

# MoPMIT: A PROTOTYPE SYSTEM FOR REACTIVE MAINTENANCE PROJECTS IN THE UK

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**ABSTRACT** *More Productive Minor Construction Project through Information Technology (MoPMIT) is a research project that focuses the use of IT to improve the management of reactive maintenance (RM) works for large clients. The research participants include a group of building owners, facilities management team, contractors and suppliers. At the early stage of this research, several existing deficiencies with RM projects were identified, which require some measures of improvement. These problems include poor communication between different parties; lack of knowledge sharing; and poor quality of information, which often lead to longer time taken to fix a problem and incurs higher cost. The current development of knowledge management and Internet technology has offered a platform for developing an online knowledge management system to improve the operation of these RM projects. A prototype web-based system called "MoPMIT" has been developed to demonstrate the idea by having all parties in the process to share information and communicate on a common interface with pre-allocated password access as a control mechanism that will limit each user to its role in the RM process. Testing has been conducted and feedbacks from potential MoPMIT users show that there is a consensus that the system will lead to better management of knowledge, improve communication and better data sharing among all parties. This paper will illustrate how the system operates and the theoretical underpinning that has enabled the development of the tool.*

**Keywords:** Reactive Maintenance Projects, Facilities Management, Web-based system, Knowledge Management

## Introduction

More Productive minor construction projects through IT (MOPMIT) is a research that focused on the application of IT on reactive maintenance work with the aim to explore its potential to improve the efficiency of minor construction work so as to increase the

capacity to manage information and learn from past experience. The study involved some building owners, facilities management team, contractors and suppliers in the UK.

In the last few decades, the share of building maintenance projects in the UK construction industry has been steadily increasing. For examples, in the late 60s, such work represents 28% of the total construction output, which accounts for about 40% of the labour force of the construction industry (Seeley, 1976). Between the year 1979 until 1989, this small work class of activity rose from 38% of the total output in 1979 to 46.4% in 1985 and slightly decreased to 41% towards the end of the decade (Griffith, 1992). Current statistics from DETR (2003) show that more than 50 percent of construction project undertaken in the UK are building maintenance projects.

Early findings revealed that two-third of these building maintenance jobs are reactive maintenance works where immediate action is needed to rectify failures resulting from unforeseen damage due to external causes or failures of planned maintenance (British Standard; CIOB (1990)). The sheer volume of works, and the unexpected nature of reactive maintenance, often caused disruption to business activities (Ali et al, 2002). In addition, this type of project is usually carried out by firms with less than 20 employees, which constitute 84 per cent of the industry (DTI, 2000).

This paper describes some background of the research, the prototype system itself as part of the research outcome and the discussion on evaluation of the system.

### **Background of Research**

An analysis of the maintenance process was performed, which included visits and interviews to different types of industrial companies involved in the project with the aim of discovering the problems that impede the cost, data sharing, speed and quality of the process. These companies are four main parties involve in a reactive

maintenance project i.e. the clients (building owner of 1000-9000 properties all over the UK); in-house or outsourced facilities management team; various scales of contractors and suppliers. Besides interviews, observation technique was also made on facilities management Call Centre to monitor how problem reported in the premises are handled.

A detail process flowchart was drawn as a result of these interviews (Ali et al, 2002). In brief, a reactive maintenance process starts when a unit manager at one of the premises reports a fault to the facilities management helpdesk, normally by telephone. The helpdesk will help to describe the problem into a computerised facilities management system that will identify a contractor according to the repair work required and the unit's location. The job description will then be sent to the contractor by fax for their further action.

Every client limits each reactive maintenance work to a certain amount of cost. Therefore, prior to the actual repair work, contractor's operative whom was sent to do the work must come out with an estimation cost. Any works that is above the budget limit would have to seek for facilities manager's authorisation that will make his decision based on the essentiality of the work. Upon completion of the job, the unit gives feedback on the operative quality of work. Contractor will prepare invoices for claiming purposes and submits it to facilities management team. The facilities manager certifies payment to the contractor upon approval of acceptable invoices. The settlement of payment by the client indicates the completion of that particular reactive maintenance job.

