RESEARCH ON INFLUENCES ON MAINTENANCE MANAGEMENT EFFECTIVENESS

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Maintenance management as a complex partnership between the people directly or indirectly involved in maintenance, the processes and strategies to direct people's actions, the physical asset being maintained and finally the Computerised Maintenance Management Systems - the main link between the "people", "processes and strategies" and "asset". Although the maintenance literature contains many recipes for success, anecdotal evidence suggests that maintenance management is not as effective as one would expect. Despite advances in instrumentation, computer capabilities, integrated asset management software and the involvement of reliability engineers and maintenance managers, equipment still experience unexpected and costly failures – sometimes with adverse effects on people and the environment. Literature on systematic research to support or contradict the anecdotal evidence is hard to find. This aims of this paper are to (1) introduce a research project aimed at beginning to identify and discuss the various influences on maintenance management. The research (using contemporary social sciences investigation methods) is conducted by experienced engineers, and is part of a larger project on the nature of engineering work. (2) discuss literature available in the public domain that might provide an insight into the various aspects leading to successes or failures of the field of maintenance management.

Key Words: SAP™ PM, Plant Maintenance, Computerised Maintenance Management System

1 INTRODUCTION AND INITIAL PROBLEM STATEMENT

Maintenance is a huge industry. On a global scale, Thomas [1] estimated maintenance cost to consist of 9% of an estimated world Gross Domestic Product (GDP) of 45,000 AUD. Individual companies also experience maintenance cost as substantial. Hägerby and Johansson [2] reported the total cost of maintenance for the companies reviewed by them to be as high as 40% of company turnover.

The size of the maintenance industry resulted in the abundant supply of software, instrumentation, analysis techniques and specialists to support the maintenance industry. Landmark books have been published in the last decade that contain "recipes" to optimise companies' maintenance. Examples of techniques widely used by companies in projects aimed at optimising their maintenance costs include Reliability Centred Maintenance (RCM) [4], root cause failure analysis [5] and preventive and predictive maintenance (PM) [6]. Our understanding of functional failures of equipment and how these present themselves in an operational environment has improved dramatically. We have generic preventive maintenance tasks and typical maintenance intervals that can be used as a main source when developing preventive maintenance programs. There have been dramatic advances in computer capabilities in the last decade. Instrumentation that measures the condition of the equipment has also become better and cheaper. Companies have maintenance engineers to address the operational day-to-day maintenance issues, and reliability engineers to address long term maintenance strategies.

Despite all of this, anecdotal evidence suggests that maintenance management still has huge issues, and that improvements in the last decade have not been as dramatic as one would expect. Equipment still experience unexpected and costly failures - sometimes with far reaching consequences and ramifications. An example of such a recent event linked to maintenance was a burst main water pipe next to a freeway in Perth, Western Australia. An estimated 12,000 kilolitres of water flooded the neighbouring areas in a short period, resulting in the hastily evacuation of business premises and private homes. Vehicles were stuck on the highway and major roads for several hours, ambulances could not transfer sick people to hospitals, parents could not pick up their kids from school, taxis could not get rid of their passengers and people missed their flights.

Companies are also becoming increasingly dissatisfied with the effectiveness of expensive maintenance optimisation projects and Computerised Maintenance Management Software (CMMS) systems. All of the companies reviewed by Hägerby and Johansson [2] for example reported dissatisfactions with their maintenance software systems – some because of inappropriate configuration of the software system, others because of inappropriate usage of the system.

2 PROJECT AIM

This paper introduces a research project aimed at beginning to identify common issues experienced in the field of maintenance management, and how these issues are being (or have been) addressed by the companies participating in the research project. The research, using contemporary social sciences investigation methods, is conducted by experienced engineers and is part of a larger research project at the University of Western Australia into the nature of engineering work [3].

3 DEFINITION OF MAINTENANCE MANAGEMENT

In the context of this research project ***maintenance management*** is defined as the preserving of the ability of an asset to safely and economically produce something through structured management of the following elements throughout the life cycle of the asset:

- The asset - the plant equipment maintained
- People – the group of individuals in the organisational structure involved directly or indirectly with maintenance. Some people are very visible in the maintenance work flow process (such as asset managers, maintenance engineers, maintenance supervisors, maintenance technicians and plant operators) while other people are less visible but not less important in the maintenance work flow process (e.g. reliability engineers, inspectors, accountants, purchase buyers, and CMMS Administrators).
- Processes and Strategies –“Processes and Strategies” are defined as the maintenance-related business processes, maintenance strategies implemented to optimise maintenance cost, maintenance engineering and analyses techniques.
- Computerised Maintenance Management Systems (CMMS) – The CMMS is the heart of each modern maintenance system, and is the main link between the "people", "processes and strategies" and "asset".

