The use of Information Systems in Fault Diagnosis

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Abstract

Excessive downtime remains a problem for many organisations, particularly those using complex capital intensive manufacturing processes. To counter this, many use computerised management systems to support various aspects of their maintenance activities including breakdown diagnosis.

This paper describes research that has been undertaken to investigate the effectiveness of maintenance information systems to support activities during machine breakdown.

A survey has been conducted to investigate computerised management system applications from the user perspective. The survey was designed to solicit user opinion on effective maintenance user support and the usefulness of existing IT systems to various personnel.

The combined survey results and literature review are used to inform the development of a pilot maintenance information system that will be evaluated in a future study.

1. Introduction

Research has been undertaken to ascertain current attitudes toward the use, implementation and effectiveness of computerised maintenance information systems. A survey was used to research current user opinion on the usefulness of existing IT systems within a maintenance environment. Other information sought, was the level of system accessibility to differing personnel, information availability, and the level of user contribution to such systems.

2. Literature review, Information Support Systems

Background

Computerised information support systems use different techniques and approaches to satisfy different maintenance requirements. Expert systems (ES) are rule-based systems developed to support specific tasks with known outcomes [6]. Computerised maintenance management systems (CMMS) assist in planning, management, and administrative procedures for effective maintenance [1]. Enterprise resource planning (ERP), is the integration of a single company wide information support system, serving the particular needs of different areas within the company [12]. The use of interactive electronic technical manuals (IETM) provides information support through the use of technical documentation presented as digital information [11]. Developed as referential technical manuals, digital maintenance manuals use

hypertext / hypermedia technology to structure information, which allows for rapid access to related information [9].

2.1 Computerised maintenance management systems (CMMS)

CMMS often fall short of delivering useful information to the maintenance work force, or allow them to record the results of their actions for the benefit of the organisation as a whole [1]. Case studies have shown this to be most evident when production demands have priority over the maintenance function. [2].

To promote business wide improvement, it has been suggested that CMMS implementation should be defined by the exact business needs and then through reiteration, fit the work control process [3].

If production and fault diagnostic systems are incorporated into larger CMMS, these are generally 3rd party modules that can fit within the work control process, or work independently. However, problems of data accuracy and system validation have been identified which can reduce the effectiveness of such applications [4]. Another approach for fault diagnostics where failure modes are well known and documented is the use of built in test equipment (BITE), for aircraft maintenance [5]. Its intention is to detect faults with a degree of self-monitoring to assist in diagnosis and trouble shooting, although the wider issue of maintenance action still remains with the technician [5].

2.2 Expert systems.

An expert system is the integration of human and documented knowledge captured within a computer to solve problems that ordinarily require human expertise [6]. The use of an ES approach within the maintenance function, is to provide consistency in task performance, improved decision making processes and, monitoring expertise etc. [6,7]

Expert systems as part of the organisational structure are considered by some authors to be too technology specific to benefit an environment with a diverse skills user base [6,8]. Further instances are shown by the lack of trust by end users, its narrow scope of operation and, poor knowledge transfer between different experts to different users etc. [6,7]

2.3 Other methods of information support.

Other methods of maintenance information support involve the use of ERP, IETM and, referential digital maintenance manuals. The use of digital maintenance manuals allow quick information retrieval and navigation to provide greater process and product support to large numbers of users. The use of hypertext / hypermedia technology for digital maintenance manuals also make them highly relevant for future web-based development. However, elements not currently visible in such systems are business wide integration, user update facilities, database access or fault recording facilities [9].

Developed to support maintenance requirements by the US Department Of Defense, IETMs, are rapidly replacing existing paper based maintenance technical manuals [9,10]. Their functional strengths are effective usability, recording facilities, parts inventory control, decision-making abilities, database management, and future web-based connectivity [10,11]. However, as they have been developed specifically for weapon systems, aircraft and other high value safety critical products requiring highly

skilled authors, hardware and software applications to achieve output, which may put them beyond the reach of many users [9].

For company wide integration, ERP systems are intended to standardise the business process by containing and sharing the collective resources of all departments into one generic computer system [12]. Notable disadvantages of the complex architecture of ERP are that businesses have to fit the system, they incur long-term process re-learning, lengthy implementation periods and, poor data conversion between old and new systems [12].

3.0 Survey review

3.1 Survey objective

The survey has been designed to solicit opinion on effective user support within a maintenance environment. The main questions comprised of:

- Who are the main users of IT for maintenance?
- Of the system features used, how effective are they?
- Since implementation have these systems proved useful in reducing maintenance downtime? If so, in what areas have they proved useful? If not, explain why.
- Are there any features that would improve the ability of your system to help reduce maintenance downtime, if so, could you explain further.
- What other approaches for information support are used during downtime?

From the combined postal and web-based survey the number of people canvassed totalled 358. From this there were 38 valid responses, of which 21 were postal and 17 were from the web-based maintenance newsgroup. Out of the 38 valid responses, 6 replies stated non-system use.

