

Web Mobile-Based Applications for Healthcare Management

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Foreword

Any sufficiently advanced technology is indistinguishable from magic.

— Arthur C. Clarke

It is my honor to write this foreword for Dr. Hakim's book. Changes in international health-care provision coupled with rapid technological advances have resulted in increased opportunities for combining these two sectors.

Health-care institutions around the world have leaned toward both wired and wireless technologies as the backbone of their technology-led strategies. With issues surrounding integration, interoperability, and standards very much at the heart of such strategies, it is inevitable that future health-care IT solutions will have to take note of these and other pressures. If one considers the staggering acceptance and adoption of wireless networks in the home, together with such must-have items as personal digital assistants (PDAs) and the latest mobile telephones—both of which may have the capacity and capability to link to networks remotely and without conventional wires—there is little wonder that such terms as *pervasive and ubiquitous computing* have gained so much favor so quickly.

So is further research required? Yes and no. Xerox's Palo Alto Research Center (PARC) has been working on applications revolving around pervasive computing since the 1980s. New technologies, although of course welcome, can easily coexist alongside established and existing research if a new application can be found for them (such as wireless protocols). Basic (pure) and applied research concepts are therefore of equal importance.

By way of an elementary example, in the United Kingdom, Homerton University Hospital in London recently started a trial of SMS (short-message service) "m-reminders" sent to patients regarding their appointments. A simple-enough concept of course, but where is the benefit? Within the United Kingdom's National Health Service (NHS), missed appointments cost about £300 million per annum (House of Commons Accounts Committee). According to *Health-News*, approximately 30% of people missed their NHS appointments because they simply forgot. A much larger percentage (60%) quoted apathy as their cause for missing appointments: These figures speak for themselves. Simple use of existing technologies can result in vast financial improvements for health-care institutions.

The efficacy of mobile technologies for health has an obvious close relationship with telemedicine and telehealth initiatives. Originally only thought workable for geographically dispersed environments (patients located far away from doctors and hospitals), as social factors came into play (less leisure time, increased pressure of work, and so forth), the application of telemedicine for all is starting to become a reality.

Cutting-edge, almost experimental, research also has a very important role to play. IBM's Almaden Research Center has stated that, by the year 2010, computing will have become so naturalized and accepted within the environment that people will not even realize that they are using computers. The emergence of smart devices with embedded location-centric information allows such technologies to be aware of their context.

With the prevalence of such transmitted information, concerns have been raised over privacy and security, both of which this book considers. It is imperative that technology-based solutions (such as encryption and advanced firewalls) are balanced with the need for accessibility and usability. There is little point in having the most technologically advanced hardware and software solution if most people cannot configure them effectively. The latter half of the book concentrates on applications of technology from the patients' perspective and also illustrates cases from the clinical environment. Behavioral change, which the book tackles, is an important hurdle that needs to be overcome.

Chapter X describes how patients prefer an interface with which they are already familiar. Mobile phones offer SMS, MMS (multimedia messaging service), WAP (wireless application protocol), and HTTP (hypertext transfer protocol) avenues, which can be readily accessed by the patient in order to transmit (and receive) personalized medical information (and, with enough context, clinical knowledge). Another chapter within the "Industrial Applications" section describes an innovative teleradiology project that illustrates the two central constructs of the book: first, the initial idea, which is to transmit in a secure environment X-ray, CT (computed tomography), and MR (magnetic resonance) images for swift diagnosis, and second, how this is to be achieved—by the use of a third-generation PDA-cum-mobile-phone; timely diagnosis can often be vital in such cases.

The book offers both a contemporary overview of opportunities and challenges as well as some insight from the field where applicable. My congratulations go to Dr. Hakim for assembling the chapters in this manner as there is much knowledge and best practice within the book from which both academics and practitioners can learn.

Rajeev K. Bali, PhD

Warwickshire, United Kingdom

June 2006

Rajeev K. Bali is currently a senior lecturer at Coventry University, UK. He is the leader of the Knowledge Management for Healthcare research subgroup, which works under the Biomedical Computing and Engineering Technologies (BIOCORE) Applied Research Group. He is an invited reviewer for several journals, conferences, and organizations. His primary research interests are in health-care knowledge management, clinical governance, e-health, change management, organizational behavior, and medical informatics. He has recently published a text on clinical knowledge management. Dr. Bali has served as an invited reviewer and associate editor for several journals, including Transactions on Information Technology in Biomedicine, and was the invited guest editor for a special issue in 2005. He is also the associate editor of the International Journal of Networking and Virtual Organisations.

