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# Lessons learned from the practice of mobile health application development

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# Lessons learned from the practice of mobile health application development

## **Abstract**

This fast abstract briefly discusses lessons learned in terms of how to overcome limitations of PDA devices, effectively capture requirements for mobile health application development and effectively reengineer a desktop application on PDA. The limitation of PDA devices includes: (1) small screen size, which limits text-based data entry, reporting and browsing; (2) limited storage space and slow processing, which requires effective and efficient coding generation; (3) security limitations and inadequate third party application support, which poses challenge for application development. The corresponding strategies addressing the above challenges are: (1) providing check box, radio button, drop down list, text field, combo box based data entry and minimize text-based data entry, such as text area; (2) allocating as much as possible data storage, communication and computation tasks to the desktop system and minimize the function PDA component needs to handle, store data in file instead of database on PDA; (3) carefully selecting the device and implementation platform that supports development. To maximize the usability of PDA-based health application, the solution to be implemented on PDA ideally should be data management tasks with minimum text-based data entry and high frequency of recording. Challenges and solutions for software reengineering from desktop system to PDA-based application is outlined based on one application developed for World Health Organisation. In this example, the complex task of communication among PDA-based application, desktop system and the existent desktop application EpiData is effectively handled through the utilisation of XML files. A dynamic tool 'Questionnaire Designer' provides a completely dynamic user interface generation tool that could easily be handled by end user. The design idea for this application sets up a model for mobile health application with adequate flexibility of handling changing data management needs of end users.

## **Keywords**

health care, medical information systems, mobile computing, notebook computers, systems re-engineering, user interfaces

## **Disciplines**

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# Lessons Learned from the Practice of Mobile Health Application Development

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## Abstract

This fast abstract briefly discusses lessons learned in terms of how to overcome limitations of PDA devices, effectively capture requirements for mobile health application development and effectively re-engineer a desktop application on PDA. The limitation of PDA devices includes (1) small screen size, which limits text-based data entry, reporting and browsing; (2) limited storage space and slow processing, which requires effective and efficient coding generation; (3) security limitations and inadequate third party application support, which poses challenge for application development. The corresponding strategies addressing the above challenges are (1) providing check box, radio button, drop down list, text field, combo box based data entry and minimise text-based data entry, such as text area; (2) allocating as much as possible data storage, communication and computation tasks to the desktop system and minimise the function PDA component needs to handle, store data in file instead of database on PDA; (3) carefully selecting the device and implementation platform that supports development.

To maximise the usability of PDA-based health application, the solution to be implemented on PDA ideally should be data management tasks with minimum text-based data entry and high frequency of recording. Challenges and solutions for software re-engineering from desktop system to PDA-based application is outlined based on one application developed for World Health Organisation. In this example, the complex task of communication among PDA-based application, desktop system and the existent desktop application EpiData is effectively handled through the utilisation of XML files. A dynamic tool 'Questionnaire Designer' provides a completely dynamic user interface generation tool that could easily be handled by end user. The design idea for this application sets up a model for mobile health application with adequate flexibility of handling changing data management needs of end users.

## Introduction

An integral part of work practice for health care professionals is that they are always mobile, frequently being called upon and moving among clinics, hospitals, patient beds, wards and even patient homes. Therefore, there is a high demand for mobile health application that really suits the needs of information capture, transmission, storage and retrieval for mobile health care workers.

The authors have two years development experience with mobile healthcare applications. This fast abstract will discuss lessons learned in terms of how to overcome limitations of PDA devices, effectively capture requirements for mobile solution and successfully re-engineer a desktop application on PDA.

## Barriers posed by limitations of device for the development of PDA based mobile health application

The limitations of the current models of personal digital assistants (PDAs) are

- Small screen size that does not support viewing of large tables / electronic health records in a single screen. It is recommended that reporting function is better not to be implemented on PDA.
- The small screen size causes extreme difficulty in typing on PDA. Mismatch is often encountered on recognition of handwriting with the PDAs we used. Therefore text-based data entry should be avoided in PDA-based mobile application.
- Limited storage space and slow processing speed determines that PDAs should not be used for performing complicated tasks such as graphics processing or support database.
- Security limitations such as messages are easily to be hacked if transmitted across wireless network. The device is easy to be lost or stolen due to its small size. The application on device is not protected by password yet. If the device is stolen, patient information privacy is under treat.
- Inadequate third party application support makes development a very tedious and time-consuming process. The current models of PDAs do not support

huge library system, such as MSDN for Microsoft VisualStudio.NET.