The survey which concerns the type of system used to support fault diagnosis concentrates on the use of IS, CMMS, ERP and, ES. The option choice of "OTHER" refers to the use of a bespoke or expert system. Freeform comments are discussed with the obtained results in section 3.3 "Survey result analysis".
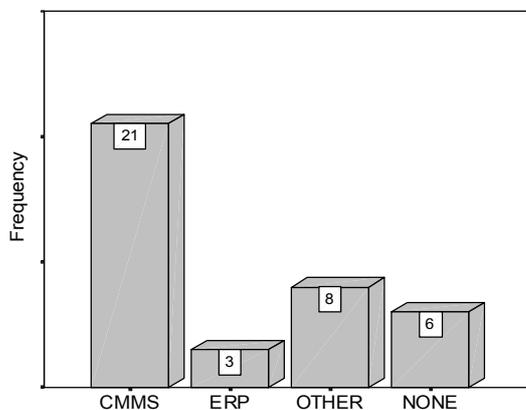
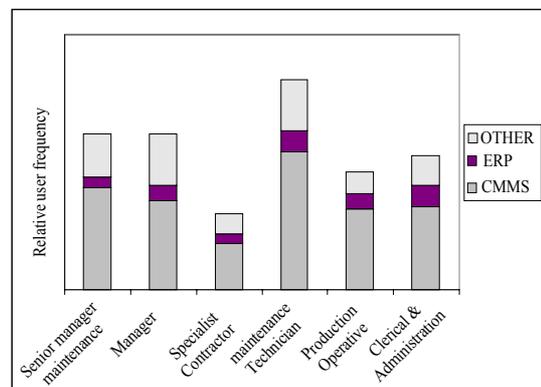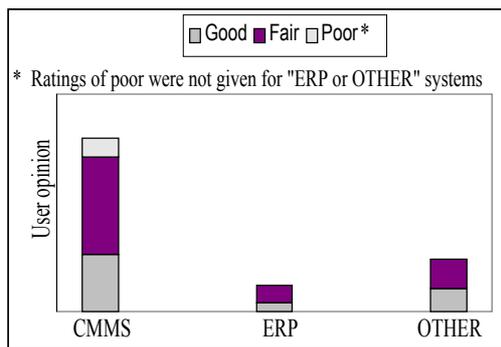### 3.2 Survey results

Figure 1 – System usage

Figure 2 – System usage by user type

Figure 3-System ratings by user

System type	APPLICATION FEATURES Predictive techniques	Fault description	Pareto analysis	Report facilities	Knowledge base	Technical database	Expert system	Diagram support								
CMMS	15	6	14	7	10	11	20	1	9	12	11	10	8	13	7	14
ERP	2	1	2	1	1	2	3	0	2	1	2	6	0	3	1	2
OTHER	2	6	6	2	2	6	8	0	3	5	3	5	2	6	3	5

Table 1- Systems application content

System performance		
System Satisfaction	Reduced Downtime	Improvement Needed
62%	62%	59%

***Table 2** – System performance*

Frequency	Paper	Experience base	Contractors	Vendors	Production operatives
All the time	9%	53%	0%	0%	16%
Frequently	44%	44%	41%	19%	25%
Occasionally	34%	3%	38%	50%	38%
Infrequently	6%	0%	22%	31%	19%
Never	6%	0%	0%	0%	3%

***Table 3** –Other information support approaches used during downtime*

3.2 Survey result analysis.

The type of system used (see Figure 1), and the overall rating given to the use of computerised maintenance information systems was 'fair' (see Figure 3). Despite this, users expressed high levels of satisfaction with their contribution to reducing downtime (see Table 2). This was attributed to effectively planned PM activities, inventory control, and resource availability. Over half the people canvassed still used experience as a main source of information support during downtime (see Table 3). However, 59% of users still expressed the need for system improvements (see Table 2). Target areas for improvement were better communication within the business structure, vendor information support, integration of web and office-based technology, and user versatility to record additional information. Despite 78% of companies using specialist contractors for maintenance activity on a combined frequent or occasional basis, only 3% of these users were allowed full system access (see Figure 2). Maintenance technicians, although the biggest system users (see Figure 2), seemed to be the least enthusiastic about the formal of process of keeping records, writing reports etc. Other areas of user concern highlighted the pull of the organisation for maintenance to fit the system being used.

4.0 Conclusion.

The literature review revealed that despite success in certain areas, maintenance IT systems do have weaknesses which restrict the role of diagnostic information support within a manufacturing environment. To evaluate the legitimacy of the research findings a survey of maintenance practitioners was conducted. However, due to the relative

newness of IETM systems, the survey concentrated on the use of IS, CMMS, ERP and ES.

The outcome of the survey confirmed a majority of findings identified within the literature research as benefits. However, although in agreement with the benefits of such systems, respondents agreed with many disadvantages identified in the literature review as elements to be used for application improvement to reduce downtime.

Research highlighted an effective approach to maintenance support, this approach made use of interactive electronic technical manuals. However, these systems have their own disadvantages in the form of being either too cost prohibitive and specialised for most users, or without the ability for business wide integration.

5.0 Future Research.

The issues discussed within this paper have recognised the usefulness of maintenance IT systems to reduce downtime. However, recognition was also forthcoming on the need to improve such systems to improve information support for maintenance activities during downtime. As a result of this, future research will concentrate on a methodology that may assist in reducing downtime further through the development of an improved diagnostic tool. As an integrated system it is envisaged that it may enable for greater flexibility and user participation in the area of dynamic information support.

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