The analysis of the current business process has identified some problems associated with reactive maintenance. Firstly, the knowledge management, storage and use of data; secondly, the problems in the procedures used during the reactive maintenance process; and lastly, the inadequacies of the current systems. The problems have been grouped together under three categories to emphasise the major issues. Among the major problems that have been revealed are:

1. Knowledge Management
2. Procedures

### 3. Overall System

#### 1) *Knowledge Management*

There are problems with the management of the information generated in reactive maintenance projects, for example the storage and utilisation of data has major inadequacies. Error prone in data acquisition when the helpdesk operator has to define what type of problem is occurring at the unit. They are given a list of possible problem types and then have to select one option. However, the operator with little maintenance knowledge has to decide which questions to ask the caller to determine the problem type, and with no guidelines. Apart from that user has to manually enter some data, such as address details, every time. This manual data entry also occurs when information is passed between client and contractor. Double handling is required to get the data from one system to the other, which is due to lack of industry data protocol. If a standard data format for the data stored in the reactive maintenance process was used, then the clients and contractors systems would be more compatible.

In addition, the existing databases are not complete and are not updated with new information and some useful information is not known or stored. Also some information is recorded on paper and is not entered into the IT system. Non-archiving of records that have been kept for years and the massive databases of jobs that evolve slowed down the system.

#### 2) *Procedures*

Some of the procedures in the reactive maintenance process are not well defined or followed by the users. About 20% of incoming calls are calls received by the client helpdesks from unit staffs that have phoned the wrong help desk. Sometimes, helpdesks are missed out of the communication chain. For example, calls go straight from the client helpdesk to the contractor area branch, when all jobs should go through the contractor's central helpdesk.

Most of the time, information is sent via conventional communication methods such as telephones, mobile telephones, facsimile machines, post and paper forms (such as client specific worksheets and job reports). This requires the operative to write down information that has already been entered into the system, the helpdesks to manually enter the data recorded on paper into the system, and the transfer of information between contractor and client involves the re-entering of information - "a manual switch interface". The use of paper forms means that recent job details are not in the system and are not available to be checked via the computer.

A long communication chain between operative, contractor and facilities manager often resulted in a re-visit by an operative which will cause longer time taken in job authorisation procedure. In addition to that, the contractor does not always pass the job quote limit for a client on to the sub-contractor when they are used for specialist jobs.

Completed Jobs often involves a lot of traveling, costs that takes up a lot of time. Besides, payment procedure that involves too much paper, such as posted certificates of payment, and too many communication steps has also impede the inefficiency of the process.

### 3) *Overall System*

The current IT systems developed by clients years ago, run on early age operating system which are not compatible with other parties modern systems and machines, and lack modern features. They are also, very fixed in design and cannot be reconfigured to handle new types of information that could be used, such as email addresses. Besides, because they are stand-alone systems, exporting of data for transfer of information to external systems, such as contractor's is difficult. Data analysis for reports are not fully available, and the information that is stored is not easily manipulated. Further more, the current interface is DOS based and therefore does not utilize the easier to use and graphical Windows based interface.

## **Improving the Reactive Maintenance Process**

Proposals were developed after considering the process analysis and the identified problems. The goal is to reduce the problematic components, and therefore increase the work efficiency in terms of time and cost during the reactive maintenance. Thus, this study proposed the following measures for improvement to the reactive maintenance business process as shown in Table 1 below.

