Journal of International Information Management

Volume 14 | Issue 2 Article 6

2005

Contextual Analysis of Enterprise Mobile Services Requirements

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ABSTRACT

This article presents a framework to classify various types of mobile services implemented in organizational settings. Based on the objectives of wireless information systems (WIS), we identify three categories viz. enterprise mobile services, enterprise-advantage mobile services, and consumer mobile services. While the last two categories of mobile services have received broader attention, there has not been much work done in analyzing the role of mobile services in the organizational settings specific to various industries. In this article, we attempt to fill this void by synthesizing the extant literature in this area. Based on the degree of user's mobility in their organizational settings, we categorize enterprise mobile services in three subcategories. This categorization helps identify differences in the information access needs of users. We then discuss how firms belonging to various industries can benefit from mobile services and various issues that need to be addressed before embracing such services. Finally this paper concludes with identification of potential research topics.

INTRODUCTION

In the first wave of mobile services, few farsighted tech-savvy early adopters (such as FedEx, UPS, Avis, and Hertz) integrated wireless technologies into their mission-critical applications. They incorporated the wireless capability into the hearts of their basic business processes and operations. The second wave, in the mid- to late 1990s, enabled the companies to provide consumer content wirelessly (e.g., CNET, Yahoo, Charles Schwab, and Fidelity). The third and latest wireless wave is characterized by the development of focused end-to-end enterprise solutions that facilitate critical applications, and have attractive cost-benefit economics.

Wireless Information Systems (WIS) can be defined as the systems that utilize wireless technologies for communication between mobile clients and other system components (Mendoza and Pérez 2002) to facilitate mobile services that can be accessed from a user's handheld devices. Based on the objectives of wireless information systems, we identify three dimensions of the mobile services namely efficiency/productivity, time immediacy/urgency, and customer orientation. To describe the mobile services based on these three dimensions, we use a three-dimensional space as depicted in

Figure 1. The efficiency/productivity dimension refers to whether the use of mobile services improves the efficiency and productivity of the members of organization. The time immediacy/urgency dimension refers to whether the content provided by the mobile services is extremely time sensitive and whether it needs the immediate attention of its user. The third dimension, customer orientation refers to whether the use of mobile services can help firms improve their customer services. Based on the degree of membership to each of these dimensions, there exist at least three categories of mobile services, which we describe next.

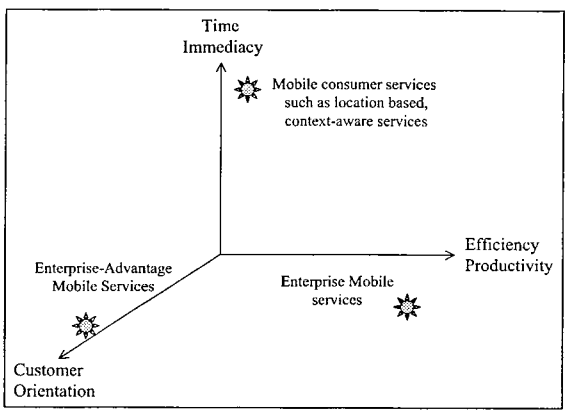
1. *Enterprise Mobile Services (EMS):* Mobile services in this category are motivated by the need to reduce latency, to increase speed of response, to enhance efficiency of current operations and workforce, and to improve productivity. By enabling information access from anywhere, employees can access mission-critical enterprise applications in a timelier manner rather than waiting until they are back at their home/office desktop. Furthermore, EMS enables the capture of complete and accurate data at the point-of-origin, which replaces inefficient paper data entry processes and reduces data entry errors (Chen 2001; Grantham and Tsekouras 2004). These EMS need to be tailored to the enterprise's specific needs. We address this issue in more detail in the Implications section that provides guidelines to any enterprise that is planning to implement mobile services. Enterprise mobile services are likely to have a much wider acceptance and stronger potential than the other two categories of mobile services. In this article, we focus

primarily on this category of mobile services.