Preface

Abstract

This Preface addresses the book "Web Mobile-Based Applications for Healthcare Management". It highlights the importance of Web-based and mobile-based systems for healthcare management and addresses the challenges facing these systems, mainly, accessibility by patients, patient disability and patient's skill and literacy. The book comprises seventeen chapters organised into six sections covering various theoretical and practical issues related to system's strategies, challenges and opportunities, information quality, patient empowerment, applications, and conceptual frameworks. It provides insights and support for healthcare professionals as well as for practitioners concerned with the management of information systems.

Overview

Under current economic conditions, one of the challenges before modern health-care executives is to design systems that reduce costs, improve the quality of health-care delivery, and achieve customer satisfaction in an environment that often gives rise to unexpected deviation from planned activities. Amongst other things, health-care executives are increasingly looking to information technology as an opportunity for developing such systems. Web-based and mobile-based technologies are two examples. These technologies are relatively new. The Web or World Wide Web (known as WWW or W3) began as a network information project at the European Organization for Nuclear Research (CERN), where Tim Berners-Lee, now director of the World Wide Web Consortium (W3C), addressed the need for a computerized collaborative tool helping scientists to communicate and share information (W3C, 2001). The WWW merges the techniques of networked information and hypertext to make an easy, straightforward, but powerful global information system that is accessible to anyone over the Internet via an interface known as browsers. There are three layers of Internet protocols. The first and most important one is the Internet protocol (IP), which defines the datagram

or packets (messages, pictures, speech, video, etc.) that carry blocks of data from one node of the network to another.

The recent growth of wireless communication technology (e.g., cellular and digital mobiles) has driven the thinking toward a new version of the IP that accommodates wireless communication. Mobile-based systems already enable Web browsing and e-mail services for mobile users. This feature adds greater capabilities for services requiring person-to-person communication connectivity over mobiles and other wireless devices. The explosion of Web-based and mobile-based technology made real-time online communication between businesses and their customers a reality. These technologies have been adopted in an accelerated fashion in all industries including the health-care industry.

The following statistics can serve as examples. (It is important to bear in mind the time at which these statistics were collected and published as the figures undoubtedly change very rapidly.)

- In December 2001, the National Health Service (NHS) dealt with 5.2 million hits from 171,900 visitors to their Web site. The figures for the same period in 2000 were 2.8 million hits and 24,830 visitors ("The UK's E-Health Services Received a Record Number of Hits Over the Holiday Break," 2002).
- Estimates in 2002 suggest that over 500 million people have access to the World Wide Web, with 50% to 75% of the users having used the World Wide Web at least once to look for health information (Powell & Clarke, 2002).
- The number of Medline searches performed by directly accessing the database at the National Library of Medicine increased from 7 million in 1996 to 120 million in 1997, when free public access was provided; the new searches are attributed primarily to nonphysicians (Sharma, Xu, Wickramasinghe, & Ahmed, 2006).
- A survey conducted in Canada to explore patients' attitude toward health services suggests that Internet users expressed interest in using the Web for several reasons, including learning about their health condition through patient education materials (84%), obtaining information about the status of their clinic appointments (83%), renewing prescriptions (75%), consulting with their health professional about nonurgent matters (75%), and accessing laboratory test results (75%; Rizo, Lupea, Baybourdy, Anderson, Closson, & Jadad, 2005).
- While the traditional media provided the primary source of information on anthrax and bioterrorism during late 2001, a survey in USA finds that 21% of respondents reported searching the Internet for this information. The survey shows that information from health Web sites is trusted slightly more than information obtained from traditional media sources (Kittler, Hobbs, Volk, Kreps, & Bates, 2004).
- A survey conducted in Colorado (USA) finds that the majority of respondents (about 95%) value having access to their medical records and more than half of them support online access (Ross, Todd, Moore, Beaty, Wittevrongel, & Lin, 2005). The study finds the primary determinants of support of Internet-accessible records are not age, race, or education level; rather, they are previous experience with the Internet and patients' expectation of the benefits and drawbacks of reading their medical records.

Dimensions: Accessibility, Timeliness, and Mobility

The World Wide Web Consortium's goal of integrating Web-based with mobile-based technologies is "to make browsing the Web from mobile devices a reality" (W3C, 2006). These technologies, however, do not routinely reduce costs, improve quality, or achieve customer satisfaction unless they create, from the customer's perspective, a value-added service. From the health-care angle, these emerging technologies considerably improve three critical value-added service dimensions in relation to information flow between hospital personnel as well as between hospitals and patients. These dimensions are timeliness, accessibility, and mobility. The third dimension is the result of integrating mobile-based applications with Web-based systems.