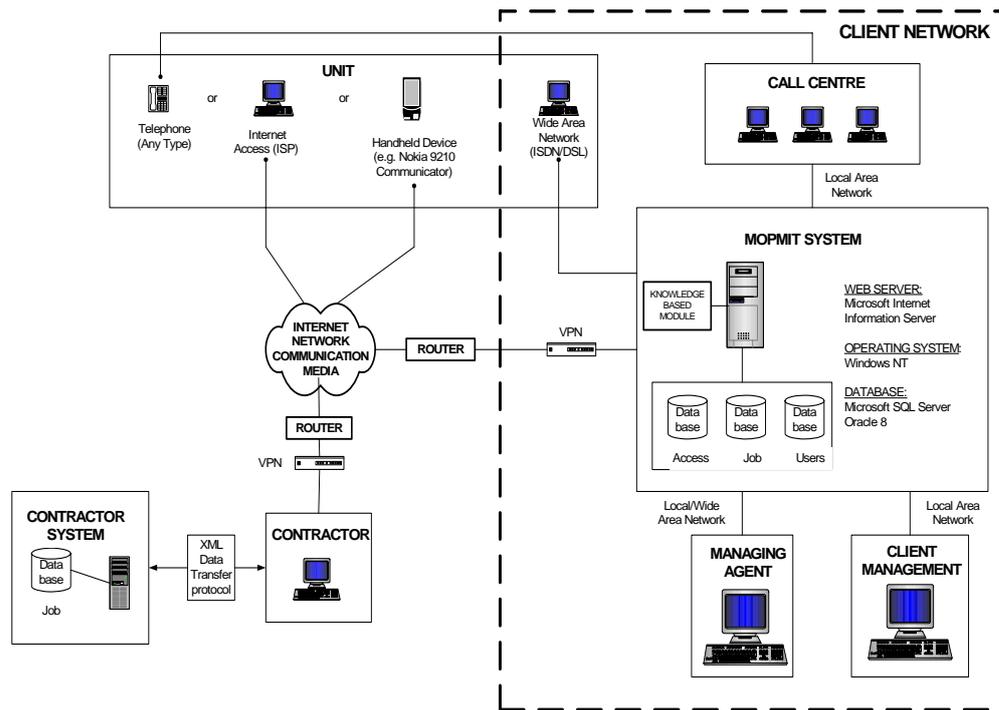
**TABLE 1:** Proposed Measure of Improvements for Reactive Maintenance Projects

<b>Keywords</b>	
Knowledge capturing	The use of IT tools to capture and update a knowledge base providing a central repository for both explicit and tacit knowledge
Electronic storage of information	Provides easy retrieval for users - for example, job feedback information is entered into the system and then used to assess a contractor's performance.
Improving communication	Communication of information flow can be improved by making full use of the Internet and other Information Communication Technology. This will in turn lead to a reduction in the use of paper, and associated delays
Easy-to-use interface	Provide an easy-to-use interface suitable for non-technical users, such as a person at the unit who is reporting a problem through an internet-based helpdesk
Controlled accessibility	A system, which can be accessed by all parties in the process from wherever they are situated, but with their access capabilities controlled by job responsibilities
Automated data entry system	For example, the transfer of information from one system to another should be done electronically

**MoPMIT – A prototype System**

The aim of this research project was to improve the reactive maintenance business process through information and communication technology. Having seen the problems emerged from the existing business process, there was a clear need to redesign the process. Client (building owner), Facilities Manager and Contractor are expected to communicate with each other and share the necessary project information via an online knowledge management system called MoPMIT. This system acts as a client server where project related data is stored. It also provides a common interface that allows these parties to update the project information and exchange information. An online system was chosen because it could work as web-based system on the Internet platform, which is often accessible nowadays.

