

# An Application of Knowledge Management for Construction Using Mobile PDA System

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**Abstract:** Personal Digital Assistants (PDA) and World Wide Web (WWW) that are rapidly gaining popularity are fundamental technologies for a vision of information access for anyone, anytime, anywhere. However, there are few applications for on-site engineers to use the Personal Digital Assistants (PDA) in the construction industry. In the view of construction productivity, the fact it is not convenient for on-site engineers to record the construction process and obtain the needed information directly by using notebooks is an unsolved problem in the construction management. This paper describes a Mobile-PDA system for construction called Construction Personal Digital Assistants (ConPDA) System. ConPDA comprises five functions including daily report, material management, quality control management, experience tips, and specification database. The advantages of ConPDA is not only to collect data and information efficiently but also manage and re-use professional experience and knowledge.

**Keywords:** Information Technology; PDA (Personal Digital Assistant); Knowledge Management

## 1. Introduction

It is not convenient for on-site engineers to record the construction process and obtain the needed information directly by using notebooks in the harsh construction environment. Furthermore, paper-based manual at the site processes becomes obsolete in today's construction industry.

The information needed for on-site engineers are either verbal or more likely written down in papers like Word and Excel documents, drawings, contract, specifications and shop drawings. On the construction site information are usually presented in paper form. Therefore, project information should be printed out from the computer in advance and be carried by engineers in the job site. To collect data during construction, such as inspection and test data are most common to write down by pen or take photo at construction site, then input these data into computers in the office. The ineffectiveness and inconvenience of current ways of information processing and data collecting at construction sites can be improved by integrated with promising information technology [1].

New technologies as personal digital assistants have the ability to extend computer support to the site. The popularity of PDA is growing rapidly with the advent of more powerful devices and wider range of available applications [2]. PDAs are being applied to many different tasks including personal information management, communications, information seeking, entertainment, location dependent services, and e-

Commerce [3]. By identifying the information flow needs and by obtaining the wireless technology that meets the companies requirements it creates a large potential to increase efficiency and effectiveness of information flow and therefore to streamline construction processes.

In order to improve current ways of data processing at construction site by providing computer support to the construction site, the structure and prototype of the proposed system are described in the following. This paper investigates how these technologies can be utilized to improve efficiency and effectiveness of construction management and knowledge management processes. These processes include access to information processing and data collecting on the site and application for personal digital assistants in construction site. Furthermore, the paper describes the prototype and example of ConPDA that allows the on-site engineer to access data and information at a remote host from a construction site.

## 2. Problem Description and Research Objective

During the process of Construction, on-site engineers have to refer to drawings and specifications all the time. It is not easy and convenient for on-site engineers to carry all the needed drawings and specifications on construction site. It is necessary and frequent for on-site engineers to refer drawings and specifications all the time in site.

Data collecting during construction, such as inspection and test data, is necessary and important during the construction. It is usually for on-site engineers to record all data by pen at the construction site, and then input the data to desktop or notebook again by using computers in the job office. The procedure of data collecting for site engineers is not effectively and is easy to make mistakes during the feedback on design and construction.

It is very necessary and important for on-site engineers to note experience tips, problems solutions, or unsolved problems during construction in the construction site. The problem is that it is not easy for them to collect and manage these knowledge and information in view of property of know-how for company. Besides, there is no suitable tool for on-site engineers to work with instead of writing down know-how and experience by paper work.

Finally, there is no handy and light tool for on-site engineers to access information that on-site engineers need to know or refer to in site immediately between main office and job site. In addition, on-site engineers always move around the construction site anytime and anywhere. It's very inconvenient to do paperwork and refer large drawings at muddy and dangerous environment.

According to the above problems, it is obvious to understand that on-site engineer and information are going to waste time in traveling without good ways of communication. Therefore, to provide a portable computing device to help on-site engineers to enter data and acquire construction site information any time in construction site, Personal Digital Assistant (PDA) is as the current technology and solution of mobile computing.

