims at evaluating and comparing the two above-described applications in terms of several aspects: technologies involved, limitations, design, usability, speed interaction, cost, etc.

E-commerce applications have different characteristics from applications designed for WAP devices. The main differences are summarized below:

- Usability: Navigation and data entry in a WAP site are far more complex than in a web site (Chan, 2002). Mobile devices are equipped with tiny screens, some of which display only three lines of text at once. The displays are black and white with low resolution. Mobile devices' keypads are less easier to use than PCs' keyboards. However, with the rapid penetration of mobile phones, users are getting familiar with that class of devices. On the other hand, PCs have a complete text input keyboard, large screen, substantial memory, and high processing power.
- Multimedia support: A web site usually includes a main page that may incorporate additional files (images, vides, animations, etc). In such case, the loading time of a page and the download times for external files are unacceptable for low-speed Internet connections. On the other hand, a WAP application uses one or more decks that contain a number of cards. Thus, the user can navigate from the one card to the other without changing the deck (i.e. without

downloading separate files every time the user switches from a 'page' to another). In addition, small screens in WAP devices (usually up to 150×150 pixels) restrict reading and graphic's appearance in comparison with PCs' screens (usually over 800×600 pixels). Moreover, changes in environmental conditions (brightness, noise, weather, etc) may have negative affect to the users of mobile devices. Difficulty in using mobile devices leads to loss of time which frustrates users.

- Technical restrictions: WML, used in WAP applications, poses more restrictions than HTML, the de-facto standard for web applications. WML only allows pages with plain text, tables, hyperlinks, colourless images, and data entry fields. On the contrary, HTML is designed for PCs with high resolution and color depth screens, equipped with mouse and hard disks. Besides, WML is restricted in the size of WML files (up to 1.4 KB), while such restriction does not stand for HTML pages. Moreover, mobile devices' users are required to be constantly connected to a mobile / wireless phone network (constant airtime) to have access to an m-commerce application. Thus, when a user is not within a wireless network range, having access to wireless services will not be feasible either. The same restriction holds on the Internet when a user desires to have access to a site.
- Interaction speed: Most WAP devices offer speeds up to 9.6 Kbps (in 2G networks). For that reason, a WAP application is based on plain text and low-resolution graphics. On the contrary, access to the Internet through a PC requires at least a modem with speed up to 56 Kbps. Therefore, an e-commerce application can be enriched with multimedia content, without increasing download delay and cost to unacceptable levels. In addition, recent researches have shown that WAP traffic differs considerably from web traffic (Ma & Irvine, 2004). Hence, without modifications a web application cannot be satisfactorily adapted to WAP. Even if page sizes decrease, the inter-arrival time will increase because of the increased reading time of every deck. Furthermore, the low potentials of mobile devices with respect to hardware discourage the incorporation of multimedia files in the applications. Even more recent mobile devices are inappropriate for the execution of demanding applications, due to the low available RAM memory (about 128-512 KB). On the contrary, the increased capabilities of PCs (~512 MB RAM for an average modern PC), allow the execution of resource-demanding applications.
- Usage cost: The high cost associated with accessing an application through a WAP device, prevents even simple and short navigations⁵. On the other hand, the cost for a 'wired' Internet connection is negligible, which increases the average time spent in e-commerce sites and, hence, the possibility of a customer proceeding to purchases.
- Development cost and speed: Certainly, the development of both e-commerce and m-commerce requires the engagement of experienced developers with sufficient understanding of related technologies. However, the use of specialized tools (such as osCommerce) that automate the development of e-commerce solutions implies their rapid development and deployment, hence minimal implementation effort and cost. On the contrary, tools for wireless web designers and developers are not yet widely available. Our development experience revealed that the lack of such specialized authoring tools increases the development effort and the amount of technical knowledge (e.g. programming

⁵ WAP 1.0 (which still maintains the largest user basis among WAP compatible devices) has been mainly operated over circuit-switched systems, where charges apply on connection duration basis. Especially for m-commerce, where the time spent in a site is typically much longer, the overall cost increases considerably. In contrast, the latest protocol's version WAP 2.0 may operate over packet-switched (e.g. GPRS, 3G) networks taking advantage of their higher transmission rates and their billing policy (pay-per-kilobyte instead of pay-per-minute).

skills) required by designers, hence, it decelerates the process of developing m-commerce applications.

