

PERSONAL DIGITAL ASSISTANTS AS A MOBILE INSPECTION SYSTEM AT CONSTRUCTION SITE

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ABSTRACT: Construction defects are always the key concern of the construction industry. Different constructed facilities generate different types of defects and demanded different levels and types of quality, depending on the functions, system types, and materials used. Nevertheless, construction projects was typically take place in an environment where it is difficult to gain access to conventional computers for use as real-time decision aids as the gone through the project quality inspection. The objectives of this study were to identify the inspection process and standard check list used in practice at construction site; to identify the potential and requirement for mobile inspection system at construction site and to develop a prototype of a mobile inspection system for construction site. Data was gathered from the literature study and also through local construction organizations by means of interviews and questionnaires. A prototype was developed using rapid prototyping method in a final phase. The finding revealed that in general construction industry does not have its standard inspection process and standard check list in practice. Besides this, the study also reveals that there was a potential and needs for mobile inspection system at construction site. Finally a mobile defect inspection which consists of a sub system checklist and reference system was developed to suit the need of industry. The developed prototype will standardize the way of managing defects and improve quality, increased productivity of inspectors, and accurate photographic records.

Keywords: Mobile inspection system, construction site, construction defects

1.0 INTRODUCTION

Construction defects are always the key concern of the construction industry. Different constructed facilities generate different types of defects and demanded different levels and types of quality, depending on the functions, system types, and materials used. Most research on defect concentrates on materials and systems, examining different types of defects under given conditions and determining methods for how to detect them. As a result, these researches are generally focused on technical and technological issues. Numerous systems have been designed to eliminate defects during construction operations. Many of these systems were very effective in detecting and eliminating defects that occurred at the construction stage, but a large number of complaints about defects were also recorded a few years after the occupants moved in, which suggested that there were still loopholes in the existing inspection and management systems (Chong and Low , 2005).

Construction projects typically take place in an environment where it is difficult for site engineers or project engineers at construction site to gain access to conventional computers for use as real-time decision aids as they gone through the project evaluation, building mechanical & electrical inspection, or the pre and post concrete quality inspection (Williams, 2003). Therefore there is a need to develop a functional prototype of Mobile Defect Inspection System (MDIS) which will help site engineers to carry out a defect inspection process by maintaining a good record keeping, minimizing office work and enhance the communication between construction site and site office.

2.0 POTENTIAL OF HANDHELD PC IN CONSTRUCTION INDUSTRY

Traditionally, the construction industry has employed paper-based data capture and communication methods. These were time-consuming and potentially error-prone, and discouraged project managers from using them on a regular basis. Thus people tend to minimize communication with other project participants. Since the various stages and tasks of construction are highly interdependent this minimal interaction in practice causes severe problems, widely reflecting on other partners and the final construction product (Ladh, 1995). It has been recognized for some time that capturing data through handheld computing devices, enabled with suitable wireless capability, can address these problems, thereby increasing operative efficiency and ensuring better integration with the existing project management systems.

Therefore, reference information is one of the basic uses for which handheld computers can be employed. The specific information included on the handheld device will vary from project-to-project and organization-to-organization. It would be assumed that contractors would place more of an emphasis on installation procedures, and owner organizations would emphasize documentation for inspection procedures and quality control. Typical documentation that can be accommodated on a handheld computer is such as real time progress monitoring of on-site works, remote expert support, on-site collection of qualitative and quantitative measurements, collaborative review of technical drawings, on-site supplier and subcontractor evaluation, on-site evaluation of equipment usage measurements, keeping track of the physical equipment position anytime and anywhere, answering audit checklists and filing audit reports during site audits (Meissner et.al. 2001).

The rapid growth of handheld computing devices in recent years has marked the beginning of a real mobile communication capability. From their roots as standalone devices that were reliant upon a cable connection to a desktop PC or a connected mobile phone, handhelds are now evolving to integrate features that enable wireless connection to mobile phone and corporate networks. However to a large extent, current use of mobile communication devices for the construction industry remains limited to use of standalone hand held device (Anumba et.al, 2002).