4 RELATED RESEARCH

The research literature found on maintenance management mainly focuses on technical issues and advanced analysis techniques. The literature on maintenance is also predominantly "prescriptive". Many writers have contributed suggestions and techniques for effective maintenance programs, but these are either based on their own experiences or are aimed at promoting a specific product. Very little empirical data and systematically researched results could be found on high level issues experienced in the field of maintenance management, and the overall effectiveness of different approaches towards addressing these issues.

5 “HYPOTHESES” TO BE TESTED

The hypotheses to the tested during the research address the following three of the four elements of maintenance management as defined in section 3:

- The people
- Processes and strategies
- The CMMS

The asset being maintained (e.g. the age of equipment) is not included in the scope of this research project.

5.1 *Hypothesis 1 related to "People"*

"Maintenance" has negative connotations and as a profession it has no social status

The following saying by an experienced consulting engineer was once overheard "*People don't stand around the barbecue bragging to their friends that they had a meeting the whole morning with their maintenance engineer. They say that about their accountants, lawyers and medical specialists though*". Maintenance is not seen as a "sexy" job, and has negative connotations within companies' top management structure where maintenance cost is many times considered an unnecessary expense. Maintenance also has a negative connotation amongst the public where maintenance (or the lack thereof) is seen as the culprit in major incidents such as Chernobyl and Piper Alpha [3]. In Chernobyl, preventive maintenance intervention was the direct cause of the accident, and on Piper Alpha a relief valve had been removed during preventive maintenance, and this together with a series of accidents and oversights led to the catastrophic destruction of the offshore gas platform and the death of people.

Palarchio [7] asked a group of managers from maintenance and production what comes to mind when the word "maintenance" is mentioned, and the most common responses he received were (i) high cost (ii) under utilised (iii) not highly valued (iv) bottom of the management group (v) non exploited opportunity for competitive advantage. All the responses were thus very negative in nature. According to Thomas [1] the feedback received by Palarchio mirrored his own experience as a maintenance consultant of 25 years. Following a series of interviews with people on what they do as engineers, Trevelyan [3] reported that "*Maintenance is a major area of engineering in its own right and it was interesting that in our early interviews it hardly rated a mention*".

In this research project, we will attempt to determine (i) what maintenance experience does people in top management have, and (ii) what is the general feeling towards maintenance.

5.2 *Hypothesis 2 related to "People"*

The strategic importance of maintenance is not understood at board level

It goes against human nature to spend time and money on something that has not happened - which is the basic principle of preventive maintenance. Maintenance does not seem to be well presented at high level in companies, and top management seem to mainly come from either accounting or law backgrounds. Thomas [1] for example writes that "*Many organigrams show maintenance at the same level as production, marketing, finances, etc, but in my experience the reality is that maintenance is not part of* "*The Management Club*". With the lack of maintenance experience in top management, it is no wonder that they find it difficult to understand the strategic importance of investing in maintenance. According to O'Malley [8], even the members in the maintenance team such as reliability engineers sometime struggle to see the importance of maintenance - making it difficult for them to "sell" maintenance as a benefit to top management.

We need to assess (i) whether top management puts unrealistic pressure on the maintenance team, and if so (ii) does this pressure sometimes force the maintenance team to introduce unsustainable cost cutting actions.

5.3 *Hypothesis 3 related to "People"*

Short company memory restricts effectiveness of maintenance optimisation projects

Based on the authors' experience, people in maintenance management roles seem to stay in a specific role for approximately 2 years before moving up the corporate ladder. They do not stay long enough to experience the effect of changes introduced by them - good or bad. New managers have their own views and strategies, and of course introduce these as soon as possible, attempting to achieve even more impressive results than their predecessors. Whether the changes are sustainable in the long term many times does not seem relevant to the manager as he does not plan to hang around for very long.