The major differences between m-commerce and e-commerce solutions are summarized in Table 1.

	E-commerce site	M-commerce site
Business entry cost	Low	High
Customer access cost	Free or low cost Internet access	High mobile service charge
Customer base	Highly educated computer users	Less educated cell phone customers
Protocol	TCP/IP	GSM, 3G
Connectivity	Global	Mainly regional
Bandwidth	High	Low
Identity	URL with IP address and domain name	Phone number
Interface device	Personal computers	WAP phones
Mobility	Fixed location	Mobile
Display	Big screen	Small screen
Main input mode	Keyboard for full text input	Small key pad
Main output mode	Text and graphics	Small text display
Local processing power	Powerful processor with large memory and disk space	Limited processing power with small memory chip
Software and Programming	Support a variety of programming languages	WML script language
Delivery destination	PC in office connected to the Internet	Person accompanied by a mobile device
Transaction complexity	Complete and complex transactions	Simple transactions
Information provided	Rich information	Simple and short information
Timing	Less time-critical	Time critical

Table 1: The major differences between m-commerce and e-commerce solutions.

6. ROADMAP FOR DEVELOPING E-COMMERCE AND M-COMMERCE MUSEUM SHOPS

On their way to developing e-commerce and m-commerce solutions, museums should follow a number of practical steps:

- conduct exhaustive marketing research to identify the applications' target group, investigate the potential customers' financial status and their familiarization with the relevant technologies and explore the applications' potential cost benefit;
- digitalize the museum shop items to create the multimedia content of the applications; on a later stage, developers will render the provided digital items so as to comply with the computational and display capabilities of the targeted user devices;
- contact ICT experts that will undertake the development of the e-commerce and m-commerce solutions;
- systematically test the applications' 'beta' versions so as to reveal potential software bugs and guarantee satisfactory functionality;

- perform usability tests with 'real' users to evaluate the applications in terms of a variety of parameters, such as: ease of use; effectiveness and efficiency of the application; user satisfaction, etc;
- advertise the fact that security threats related to such applications have been seriously taken into account and that electronic transactions are highly secure;
- promote the applications to the museums' visitors.

It is stressed that even if museums follow the above suggested roadmap, a number of additional factors are expected to critically affect the success of e-commerce and m-commerce museum shop applications.

The adoption of an 'electronic shopping culture' among museum visitors will play a significant role; that mainly relates to overcoming their hesitance in using new technologies and their trust towards the security of their financial transactions. Notably, e-commerce technologies have come to maturity and electronic transactions over the Internet are now performed by the majority of web users; hence, the cost benefit of e-commerce museum shop applications is almost guaranteed.

However, sufficient ground still needs to be covered in the m-commerce world. First, the evolution of broadband wireless networks, that is, the pricing policy of mobile operators, the transmission rates and the process of 3G networks deployment will affect the trail of wireless Internet applications. Thus, the users of 3G networks will enjoy faster and cheaper wireless connections and will always be online (Varshney, 2003). Second, the design of a new generation of devices (with capabilities of managing any format of multimedia content, simplified user input and content browsing) will also enhance the perspectives of wireless web (Gavalas et al., 2006). Hence, the development of m-commerce museum shop applications involve a high degree of business risk.

7. CONCLUSIONS & FUTURE WORK

Information and telecommunication technologies have already caused significant changes in the way museums perform their functions and the way they are perceived by the public. Initially, museum websites used to serve as digital brochures and later developed into online representations of the physical museum collections. However, this has only been the beginning. Having realized the possibilities of on-line shopping and other commercial ventures that e-commerce offers, museums have started taking advantage of the commercial and marketing opportunities offered in the web arena.