Nevertheless the used of PDA¹ and telecommunications are long exists in Construction industry and there are few research been carries out on concept of using obsolesce technology such as concept of using Psion as mobile web browser to browse through the internet at any ware in the paper of “PDA as mobile WWW browsers” (Gessler, 1995), and also using handheld computer to browse through an electronic document such as e-book in the construction industry and also using a third party software for data collection in the paper of “Applying Handheld computers in the construction industry” (Williams, 2003).

Later, the player in the construction industry had aware of the need of more capable mobile computing system in the construction industry due to the booming of information technology, then they had put their mind into and develop a concept of interaction between mobile computing system and construction in the paper “Mobile Communication In Construction-Trends And Prospects” (Anumba et.al, 2002)”. In the paper of “The application of PDA as mobile computing system on construction management” (Kimoto et.al, 2005) had draft out a stand along construction management prototype where the information collection from construction site is not transmit instantaneous and only can be retrieve and analysis when the mobile device is send back to office, further more the interface use in this prototype is a set of static programs which more to structure engineering analysis. Therefore it can not perform dynamic interaction to collect data due to the dynamic nature of construction environment.

¹ According to Apple Computer Inc (The Founder), the terminology of PDA is define as personal digital assistants which is a tools that would hold telephone numbers, keep your calendar, store notes, plus send and receive data wirelessly.

3.0 PROTOTYPE DEVELOPMENT

To serve the purpose of mobile defect inspection system, basically the MDIS is design to support two separate system parts. One part is a moveable part such as Pocket PC which runs with window CE system, and the other part is to serve a workstation which is moveable in the office for administration purpose such as Microsoft Windows 98 OS and above. The mobile support part in MDIS is design to let user to enter the data and information at any place and any time. This mean the user do not have to go back to the office to reenter the data into the work station, because all the data and information was stored in the internet portal server. Therefore, the user of the MDIS can retrieve and store information where ever they go and where ever the site is located, provided as long as there is a cellular network signal and can be connected to internet. However on the other hand, the MDIS also designs to include the non moveable unit such as work station in the office. This is to serve the purpose of defect report reference system to contractor who involve in the project and also to serve the purpose of system admin in database and also MDIS core system maintenance (Figure 1).

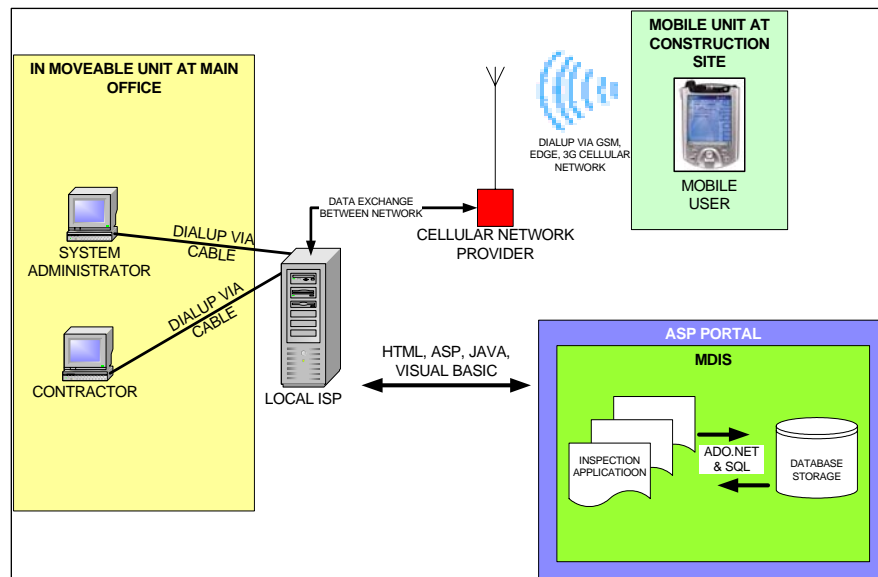


Figure 1: MDIS system topology

3.1 Database System Design

Similar to other study approach, to create a proper work flow of defect management process is to collect and study their defect process and then reengineered it to more effective and smooth defect management process as in Figure 2. Then by conducting Data Flow Diagram study, the source of input and the source of output to the MDIS system can be identified (Figure 3).