Timeliness

Timeliness is a reference to how up to date information is with respect to IS users' needs. It reflects also how fast the information system is updated after the state of the represented hospital system changes. Accurate but out-of-date information may have no value for the decision-making process. Difficulties in updating the information in a timely fashion make the system less valuable. Timeliness also requires real-time information flow between various functions of health-care organizations.

Accessibility

The availability of relevant and complete information when needed is one of the key issues that drive health-care executives to allocate a considerable portion of their budgets to installing advanced information systems. The flow of health-care information is restricted and governed by legislation. This raises the issue of security. Accordingly, the acceptability of a system is directly related to the consistency between accessibility and security issues.

Accessibility and timeliness form key drivers for adopting Web-based systems. The literature provides ample examples. One earlier instance was reported in 1996. The Massachusetts General Hospital in Boston has implemented a Web-based clinical information system that provides physicians in the hospital with access to clinical information for patients they refer to the hospital. The system uses electronic medical records (EMRs) as a middle-layer service (Kittredge, Estey, & Barnett, 1996).

Accessibility and timeliness allow local, state, or even national authorities to receive up-to-date information from all or designated hospitals to guide the authority in emergencies at the national level. A constructive example is the Web-based reporting system implemented by the state of Illinois (USA) launched in 2004. The system provides the state with up-to-the-minute information from more than 200 hospitals in Illinois on the availability of medical resources and beds. This allows it to monitor the status of hospital facilities statewide to "ensure adequate resources are quickly made available for emergency patient care in the event of crisis" (Office of the Governor, 2004). A system with adequate accessibility and timeliness of the flow of information can be used to exchange information at the international level to

combat the international spread of SARS (severe acute respiratory syndrome), bird flu, or any other infectious diseases that may pose a serious threat to global health security.

Mobility

Mobility is the ability to move. In mobile-based computing, mobility refers to the capability of a device (e.g., a mobile phone) to handle information access, communication, and business transactions whilst in a state of motion ("Mobility," 2006). Mobility causes mobile-based applications to differ from Web-based applications at two levels (Maamar, 2006).

1. The communication level: Web services are connected with wired channels to the external environment, whereas mobile services (m-services) are connected with wireless channels.
2. The computation-location level: Web services are executed on the service side. M-services are executed on the client side after being transferred from the server side.

At the communication level, the integration of mobile-based and Web-based systems would emulate everything the PC (personal computer) can do while on the move (Olla, Patel, & Atkinson, 2003). The integration allows real-time, anywhere, anytime connectivity to services. It is expected that such integration would save considerable time for hospital personnel and would enhance productivity. Microsoft (2005b) reported the implementation of an integrated system at Moorfields Eye Hospital in London. Effective management of the hospital relies on communication with senior managers while they are away from the office. With the integrated system, "managers can stay in touch with their colleagues from any location, save an hour a day by catching up with e-mail messaging while commuting, and help speed up the decision-making process." Another integrated system, called Mobile-Doctor, implemented at Klinikum der Stadt Hanau hospital (Germany), enables doctors to access information they need on the move. Mobile-Doctor eliminates time-consuming paper documentation and manual processes. It allows doctors to complete critical documentation and immediately submit information needed to claim funds for patient treatments (Microsoft, 2005a). In addition, the integrated system allows medical staff to collect information to research and record patient diagnoses from anywhere in the hospital.

During an emergency, terrorist attack, or war, a doctor may deal with several patients simultaneously; he or she may have no time to prepare a written record in handwriting or via a traditional computerized system. A dictation facility built into the mobile-based application is a good solution. This facility has been used in many hospitals. One constructive example is the innovation referred to as the Battlefield Medical Information System: Tactical (BMIS-T) developed as a result of the first Gulf War in 1991. It is claimed that the solution gives medical providers an all-in-one tool for diagnosing and treating conditions, and capturing patient information (Microsoft, 2004).

Challenges

Web mobile-based technologies seem to be beneficial and promising to both health-care organizations and their patients, but they also face challenges that should be resolved before the technologies become commonplace. The list below is limited only to those related to the patients' perspective of using online and mobile technologies. Interested readers may refer to literature such as Olla et al. (2003) and Sharma et al. (2006) for other related challenges.

Accessibility by Patients

The literature indicates a high rate of deployment of personal computers and mobile phones. Yet, a considerable proportion of society cannot afford computers, constant access to the Internet, or mobile phones. In addition, rural areas in many countries may lack the necessary infrastructure for reliable and high-speed access to information technology (Goslee & Conte, 1998). Furthermore, mobile-based technology may require specific devices that are not yet widely deployed and accordingly, this will limit the full utilization of integrated Web-mobile-based systems.

