

## UNDERSTANDING THE BUSINESS PROCESS OF REACTIVE MAINTENANCE PROJECTS

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**ABSTRACT:** This paper presents the analysis of the existing business process in reactive maintenance projects including the information and communication technology that supports the process. All information reported in this research is mainly primary data gathered from interviews with the parties that are involved in the process. The analysis consists of identification of the parties involved, understanding the business process, understanding the information and communication technology used in the process and identification of problems within the process. The research reveals several existing deficiencies with RM projects which require some measures of improvement i.e. 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.

**Keywords:** Reactive Maintenance Projects, Business Process, Maintenance Management

### 1. INTRODUCTION

In most countries, the construction industry amounts to 10%-20% of GNP, making it the largest economic sector employing the largest amount of manual workers with the total value of US\$2 trillion worldwide (Albert & Chan, 2002). In the USA, 35% of the overall turnover in the construction sector consists of renovation and modification projects (Mitropoulos and Howell, 2002). In Canada the value of maintenance activities (US\$104billion) is greater than the new construction projects which is US\$100 billion (Vanier, 2001).

The UK's expenditure on maintenance, repair and refurbishment, covers more than 50% of all annual construction activities (DETR, 2000; Baldry, 2002; Olubodun, 1996; Torrance, 1997; and Sun, 2003b) compare this to the period between 1970-1980 where from there on, the share of maintenance steadily increased until now. It has always been well over 40% since late 70's and early 80's (Chanter & Swallow, 1996).

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 or failures of planned maintenance (British Standard, CIOB (1982). The sheer volume of works, and the unexpected nature of reactive maintenance, often causes 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).

### 2. MAINTENANCE ORGANISATION - PARTIES INVOLVED IN THE RM PROCESS

Maintenance operation for a small firm can be under the responsibility of a member of staff in addition to his core duties. In a large firm it would usually be undertaken by a separate organisation solely responsible for maintenance (Wordsworth, 2001), either independent consultants to advise on a particular problem or a maintenance contractor who carries out the repair work.

Deciding between employing in-house consultants directly and engaging an independent consultant/ contractor has to be based on the feasibility of cost, quality and convenience. To a large company, employing a direct labour force could cause a high overhead cost (Wordsworth, 2001). However, there are some factors which influence the decision for a client to engage an outsourced consultant/ contractor or otherwise i.e. 1] nature of work 2] volume of work 3] response time and 4] location. Other than the above mentioned factor, availability of space, market condition and cash flow also have to be considered.

Investigation on the case study and intensive reading on literature material have identified three main parties involved with the building maintenance work i.e. client, Facilities Management (FM) Team and contractors. The client is the organisation who owns the property and is ultimately responsible for paying for any repairs. The contractor is responsible for carrying out the repair work. The FM team, either an in-house department or an outsourced managing agent, manages the contract between the client and Contractors. Suppliers are involved in providing the necessary parts for repair work. In brief, the client's branch or Unit reports to the Facilities Management's Helpdesk about a repair work and then passes it to the Contractor. The Contractor informs his Operative or Subcontractor to go and repair the work at the Unit. The Facilities Manager is consulted if the work needs to be authorised.

### 3. UNDERSTANDING THE BUSINESS PROCESS

Process is basically an activity to convert (deliver) input into output (product/services). Harrington (1991) defined process as *any activity or group of activities that takes an input, adds value to it and provides an output to an internal or external customer*. People in an organisation work together on the activity to achieve some desired outcome (Ould, 1995).

Modelling the business process could help visualise these elements in such a way that could be quickly understood by the team. In a situation where the existing business process is being questioned, process modelling is used to identify improvement opportunities in order to do work better, quicker and with fewer resources by clarifying the requirements for inputs and output, especially if many different functions or parts of business are involved in producing the final output (Damelio, 1996). Damelio (1996) suggests that improvement opportunities show up in the form of reducing the clutter of the process model by simplifying a process or by eliminating redundancies or non-value-added steps. These non-value-added steps are part of the 80% of the repetitive processes occurring daily in most businesses (Harrington, 1991).