2. *Enterprise-Advantage Mobile Services (EAMS):* Mobile services implemented in this category for an organization are used primarily to attract and retain the customers so they continue using the products/services provided. Main objective of such services is to help organizations to strengthen customer relationship by improving customer satisfaction. EAMS can be implemented as a competitive weapon or to defend an existing market position (Dekleva 2002). Examples of such services include the wireless check-ins for travelers, mobile banking services, provision of premium service packages for wireless phone subscribers with capabilities such as email, calendar, and musical ring tones etc. Organizations developing wireless information systems in this category need to answer questions such as "Is the customer service critical (Dekleva 2002)?"

3. *Consumer Mobile Services (CMS):* Mobile services implemented in this category are primarily targeted towards mobile B2C and C2C segments. Examples of such services include mobile advertising, auctioning, gaming, and shopping. Applications such as symbiotic networking, personalized devices, and location-based services are becoming mainstream reality (Business Week, 2002). Unlike first category of mobile services, consumer mobile services are primarily motivated by the need of immediacy, urgency, time-sensitivity, and personalization of the information. Such services include driving directions, traffic report, tracking misplaced or stolen phones and locating stores or restaurants. Large body of research has emerged in an effort to realize this category of mobile services especially focusing on the location-based services (For example, CyberGuide (Abowd et al. 1997) and CityGuide (Kreller et al. 1998)).

Figure 1: The Three Dimensions of Mobile Services.



In this article we focus primarily on the analysis of enterprise mobile services (EMS) that enable smoother and efficient operations of employees in an organizational setting. Although consumer applications have generated the most wireless buzz and interest among the researchers, we believe that more sustainable opportunities exist for enterprise mobile services. There has not been much work done in analyzing the role of mobile services in the organizational settings specific to various industries. In this article, we attempt to fill this void by synthesizing the extant literature in this area.

Outline of the article is as follows: In the next section, we present our classification scheme for enterprise mobile services and the benefits realized in terms of various performance criteria. In section three, in-depth discussion on the role played by enterprise mobile services in various organizational settings is presented. This discussion focuses on the nature of services that can be provided on handheld device to improve their business processes. This discussion is then supplemented with a discussion of various issues that need to be addressed. In section four, we present implications for practitioners and researchers and finally we conclude in section five with contributions and present our future research agenda.

ENTERPRISE MOBILE SERVICES

In this section, we present our classification scheme for enterprise mobile services. Based upon the degree of user's mobility in their work environment we classify various industries in three groups. We believe that degree of user's mobility is an important factor as it helps reveal differences in information access needs of users in diverse set of industries.

1. *Industries with highly critical mobility:* This group involves organizational settings where users as well as the assets are moving at all the times. Examples of such settings include shipping and trucking industry, home building industry, and the law enforcement agencies. Although in agricultural and electric utility industries assets are fixed, these assets are spread over a wide geographic region and the most work is accomplished in the field (Grantham and Tsekouras 2005). Enterprise mobile services are crucial in high-mobility environments as they enable mobile employees to fulfill their data needs while away from their office (Grantham and Tsekouras 2004).

2. *Industries with medium mobility:* This group involves organizational settings where users are highly mobile. However, users do need to come back to their offices to perform other functions. Example of such setting includes healthcare setting where healthcare professionals need to perform not only medical rounds but also other clinical duties.

3. *Industries with low mobility:* This group involves organizational settings where users are occasionally mobile and hardly rely on mobile computing technologies to accomplish their daily operations. Examples of such settings include office environment. One specific application that we discuss here is remote network administration and troubleshooting.

In Table 1, we provide a summary on benefits that can be achieved by the implementation of various enterprise mobile services. We supplement this discussion with various issues faced when implementing these mobile services. Panis et al. (2002) identify various key factors that influence the evolution of mobile services pertaining to the consumer mobile services. From this list we select factors that are most relevant for enterprise mobile services. These factors include issues related to the security, availability of wireless networks, suitability of the enterprise service to mobile device, and various federal regulations. Table 2 presents a summarized discussion of these issues that influence the evolution of mobile services. With this classification scheme in place, next section provides a detailed discussion of various organizational settings where wireless infrastructures for deploying mobile services can be implemented.