Patient Disability

Patients with disabilities may face difficulty in accessing the Internet or using mobile phones. Kaye (2000) reports that the rate of having a computer among Americans with disabilities is less than half of their counterparts without disabilities. Kaye also reports that patients with disabilities are less likely to use the Internet and other information technologies.

Patients' Attitude and Perception

There is no doubt that many patients would like face-to-face communication rather than online or wireless communication. Security and privacy issues play an important role in hindering the effective use of the Web and mobile facilities for health-care delivery. Medline health seekers may have the view that Internet companies will collect and share information about their medical status with insurance companies, and fear arises that insurance companies may change their coverage (Sharma et al., 2006).

Patients' Skills and Literacy

Engaging with information technology to promote health and health-care delivery requires specific levels of skill or literacy that allows the users to operate the systems, navigate the Web, retrieve and input information, and grasp the correct contextual meaning of information. At this stage, it is unrealistic to hypothesize that those individuals with access to Web and mobile technologies have the required skill and literacy to use these technologies pro-

actively. Studies show that even in countries with high rates of Internet adoption such as the USA and Canada, over 40% of adults have a basic literacy level below the requirement for optimally participating in the information society (National Assessment of Adult Literacy [NAAL], 2005; Norman & Skinner, 2006; Statistics Canada, 2005).

Book Structure

This book aims to present cutting-edge research on the theory, applications, and challenges facing the implementation of Web-based and mobile-based systems in health-care industries. The book provides insights and support for the following groups of people.

- Professionals and researchers working in the field of Web-based and mobile-based systems information in general and in the sector of health care in particular.
- Practitioners and managers of health-care organizations concerned with the management of Web and mobile systems.

The 17 chapters of the book have been organized into six sections: "Web and Mobile Strategies," "Challenges and Opportunities," "Security, Reliability, and Interpretability," "Patient Empowerment," "Industrial Applications," and "Conceptual Frameworks." The following is a brief description of each section and the chapters included in them.

Section I: Web and Mobile Strategies

The first section of the book comprises three chapters that deal with the Web-based and mobile-based strategies used in the health-care industry. Chapter I, entitled "The Development of a Web Strategy in a Healthcare Organization: A Case History," is by Massimo Memmola, who presents a way of defining a Web strategy by aligning a company's corporate strategy, in which there is an acceptance and awareness of the possibilities that Internet offers by the principal company stakeholders, with a general strategy of utilizing information and communication technology. With the aid of a case study conducted in a private health-care organization, the chapter demonstrates how a health-care organization can develop its own Web strategies. In dealing with the development process of the Web strategy, the chapter takes into consideration the alignment of the Web strategy with the business strategy and the ICT strategy. The chapter also considers the readiness and acceptance of the Internet by inside and outside patients, by outside practitioners, and by the organization's staff.

The application of mobile commerce to health care, namely, m-health, appears to offer a way for healthcare delivery to revolutionize itself. However, little has been written regarding how to achieve excellence in m-health. "A Framework for Delivering m-Health Excellence" by Nilmini Wickramasinghe and Steve Goldberg, the second chapter of this book, serves to address this major void by presenting an integrative framework for achieving m-health, developed through the analysis of longitudinal applied research conducted by industry in conjunction with academe. The chapter illustrates how the mapping of case data to the

model enables the attainment of a successful m-health application to ensure the benefits of adopting such a methodology. It stresses that health-care organizations are responding to market challenges by focusing on three key solution strategies, namely, (a) access, which is caring for anyone, anytime, anywhere, (b) quality, which is offering world-class care and establishing integrated information repositories, and (c) value, providing effective and efficient health-care delivery. These three components are interconnected such that they continually impact each other; all are necessary to meet the key challenges facing health-care organizations today. The chapter closes by strongly urging for more research in this area that will further test the developed framework.

The opportunity of innovating business models has basically been linked to continual progress in information and communication technologies. Health care is no exception; information and communication technologies are generally considered the most effective driver for changing organization, improving quality, optimising resources, and so forth, at least in theory. In practice, it is not clear which and how many of these opportunities are really exploited by organizations operating in health care. Chapter III of the book, "Healthcare Organizations and the Internet's Virtual Space: Changes in Action" by Stefano Baraldi and Massimo Memmola, presents the results of a research project aimed at understanding to what degree and how Italian health-care organizations make use of the virtual space made available to them by the Internet. The chapter emphasizes that the Internet has extended the traditional market space by providing new spaces in which economic agents can interact by exchanging information, communicating, distributing different types of products and services, and initiating formal business transactions. It considers four segments of the Internet virtual space: the virtual information space, virtual communication space, virtual distribution space, and virtual transaction space. The chapter explores how Italian health-care organizations actually exploit and use the virtual space offered by the Internet and concludes that the Italian health-care industry does not yet realize and use the full potential of the Internet.