The process modelling technique adopted for this study is a technique suitable to illustrate activities in the organisations involved, the interaction between them, the rules and procedures and the information flows. It is also important that the tool could describe the process in a way that it is easy for the process owner to understand. Ould (1994, 1995) highlights that process modelling should be intuitively familiar, easy for readers to grasp, unambiguous for analysing and enacting the process, and able to describe what people do rather than how they do it. With that notion in mind, this research has adopted process mapping/ flowchart technique to model the business process of reactive maintenance projects.

Block diagram process maps or flowcharts, which graphically represent the activities that make up a process, were used in this research to identify weaknesses in the organisation structure and business processes. It provides the basis for reengineering or improving these processes and the enacting of the process of which the models could be used to map out the "To-Be" models and to test the effect of various scenarios on the organisation.

### 3.1 The Process Modelling

A series of one-on-one interviews, group interview, site visits and observation at Call Centres have enabled the researcher to model the process. Every process was taken back to the process owners and reviewed for the final generic process map. Eventually the model was presented to the representative of the organisations involved in this research for their comments and feedback.

Ould (1995) suggests that there are *no hard and fast rules for procedures... that should be followed* (page 182) to model a process, but recommended some steps which the researcher has adopted in this study with some modifications to suit the needs requested to design the models. The route to model a generic process map in this study was as follows:

1. Started by getting an overall picture of the process particularly on who are involved in a reactive maintenance work and identifying the major processes. This was done by interviewing senior people (e.g. Heads of Facilities Management or Maintenance Division) in the organisations which led to many other groups and individuals.
2. Interview groups about how they collaborate in the process and the interactions that take place.
3. Interview individuals (such as the Facilities Manager, helpdesk operators, operatives on the move, unit manager and supplier) about their individual roles in the process so as to refine the models. Interviews were also conducted with IT managers in the clients, Facilities Management and contractors' organisation to understand the IT aspect of the process.
4. Collecting the necessary documents to ensure minute details of understanding the process.
5. Observing and experiencing the Helpdesk's scope of work at the Call Centre.
6. Reviewing and revising the draft of the process model by taking it back to the process owners before they could eventually validate the generic model.
7. Analyse the process model. This was done throughout the modelling process where problems and potential solutions emerge to be recognised and taken into consideration. Most clients participated in the research documented their business process which allowed the researcher to carry out a comparative analysis and come out with a generic process flowchart of the business process.

In the next section and onwards, some flowchart standard rules for modelling the process are briefly explained followed by the business process of the reactive maintenance projects and also the outcome of the analysis.

### 3.2 Reactive Maintenance Projects – The Business Process

The process model for reactive maintenance was developed. Figure 1 shows the interactions involved between the four different organisations: the client, the FM agent, the contractor and the suppliers with every party is indicated with different colours. It shows a high level representation of the reactive maintenance business process, with the links between the main parties and their roles. The process basically starts when someone at the client's premises raises a problem by calling the helpdesk, and the description of the work is forwarded to the contractor. The contractor ensures an operative is assigned to deal with the problem. When the repair work is completed, the contractor will prepare an invoice for payment purposes. In any case where a job needs the Facilities Manager's authorisation, a quotation of the said work is submitted for the FM's approval before the Operative could proceed.

Further detailed process diagrams based on Figure 1 are shown in Figures 2, 3 and 4. These figures illustrate a detailed generic process map for the case study of this research. Figure 2 shows a process where reactive maintenance starts when a business unit reports a fault to the FM helpdesk by telephone, fax or occasionally by email. The helpdesk, using a computerised FM system, records information about the unit, the problem that has occurred and allocates the job a reference number. The system identifies a contractor according to the type of building work required and the unit's location. The helpdesk then prints out the job description and sends it to the contractor, by fax or phone if it is very urgent. The contractor might have the client's system installed at their offices and in this case the job is received via the system. The client helpdesk often prints out the job descriptions for later reference.

