

Development of a Computerised Maintenance Stores System in a Distiller Manufacturer: A Case Study

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Abstract: This paper presents the development of a computerised maintenance stores system (CMSS) in a distiller manufacturer in Trinidad. It investigates the information requirements and stores operations and describes the conceptual, logical and physical database designs of the CMSS for the Company. The system design partitions the data according to various categories, thereby ensuring quick and easy access to the items belonging to each group. The evaluation of the system stresses its operational effectiveness by comparing the time requirements in manual versus computerised stores operations. User feedback is acquired to examine the user-friendliness and security of the system. The evaluation findings verify that using the system could assist the company in improving the stores operations, time saving, and materials utilisation. The case study presented provides some practical references for other manufacturers and practitioners to develop their CMSS.

Keywords: Maintenance management, stores operations, database

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Introduction

The maintenance of production machinery and equipment and assurance of availability of spare parts are becoming increasingly important. Maintenance management is a data-intensive activity. Westerkamp (1999) states that the use of computerised maintenance documentation and parts requisition system is an effective means to keep an up-to-date catalogue of stores items with changes. This paper presents the main findings of a recent study of maintenance management practice in the production department of a distiller manufacturer in Trinidad.

The distiller manufacturer has been facing problems in carrying thousands of items in its maintenance stores. Its manual store system was proven time-consuming and unproductive. There has been a pressing need to revitalise its maintenance practice in managing inventory parts and maintenance database. The company has taken improvement initiatives to enhance the maintenance capabilities in its Production Maintenance Stores. These include:

- Development of a computerised maintenance stores system;
- Installation of the system with pilot implementation; and
- Evaluation of the effectiveness and user-friendliness of the system.

Current Stores Operations of the Company

The company has four categories of activities in the life of a stores item, including acquisition, receipt, disbursement and return of items. The basic activity for current stores operations of the company is shown in Figure 1.

(Insert Figure 1 about here)

Figure 1. A workflow diagram of current stores operations

Materials Acquisition

According to the manual stores operations of the company, a material requisition request is submitted to the purchasing department whenever a need occurs. The Stores Manager will invite quotations, determine vendor, price and delivery, and then forward this information to the respective Purchasing Stores. The Purchasing Stores will liaise with the Stores Manager to finalise information stated on the requisition. A purchase order is then prepared. This ensures appropriate terms and conditions governing the transaction.

Materials Receipt

When the purchased item(s) arrive at the stores, the original invoice is compared with the delivery note to ensure that 1) the price and the goods agree and 2) the condition of the product is good. The item(s) are then put away in the storeroom, and the stores inventory records are adjusted to show the current quantity on hand accordingly.

Materials Disbursement and Return

The stores will issue materials with respect to the requests made from technicians for repairs and general maintenance work. Stores inventory records would be adjusted to show the current quantity on hand. When issued items are not used, they must be returned to the stores. The return is recorded and the quantity on hand is adjusted.

Problems with the Current Stores Operations

After discussions with the stores manager and engineers in the production department, several problems of the current stores operations were identified. These include: 1) incomplete/outdated equipment data; 2) insufficient information on parts; 3) unavailability of equipment materials or spares; 4) long processing time on materials requisition; and 5) lack of performance indicators. They are elaborated separately below

Incomplete/Outdated Equipment Data

The company relies significantly on the only source of equipment data, which come from technical data booklets, supplied by the equipment manufacturer. A major problem that hinders the diagnostic capabilities of technicians is having incomplete/outdated equipment data. O'Brien (1998) states that many organisations cannot survive or succeed without quality data about their internal operations and external environment.

Insufficient Information on Parts

Not enough data are being supplied to purchasing resulting in wrong parts being ordered. In addition the vendor/supplier has problems with identifying the material requested, thus leading to unnecessary and time-consuming investigation into the materials requests.

Unavailability of Equipment Materials/Spares

Incomplete equipment data and insufficient part information have caused serious problems in getting parts on time to the required job. Time gaps always exist in obtaining

the correct part number and this leads to wrong parts being ordered. Reordering of correct parts has to be done, leading to an increase in downtime of the machinery, and hence decreasing the company's productivity. The unavailability of equipment spares is thus a main concern of the stores operations.

Long Processing Time on Materials Requisition

Materials requests are done manually starting from filling out the requisition forms. The requisition process is then completed through: 1) searching the card system manually and 2) obtaining the items that have been depleted below the minimum stock level. This is very time-consuming and prone to errors since the data on the cards are in many instances inaccurate or not properly updated.

Lack of Performance Indicators

The production department is responsible for providing performance data (such as reliability and availability) of the stores operations on quarterly and yearly bases. Problems regarding the lack of performance indicators were identified. The important one was incomplete equipment data and insufficient part information being used to determine the performance of the stores operations. Another problem stems from the fact that it was difficult to conduct thorough analysis and to obtain conclusive feedback using available performance data. Because of these, the department has been operating the stores with no strategic plan to improve its performance.