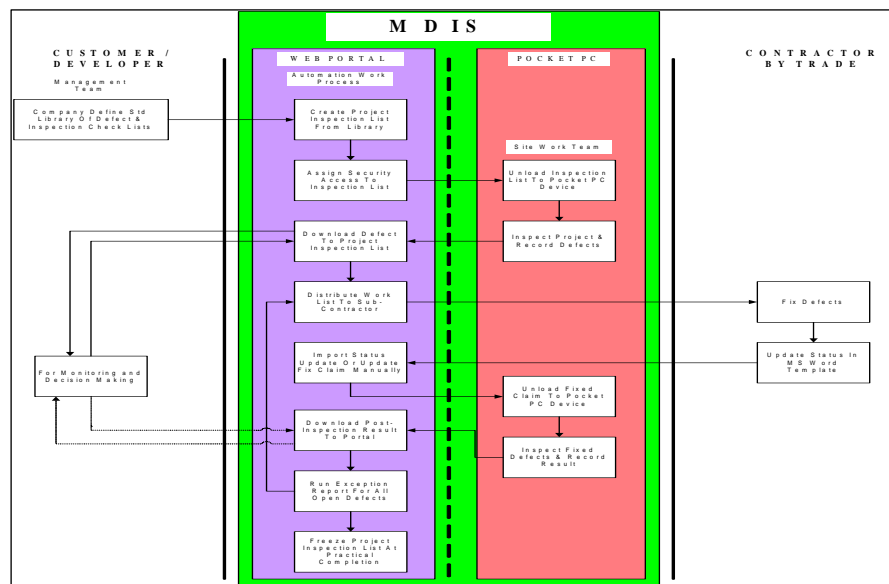


Figure 2: Defect Management Business Process

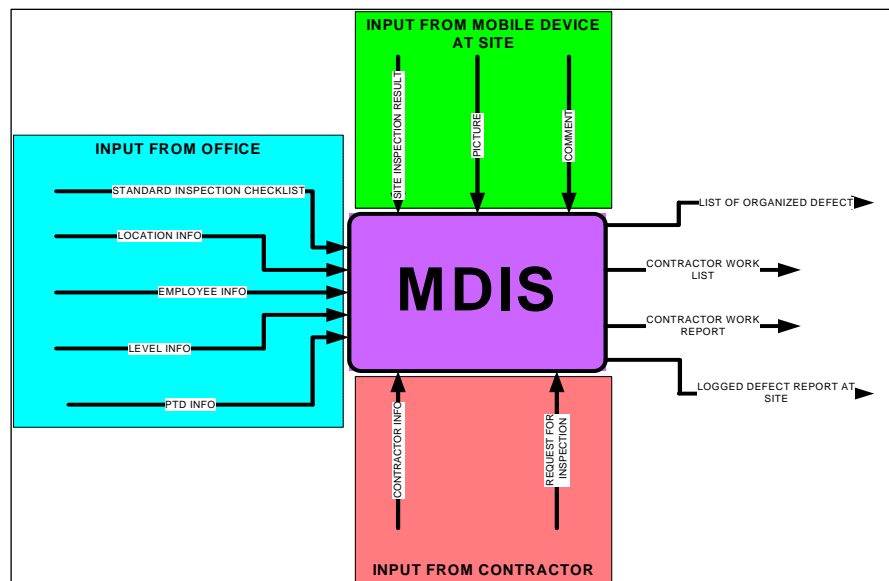


Figure 3: Data Flow for Input and Output from MDIS

Later, with the combine of reviewed and an adoption of standard defect check list from the study of “Penyediaan Senarai Semak Untuk Pemeriksaan Di Tapak Bina Bagi Kegunaan Jabatan Kerja Raya Penampang Sabah” (Nelliah, 2005), the blue print of the complete database for the MDIS was developed as in Figure 4. The basic concept of the MDIS database structure was based on seven key elements which were:-