The people affected the most by the continuous change in approaches (e.g. the maintainers) eventually become "change weary" because they "*have been there, seen that*". They embrace new ideas with difficulty and trepidation, and with the underlying thought this change will be replaced by another "new idea" before long. Hayword [9] noted that most of the employees in the maintenance department of an American energy provider have been through some form of a change process between 1990 and 2000. They have been exposed to re-organisations, process re-engineering, competency modelling, continuous improvement, organisation development intervention and RCM. Few questioned the intent of these efforts, but many however questioned whether these changes were truly successful as no feedback was provided regarding the success rate.

We will attempt to determine (i) how long individuals have stayed in particular maintenance management roles in the past decade (ii) how many changes have been introduced by the each maintenance managers, and (iii) what feedback has been provided regarding the success rate of the changes.

5.4 *Hypothesis 4 related to "People"*

Background of Maintenance Managers and Supervisors do not prepare them sufficiently for the demands of their roles

Hägerby and Johansson [2] reported that many companies reward their top performance workers in the maintenance field through internal promotions to maintenance supervisors and maintenance engineers. These individuals thus end up managing their friends they have worked with for many years, leading to a lack of professional respect for the managers and difficulties in managing the work force. Thomas [1] is of the meaning that maintenance supervisors and team leaders lack management skills in general, and therefore are working at less than 60% of their potential. According to Orr [10] many technicians try the job of maintenance manager, but the pressures are such that few last.

Information will be gathered on (i) the current background of current maintenance managers interviewed in the case study, and (ii) whether the maintenance managers experience major frustrations directly linked to their background.

5.5 Hypothesis 5 related to "People"

Workforce is ageing, and there is no special preparation to transfer experience and knowledge

According to Hayward [9] 40% of craft work force in the Department of Energy in USA will retire between 2002 and 2007, with the average age of the maintenance work force at the beginning of that period 50 yrs old. No statistics could be found on the average age of the maintenance work force in Australia, but anecdotal evidence suggests that the work force is also ageing in Australia. There seem to be little attempt by companies to transfer the knowledge of this experienced work force to the younger technicians in a formal manner. One way of transferring this knowledge would be to get the older workforce to review and update all the job procedures attached to preventive maintenance tasks (job procedures contain the details of specific maintenance tasks, and are supposed to be followed to the letter by the maintainers). These procedures often have mistakes, as highlighted by an engineer involved in the development of job procedures [3] "*To a certain extend, the engineer will also rely on trained workers to detect and avoid mistakes or simple omissions in the instructions*". Experienced maintainers recognise mistakes and shortcoming in the job procedures, and adapt the maintenance tasks accordingly. This is sometimes done automatically, as noted by Orr [10] when he shadowed (i.e. followed) some technicians for a period "*The instruction tell the technician to cut off the redundant wire, but Tom tapes it and tucks it out of the way*", and "*The instruction say use a shim, but you cannot actually reach in there to do so*". Inexperienced younger maintainers will not have experience to adapt job procedures "on-the-run", and in highly regulated maintenance environments they should also not be allowed to adapt the procedures without prior approval.

We need to determine (i) the average age and statistical age distribution of the maintenance work force - especially that of the maintainers in the field, and (ii) if the work force is ageing as suspected, are there special preparation by the companies involved in the case study to transfer the experience and knowledge.

5.6 Hypothesis 6 related to "People"

Maintenance Managers are over-allocated and over-stressed – especially in a corrective "fire-fighting" environment

Most companies have reliability engineers to develop long term maintenance strategies, and maintenance engineers to provide operational shorter term maintenance engineering support. Maintenance engineers would for example be involved in the complex repairs of a compressor. From the author's experience, the maintenance engineers are the first to suffer in a corrective "fire-fighting" maintenance environment. There is also a growing trend in companies to communication mainly via elaborate e-mail. Between managing the technical aspects of high-priority and complex repairs, and reading hundreds of e-mails (of which a guesstimated 80% were sent to the maintenance manager "for information only") there is little time left for the maintenance managers to reflect on the situation, and to introduce actions to move away from this corrective "fire-fighting" mode. A few of the people interviewed by Mintzberg [11] expressed a dislike for long memos, and most long reports and were correspondence skimmed quickly. Skimming though e-mails by a maintenance manager is risky as important information might be missed or misunderstood.

Information will be gathered to determine how maintenance managers spend their days, and whether the managers are over-allocated and over-stressed.