Three Phases of Database Design

In order to revitalise the maintenance practice of the Stores, an improvement initiative of developing a CMMS was made. Specific requirements of the system were identified. These included: 1) an update and retrieval mechanism of inventory information; 2) an ordering subsystem for replenishment of spares; 3) a control subsystem of spare parts; and 4) a monitoring subsystem that manages the accountability and accuracy of information (Connolly *et al.*, 1998 Westerkamp, 1999).

The development of the CMMS has gone through three phases of database design from conceptual, via logical to physical design. First of all, the information sources and users were examined to determine the information needs and user requirements. Interviews with users (including the stores manager and other engineers) of the stores system were conducted in the production department. The information acquired was used to identify important entities and relationship types and build the conceptual representation of the database. The findings were then translated to the logical structure of the database. When the design of the relations among entities was completed, the physical database design phase started. In this phase, the logical structure was physically implemented as different data tables with the aid of the Microsoft Access database management system (DBMS).

Evaluation of CMMS

The evaluation phase aims to determine the extent to which the CMMS can achieve the improvement objectives of the company. It consisted of two main parts. The first part evaluated the system's effectiveness, comparing the differences between the manual

clerical stores operations versus the computerised operations. The second part evaluated the users' feedback on the user-friendliness and security of the system. Besides, the improvement opportunities of the system were analysed.

System's Effectiveness

A comparison of the operational effectiveness between the manual system and CMMS was made. Transactions were broken down into categories of materials acquisition, receipt, disbursement and return. The times to perform manual clerical stores operations for inventory transactions, searches and reports were estimated by the stores manager and attendants. Similar operational procedures were repeated using the prototype CMMS and the resultant times were recorded.

The clerical work involved in the preparation of materials acquisition orders and the updating of the inventory cards were recorded. The results showed that the average time saved per item requisitioned using CMMS is one minute. Regarding materials receipt, disbursement and return, the clerical time saved in these operations are summarised in Table 1. From the comparison analysis, all of the manual clerical work times were greater than the times of the CMMS. In particular, tremendous time saving was achieved on the making of inventory reports. In the manual system, the stores manager and attendants have to sort through inventory cards, requisition and equipment maintenance history forms to create a report. The CMMS does the tasks involving a few clicks of the right buttons on the keyboard, and a print-out of reports can be obtained accordingly.

(Insert Table 1 about here)

Table 1. Comparison of manual versus CMMS operations

System's User-friendliness

The user-friendliness of the system was evaluated in four areas, namely: 1) simplicity; 2) consistency and predictability; 3) clarity of organisation, purpose, and navigation; and 4) ease of use. A group of users and representatives were invited to pilot-test the system and provide feedback. These included the production/maintenance engineer, the stores manager, several mechanical technicians of the company and representatives from The University of the West Indies. Major feedback on the strengths and weaknesses of the system is depicted in Table 2.

(Insert Table 2 about here)

Table 2. Evaluation of system's user-friendliness

In an attempt to tackle the faults that reports are fixed and do not allow for *ad hoc* requests, it was proposed that the design capabilities of reports be enhanced using the data generated by the system. The proposed improvement was re-tested by the users who were involved in the evaluation of the system. The results showed that the users were satisfied with the new report design. The design capabilities of CMMS also allow users to juggle the data to produce the required reports needed. Another improvement opportunity is to standardise the location of command buttons, including the Categories, Equipment Manager, Employees, Manufacturers, Suppliers, Products and Purchase Requisition

sections of the system. The change was re-tested by the same group of users, and the results showed that the users were in favour of the design change.

Discussion

Maintenance management is a data-intensive activity. Many maintenance departments handle thousands of inventory transactions, and must generate frequent reports as soon as possible to ensure the data are fresh and useful (Connolly *et al.*, 1998; Rob and Coronel, 2000). A CMMS is a practical tool for managing spares and equipment information. It can yield benefits in time saving, resource utilisation and effectiveness when compared to other manually operated methods.

Management leadership plays the central role in implementing a successful CMMS, while technology plays a supporting role. Typically, commitment at the senior level occurs because these executives realize that cost savings and other competitive advantages will accrue from sustained quality and reliability improvement efforts in parts and equipment information. The database approach would require considerable investments in both hardware and software. The hardware to run a large DBMS must be efficient and will generally require more main memory and disk storage than simpler file-based systems.

Connolly *et al.* (1998) argue that any system using online updating requires explicit backup to protect data from system failure. When a computer system goes down, all users directly involved in accessing the database must wait until the system is functional again. This may require a long wait. The company will there have to revert to the manual operation until the system is functional again.