i. List Of Standard Defect Check List

A standard defect check list proposed by previous researcher (Nelliah, 2005) which consists of 10 types most commonly used defect check list by the local Malaysian construction industry.

ii. Inspection Information

Contain necessary information to access current inspection such as inspection type, type of buildings, project name and block name.

iii. Employee Information

Consists of basic information of all employees involve in the project team and includes the inspector's background information.

iv. Level

Information which is use for accessing multistory building.

v. Location

Hold information of section in a building, example: Car park, Master Bedroom and Kitchen.

vi. Contractor Information

All the necessary basic background information of contractor will be stored. Example: Contractor's trade.

vii. PTD Number

PTD number was a very unique lot number which is register and assign by the land office of Malaysia to a particular lot of land or property, therefore this section will hole the information of the PTD number which will be use as a unique primary key to store defect information.

Microsoft Access was chosen as primary software used to manage and create the MDIS database in earlier stage. In the implementation stage of MDIS in the web portal, Active Server Language was used to access the server in retrieving and updating the MDIS portal database.

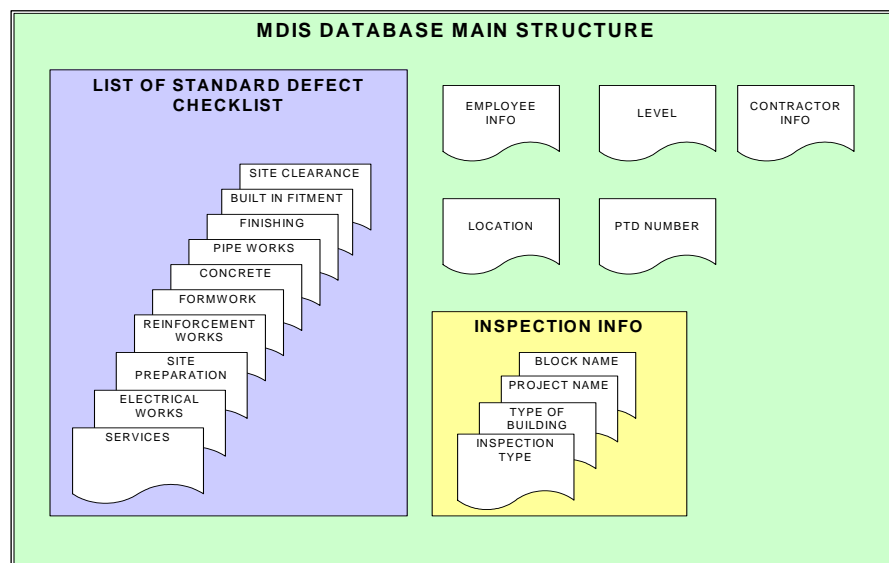


Figure 4: MDIS database

3.2 System Architectural Design

The system architecture of MDIS basically was supported by 9 functional modules written in Active Server Page Language. Each module function is unique and interacted with each other so that it serve the function of database management and control; OS detection and GUI control; image processing; information access security control by level and group; data export; data print; report auto generation; database acquisition; and data post (Figure 5).