Table 1: Benefits Offered by the Implementation of Enterprise Mobile Services.

Performance criteria	*Wireless features*	*Comments*
Decision making and responsiveness (Hodgkin et al. 2004; Sharaf and Chrysanthis 2002)	Access to information across a wide variety of settings	Access to real-time business intelligence speeds up and improves accuracy in decision-making process (Sharaf and Chrysanthis 2002)
Improvements in supply chain management and flexibility (Singh 2003)	Radio frequency data capture	Helps minimize or eliminate information lag (Singh 2003), reduction in input errors, delivery times, and better inventory management (Songini 2001).
Efficiency and effectiveness, productivity (Grantham and Tsekouras 2004)	Always-on connectivity independent of location, constitutiveness to the individual user	Access to accurate, timely data at point-of-need (The wireless hospital: Extending the reach of your information system directly to the point of activity, Symbol Technologies Inc 2000)
Collaboration and communication with other members of the organization (Bergenti et al. 2002).	Mobility, flexibility, and instant access to information with the use of handheld devices to support interactive, real-time anywhere, anytime collaboration	Facilitates collaboration among the members of organization (Farooq et al. 2002). For example, in the construction industry, masons working on in-progress buildings can communicate with an architect directly for discussing the work (Bergenti et al. 2002)

Table 2: Issues in the Evolution of Enterprise Mobile Services.

Issues	*Comments*	*Examples*
Reliability, security, and privacy	Major concern for all industries using mobile computing. Can be potentially addressed by the combination of the integrated biometric based or the smart card based authentication and by adding the strong security mechanisms such as encryption at various steps during the life of a transaction (Ghajar and Khalife 2003; Griazina et al. 2002)	For example, when troubleshooting remotely, security of organizations' internal resources becomes crucial. Similarly for healthcare industry this is a bigger issue as it is regulated by various federal mandates. For electric utilities industry, since metering devices may operate in hostile open environments, reliable and secure communication of data is an important issue.
Availability of wireless networks	Important concern for primarily for high-mobility environments as most of the work is done outdoors (McKinion et al. 2004). Can be addressed by the various different combinations of the wireless network technologies. Options include cellular, personal communications service, mobile satellite service, specialized mobile radio, wireless wide area networks, and wireless local area network.	For example, in agricultural industry farmers may need to opt for combination of wireless local area network and satellite solution to address their various communication needs. To make use of precision agriculture methodology farmers may need to depend on various remote servers for their image and/or data analysis needs.
Suitability of the service in terms of the design and the functionality	User-friendly and intuitive interfaces that make information access easier will be crucial in the adoption of handheld devices. Variety of different hardware and software platforms will co-exist, as different industries will have different working conditions (Choi et al. 2004; Thysen 2000). Device considerations such as physical size, processor type, memory, method of data access, and battery life need to be addressed in the design of mobile services.	For example, for agricultural and home-building industries this is a major issue given their existing level of familiarity with information technology.
Standards and regulations	Can be important in industries such as healthcare where HIPAA plays a major role (Barrett et al. 2004).	Federal regulations such as HIPPA in healthcare industry are greatly concerned with information privacy and security. Such regulations can greatly impact the widespread adoption of handheld devices that are capable of storing and communicating such information

INDUSTRY SPECIFIC ANALYSIS OF MOBILE SERVICES

In the next subsections we present in-depth analysis of benefits and issues summarized in Table 1 and Table 2 with respect to each industry exhibiting different degrees of mobility. It is necessary to understand issues specifically for each industry as the nature of the work and the context in which work is done differ significantly from one industry to another.