The objective of this paper is to develop a PDA application called Construction Personal Digital Assistants System (ConPDA) to manage and communicate the information between the construction site and the construction office.

### 3. Framework of Construction using mobile PDA System

In this research, the ConPDA system provides electronic document format to minimize the possibilities for recording mistakes, and the application of experience collection and knowledge sharing in the construction knowledge management portal (CKMP). Figure 1 and Figure 2 show the overview and architecture of ConPDA.

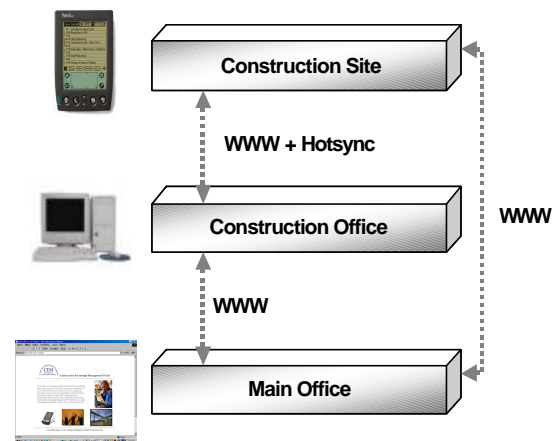


Figure 1: ConPDA architecture (overview)

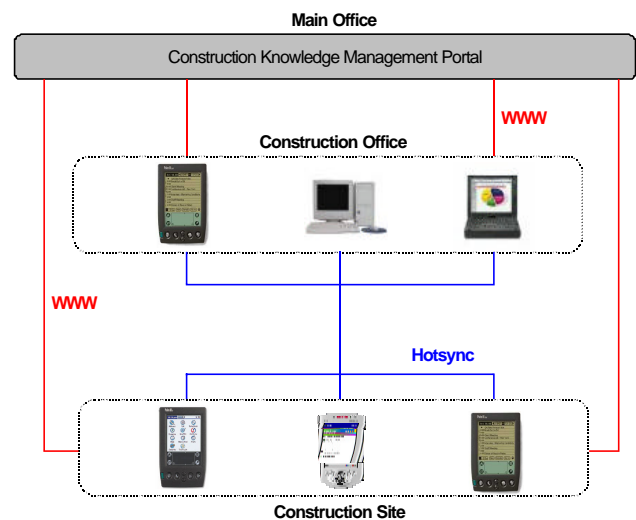


Figure 2: Construction Personal Digital Assistants System

The ConPDA system is developed to solve the problems described above, including experience tips module, daily report module, material management module, quality control module, specification module, as illustrated in Figure 3. The functions and contents are described as follows:

#### 3.1. Experience Tips Module:

The main objective of this module is to supply on-site engineers a tool to record or note their experience, solutions, unsolved problems, and important notes during construction in the site. Above information collection is very important for knowledge management in construction. On-site engineers note the information on the PDA and send back to Construction Knowledge Management Portal directly by linking with the PDA's wireless telecommunication extended device. Besides, these information, unsolved problems, and valued

knowledge will post in the Construction Knowledge Management Portal to furnish the service of the knowledge collection, knowledge sharing, and e-learning in the construction field.

### 3.2. Daily Report Module:

The daily report module provides on-site engineers with an exhaustive record of daily activities on site. Engineers can record the data and information concerning date, weather, schedule, detail information, description of works done, problems occurred and accurate quantity of human, machine, and material. All information of this module can be utilized directly again for weekly reports; monthly reports, schedule control reports, and cost control reports because they are electronic document format.

### 3.3. Material Management Module:

The material management module mainly provide the easy and portable environment for on-site engineers to trace and record all information concerned about the material status which have stored in the warehouse or will be delivered to the site recently. The content of module records the information including material name, location, safety quantity, quantity and duration of inbound and outbound orders. The module can let on-site engineers to keep material management well and quick in construction site and meet the objective of supply chain and quick respond in construction site.