The above factors lead to the realisation that any PDA based application useful for end users should optimally utilise GUI-based application, with major mode of data entry based on check box, radio button, drop down lists, combo boxes or text field with minimal need for typing or text based data entry. The mechanism to overcome memory limitation of PDAs is to store captured data on files other than database on PDA. Complicated functions and storage function should be maximised on the desktop application with the purpose of minimising the workload of PDA. Microsoft Compact Framework, a short-cut version of Microsoft Visual Studio.NET, provides a relatively convenient and friendly development environment in terms of ease of synchronisation with desktop system and GUI component support. Choosing PDAs that support Compact Framework definitely will ease the workload of programmers and increase the speed of application development.

### **Challenges for requirements engineering when developing mobile health applications**

Capturing requirements for PDA based mobile health care application development are significantly challenge due to the limitations addressed above.

The first challenge faced by developing a PDA based 'Electronic Resident Management System' for a nursing home was the accurate and complete mapping of nurse's workflow and documentation needs to the PDA application. Tasks required long text-based data entry was eliminated from re-engineering consideration due to limitation of PDA device. A user-centered requirements development process identified that the work practice of 'bowel movement management' activity has potential to be optimised by PDA based application. The reason is: (1) it is a task that requires high frequency of data entry, which effectively justifies the need for the investment of PDA device and application development. (2) Recording of the task does not involve large amount of text-based data entry. The major data entry for this work practice could be nicely fit in drop down lists, radio buttons and check boxes, which is the recommended data entry format for PDA based application.

### **Challenges in software re-engineering when moving from desktop system to PDA-based application**

The limitations of PDA device and its computational power makes the move from desktop information system to PDA based application a real challenge. The first author was commissioned to develop a PDA-based data collection/entry tool to increase efficiency and reduce data transcription errors for the STEPS non-communicable

disease (NCD) risk factor surveillance project by the World Health Organisation (WHO). The original questionnaire was designed in open source software EpiDATA, which provides means for users to build a questionnaire, collect data with the questionnaire and store data in file format. The re-engineering of the data capturing mechanism on PDA was a real challenge in terms of (1) mapping the data captured by PDA application to the existent database EpiDATA, (2) providing a flexible application capable of handling changing information capture and data entry requirements of user, (3) making interface for PDA application simple, easy to understand and user friendly.

The solution to the first problem is the dynamic generation of XML files for mapping questionnaire files and records on PDA between those stored on desktop system and EpiDATA. An application component 'eSTEPS Manager' was built with GUI interface that manages the data transmission among PDA component, desktop systems supported by Windows operating system and EpiData. Solution for the second problem is the inclusion of an independent component 'Questionnaire Designer', which provides a completely dynamic application tool for user to customise their own PDA interface in terms of creating question text displayed on PDA and the GUI container for answering the questions, such as radio buttons, text fields, numeric fields and text areas. The questionnaire file created is an XML file, which is transmitted onto PDA and used to capture data. The record captured on PDA is stored in another XML file .rec file. Through 'eSTEPS Manager', the user can transmit any questionnaire file or record file on PDA to the desktop, and the record file to EpiData database, or vice versa. As users are given the complete autonomy of building up their own dynamic interface, solution for the third problem is passed on to the user. The questionnaire interface we built up so far are all very simple and easy to use. The application is completely dynamic, easy to use and fully satisfy user's requirements.

### **Conclusion**

Mobile health application based on PDA device provides a new way of information management for health care professionals. It gives promise for the pervasive computing to enable "providing the right information to the right health care provider about the right patient at the right time and at the right place". However, many challenges such as processor speed of PDA, security and most importantly, interface design have to be improved before mobile health application will be accepted by health care workers.