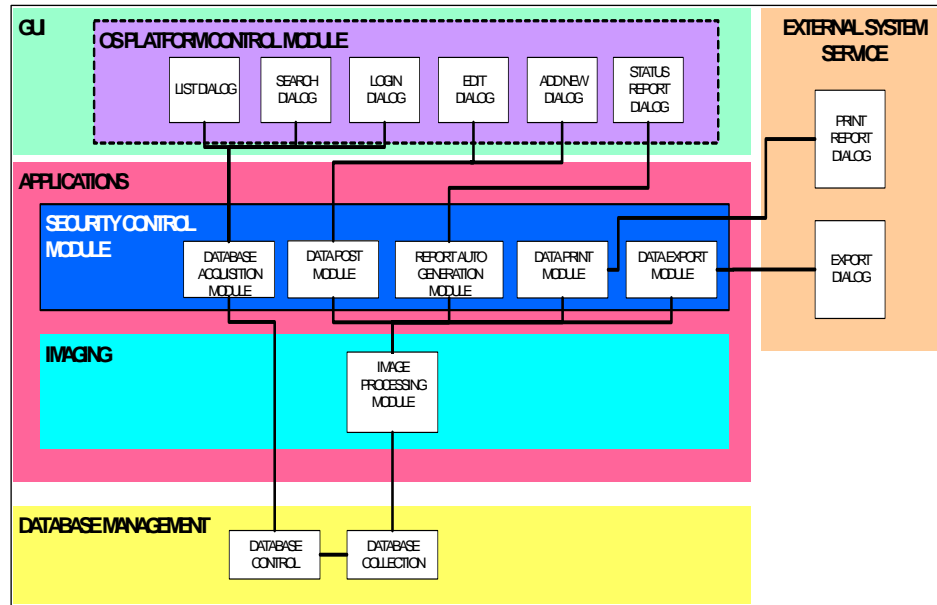


Figure 5: MDIS main system architectural

3.3 System Platform

As mentioned earlier, the MDIS system is design to support across two different OS platform which is Win CE and Standard Microsoft Windows 98 and above, therefore it is important to select a language which can communicate between these two different OS platform. Besides this, never to forget that the MDIS is an application which need to be designed and operated in a Internet Information Service (IIS) server to retrieve and save information inside the server database (Figure 6).

Therefore, in this MDIS project, Active Server Page Language (ASP), Visual Basic (VB) Language and JAVA was used as a medium which communicate through three different platforms. First, the ASP language was used as the primary medium to interact most of the process server instruction between these three different platforms. Second, the VB language was used in some form design and security checksum, and finally, the JAVA language was used in the table form to control the Graphics User Interface (GUI). Although the JAVA language was used to control tables form GUI, but the orientation and presentation of information to the user at different platform was controlled by the Hyper Text Markup Language (HTML).

For the information database retrieval at portal server, it was controlled by the ActiveX Data Object (ADO) method in order to connect the user to the database. After it have been connected to the database, it is more appropriate to use Structured Query Language (SQL) to retrieve the data or the information in the way as the end user required.