The job description sent from the client helpdesk is to be received by the contractor's helpdesk; a contractor with nationwide coverage then forwards this onto the area branch. Based on the description, the contractor area branch or contractor helpdesk allocates the job to an operative (in-house engineer or subcontractor) and informs them via their mobile phone to attend the problem. The operative is selected by location, availability and the maintenance skills required for the job; if none match then a sub-contractor would be given the job.

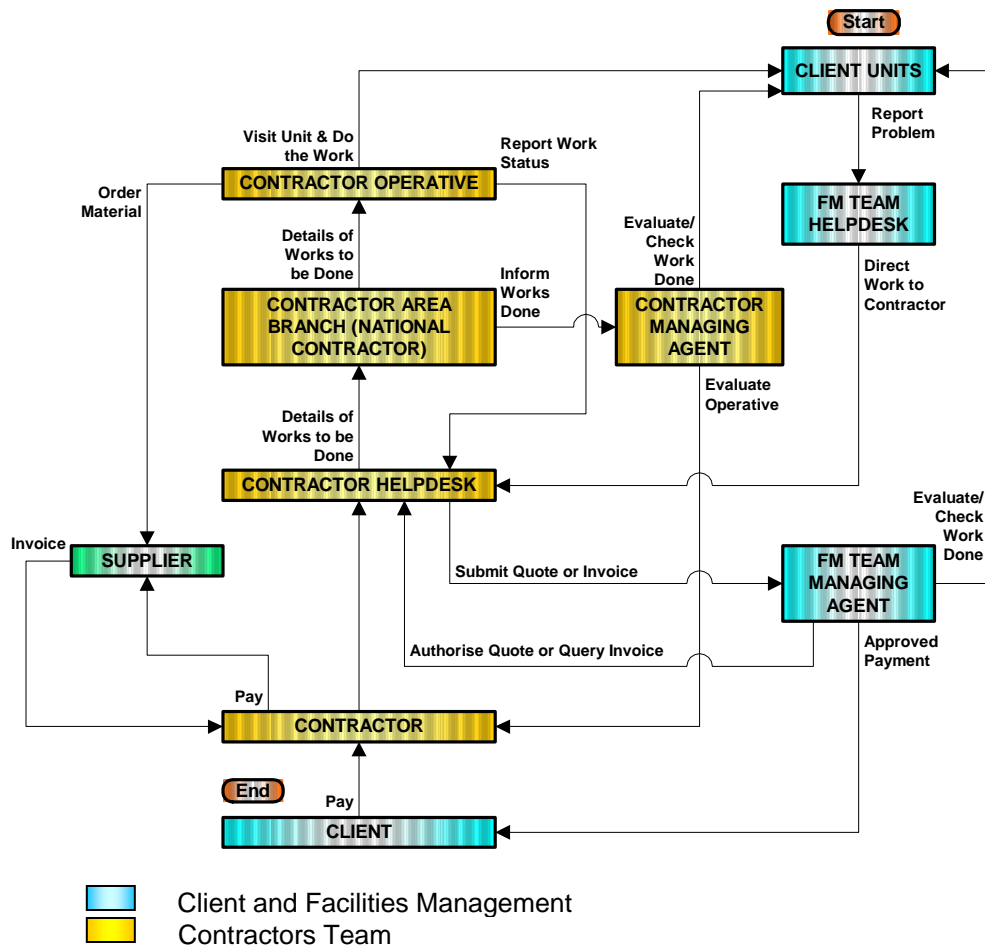


Figure 1: Reactive Maintenance Project – High Level Business Process

The operative visits the unit when they are available, normally when they have finished their current job. The first thing that the operative does is to estimate the cost of fixing the problem. If it is over the budget limit for a reactive job then the operative provides the contractor with an estimated cost for authorisation purposes. Otherwise, they check whether any equipment or spare parts are needed from a supplier and then start the repair work.