Section II: Challenges and Opportunities

The second section of the book contains three chapters that explore the opportunities and challenges facing the implementation of Web-based and mobile-based systems in relation to three fields: network collaboration, relatively healthy populations, and ubiquitous elder care.

Chapter IV, entitled "An e-Healthcare Mobile Application: A Stakeholders' Analysis" by Niki Panteli, Barbara Pitsillides, Andreas Pitsillides, and George Samaras, presents a longitudinal study on the implementation of an e-health mobile application, known as DITIS, which supports network collaboration for home health care. By adopting the stakeholders' analysis, the study explores the various groups that have directly or indirectly supported the system during its implementation. The system was originally developed with a view of addressing the difficulties of communication and continuity of care between the members of a home health-care multidisciplinary team and between the team and oncologists, often hundreds of kilometres away. DITIS evolved to be much more than that, and even though it was introduced 5 years ago, it is considered a novel application. Despite this, its implementation has been slow, and several challenges, including the system's sustainability, have to be faced. This chapter aims to identify these challenges, and the results of the study point to a diversity of interests and different degrees of support.

New communication technologies have made an impact on several areas of our everyday life, including the areas of health and health promotion. The Internet provides opportunities for personalised interactive health communication at a much larger scale than is possible in face-to-face communication. It has been suggested that only interactive health behaviour-change Web sites that advise, assess, assist, provide anticipatory guidance, and arrange follow-up have the potential to lead to successful behaviour change. Additional factors that may affect the success rate of behaviour-change programs are the reach of and the exposure to such programs. Chapter V, entitled "Behavior Change through ICT Use: Experiences from Relatively Healthy Populations" by Marieke W. Verheijden, elaborates on all of these issues and discusses the following components in more detail: the Internet as a communication channel; the potentials and minimum requirements of Web-based behavior-change programs; the delivery of, reach of, and exposure to Web-based behavior-change programs; and the feasibility and effectiveness of Web-based behavior-change programs. This chapter focuses specifically on relatively healthy populations as opposed to patient populations. The chapter emphasizes that conventional mass media generally focus on new discoveries about diseases and their treatment. Much less attention is focused on disease prevention, health behaviour, or early detection. This is in sharp contrast with the general idea that an ounce of prevention is worth a pound of cure, and stresses the need for a focus on applications for relatively healthy populations. This is particularly challenging because (otherwise healthy) patients at elevated risk for cardiovascular disease stated that they were more interested in using Web-based health-promoting programs for information when confronted with a direct medical condition than for prevention purposes. The chapter concludes that the World Wide Web should never fully replace consultations and clinical examinations by health professionals. Depending on factors such as the available resources (time, space, staff, etc.) and the personal preferences of all individuals involved, an ideal mix of intervention approaches may be composed.

A nonnegligible number of elder citizens, who represent a growing fraction of the population in developed countries, has to face a number of daily-life problems stemming from their partial and progressive loss of motor, sensorial, and cognitive skills. This often makes it difficult to live autonomously and, in today's small families, often results in the hospitalization of the people concerned. Chapter VI, entitled "Challenges, Opportunities, and Solutions for Ubiquitous Eldercare" by Paolo Bellavista, Dario Bottazzi, Antonio Corradi, and Rebecca Montanari, overviews the state of the art of solutions for elder assistance, typically at home, and for coordinated-care networking. It argues that wireless sensors and actuators can improve elder life independence, for example, by transforming homes in smart elder-care environments with remote health-status monitoring, remote diagnostics, and facilitated house activities. On the other hand, pervasive wireless computing enables novel opportunities for caregivers, elders, family members, friends, and neighbors to collaborate and coordinate in an impromptu way to provide elder care and social support anytime and anywhere. The chapter points out to the need for advanced context-aware frameworks to properly establish ubiquitous and spontaneous communities of helpers when needed.

Section III: Security, Reliability, and Interoperability

The third section of the book deals mainly with three interrelated dimensions of service quality for Web-based and mobile-based systems, that is, security, reliability, and interoperability.