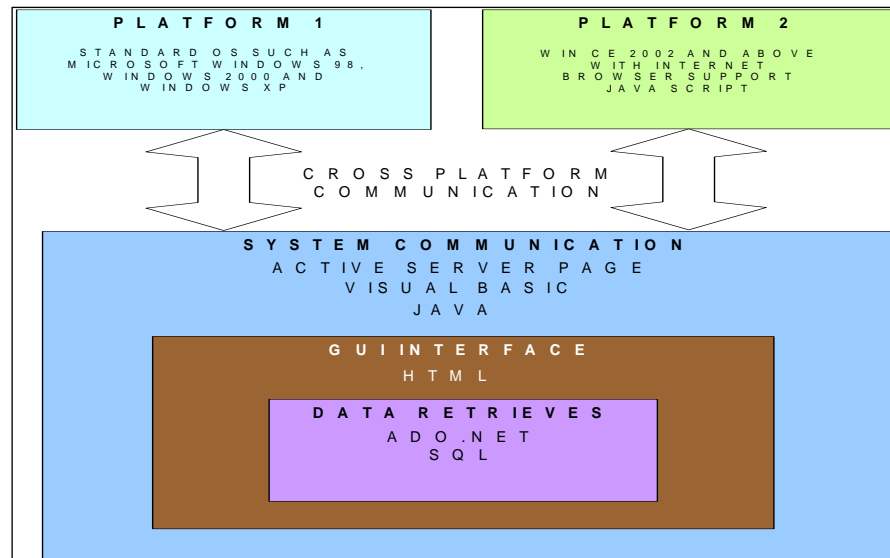


Figure 6:Cross platform function

4.0 Conclusions

By comparing the construction scenario in 80's and today, the role of information technology in construction industry have become more important because most of the construction process is going for automation and simplification. Therefore it is very important for the construction company to equip themselves with appropriate IT tools and technology in order to survive in a very competitive industry.

The development of a functional Mobile Defect Inspection System (MDIS) (Figure 7) is tailored with the current construction industry scenario which emphasized more on mobile computing at construction site. Hopefully the prototype will help site engineers to carry out a defect inspection process in a more efficient way by incorporating several advantages as follows:

- a. Standardize the way of managing defects and improve quality (Figure 8).
- b. Accurate photographic records and improved communication to contractors (Figure 9).
- c. Increased productivity of inspectors by eliminating the need for data entry back in the office and centralize and standard defect management platform (Figure 10)
- d. Eliminate delays in communicating defects to contractors (Figure 11).
- e. Instant Auto Generations for Defect Report (Figure 12)