Figure 1 shows the configuration for the MoPMIT system. The main components of the system are the knowledge based module and the web interface. The system links



**Figure 1:** MoPMIT System Architecture

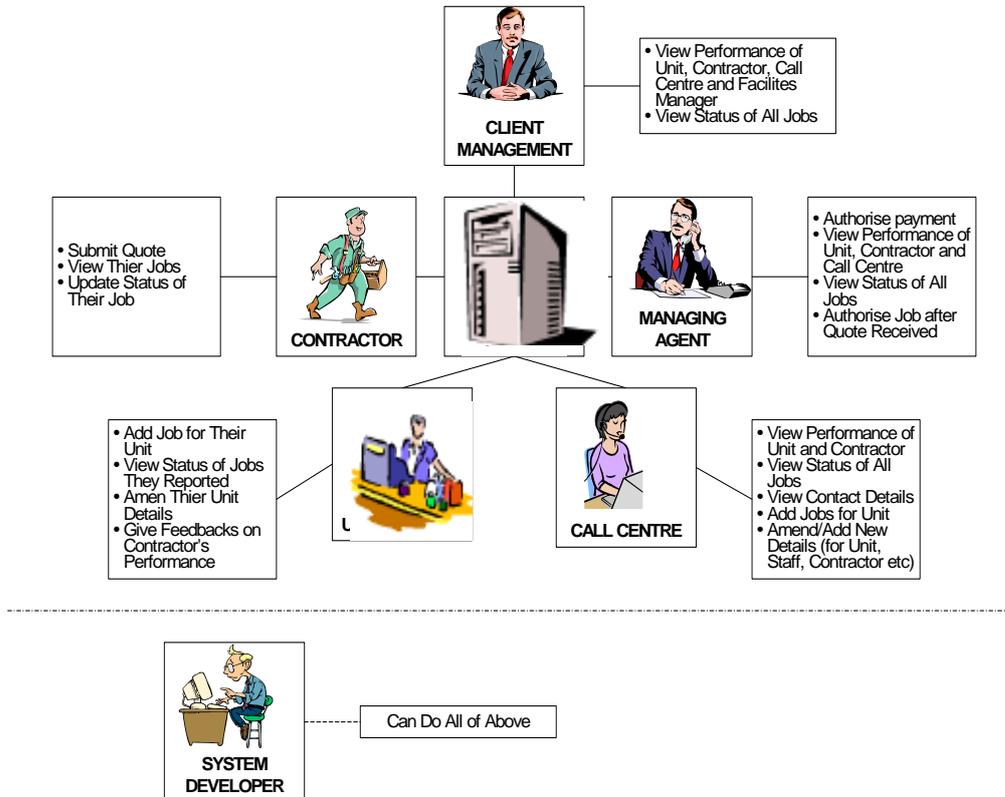
to an existing Facilities Management (FM) system with a generic design that ideally allows it to port to other FM systems at a later stage. The system is web based and so to access it the user has to have a device with a web browser and a connection to the Internet. The diagram shows the methods available for a unit to enter a job, either accessing the system themselves or phoning the call centre and they then access the system. The call centre, managing agent and client management will access the system from their PC, which will be within the clients network.

The contractor is an external user, as was the case for the unit, and will have to access the system via some Internet network communication media. For security a Virtual Private Network (VPN) is at each end of the connection. The VPN prevents hackers getting into the system and makes the data transferred secure. The MoPMIT system requires a machine to act as the server. This machine will run a web server for hosting the web pages and a database for handling the information.

Figure 2 indicates a circle of process of how every party is interconnected by MoPMIT system. The system allows them to share information and communicate on a common interface with pre-allocated password access as a control mechanism that will restrict each user to its role. Figure 3 explains in clear details the features that each user is allowed to perform on MoPMIT.



when an automatic door is not closing, the system will suggest the user to check if anything blocked the door laser beam that could prevent the door from closing. The user will check the situation and see if the self-check has actually solved the problem. Job will not be created if the problem is solved on-site. Otherwise, the system will proceed with questions and answers session in order to identify the exact problem. This is important, as the system will rely on these answers to decide and select the appropriate Contractor to do the job whom would consequently visit the Unit with the



**Figure 3: System Users and Their Roles**

right tools and equipment. The questions and answers session basically replicates what a Helpdesk Operator would do in the current practice.

Apart from self-check, the user would also be asked if the problem covered by insurance or warranty. For health and safety issue, the system will suggest what actions should be taken before the Operative arrives on site to see if the problem incurs any hazard. For instance, a warning sign should be put up to avoid people from using the faulty elevator.