The need for database administration of the stores system also imposes a challenge. This entails modifications of the stores system to make it more efficient and to satisfy the user's request for changes. This database administration function will require skilled personnel who are capable of fine-tuning the physical structure of the database to meet the acceptable performance criteria. One of the major concerns will be the lag time before the system is fully operational and the personnel resources needed to achieve this. A significant amount of time will be required to collect, input and categorise data. The maintenance of the data in the database is also essential, to create true reports that represent the actual situation. Besides, pooling data in a common database may not be politically feasible in some organisations. Certain user groups may not be willing to relinquish control over their data to the extent needed to integrate data. Rob and Coronel (2000) argue that the risk involved in data sharing and the potential system problems that may limit a group's access to its own data may be viewed as more troublesome than beneficial.

The prototype system presently deals with parts inventory and equipment management (e.g. maintenance history, components listing) in the company. A recommendation for future work is to add work order forms for the department to the system. The objective of the work order forms used is to provide optimum maintenance through uniform requesting, authorisation, planning, scheduling and assignment of work and to provide a written record of the actual day-to-day work done.

Conclusions

Although considerable challenges exist in using CMMS, it is a viable option for the company to enhance its maintenance capabilities from the manually operated system. The transition from the manual system to CMMS would call for a substantial investment. This investment will be paid back through the reduction of downtime of equipment and the more efficient control of inventory items. The productivity of the staff in the stores department will be increased along with the reduction of clerical operations times. The CMMS can offer tremendous benefits on managing the stores operations. Its capabilities can enable organisations to manage spare parts inventory more efficiently, improve reordering and materials tracking procedures, and monitor the total materials costs. Nevertheless, the successful development and installation of a CMMS relies significantly on top management commitment in a company. The successful experience presented provides some practical references for other manufacturers and practitioners to develop their CMSS.

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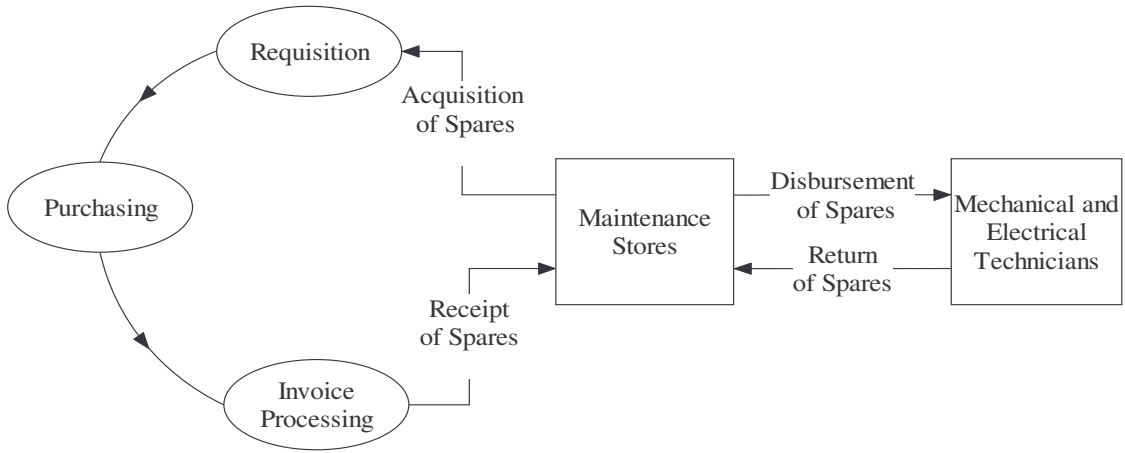


Figure 1. A workflow diagram of current stores operations

Table 1. Comparison of manual versus CMMS operations

Categories	Estimated Time		Difference Time Saved
	Manual System	CMMS	
Inventory Transactions			
Materials Acquisition per Item	2 mins	1 min	1 min
Materials Receipt per Item	1 min	0.5 min	0.5 min
Materials Disbursement per Item	1 min	0.5 min	0.5 min
Materials Return per Item	1 min	0.5 min	0.5 min
Searches			
Part Information per Item	1 min	0.5 min	0.5 min
Equipment Information	3 mins	0.5 min	2.5 min
Reports			
Maintenance History per Equipment per Quarter	30 mins	2 mins	28 mins
Product Listing of Items per Category	120 mins	2 mins	118 mins
Product Listing by Supplier	60 mins	2 mins	58 mins
Product Listing of Items to Order	120 mins	2 mins	118 mins

Table 2. Evaluation of system's user-friendliness

Strengths	Weaknesses
<ol style="list-style-type: none">1. There is little scrolling for the user to do.2. The system can be easily navigated.3. The response time for searches is good.4. The system's format is consistent and predictable.5. The reports of the systems may be printed easily.	<ol style="list-style-type: none">1. Reports are fixed and do not allow for <i>ad hoc</i> requests.2. The Command buttons are not always in the same place.