For repairs over the budget limit (Figure 3), the contractor needs to request for authorisation by calling the facilities manager; except in cases where the work is urgent and essential, in which case the work can proceed without explicit authorisation. Urgent and essential work refers to problems which affect health and safety, security, or the unit's business, in which further damage would be caused without immediate attention. When an authorisation request is received, the facility manager evaluates the estimated cost and decides whether the problem is worth repairing. Meanwhile, the operative waits at the unit for the authorisation to go ahead with the work.

If the over budget work is non-essential, then the contractor prepares a quotation with a breakdown of the expected costs for the work, and sends it by fax to the helpdesk. In this instance, the operative leaves for their next job and will only return when the contractor has got an approval from the facilities manager. The facilities manager evaluates the quotation and may ask the contractor to resubmit the quotation. This continues until they agree on an acceptable cost for the job. After the job is authorised, the contractor informs an operative who will return to the unit and start the work. Jobs that fail to get authorisation will be abandoned, and if an operative proceeds with a job without permission then the contractor might not get paid. However, this authorisation rule can be ignored when the job occurs outside of office hours and needs to be completed.

Upon completion of the job (Figure 4), the operative gets feedback from the unit on the quality of the work, and this is sent to the contractor. The normal procedure is for these worksheets to be handed in once a week in person by the operative to the contractor's area branch. The helpdesk is also informed about the completed work. The contractor then prepares measurements and invoices for claiming purposes and submits it to the FM team. The facilities manager checks the measurements and invoices for any discrepancies. If necessary the facilities manager will discuss any problems with the contractor until both parties agree a final cost. The Facilities Managers choose sites at random for Site Evaluation. This is done but to varying degrees.

The facilities manager certifies payment to the contractor upon approval of acceptable invoices. Once the managing agent certifies a payment, then the contractor can apply to the client for payment; this is done once a month to limit the number of transactions and their associated costs. Outsourced FM teams issue a certificate of payment to the client in order to get payment, while an in-house team issues an instruction of payment to their internal account division to pay the contractor. The settlement of the payment indicates the completion of that particular reactive maintenance job.