Industries with high-mobility

Home-building Industry

One booming application of the mobile computing is in the home-building industry. Even though traditionally this industry has been slow to embrace and utilize new technologies the right deployment of mobile services can bring in considerable cost-savings and jobsite efficiency (Stewart et al. 2002). One of the major concerns in this industry is the efficiency of supply chain and mistakes made due to the miscommunication along with the tackling of the schedule changes and the re-notifications of caused by the same (Garzaa and Howitt 1998). Such miscommunication results into the right information never getting into the right hands at the right time leading to the loss of operational efficiency (McGarvey 2002). Mobile IT applications running on handheld devices include collaborative dynamic project

management tools (Penã-Mora and Dwivedi 2002) such as scheduler, estimator and tracker services, and 2D/3D graphics applications that display traditional CAD drawings (Lipman 2004). The contractors can coordinate the scheduling of subcontractors and communicate with the suppliers to ensure the timely arrival of the construction material. These mobile services can also help to reduce the number of mistakes committed by delivering the wrong material at the wrong time at the wrong housing site (Hamblen 2002). This can speed up the distribution of information to all interested stakeholders in timely fashion. Further efficiencies can be achieved by integrating such services with other back-end applications such as the payment and accounting applications (Grantham and Tsekouras 2004). Such mobile services should be capable of detecting a schedule change, determining the effect of the change on other contractors, and finally be able to notify these parties through cell phone, e-mail or fax rather than having on-site supervisor place numerous calls for rescheduling.

Three primary considerations for this industry are information security, the potential for electromagnetic interference to other jobsite equipment, and the interaction among wireless signals resulting from transmitting in a cluttered environment leading to poor quality wireless signal (Garzaa and Howitt 1998). Wireless communication technologies that can support the information needs at a construction jobsite include 1) circuit-switched cellular modem, 2) packet-switched SMR, 3) Cellular Digital Packet Data (CDPD), 4) Wireless Local Area Network (WLAN), 5) satellite-based data communications (Garzaa and Howitt 1998). It is necessary that the mobile devices used at such construction sites have interfacing capabilities to access such different types of wireless networks in order to achieve mission-critical real-time updates. Finally, user-friendly and intuitive interfaces are key considerations.

Agricultural Industry

Agricultural sector is a booming area for deploying wireless information systems. Treiblmaier et al. (2002) conducted a survey of agriculturists to determine the nature of agricultural applications appealing to them. Agriculturists showed interests in IT applications that support the operational aspects of farming (Thysen 2000) for real-time decision support on high-bandwidth wireless internet connections. Such applications could help them record a fertilizer plan, store a field master data plan, and record a crop-growing plan (Treiblmaier et al. 2002). In addition, these agriculturists also showed interest in the applications that aid them to keep track of the general working time, Global Positioning System (GPS) field maps, stock farming, and forestry. Since most of the work is done outdoors, it is natural to record and process the data at a location where it is created. Scanners can be used to read the stored data and make such data available immediately. Such documentation is seen increasingly crucial in food health control systems to provide traceability in healthy food production (Thysen 2000). More sophisticated applications can be used for navigation of tractors and the operation of machinery thereby supporting agriculturists in their daily work routine. Bulusu et al. (2004) highlight how embedded networked sensors can be used for precision agriculture to efficiently and effectively utilize natural resources to reduce waste of time and money.

Although extant literature in the area of agriculture informatics doesn't explicitly address security and privacy issues, these issues will become crucial. To address communication problems such as remote, high-speed communications between the farm and service providers and wireless local area networking on the farm (McKinion et al. 2004), agriculturists may need to opt for one or more mixed wireless network solutions similar to that of the home-building industry. Applications developed for such agricultural purposes need to be easy to use with user-friendly interfaces as the agriculturist may not be acquainted (Thysen 2000) to using such devices and/or applications. Agriculturist should be capable of mastering the use of these applications & devices on their own without a need for extensive rigorous external training.