5.7 Hypothesis 1 related to "Processes and Strategies"

Tools and techniques used in maintenance optimisation projects do not always deliver

Anecdotal evidence suggests that companies are realising more and more that the tools and techniques used to optimise their maintenance do not always deliver what they promised. It could be that the tool or technique was inappropriate for that particular application, or that the facilitator and/or members involved in the discussions were not experienced in the subjects under discussion. The author has seen results of elaborate Reliability Centred Maintenance (RCM) analyses on equipment that were neither critical to the safe operation of the plant, nor to maintaining production levels and quality. The equipment also did not have high failure rates or was it costly to repair. Leonard [12] concluded that the failure of many RCM initiatives in industry was because of the application of the cumbersome and inflexible RCM methodology in industrial contexts that differ widely from the aviation industry where the RCM technique was first applied. Feedback from Hägerby and Johansson [2] suggested that "first line maintenance" as a maintenance technique has not been unsuccessful because the little first line maintenance the operators did (such as lubrication) was not preformed well. Thomas [1] writes "*I cannot remember the number of times when visiting maintenance offices that I have seen expensive condition monitoring equipment gathering dust [……]. No doubt these were bought in good faith but they failed due to the lack of basic maintenance principles.*"

Many misconceptions exist around what is the "correct" amount and type of maintenance for an asset. Weber [13] noted that "*Many organizations feel that if they can move from reactive to preventive maintenance they are headed on the right path…However, studies have shown in excess of 80 percent of all failures are random. Therefore, time-based preventive maintenance programs will not be effective because you will, in most cases, be doing too much work too soon or too little work too late*". According to Anderson [14] up to 40% of the costs spent on preventive maintenance have negligible impact on the failure rate. Levitt [6] gives an example of where a company tried to "band-aid" an ailing and failing old plant by introducing a preventive maintenance (PM) program – with no improvement. The company finally ended up replacing the worst equipment, and overhauling the remainder of the critical equipment.

The majority of the maintenance people interviewed by Hägerby and Johansson [2] reported dissatisfaction with the amount and type of maintenance done on their assets, identifying the following main frustrations regarding the maintenance programs: (i) supplier documentation was used as main source during the development of the initial maintenance program. The supplier recommendations are now during the operational phase being experienced as excessive, and sometimes even totally inappropriate. (ii) The PM program does not consider what stage of the production life cycle the equipment is in. Commonly, more maintenance is needed during the start-up of the production line which leads to large backlogs if this is not considered.

As can be seen from the numerous examples above, selecting an effective maintenance regime is not easy, and many companies had it wrong in the past. Information will be gathered to determine (i) the main tools and techniques that have been used in the past to optimise the maintenance, and (ii) how successful these attempts have been to optimise maintenance.

5.8 Hypothesis 2 related to "Processes and Strategies"

There is an oversupply of tools and techniques to support maintenance management and optimisation efforts

Because of the size of the maintenance industry, there are abundant tools and techniques available to help the reliability and maintenance engineers in their efforts to optimise the maintenance. Technology changes extremely fast; and new terminology, tools and techniques are introduced continuously. Levitt [6] writes "*Every year some smart scientist, engineer, or maintenance professional comes up with one or two more techniques for predictive maintenance*. On only one website (http://www.plant-maintenance.com) over 700 software packages are listed that manage some aspect of maintenance.

There are no definite rules as to what tools and techniques are the best, and a lot therefore relies on the experience of reliability engineer as it is expected of him to select the appropriate tools and techniques (O'Malley [8]) – a daunting task given all the choices, and easy to get it wrong.

We would like to determine (i) whether reliability engineers find it difficult to keep up with the change in technology in the maintenance field, and (ii) how they determine which tool and/or technique to select when aiming to optimise the maintenance.

5.9 Hypothesis 3 related to "Processes and Strategies"

Improper work flow processes and work order execution rules

The maintenance work flow processes and work order execution rules define the activities involved from identifying a requirement for maintenance to execution of the maintenance activity, and close-out of the job. For the maintenance work flow process to be utilised as an effective communication and management tool, it should contain the following: (i) A clear definition of each activity (i.e. the "what") (ii) The person/role responsible for the execution of each activity (i.e. the "who")

(iii) A link to detailed instructions on how to execute the activity in the CMMS (i.e. the "how") (iv) Decision gates to ensure that jobs are correctly prioritised, scoped and executed. (v) Regular reports that will identify bottlenecks in the work flow process (vi) Regular audits on the quality of the data gathered during each step of the process. Poor quality of data might for example be an indication that people require more training in the CMMS (vii) Limiting of people's access in the CMMS to reflect their responsibilities and accountabilities in the work flow process.