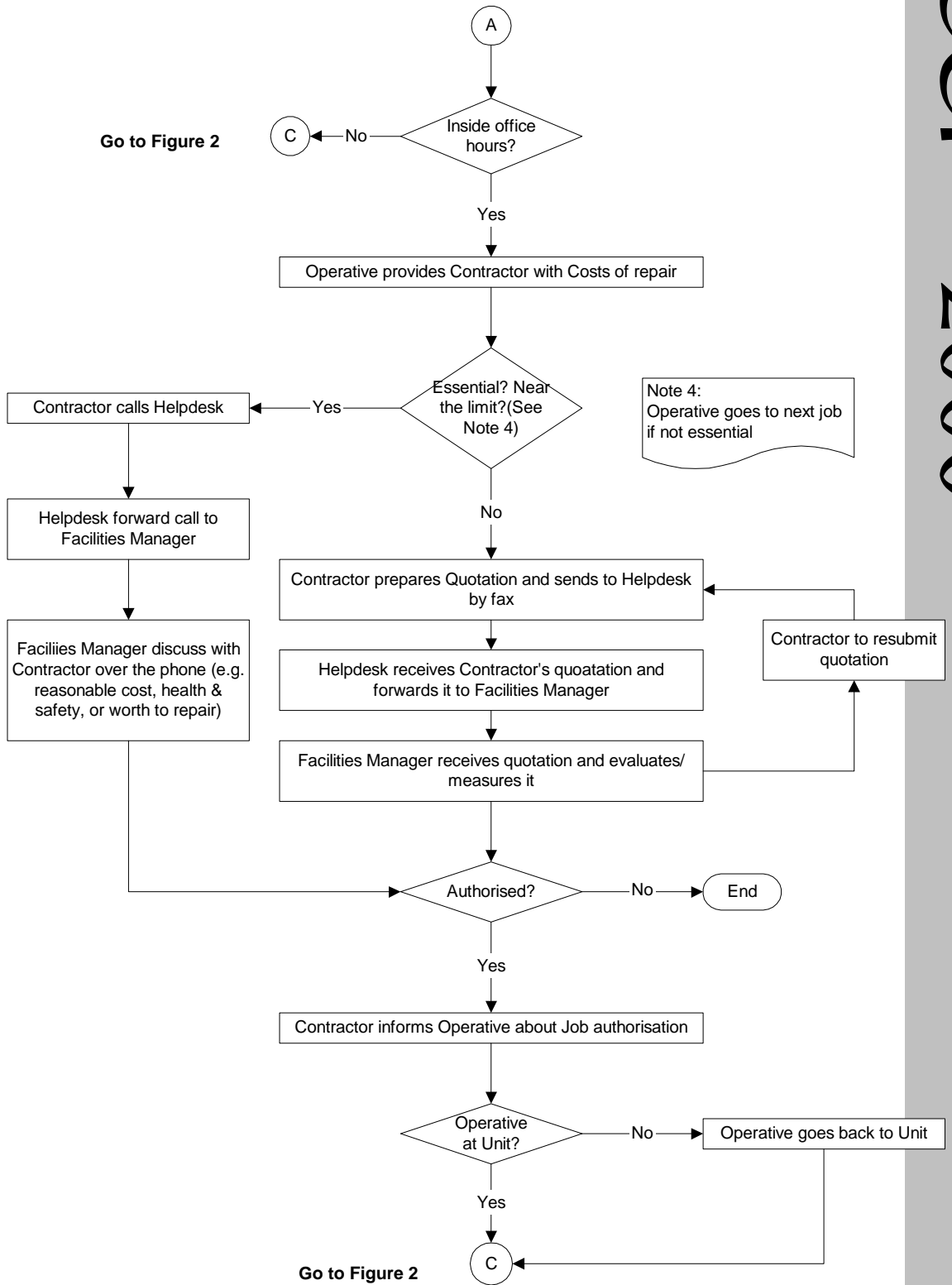


Figure 3: Generic Reactive Maintenance Actions

#### 4. INFORMATION AND COMMUNICATION TECHNOLOGY SUPPORT IN THE EXISTING PROCESS

During the study, it was revealed that all the FM helpdesks (in-house or out-sourced) use IT systems to manage the reactive maintenance jobs. However, the age and sophistication of the IT systems in use varied from ten-year old DOS-based programs, to the latest MS Windows-based ones. Some of these IT systems were off-the-shelf commercial packages and others were bespoke systems developed in-house. These systems allow the helpdesk to quickly and easily enter the information about the repair work reported by a unit. They automatically select the contractor from the type of repair work and based on the location of the unit. On the contractor side, most companies had computers, but the systems varied from a basic database system, to a specifically developed system to support their business operation, depending on the size of the company.