Utilities Industry

Another fascinating application of enterprise mobile services is in the utilities industry. The electric utility industry is undergoing rapid changes in response to political, economic and environmental forces and expectations (Asmus and Quotes 2002). In response to these forces, this industry is finding new ways to become more efficient in utilizing scarce resources. For example they can arm their mobile field-workers with the mobile devices for entering the results of their power and production meter readings (Olla and Patel 2002). Ghajar and Khalife (2003) suggest that by implementing mobile Automated Meter Reading (AMR) systems with radio frequency (RF) communication, various benefits can be realized. These benefits include faster reading of the meter, better accuracy of reading, fewer contacts with adverse elements, outage management, and time-of-use pricing (McEver and Childress 2004). With such mobile AMR systems reduction in operating costs and bill complaints, timely collection of payments can be achieved

(Ghajar and Khalife 2003). Such systems can also aid in the proactive monitoring, fast repair, and the timely maintenance of the equipment. As a result, maintenance costs can be reduced by eliminating the need for outside contractors to do the maintenance checks (Kuchinskas 2002).

One of the critical issues for this industry includes secure and reliable communication of metering data with a central server (Ghajar and Khalife 2003; McEver and Childress 2004). McEver and Childress (2004) emphasize the need to use a combination of public and private wireless networks to identify a cost-effective solution. Other issues include intuitive user-friendly interfaces (Olla and Patel 2002) and compatibility with various federal, state, and local regulations concerning air, water quality, and the protection of wildlife (Bureau of Reclamation, 2004).

Industries with medium-mobility

Healthcare Industry

In a survey conducted by Medical Records Institute in 2002, many hospital administrators indicated that they were planning to deploy the mobile healthcare services for order entry, e-prescriptions, to capture clinical information and to retrieve clinical information at the point-of-care (such as the lab results, drug reference information), and emergency admissions/ registration along with the charge capture and/or the coding information. To better manage, analyze, and communicate information during patient care, services offered by mobile systems can make possible quick entry and retrieval of notes, rapid ordering and reporting of findings, and timely access to current patient records (Choi et al. 2004). It enables healthcare professionals to make decisions and take actions with increased accuracy and efficiency (Parekhji 2002). Also having patient information readily available can enhance a physician's ability to follow-up on patients and can result in effective conversations with patients (Barrett et al. 2004). As a consequence, quality of patient care can be improved while realizing a reduction in the patient care cost and documentation errors. Having instantaneous access to up-to-date medical information can significantly reduce the claims for the malpractice as doctors can immediately check for drug interactions. It can improve hospital's position in the event of litigation in addition to improving the audit results by the various health care organizations (Parekhji 2002).

One of the major concerns in healthcare industry includes security of confidential protected health information when sending/receiving messages to prevent healthcare fraud and abuse as stipulated by HIPAA (Health Insurance Portability & Accountability Act) (Barrett et al. 2004; Fedorowicz et al. 2004). Barrett et al (2004) indicate that usage of handheld devices will become widespread if following issues can be addressed: 1) provision of secure clinical data for the current patients and 2) alleviating concerns of catastrophic data loss from handheld devices. Related concern is the security of the handheld devices from unauthorized users. Prior research (Hsieh and Lin 1998; Tan and Gunasekara 1999) has also highlighted these issues when accessing healthcare information using internet-based services. Doctors may need on-demand access to X-ray images or CT-scans or they may need wireless connectivity to perform clinical documentation, to access patient information, clinical protocols, or drug references (Jepsen 2003). Such diverse need for the data will significantly impact the choice of wireless network technology for implementation. Easy-to-use intelligent and effortless user interface is essential to access crucial information easily and quickly (Choi et al. 2004). Finally, another potential concern is the interference caused by the radio waves to other frequency-sensitive equipments such as pacemakers and respirators (Hekmat et al. 2004).

Industries with low-mobility

Remote Troubleshooting

While all the mobile services described above are an example of one-way data collection/provision primarily, remote troubleshooting such as remote network administration is an example of interactive services. Most of the problems that network administrators face bring the portions of the network to a halt and require human intervention even though they have simple known solutions. These problems include changing the password, unjamming the email queues, restarting the frozen server processes, and rebooting the servers (Yokomizo 2002). Mobile administration applications running on handheld devices or cellular phones can be used by network administrators to solve these problems while they are away from the office.