M-commerce represents a more recent type of e-commerce which has lately seen a rapid evolution, providing the ability for communication and interaction over the Internet anytime, anywhere. Despite its 'childhood illnesses', mainly related to resource constraints, interactivity, usability and communication speed, the market share of m-commerce is expected to grow even faster in the foreseeable future. Of course, the future of m-commerce will depend on a number of factors, such as: the evolution of broadband wireless networks (pricing policies, transmission rates, etc); provision of a secure framework for wireless electronic transactions; design of a new generation of mobile devices with enhanced processing capabilities, memory capacity, larger screens and simplified user input and content browsing; design of innovative services that take advantage of the unique characteristics of mobile devices. As a result, museums and museum shops have a lot to profit from a successful presence in the wireless web and from developing innovative m-commerce applications.

This article introduced an e-commerce and an m-commerce application for a natural history museum shop, as a means for evaluating and comparing their relevant strengths and weaknesses. Although many e-commerce sites for museum shops already exist, to the best of our knowledge no such m-commerce application

currently exists for promoting the products of museum shops. It should be stressed that the technologies used for the development of the presented e-commerce and m-commerce prototypes have not been adapted in any way as they were found to sufficiently meet the particular needs and context of museum environments.

Such e-commerce and m-commerce museum shop applications are expected to have a positive impact on museums: they will complement the experience of museum visitors allowing them to browse museum shop exhibits off-site; museum shops will expand their customer base attracting votaries of the arts that have not necessarily visited or even have no intention to visit the museum; the brand name of the museum will become widely recognizable amongst web and wireless web users.

On their way to providing e-commerce and m-commerce applications, museums will certainly face several difficulties/issues, such as: (a) implementation cost for developing and maintaining the electronic commerce solutions, since the engagement of experienced developers with sufficient understanding traditional web and wireless web technologies will be required; (b) the 'traditional' public's hesitance in adopting new technologies, especially in the context of securing their financial transactions (however, e-commerce transactions are now widely adopted by the majority of web users).

Regarding future work, we plan to:

- integrate additional commercial functions to both our e-commerce and m-commerce applications, such as online ticketing and digital image libraries organization,
- perform a systematic evaluation of the e-commerce and an m-commerce applications using well established evaluation frameworks that have been developed and used extensively in the past, such as the 'Technology Acceptance Model' (TAM) (Davis, 1989; Venkatesh and Davis, 2000) or the 'Innovation Diffusion Theory' (Rogers, 2003).

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GLOSSARY OF TECHNICAL TERMS

3G	A short for third-generation technology. It is used in the context of mobile phone standards. The services associated with 3G provide the ability to transfer simultaneously both voice data (a telephone call) and non-voice data (such as downloading information, exchanging email, and instant messaging).
CSS	Cascading Style Sheets: a stylesheet language (a computer language used to describe the presentation of structured documents) used to describe the presentation of a document written in a markup language. Its most common application is to style web pages written in HTML and XHTML. The CSS specifications are maintained by the World Wide Web Consortium (W3C).
Electronic Commerce (e-commerce)	The exact analogous to a marketplace on the Internet. It consists primarily of the distributing, buying, selling, marketing and servicing of products or services over electronic systems such as the Internet and other computer networks.
GSM	Global System for Mobile communications: the most popular standard for mobile phones in the world; it is considered a second generation (2G) mobile phone system
HTML	HyperText Markup Language: the predominant markup language (combines text and extra information about the text, e.g. about the text's structure or presentation) for the creation of web pages.
ICT	Information & Communications Technologies.
LAN	Local Area Network: a computer network covering a small geographical area, such as a home or office.
Mobile Commerce (m-commerce)	A special type of e-commerce which adds the ability to conduct commerce, using a mobile device e.g. a mobile phone, a PDA, a smartphone while on the move.
MySQL	A multithreaded, multi-user database management system (DBMS), typically used to support web applications
PC	Personal Computer
PDA	Personal Digital Assistant: a handheld computer, which was originally designed as personal organizers, but became much more versatile over the years.
TCP/IP	Transmission Control Protocol / Internet Protocol: the dominant Internet protocol suite, i.e. the set of communications protocols that implements the protocol stack on which the Internet and many commercial networks run.
Thin client	A lightweight portable devices with limited computational, processing and display capabilities
URL	Uniform Resource Locator: a compact string of characters used to identify or name a resource. The main purpose of this identification is to enable interaction with representations of the resource over a network, typically the World Wide Web.
WAP	Wireless Application Protocol: an open international standard for applications that use wireless communication. Its principal application is to enable access to the Internet from a mobile phone or PDA.
WML	Wireless Markup Language, based on XML, is a content format for devices that implement the WAP specification, such as mobile phones, and preceded the use of other markup languages now used with WAP, such as XHTML and even standard HTML (which are gaining in popularity as processing power in mobile devices increases).