Wireless technology has broad implications for the health-care environment. Despite its promise, this new technology has raised questions about the security and privacy of sensitive data that are prevalent in health-care organizations. All health-care organizations are governed by legislation and regulations, and the implementation of enterprise applications using new technology is comparatively more difficult than in other industries. Using a configuration-ideographic case-study approach, Chapter VII of the book, "Bringing Secure Wireless Technology to the Bedside: A Case Study of Two Canadian Healthcare Organizations" by Dawn-Marie Turner and Sunil Hazari, investigates security and privacy challenges faced by two Canadian health-care organizations. In addition to interviews with management and staff of the organizations, a walk-through was also conducted to observe and collect first-hand data about the implementation of wireless technology in the clinical environment. In the organizations under examination, it was found that wireless technology is being implemented gradually to augment the wired network. Problems associated with implementing wireless technology in these Canadian organizations are also discussed. Because of different standards in this technology, the two organizations are following different upgrade paths. Based on the data collected, best-practice guidelines for secure wireless access in these organizations are proposed.

The quality and accuracy of online health information is an area of increasing concern for health-care professionals and the general public. Chapter VIII, "Reliability and Evaluation of Health Information Online" by Elmer V. Bernstam and Funda Meric-Bernstam, discusses the problem of how to evaluate online health information. The chapter defines relevant concepts including quality, accuracy, utility, and popularity. It briefly reviews Web search-engine fundamentals and discusses desirable characteristics for quality-assessment tools and the available evidence regarding their effectiveness and usability. The chapter points out that although there is evidence that online information affects health-care decisions, there is little evidence that users are considering quality when accessing health information online. Helping users identify problematic health information online remains an open problem. The chapter emphasizes that the currently available quality-assessment tools cannot be reliably assessed by Web users and may not be effective at identifying problematic health information online. It concludes with advice for health-care consumers as they search for health information. The prudent health seeker will use online resources for education, but review important decisions with their health-care provider. In general, the chapter asserts that government, charity-organization, or academic Web sites are more likely to provide impartial advice compared to company (commercial) Web sites. However, this is a generalization and there may be exceptions.

One of the major challenges in healthcare database integration is the fact that the lack of guidance from central authorities has, in many instances, led to incompatible health-care database systems. Such circumstances have caused problems to arise in the smooth processing of patients between health-service units, even within the same health authority. Due to the lack of uniformity, these systems have very poor interoperability and therefore usability.

There are two potential solutions to the problems of interoperability and automated information processing: redesigning and re-implementing the existing databases or using a database federation. Redesigning and re-implementing existing databases requires large capital investments, and sometimes it is impossible. An alternative solution is to build a database federation in which problems caused by database heterogeneity are remedied by the use of a mediator: metadata. Chapter IX, entitled "Integrating Mobile-Based Systems

with Healthcare Databases" by Yu Jiao, Ali R. Hurson, Thomas E. Potok, and Barbara G. Beckerman, discusses the issue of interoperability and focuses on two major challenges in distributed health-care database management: database heterogeneity and user mobility. The chapter designs the prototype of a mobile agent-based data-access system framework that can address these challenges. It applies a thesaurus-based hierarchical database federation to cope with database heterogeneity and utilizes the mobile-agent technology to respond to the complications introduced by user mobility and wireless networks. The functions provided by this system are described in detail, and a performance evaluation is also provided.

Section IV: Patient Empowerment

The new patient-empowerment paradigm promotes the development of novel care approaches in which outpatient monitoring is a basic aspect. Section IV of the book comprises three chapters that deal with issues related to patient empowerment.

Mobile information and communication technologies are advancing rapidly and provide great opportunities for home monitoring applications in particular for outpatients and patients suffering from chronic diseases. Because of the ubiquitous availability of mobile phones, these devices can be considered as patient terminals of choice to provide a telemedical interaction between patients and caregivers. Chapter X, "Utilizing Mobile Phones as Patient Terminal in Managing Chronic Diseases" by Alexander Kollmann, Peter Kastner, and Guenter Schreier, deals with the management of chronic diseases and identifies three phases of monitoring: pretreatment, adoption, and long-term treatment. It emphasizes that the most challenging part is the user interface, that is, to offer the user a method to enter measured data into a system as well as to receive feedback in a comfortable way. The chapter presents a solution for the mobile-phone-based patient terminal developed. The chapter illustrates that mobile data services and transmission protocols like SMS (short-message service), MMS (multimedia messaging service), WAP (wireless application protocol), and HTTP (hypertext transfer protocol) can be used to exchange data and information between patients and their caregivers. These methods have already been evaluated in several clinical trials and feasibility studies, and medical benefits could be demonstrated as well. However, the possibilities for using mobile phones as patient terminals are limited due to small displays, poor resolution, and small buttons for user interaction.

According to the authors, up to now there has not been any method that fulfils all criteria of an ideal patient terminal in terms of high usability, adaptability, flexibility, and low cost. Every method for entering data implies specific advantages and disadvantages. The chapter recommends that when designing a mobile-phone-based home monitoring system, the patient terminal that best fits into a particular monitoring application should be chosen on an individual basis, depending on the requirements, the user group, and the medical demand.