##### 4.1 The Systems

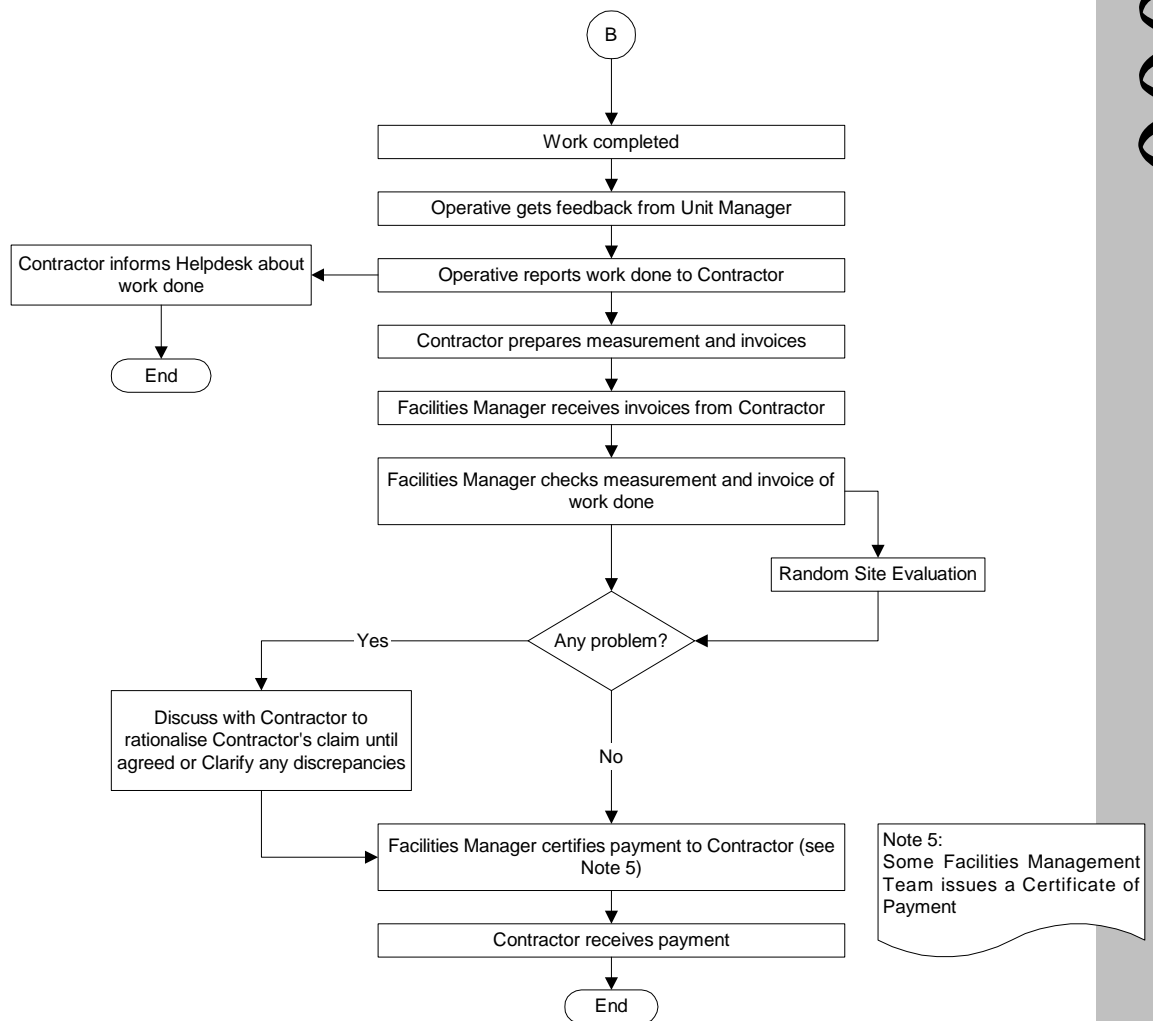


Figure 4: Generic Reactive Maintenance Actions

There are a number of systems used by the clients to support their business process. The systems are:

1. MEMO - in-house MS-DOS based package
2. CALL LOG and HEADERS - FM consultants Windows based in-house system
3. QFM-SERVICE WORK - a configurable off-the-shelf Windows based software (QFM, online).

CALL LOG and HEADERS are Windows-based system, which are operated by outsourced Facilities Management; DOS based MEMO is a client's system used by outsourced Facilities Management; and QFM - SERVICE WORK, is also a Windows-based system operated by the in-house Facilities Management of a client.