Having handheld devices operate outside the corporate firewall and access the basic crucial resources pose a major security threat (Yokomizo 2002). Since the network administrators need to be informed of the network problems

immediately, these devices demand the use of always-on networking technology. The server should be capable of reporting the problems as well as carrying out the commands ordered remotely by network administrators. Network administrators can preload the trouble-fixing scripts into a server that monitors the network, so when something breaks the server sends the alert messages to the administrator who in turn can run these scripts remotely. While developing user interfaces for such applications, developers can take advantage of the fact that there are not many unpredictable sets of operations that an administrator will need to perform (Murillo 2003). Designers can design the menu-driven applications for the most commonly used operations while also providing the capability to enter the text-based commands/instructions for not so frequently utilized operations (Yokomizo 2002).

The above discussion highlights a number of differences in the nature of these various industries and variety of regulations facing each of them. Such context-specific nature needs to be accounted for, when developing enterprise mobile services rather than taking one-size-fits-all approach. In the next subsection, we present implications for researchers and a set of guidelines that practitioners can follow when considering the implementation of enterprise mobile services.

IMPLICATIONS FOR PRACTITIONERS AND RESEARCHERS

Ensuring adequate levels of training, data integrity, and the device interoperability is critical for the successful deployment of the wireless infrastructure in the enterprises. It should be noted that the technology implementations alone would not succeed unless they are backed by the real need of the business processes. Enterprises need to ensure that the architecture of these new mobile services is flexible enough for the future growth and can integrate easily with their existing infrastructure. Furthermore enterprises may wish to integrate their voice and data applications. Network design issues in such instances include bandwidth sharing between the data and voice applications, the usage of wireless telephones versus data devices, the mobility of wireless telephone users versus that of data users. IT managers need to realize that committing too many resources to the initial wireless project is risky and they need to conduct the pilot projects before starting with the full-blown infrastructure to avoid the costly system failures. Federal Wireless User's Forum FWUF (Wireless Pilots Catalog 2002) suggests that pilot projects can help managers to

1. Determine whether a particular wireless technology or service can be used to support existing functions or provide additional capabilities,

2. Explore quality of service issues such as reliability, interoperability, scalability, capacity, latency, coverage, convenience, operational impact, cost,

3. Establish the business case for wireless communications versus other solutions,

4. And importantly to clarify their needs and wants.

While realizing and implementing mobile services presents significant challenges to IT managers, it offers enormous opportunities to researchers. When implementing the enterprise mobile services for improving current business processes, new business practices may emerge. With new ways of conducting business processes, researchers can identify various patterns of adoption of mobile computing. It will be interesting see if the existing theories of adoption, innovation diffusion can address these new patterns.

CONCLUSION AND FUTURE RESEARCH

In this paper we presented the framework with which mobile services can be categorized by the objectives of the services provided. We build upon this framework and provide a classification scheme for enterprise mobile services based on the mobility levels of users in their work environment as it is a critical factor in determining information access needs of employees. In this paper we also highlight the criticality of the availability of integrated wireless networking solutions in high-mobility ubiquitous environments. Primary contribution of this work is that it synthesizes and identifies various benefits and issues from the perspective of different industries. If designed and implemented appropriately by taking into consideration various issues faced in these industries, enterprise mobile services will likely to have a higher degree of fit with the requirements of their mobile users and nature of the tasks they perform. This can ultimately impact the user acceptance (Goodhue and Thompson 1995) of mobile services especially in industries where

individual users are given the responsibility to make the choice. Besides the issues presented in Table 2 there is a growing recognition that development of communities of practice engaged in using, spreading, and developing knowledge about the mobile technology and endorsing it to non-users will be a critical factor in the widespread diffusion of mobile services (Grantham and Tsekouras 2005). Future research will focus on conducting field studies in one or more such industrial settings to identify new patterns of enterprise practices resulting from the interaction with these new mobile services.

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