### 3.4. Quality Control Module:

On-site engineers may download the current quality tests formats via the Internet. They can write down the test value and status, check the test data, and compare the result with standard value written on the specification. This module is programmed the function of the mean, standard deviation, and coefficient of variation automatically. The advantage of the module is that on-site engineers may obtain the result of test quickly in construction site and all record of test can be communicated between job site and job office through real-time synchronization without reentering the data again.

### 3.5. Specification Module:

This module can provide on-site engineers a more convenient way to work in the construction site without carrying heavy contracts and weighty specifications. On-site engineer can download these specifications in advance and reference them just like reading e-book in the job site during construction. Besides, the function of query and search will be added for the on-site engineer easy to seek and retrieval the needed information in the more activated

and portable construction environment.

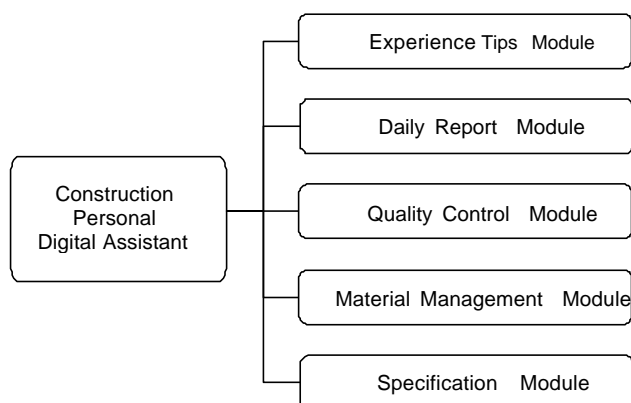


Figure 3: The main five modules in ConPDA

## 4. System Implementation

A Construction Personal Digital Assistants (ConPDA) is a part of construction knowledge management system (CKMS). The integration of construction personal digital assistants system with construction knowledge management portal can make on-site engineers to communicate data, information, and knowledge effectively between office and site and get timely feedback on design and construction. The framework of construction knowledge management system is described in Figure 4.

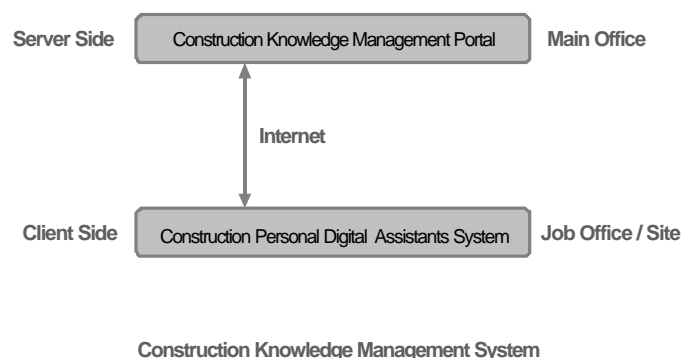


Figure 4: The framework of CKMS

A web-based construction knowledge management portal is developed by programming language - ASP (Active Server Page) and JSP (Java Server Page). By using a web browser user interface, CKMP offers a solution for on-site engineers to access information between portal and PDAs.

Most of the PDAs are using either PalmOS or Windows CE operating systems. PalmOS is still the market leader and promises to be an efficient and effective operating system although Windows CE is catching up its market share. The latest version is PalmOS 4.0, which supports Multimedia Card and SD expansion card, Infrared, and wireless

communication. 3COM has released PalmOS specifications as well as development packages, which has led to a wide selection of available software. Because of above reasons, The Palm device is selected as on-site engineers' PDA in ConPDA.