The user has to select the Response Time needed for the Contractor to come and also identify the repair location. At this point, the system will assign a Contractor that would send an Operative to do the work.

It is possible that at any time while reporting the problem via online, technical problem might occur. The system should be able to escalate the report to a Helpdesk Operator whom will help the user via telephone. Helpdesk Operator will be seeing the same interface as the Unit Manager's, i.e. self-check; insurance & warranty check; and the questions and answers session. In a way, this system would also offer an element for Helpdesk training purposes. The structure of question and answer session between MoPMIT system and the user is as shown in Table 2. The arrows at the bottom of the table indicate the flow of questions that a user will encounter when adding a new job in the system.

Until this point, the problem description is successfully entered into the system. MoPMIT will alert the Contractor about the new job when the Contractor logs in into the system. An Operative will then visit the Unit and estimates the repair work. If authorisation is needed from the Facilities Manager, Operative will supply the Contractor with the quotation of the estimated work.

Instead of faxing the quotation to Facilities Manager, Contractor could upload their quotation and measurement for the Facilities Manager to check. The system will alert the Facilities Manager about the awaiting job authorisation. Decision on whether the job should be authorised could be based on the information stored in MoPMIT server e.g. history of repair work at the Unit; Contractor's previous history data or cost of material. As usual, discussion or negotiation with Contractor could always take place when necessary. Job will not proceed if authorisation is refused.

Facilities Manager will update the job status in the system once he has decided to grant the authorisation. Operative will go back to the Unit with the necessary equipment to complete the work.

When job is completed, Contractor will update the job status in MoPMIT. Unit Manager could check the progress of work by logging in into the system and also give feedback on Contractor's quality of work. This information could be use by Facilities Manager to assess the Contractor's performance for future reference. To claim payment of work done, Contractor may do so by uploading the invoice into MoPMIT. Once received, Facilities Manager evaluates the invoice against work done and certifies the payment for the Client to pay the Contractor.

### **System Evaluation**

At the final stage of the development, MoPMIT prototype was implemented and demonstrated at different occasions as a final evaluation. The main goal of MoPMIT system is to explore the use of technology to improve the managing of reactive maintenance projects. In other words, it aims at providing support during fault reporting, contractor allocation, jobs authorisation and performance evaluation. Hence, this evaluation is vital in order for these aims to be recognised by the potential users.

The system was demonstrated to a group of people consisting of various expertise related to the nature of the project such as IT expert, facilities managers, surveyors, builders and project managers. MoPMIT prototype was also taken to Call Centre and IT staff in FM, Clients and contractors' firm. They were shown all the user interfaces and their functionalities in the system i.e. Unit Manager, Contractor and Managing Agent upon which they were asked if these three main users would be able to understand, operate and view the system as beneficial.

At another occasion, a group of six individuals from facilities management division have taken part in a one-day pilot at one of the industrial partners in this project where four of them from call centre division with various range of experience in

handling calls and two from the administration. In order to evaluate the usability of the system interface, the people are selected from various ranges of computer skills, as realistically, the targeted users for this system could be someone whom never has experience with computer before. During this one-day pilot, participant were all given the opportunity to actually test the prototype according to the cycle of reactive maintenance process. Thorough discussion was held at the end of the pilot and questionnaires administered to them to answer.

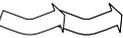
In general, the overall responses were very positive. Participants in the evaluation positively agreed that web enablement reactive maintenance reporting could benefit in better management of knowledge. A large majority thought the system was an improved method of communication and data sharing between all the parties in the reactive maintenance process being better with MoPMIT system. Although some of the invoicing and payment part of the reactive maintenance process are missing from the current MoPMIT system, they believe that the system would be able to expedite the reactive maintenance process.