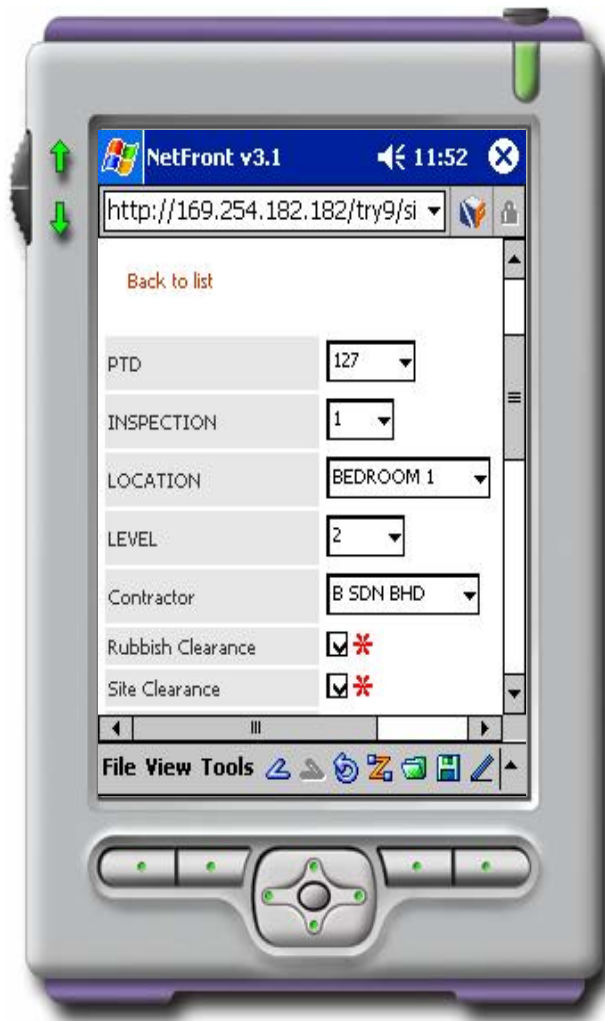


Figure 7: A Mobile Inspection Prototype

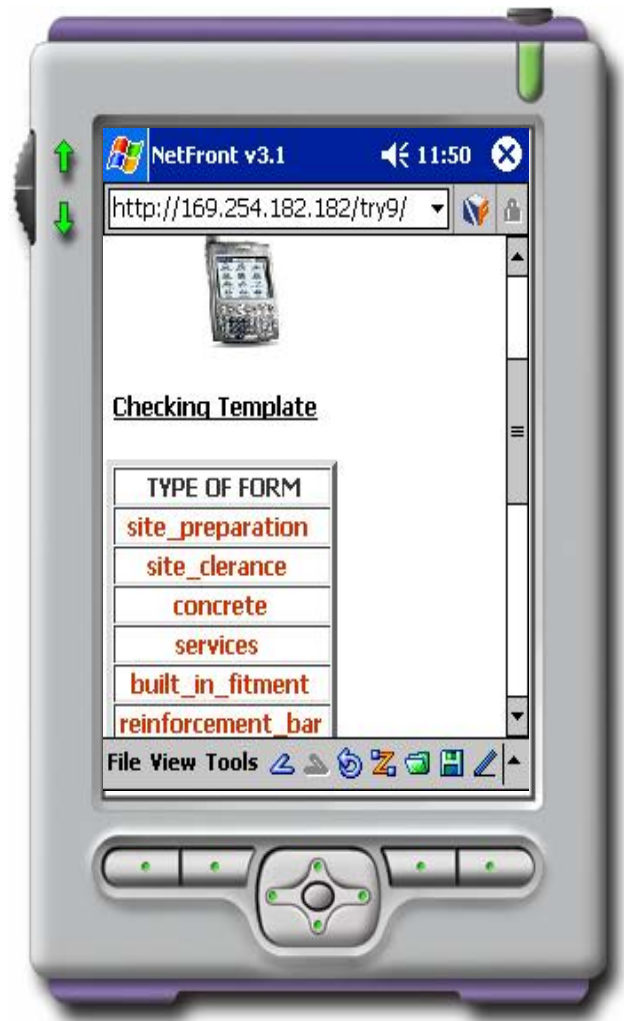


Figure 8: A Standard Inspection Checklist

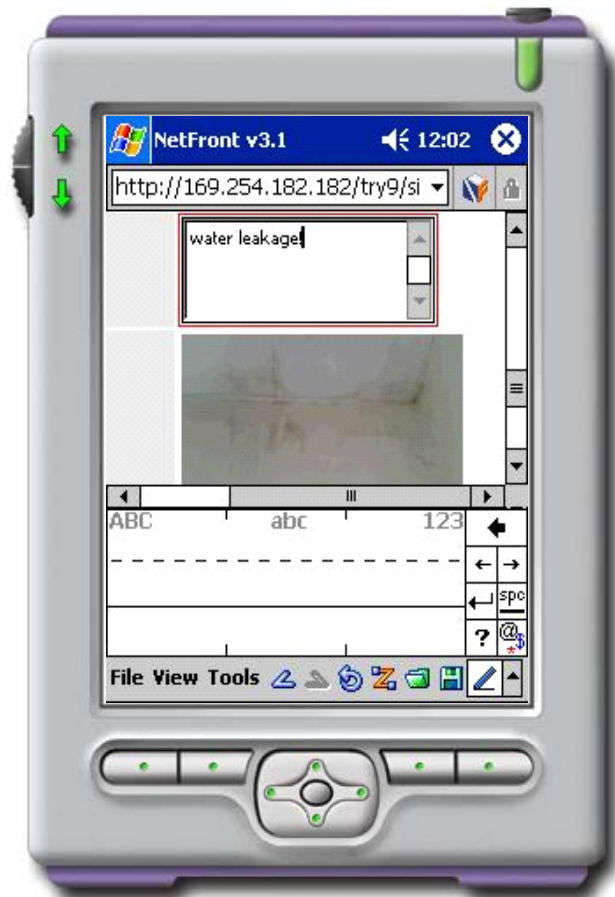


Figure 9: Photographic Records in Prototype

WELLCOME TO
UTM THESIS TEST SITE

UTM.MY

Logged as George group 2

CURRENT DEFECT STATUS ARE BASE ON THE LAST UPDATE TO SEVER

TODAY DATE IS : 3/21/2006 And THE TIME IS : 6:26:02 AM
CURRENT LOGGING FROM : 127.0.0.1

2	: OF DEFECT REMAIN IN SITE PREPARATION AND	0	: OF THE DEFECT IS COMPLETED
1	: OF DEFECT REMAIN IN SITE CLEARANCE AND	1	: OF THE DEFECT IS COMPLETED
2	: OF DEFECT REMAIN IN CONCRETE AND	0	: OF THE DEFECT IS COMPLETED
4	: OF DEFECT REMAIN IN SERVICES AND	0	: OF THE DEFECT IS COMPLETED
2	: OF DEFECT REMAIN IN BUILT IN FITMENT AND	0	: OF THE DEFECT IS COMPLETED
0	: OF DEFECT REMAIN IN REINFORCEMENT BAR AND	0	: OF THE DEFECT IS COMPLETED
0	: OF DEFECT REMAIN IN ELECTRICAL WORKS AND	0	: OF THE DEFECT IS COMPLETED
0	: OF DEFECT REMAIN IN FINISHING AND	0	: OF THE DEFECT IS COMPLETED
0	: OF DEFECT REMAIN IN PIPE WORKS AND	0	: OF THE DEFECT IS COMPLETED
0	: OF DEFECT REMAIN IN FORMWORKS AND	0	: OF THE DEFECT IS COMPLETED

OVER ALL PROJECT CONDITION

12 : OF TOTAL DEFECT LOGGED IN
1 : OF TOTAL DEFECT COMPLETED

**role of thumb, do not summit the picture over size 640 pixel X 480 pixel in to the server

ADMINISTRATION MENU

PROJECT

PROJECT NAME
INSPECTION INFO
BLOCK NAME
INSPECTION TYPE
LEVEL
LOCATION
TYPE OF BUILDING

INTERNAL

EMPLOYEE