Περίληψη

Η χωρίς προηγούμενο επιτυχία του παγκόσμιου ιστού (web) παρέχει στους μουσειακούς οργανισμούς ένα ιδανικό μέσο για επικοινωνία, τεκμηρίωση, προώθηση, διαφήμιση, διάχυση πολιτιστικών δραστηριοτήτων και μάρκετινγκ. Τα εμπορικά καταστήματα μουσείων, τα οποία σήμερα αποτελούν αναπόσπαστα τμήματα των μουσείων, έχουν επίσης πολλά να κερδίσουν από μία επιτυχή παρουσία στο χώρο του web. Εκτός των παραδοσιακών ιστοτόπων, προσεκτικά σχεδιασμένοι τόποι ηλεκτρονικού εμπορίου (e-commerce) μπορούν να ενισχύσουν τη δυναμική των μουσειακών καταστημάτων, προσφέροντας δυνατότητες για online αγορές και άλλες εμπορικές λειτουργίες, όπως online αγορά εισιτηρίων και οργάνωση βιβλιοθηκών ψηφιακών εικόνων. Παράλληλα, η πρόσφατη σύγκλιση των παραδοσιακά διακριτών τεχνολογιών του διαδικτύου και της κινητής τηλεφωνίας έχει φέρει την έννοια του «ασύρματου διαδικτύου» στο προσκήνιο. Σε αυτό το πλαίσιο, το «κινητό εμπόριο» (m-commerce) αποτελεί μία σχετικά νέα τάση που αντιπροσωπεύει μία φυσική επέκταση του ηλεκτρονικού εμπορίου στον κόσμο των ασύρματων επικοινωνιών. Το κινητό εμπόριο αναφέρεται σε ηλεκτρονικές επιχειρηματικές συναλλαγές και διαφοροποιείται από το ηλεκτρονικό εμπόριο καθώς περιλαμβάνει τη χρήση κινητών συσκευών και ασύρματων καναλιών επικοινωνίας (αντί ενσύρματων). Τα μοναδικά ιδιο-χαρακτηριστικά της κινητής επικοινωνίας αποκαλύπτουν νέες προκλήσεις και ευκαιρίες για τα μουσειακά καταστήματα, ανάμεσα σε άλλες επιχειρήσεις. Το παρόν άρθρο παρουσιάζει το σχεδιασμό και υλοποίηση μιας εφαρμογής ηλεκτρονικού και κινητού εμπορίου για ένα μουσειακό κατάστημα. Στοχεύει στην αξιολόγηση και σύγκριση των δύο εφαρμογών αναφορικά σε διάφορες παραμέτρους, όπως διαθέσιμες τεχνολογίες, πλεονεκτήματα και μειονεκτήματα, σχεδιαστικές απαιτήσεις, χρηστικότητα, ταχύτητα αλληλεπίδρασης, κόστος χρήσης, κλπ. Επίσης στοχεύει στον προσδιορισμό μεθόδων για την ενίσχυση της δυναμικής τέτοιων εφαρμογών και για το σχεδιασμό επιτυχημένων και επικερδών επιχειρηματικών μοντέλων.

Λέξεις-κλειδιά

Μουσειακό κατάστημα, ηλεκτρονικό εμπόριο, κινητό εμπόριο, ασύρματο διαδίκτυο, WAP.