Hägerby and Johansson [2] noted that if the work flow and work prioritisation are not regulated, people tend to do the interesting work orders first, leaving the boring work such as regular oil sampling for the next shift. This can lead to a backlog of "uninteresting" but sometimes essential maintenance work. It could escalate to the point where maintenance technicians disregard the CMMS work orders and job procedures entirely, and do only what they consider necessary.

We need to determine how well the work flow processes are defined and followed in the companies taking part in the research project.

5.10 Hypothesis 4 related to "Processes and Strategies"

Maintenance history data is of poor quality

Yang W.L. & Strong D.M. [14] define data quality as data fit for purpose, and may be measured using key parameters that are important to the users of the data. Typical parameters include accuracy, relevance, completeness, timeliness and accessibility. From the author's experience, many companies have in the past not been serious about the quality of the maintenance history gathered in the CMMS. Levitt [6] confirm this experience by reporting that "*Management has been wishy washy about requiring work orders and other maintenance record keeping to be accurate and complete*".

Poor data quality makes it difficult to identify the current status of maintenance, and to measure the effectiveness of maintenance optimisation projects. The following are possible reasons why the data quality might be poor:

(i) The data is not used by reliability engineers in analysis, or if used no feedback is provided to the maintenance technicians and operators as data collectors. An engineer made the following comment during an interview with Trevelyan [3] "*Often that I find that we are collecting data but not using it effectively. Of course there are sometimes issues with the quality of the data and that needs to be taken into account before making too much use of it*".

(ii) Instructions as to when, where and who should enter data in the CMMS is unclear.

(iii) Insufficient auditing of data quality

Data will be gathered to allow assessment of the quality of the maintenance history data. We will also attempt to determine the major contributing factor/s to the quality of the data.

5.11 Hypothesis 1 related to "CMMS"

Poor CMMS implementation

Companies are becoming increasingly aware that the trend to use "quasi-experts" (i.e. experts in the Computerised Maintenance Management Systems (CMMS) but with little understanding of maintenance) to configure and support the CMMS is a dangerous practise. The following was reported by people interviewed by Hägerby and Johansson [2] "*The initial (PM) program was developed by people with little or no experience in operative maintenance. For this reason, unrealistic assumptions have been made, resulting in a PM program that contains several unnecessary or even totally inappropriate activities*". Mather [16] considers maintenance an area neither easily nor rapidly understood by those outside the disciple, and advises that only people with sufficient knowledge in both maintenance and the company's specific business requirements take critical decisions regarding the way in which the system should be configured. Levit [6] suggests using CMMS representatives as advisors only, which is of course only viable if the decision makers have sufficient knowledge of the CMMS.

We need to gather information from case studies to assess whether (i) companies are happy with the CMMS implementations (ii) Who were the main implementers of the CMMS (iii) Are the results distinguishable from alternative implementation policies.

5.12 Hypothesis 2 related to “CMMS”

Insufficient maintenance of CMMS post go-live

The “go-live” date of a new CMMS is normally broadcasted widely in a company, and awaited with excitement. After the CMMS has gone operational though, people are expected to get on with the “real job” of maintenance. There seem to be a trend by companies to allocate as little time and resources as possible to the review, update and maintenance of the master data in the CMMS (“master data” is defined as that data in the CMMS that do not change regularly as part of the day-to-day operations of the plant). The data administrator for example is one of the lowest job-levels in many companies. People interviewed by Hägerby and Johansson [9] reported that “*CMMS is used extensively but these plans are not kept up to date and therefore not trusted by the maintenance personnel*.”

We will attempt to determine (i) whether companies consider the maintenance of CMMS master data a high priority activity, and (ii) Has the quality of CMMS master data increased or decreased following the CMMS implementation.

5.13 Hypothesis 3 related to “CMMS”

Inappropriate initial CMMS training

Training of end-users before going operational with a new CMMS is essential as it communicates the new business processes as well as how to navigate in the CMMS. The author’s experience has been that companies provide comprehensive training on how to navigate in the CMMS, leaving a gaping hole in the user’s understanding of “why” they need to certain things and “who” is responsible to executing certain activities.

During the research project, we will evaluate the type of training provided to new CMMS users. We will also attempt to determine the contribution of the training to the maintenance data quality. Is there for example a trend by CMMS users to adapt the rules by leaving out the “boring bits” such as maintenance feedback after completing the job?