CONTRACTOR LIST
PTD LIST

TYPE OF FORM

SITE PREPARATIONS
SITE CLEARANCE
CONCRETE

Figure 10: Centralize and Standard Defect Management

WELCOME TO UTM THESIS TEST SITE UTM.MY

Logged as A SDN BHD group 0 Log out

DEFECT AND REPAIR

CURRENT DEFECT STATUS ARE BASE ON THE LAST UPDATE TO SEVER

TODAY DATE IS : 3/12/2006 And THE TIME IS : 11:50:13 AM
CURRENT LOGGING FROM : 127.0.0.1

DEFECT TO YOU ATTENTION UNDER IN SITE PREPARATION ACTIVITY (Print)

CONTRACTOR	PTID	INSPECTION	LOCATION	LEVEL	COMMENT	STATUS
A SDN BHD	111	2	BEDROOM 2	23		INCOMPLETE

DEFECT TO YOU ATTENTION UNDER IN SITE CLEARANCE ACTIVITY (Print)

CONTRACTOR	PTID	INSPECTION	LOCATION	LEVEL	COMMENT	STATUS
A SDN BHD	114	3	BEDROOM 1	26		INCOMPLETE

DEFECT TO YOU ATTENTION UNDER IN CONCRETE ACTIVITY (Print)

CONTRACTOR	PTID	INSPECTION	LOCATION	LEVEL	COMMENT	STATUS
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Figure 11: Better Defect Communication with Contractor

MDIS DEFECT FORM

ARCHITECTURAL & BUILDING WORKS

REFERENCE : MDIS-
INSPECTION : 3
DATE : 3/21/2006
STATUS : INCOMPLETE

CONTRACTOR : Haji Ismail Bin Ishak

UNIT	LOCATION	LEVEL
114	BEDROOM 1	26

ITEM	CONDITION
Rubbish clearance	**INCOMPLETE
Demolition of worker's accommodation	COMPLETED
Construction equipment	COMPLETED
Demolition of temporary toilet	COMPLETED
Site office	COMPLETED
Disconnected of the services supply	COMPLETED

PICTURE	COMMENT
	roof full with rubbish

Figure 12: Instant Auto Generations for Defect Report

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