The second chapter in Section IV is Chapter XI, entitled "Considerations for Deploying Web and Mobile Technologies to Support the Building of Patient Self-Efficacy and Self-Management of Chronic Illness" and written by Elizabeth Cummings and Paul Turner. This chapter examines issues relating to the introduction of information and communication technologies that have emerged as part of the planning for the Pathways Home for Respiratory Illness project. The project aims to assist patients with chronic respiratory conditions (chronic obstructive pulmonary disease and cystic fibrosis) to achieve increased levels of

self-management and self-efficacy through interactions with case mentors and the deployment of ICTs.

The chapter highlights the fact that in deploying ICTs, it is important to ensure that solutions implemented are based on a detailed understanding of users, their needs, and complex interactions with health professionals, the health system, and their wider environment. Achieving benefits from the introduction of ICTs as part of processes aimed at building sustainable self-efficacy and self-management is very difficult, not least because of a desire to avoid simply replacing patient dependency on health professionals with dependency on technology. More specifically, it also requires sensitivity toward assumptions made about the role, impact, and importance of information per se, given that it is often only one factor among many that influence health attitudes, perceptions, actions, and outcomes. More broadly, the chapter indicates that as ICT-supported patient-focused interventions become more common, there is a need to consider how assessments of benefit in terms of a cohort of patients inform us about individual patients' experience and what this implies for aspects like individualised care or patient empowerment. At this level, there are implications for clinical practice and one-size-fits-all care-delivery practices.

Chapter XII is the third chapter in this section. The chapter is entitled "PDAs as Mobile-Based Health Information Deployment Platforms for Ambulatory Care: Clinician-Centric End-User Considerations" by Jason Sargent, Carole Alcock, Lois Burgess, Joan Cooper, and Damian Ryan. It discusses the broad theme of clinician-centric end-user acceptance toward the adoption of personal digital assistants (PDAs) as mobile-based health information deployment platforms within ambulatory care service settings. Personal digital assistants, ambulatory care, and point of care (POC) are defined and their interrelatedness discussed. Issues, controversies, and problems such as mapping existing workflows, security, and change management are identified, and solutions are suggested for the process of transforming predominantly paper-based ambulatory care systems into electronic point-of-care (ePOC) systems. A current research and development project, the ePOC PDA project, is used as a case study to highlight discussion points. The purpose of this chapter is to illustrate end-user implications and considerations when introducing ePOC systems into ambulatory care service settings and to highlight ways and means of improving future levels of acceptance and support of ePOC systems for clinician end users.

Section V: Industrial Applications

The fifth section of the book features three chapters that deal with three applications of Web-based and mobile-based technologies: image viewing, radio-frequency identification (RFID), and waiting-list rescheduling using GSM (Global System for Mobile Communication) SMS messages.

Teleradiology is the technology of remote medical consultation using x-ray, computed tomographic, or magnetic resonance images. It has been commonly accepted by clinicians for its effectiveness in making diagnoses for patients in critical situations. Because of the huge volumes of data involved in teleradiology, clinicians are not satisfied with the relatively slow data transfer rate. It limits the technology to fixed-line communication between the doctor's home and his or her office. Chapter XIII of the book, entitled "3G Mobile Medical Image Viewing" by Eric T. T. Wong and Carrison K. S. Tong, presents a mobile high-speed wireless medical image-viewing system using 3G (third generation) wireless network, virtual private

network, and one-time two-factor authentication (OTTFA) technologies. Using this system, teleradiology can be achieved by using a 3G PDA phone to query, retrieve, and review the patient's record at anytime and anywhere in a secure environment. The chapter emphasises that the system significantly improves the patient-data availability, which is crucial to the timely diagnosis of patients in critical situations.

When dealing with human lives, the need to utilize and apply the latest technology is very important and requires accurate, near-real-time data acquisition and evaluation. At the same time, the delivery of patients' medical data needs to be as fast and as secure as possible. One way to achieve this is to use a wireless framework based on radio-frequency identification. This framework can integrate wireless networks for fast data acquisition and transmission while addressing the privacy issue. Chapter XIV, entitled "Intelligent Agents Framework for RFID Hospitals" by Masoud Mohammadian and Ric Jentzsch, discusses the development of an agent framework in which RFID can be used for patient-data collection. The chapter presents a framework for the knowledge acquisition of patient and doctor profiling in a hospital. The acquisition of profile data is assisted by a profiling agent that is responsible for processing the raw data obtained through RFID and a database of doctors and patients.