5.14 Hypothesis 4 related to “CMMS”

No follow-up training is provided on the finer aspects of the CMMS

A lot of research has gone into the capacity of people to assimilate new information (e.g. Miller [17]). Based on the experience of one of the authors gathered from training more than 1000 users on new CMMS’s, only a guesstimated 10% the initial information is retained by the trainees. Should initial CMMS training therefore concentrate on transferring only the basic principles? Do companies rely on regular follow-up training, and how structured is this training?

6 RESEARCH METHODOLOGY

Phases of the project: The wide scope of the list of hypotheses will have to be narrowed down early in the research project to only those that seem to have a substantial impact on the effectiveness of maintenance management. The first phase of the project will thus be exploratory in nature, and will gather qualitative high-level data around each of the hypotheses. Data gathered during interviews will be coded and analysed with the aim of identifying common experiences. The output of the first phase will be a reduced list of hypotheses.

The second phase of the research project is defined as the confirmatory fieldwork phase, and will aim at collecting and analysing in more detail data around the common experiences that emerged during phase 1. These common patterns will either be confirm of disconfirm through analysis of new data gathered in the second phase of the research project.

Sampling group: During the first phase of the project, maximum variation sampling will be used by interviewing people from as wide a range of maintenance roles as possible and practical. It will be attempted to interview maintenance engineers, reliability engineers, field workers/maintenance technicians, operators, inspectors and purchase buyers. During the second phase of the project the people or roles most influence by the common experiences identified in phase 1 will be interviewed.

Data source: Data triangulation (i.e. the use of a variety of sources) will be applied during this research, with the main source of the data qualitative questionnaires used during interviews to direct the questions to address specific issued. This data will be coded and analysed appropriately. Where considered important for understanding certain aspects, individuals might be shadowed for a period. Finally, where required the Computerised Maintenance Management System (CMMS) might be interrogated and company documentation might be reviewed.

7 OUTCOMES AND BENEFITS

Maintenance is a huge and fast changing industry. The main role players in this industry are the companies with the maintenance needs (and they can spend up to half of their turnover on maintenance) and the providers of software, instrumentation, consulting, training etc. aimed at reducing companies' direct and indirect maintenance costs. It is mainly up to the reliability and maintenance engineers and managers to decide on the tools and techniques that would best help them to optimise their maintenance.

Much of the literature available in the public domain has been written by these providers with the aim of promoting their products or services - making it very difficult for the decision makers to select the "best" tool. Many companies have opted to go down a certain path paved with promises of huge reductions in costs, only to find at the end of it all that not much has changed.

The aim of this research is to provide a better understanding of the major factors that have influenced (or still are influencing) the effectiveness of maintenance management efforts – whether the influence has been negative of positive. This will provide a foundation for future research.

8 PROPOSED RESEARCH PLAN

Refer to Table 1 for details on activities within the various phases of the research.

Table 1

Activities of research project

Task	Detail	Start	Finish	Milestone / Deliverable
PHASE 1: Preparatory Phase				
Activity 1.1	Literature review	2005; Q2	2005; Q4	Chapter 1 of thesis
Activity 1.2	Research Proposal	2006; Q1	2006, Q1	Research Proposal (including hypotheses)
PHASE 2: Exploratory Phase				
	Development of qualitative questionnaire#1 Identification of people to interview Gathering of high-level data (field work) mainly through interviews Coding and analysis of data Identification of common experiences Reduction of list of hypotheses	2006, Q1	2007, Q2	Qualitative questionnaire#1 Transcripts of interview Reduced list of hypotheses
PHASE 2: Confirmatory Phase				
	Development of qualitative questionnaire#2 Identification of people to interview Gathering of targeted data around reduced list of hypotheses through interviews, shadowing, CMMS interrogation and documentation Coding and analysis of data Confirm or disconfirm principle outcomes / hypotheses	2007, Q3	2008, Q4	Qualitative questionnaire#2 Transcripts of interview Confirmed or disconfirmed hypotheses

PHASE 3: Thesis Documentation				
	Documentation of results	2009, Q1	2009, Q4	PhD Thesis
	Preparation of scientific journal publications on results and analysis methods			Publications
				Conference Proceedings
	Presentation of results on conferences			

9 LEADING SCHOLARS

To be completed later

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