The participants think that Managing Agents would be able to understand and operate the system. One of the features that enable Managing Agent, which is to analyse the Units and Contractors performance, could be a very useful support data for future action and decision-making practice such as review on budget allocation for the Unit or decision on whether to engage the same Contractor for future maintenance work.

Majority of them agree that Contractors would be able to understand and operate. The system ability to provide the correct description of repair work plus warning on possible health hazard would be greatly benefits the contractor as this will help them to decide the correct tools and parts to bring to the site and get prepared to face the hazard.

**TABLE 2:** Structure of Questions

REPAIR TYPE	WARRANTY & INSURANCE	SELF-CHECK	PROBLEM IDENTIFICATION	INFORMATION ABOUT THE PROBLEM	LOCATION OF PROBLEM	REPAIR TIME
Automatic Door	<ul style="list-style-type: none"> <li>• Check if element is under warranty</li> <li>• Insurance or claims that could be made (such as vandalism)</li> </ul>	<ul style="list-style-type: none"> <li>• No object obstructing the eye</li> <li>• beams</li> <li>• The emergency button is not pressed</li> <li>• The fire alarm is reset</li> <li>• Entry Key Switch is in normal positions</li> </ul>	<p style="text-align: center;">Problem with Automatic Door</p> <p>Q1 → Auto door will not open</p> <p>Q2 → Auto door will not close</p> <p>Q2 → Are there any other entrances?</p> <p>Q3 → Is this affecting closing?</p> <p>Q3 → Is this effecting trading? *</p> <p style="text-align: center;">* Problem that effects trading will reflect to higher priority of response time</p>	<ul style="list-style-type: none"> <li>• Make of Automatic Door</li> <li>• Type of door (Single leaf, Double leaves, Swing, Sliding etc)</li> </ul>	<ul style="list-style-type: none"> <li>• Which floor?</li> <li>• Which Building?</li> <li>• Or manually describe the location</li> </ul>	<ul style="list-style-type: none"> <li>• #</li> <li>• ch</li> <li>• wit</li> <li>• pri</li> </ul>



As for the Unit Manager, they are all agreed the system would be beneficial to the unit manager especially on checking the status of work and giving online feedback on completed work. However, majority of the participant from the call centre has concern that the Unit Manger would be able to understand and operate the system. This is due to lack of robustness in the questions and answers provided by the system. The system may not cover most of the repair work but it is suffice to demonstrate the idea of online self-reporting. For the benefits of all parties in the reactive maintenance process, an appropriate incentive based on a share of the reduced transaction costs would be necessary to motivate the Unit Manager to be involved in the reengineered business model.

### **Conclusion and Recommendations**

More Productive Minor Construction Projects through Information Technology (MoPMIT) project seeks to explore the use of a web based technology to improve the reporting and managing of reactive maintenance projects. It aims at providing support during fault reporting, contractor allocation, job approval and performance evaluation. The process of reactive maintenance project involves four main parties: the client, the contractor, the facilities management agent and the suppliers. Analysis on business process of reactive maintenance projects unearthed problems that impede the process in term of time, cost, quality of work and the health and safety of the users. These problems can be summarised as [1] poor communication among different parties in the process; [2] lack of knowledge sharing; and [3] poor quality of information. An online knowledge management system named MoPMIT has been developed as a prototype with the aim to improve the operation of these reactive maintenance projects, which the main idea is to bring all the different parties to share information and communicate on a common interface. Internet technology brilliantly offers a platform for such a system to be accessed by anyone, anywhere and at anytime with a valid password.

A pilot exercise was performed to test and evaluate the system on some potential users such as building owners, helpdesk staffs, facilities managers, contractors, project managers and IT managers. Feedback from the industry shows that there is

a consensus that the system will lead to better management of knowledge, improve communication and result in better data sharing among all parties. Above all, the respondents also agree that MoPMIT will be able to speed up the reactive maintenance process and produce significant savings in transaction costs. Although they recommended that training would be required for non-technical users, the prototype has shown the potential benefits to minor construction and reactive maintenance in particular.

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