NS-Basic for Palm is adopted as programming language to develop Construction Personal Digital Assistants System (ConPDA) because it can develop applications for both PalmOS and WinCE. Its special character are follows [4] :

- Easy to use, standard and structured BASIC .
- Over a dozen standard Palm OS objects.
- Math and trigonometric function support .
- Produces standard standalone Palm apps .
- Symbol Bar Code device support .
- Built in indexed database support .
- Test on the Palm OS Emulator .

The main system requirements of construction personal digital assistants system are follows [5]:

- Hardware: a Palm device using Palm OS 3.1 or later unless otherwise stated.
- Software: Palm OS 3.1.
- Database for Palm PDA: HanDBase (David Haupt).
- Internet device: Ohfish , 56K Modem, ADSL.
- Internet: Microsoft Internet Explorer 5.0.
- Hard Space on server side: 60MB of free space

Because the data format in PDAs is different from the one of CKMS, the data format stored in PDAs is needed to transfer before accessing the information between these two systems.

The process of data format transformation in ConPDA is shown in Figure5. The figure 6 shows the construction knowledge management portal homepage and figure 8 ~ figure 15 show the screen for each model in ConPDA.

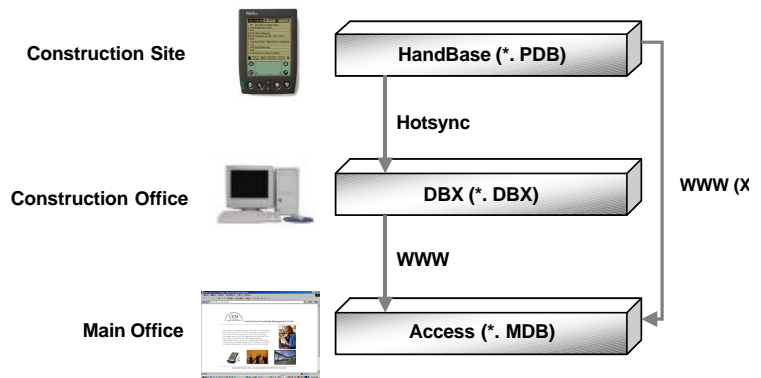


Figure 5: Process of Data Format Transformation in ConPDA

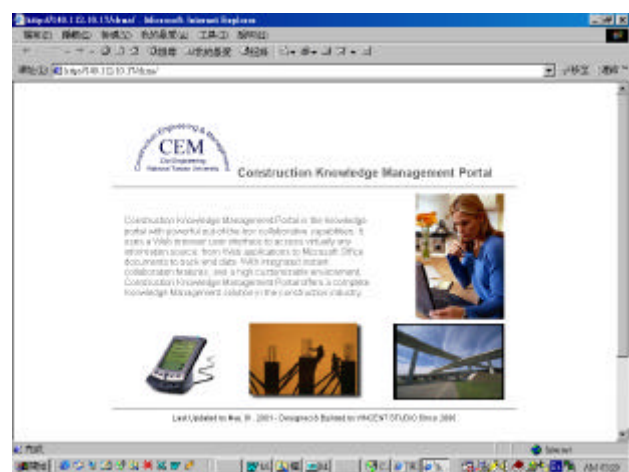


Figure 6: Construction Knowledge Management Portal



Figure 7: Table of Main Menu of ConPDA

**Welcome CKMS!**

Select Project:

Project ID: ▼ 00101

Project Name: Financial Building\_A

Description:

Name: Financial Building A

Location: Taipei, East-south

Owner: Universal Finance Co.

Contractor: XYZ construction Co.