The client with the MEMO system (client A) engages an outsourced FM which already has CALL LOG and HEADERS in operation for maintenance projects. Hence every job logged in CALL LOG will also have to do the same for MEMO as required by this client (Figure 5). Meanwhile, other clients without any FM system (client B) managed by the same outsourced FM will rely on CALL LOG and HEADERS, as shown here in Figure 6. Figure 7 depicts QFM-SERVICE WORKS used by in-house FM for client C.

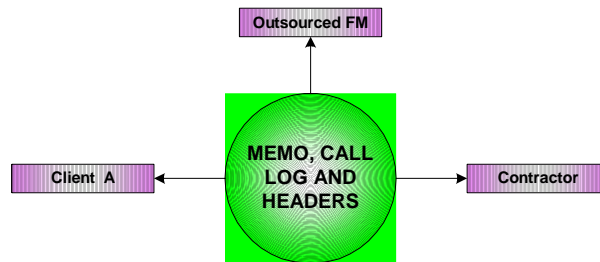


Figure 5: IT Systems that Link client A, Outsourced FM and Contractor

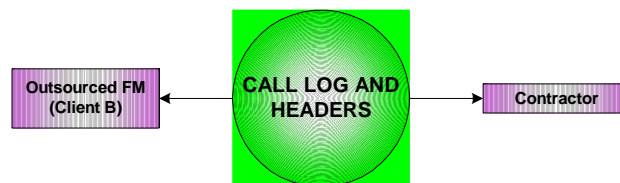


Figure 6: IT Systems that Link client B, Outsourced FM and Contractor

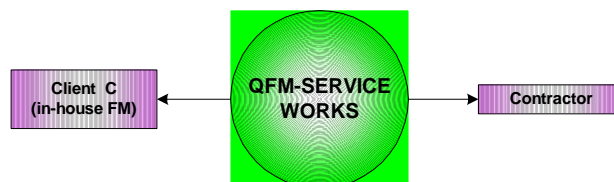


Figure 7: IT Systems that Link client C's In-house FM and Contractor



## 5. EXISTING DEFFICIENCIES

The problems identified from the visits and process analyses are listed in this section. They can be elaborated as explained below:

### 5.1 Inadequate Knowledge Support

One of the main functions of the helpdesk IT system is to help to identify the right contractor for a job. The helpdesk operators are responsible for choosing the type of work from a list on the system while the person reports the fault. It is important that the type of work entered into the IT system matches exactly what the unit needs, because it is the key criterion for choosing contractors. If the proper questions are not asked, misunderstanding of the problem can occur which will lead the wrong repair type being selected, and the wrong contractor being sent. Furthermore, if an inadequate job description is recorded, the contractor could send out a wrongly skilled or equipped operative.

The system's ability in choosing the Contractor according to type of building work and location of the Unit is undeniable and so far has helped expedite the response to repair work reported by Units. Helpdesk operators depend so much on the types of building maintenance work that are listed in the system. They have to choose the type of work as the person at the Units describes it. Their main task is to ensure that the type of work they chose is exactly what the Units need. This is because the system will choose a Contractor according to that specific criterion. Therefore, Units have to be asked for detail about the repair work, and with the answer the Helpdesk operators get from the Units they describe the work into the system using plain English.

There are conditions where the problems could be solved on-site. If the right questions were asked, the person at the Unit would probably discover that the problem does not require a Contractor to attend. An example for this would be; if an automatic door could not close because the eye beam was blocked by large box placed near to the door. This can be solved by removing the box away from the door and it will work like normal again. It is important to highlight that the Contractor will charge the Unit regardless of the need to repair the problem.