"Rescheduling Dental Care with GSM-Based Text Messages" is the title of Chapter XV. This chapter is authored by Reima Suomi and Ari Serkkola. In this chapter, the authors propose a framework for an integrated electronic health platform (e-health). Most of the platform is still at the planning stage, but the first applications are already up and running, among them, dental service appointment rescheduling. In this application, new patients for filling cancelled dental service appointments are searched for from an existing waiting list using GSM SMS messages. The first few months of operation have already shown that the new application, in conjunction with other methods in use, could limit the share of time slots that dentists completely lose through cancellations to under 10% of all cancelled times. The chapter presents and analyses the function of this SMS-message-based dental service appointment reservation system, which is being implemented in Lahti, Finland. The analysis contains a description of the system functions, as well as some assessment of the success from a service provider and customer point of view.

Section VI: Conceptual Frameworks

The significance of aligning IT with corporate strategy is widely recognized, but the lack of an appropriate framework often prevents practitioners from integrating emerging information technologies within organizations' strategies effectively. The sixth and final section of the book features two chapters that address conceptual frameworks for mobile-based and Web-based systems.

Chapter XVI, entitled "Conceptual Framework for Mobile-Based Application in Healthcare" by Matthew W. Guah, addresses the issue of deploying Web services strategically within a mobile-based health-care setting. A framework is developed to match potential benefits of Web services with corporate strategy in four business dimensions: innovation, internal health-care process, patients' pathway, and the management of the health-care institution. The author argues that the strategic benefits of implementing Web services in a health-care organization can only be realized if the Web-services initiatives are planned and implemented within the framework of an IT strategy that is designed to support the business strategy of

that health-care organization. The chapter uses case studies to answer several questions relating to wireless and mobile technologies and how they offer vast opportunities to enhance Web services. It also investigates what challenges are faced if this solution is to be delivered successfully in health care. The health-care industry globally, with specific emphasis on the USA and United Kingdom, has been extremely slow in adopting emerging technologies that focus on better practice management and administrative needs. The chapter elaborates certain emerging information technologies that are currently available to aid the smooth process of implementing mobile-based technologies in the health-care industry.

The last chapter of the book, Chapter XVII, is written by Latif Al-Hakim and is entitled "IDEF3-Based Framework for Web-Based Hospital Information System." The chapter presents a framework for a Web-based hospital information system to manage the surgery-management process (SMP). The framework can also be used to manage any other hospital information-system processes. The developed framework challenges the traditional hospital Web strategies with a dual aim: first, to improve customer satisfaction in an environment that often involves unexpected deviation from planned activities, and second, to create a system that is an effective decision-support system for SMP. The chapter identifies factors affecting SMP decisions and employs a descriptive modeling technique known as IDEF3 to map the information flow within and between elements of SMP. IDEF3 is a member of Integrated Definition (IDEF) initiatives developed by US Air Force. The IDEF3 process mapping becomes part of an integrated Web-based system of multiple stages. Each stage has three levels of accessibility. The first level of the Web system is accessible by the public. It allows the public to obtain the necessary information and download the required forms. The second level is accessible by patients and their designated representatives. It allows them to communicate actively with the hospital management and to receive explanations for delays and any other complications. The third level is accessible only by hospital professionals. It allows them to retrieve and update the required information and enables real communication between them during the decision-making process.

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List of Reviewers

Among 39 chapter proposals initially received, only 26 of them had been accepted for possible inclusion in this book. Each chapter of the book has been blind reviewed by at least two reviewers. Some chapters had been reviewed more than once before final acceptance. The number of accepted chapters is 17. Below is the list of reviewers.

Rajeev Bali	Coventry University, United Kingdom
Paolo Bellavista	University of Bologna, Italy
Elmer Bernstam	University of Texas, USA
Eberhard Bischoff	University of Wales Swansea, United Kingdom
Elizabeth Cummings	University of Tasmania, Australia
Matthew W. Guah	University of Warwick, United Kingdom
Sunil Hazari	University of West Georgia, USA
Yu Jiao	Oak Ridge National Laboratory, USA
Alexander Kollmann	ARC Seibersdorf Research GmbH, Austria
Heather Maguire	University of Southern Queensland, Australia
Massimo Memmola	Catholic University, Italy
Masoud Mohammadian	University of Canberra, Australia
Niki Panteli	University of Bath, United Kingdom
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Barbara Roberts	University of Southern Queensland, Australia
Mark Toleman	University of Southern Queensland, Australia
Paul Turner	University of Tasmania, Australia
Marieke Verheijden	TNO Quality of Life, Netherlands
Nilmini Wickramasinghe	Illinois Institute of Technology, USA
Eric Wong	The Hong Kong Polytechnic University, Hong Kong

Section I

Web and Mobile Strategies