Architect: Eric Lee Co.LTD

Start Date: 2001/01/01

[New] [Select] [Cancel]

Figure 8: PDA Screen of Project Selection

**Quality Control Module**

Date: 2001/01/01

Project ID: 00101

Project Name: Building\_A

Test Name: Compress

Test Times: ▼ 03

Value type: ▼ Share Strength

Unit: kg/cm<sup>2</sup>

Standard Value: 800

Value1: 812

Value2: 896

[Submit] [Cancel]

Figure 12: Quality Control Module

**New Daily Report**

Date: 2001/01/01

Project ID: 00101

Project Name: Building\_A

Labor type: ▼ Site Engineering

Labor unit: ▼ 01

Labor no: ▼ 01

Machine type: ▼ mobile crane

Machine no: ▼ 1

Machine unit: ▼ 8hours/day

Material type: ▼ concrete 3000psi

Material unit: ▼ 1

[Submit] [Renew] [Cancel]

Figure 9: Daily Report Module

**Specification Module**

Search: [Submit]

01.General Requirements

02.Sitework

03.Concrete

04.Masonry

05.Metals

06.Wood and Plastics

07.Thermal and Moisture Protection

08.Doors and Windows

09.Finishes

10.Specialties

[Enter] [Exit]

Figure 13: Specification Module(a)

**Experience tips**

Topic: Be careful

Date: 2001/01/01

Sender: Alex Lin

Sender dept: Job-site

Content:

Hi, Dear All:

When I walk into the constructor site this morning, my foot was hurt because of the fragment of broken steel. I hope everyone can

[Submit] [Export] [Cancel]

Figure 10: Experience Tip Module

**Specification Module**

Search: [Submit]

01.General Requirement

02.Sitework

02010.Subsurface investigation

02050.Demolition

02100.Site Preparation

02140.Dewatering

02150.Shoring and Underpinning

02160.Excavation Support System

02170.Cofferdams

02200.Earthwork

[Enter] [Exit]

Figure 14: Specification Module(b)

**Material Management Module**

Date: 2001/01/01

Project ID: ▼ 001

Project Name: Building\_A

Storage No: ▼ 003

Storage Name: ▼ Taiwan\_Taipei\_B

Location: A12\_area B

Material Type: ▼ Pipe

Material Name: ▼ PVC Pipe  $\phi$  50mm

Quantity: ▼ 01

Safe Quantity: ▼ 30

Demand Order: ▼ 01

[Submit] [Renew] [Cancel]

Figure 11: Material Management Module

## 5. Discussion and Conclusion

Current construction sites are usually manual paper-based processes at the site. New technologies as personal digital assistants have the ability to extend computer support to the site. This paper investigates how these technologies can be utilized to improve efficiency and effectiveness of construction management and knowledge management processes. These processes include access to information processing and data collecting on the site and application for personal digital assistants in construction site. Furthermore, the paper describes the prototype and example of Construction Personal Digital Assistants System (ConPDA) that allows the



on-site engineer to access data and information at a remote host from a construction site.

Personal digital assistants have been on the market for around nine years, during which times their capabilities have improved and prices have gone down. Today's personal digital assistants are not capable of presenting multimedia for a number of reasons. The most important of these reasons are shortage of RAM memory, lack of mass media devices, size and resolution of displays, network connectivity either missing or too slow for streaming usage, and lack of computing power. These capabilities will be improved in the future, however. A new generation of microprocessors will provide enough computing power for multimedia. New memory cards and mass media devices will expand memory capabilities. Display devices are improving so that in the near future users can have more colors and higher resolution without changing the display size. Also the networking capabilities are improving through the new network standards [6].

Future developments of Construction Personal Digital Assistants System (ConPDA) prototype would be a format in XML that allows a user unique structure in the text. Furthermore, the Construction Knowledge Management Portal will be performed at the server side and on-site engineers search for information and upload the data from personal digital assistants directly by the Internet at construction site or office. Integrated Construction Personal Digital Assistants System (ConPDA) with Construction Knowledge Management Portal, on-site engineers can search for information and knowledge that post in the CKMP directly and refer to all construction related information that include documents, know-how tip, contract, specifications and shop drawings by using personal digital assistants. Further, improving programming code towards small, fast performing and increasing functionality, tools as Construction Personal Digital Assistants System (ConPDA) can become useful all-inclusive useful tools for construction site engineers.

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