Very often, novice helpdesk operators have no technical background and little knowledge about maintenance work. They are given a standard script for handling calls from the unit managers. They gain experience through:

1. Training given by the company in charge of the helpdesk
2. Day by day experience
3. Other colleagues

Once they have gained some experience, they were found to no longer need the standard script or guidelines. The helpdesk operators build up tacit knowledge over time with their experience and knowledge gained from the job. However, because this is not explicitly captured and codified, this knowledge is lost to the organisation when an operator leaves. For a new operator to become similarly skilled will require either lengthy working experience or costly training. If the knowledge can be captured and disseminated, it will help in the training of new as well as experienced helpdesk operators. The over reliance on human interaction between the unit managers and the helpdesk operators also requires a large number of operators to be employed at call centres. Knowledge Management techniques can be used to automate some of the interaction and reduce the need to speak to a human operator when a fault is reported. The clients involved in this study identified this as a potential cost saving area.

## 5.2 Double Handling of Data Entry

MEMO is a DOS based system that is not compatible with a Windows based system. As a result, there are two categories of IT systems in the reactive maintenance business process, one on the client side and the other on the contractor side. Unfortunately, the lack of compatibility between the two systems causes major inefficiencies. Data has to be entered twice because it cannot be transferred electronically. This 'double handling' is an unnecessary process that makes the work tedious. At present, there is no widely recognised data standard for the building maintenance domain. This makes the integration between different maintenance systems particularly challenging.

## 5.3 Poor Communication Medium

Due to the lack of integration, paper is still widely used for data transfer between clients and contractors in the forms of faxes, memo messages, quotations, forms, reports and certificates. The parts of the process that still use paper are:

1. *Job description*: The Helpdesk operator prints out the job description from the system that is to be sent to the Contractors.
2. *Quotation for authorisation*: Contractor sends quotation to the Helpdesk for authorisation by the Facilities Manager.
3. *Worksheet and Feedback form*: Operatives have to get the form signed by the Unit and their quality of work is assessed.
4. *Certificate of Payment*: The Facilities Manager certifies the payment to Contractor upon approval of invoice. With a Certificate of Payment, the client will pay the Contractor for on the work they have done.

The facsimile machine is the most frequently used device for the transfer of information. The Internet was not very popular among the companies in the survey, especially the contractors. Besides the facsimile machine, some paper documents are also sent via post or handed in to the office by the operative once a week. The use of paper in this way causes delays in the entry of recent job details, as the user must wait for the paper forms' arrival before the information can be entered into the system. Therefore, the status of current jobs cannot be checked on the computer if queries are made from the unit. In addition, the job authorisation procedure involves a long communication chain from the operative - to contractor's regional agent branch - to contractor helpdesk - to client's helpdesk - to client's managing agent and then all the way back again. Where approval is required, operatives have to revisit the unit after the arrival of the managing agent's approval, instead of carrying out the repair instantly.

The use of paper slows down the speed in which reactive maintenance work is handled. Hence, creates management difficulties. Moreover, it creates additional problems for "double handling" as data needs to be transferred from paper into the system.

The filing of paper documents is space consuming, and certain levels of information detail recorded on the paper documents are abandoned. For example, the unit manager's comments in the feedback part of the worksheet are seldom used to assess the contractor's performance for payment approval, because they are not entered into any of the IT systems. The forms are filed and forgotten about, unless a complaint is made.

## 6. CONCLUSION

This paper has given an insight into the business process of reactive maintenance projects in the UK. The flowchart technique used to mapping the whole process has made it visible enough to be analysed. The problems highlighted were agreed by the parties involved in this research which can be summarised as [1] poor communication among different parties in the process; [2] lack of knowledge sharing; and [3] poor quality of information. This has consequently opened up the opportunities for improvement particularly in the area of knowledge management, knowledge management system, communication and data sharing.

## 7. ACKNOWLEDGEMENT

The authors would like to thank EPSRC for funding this research and Industrial Partners WS Atkins Consultants, WS Atkins FM, Lloyds TSB Group PLC, Whitbread PLC and Willmott Dixon

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