BUILDING AN EXECUTIVE INFORMATION SYSTEM FOR MAINTENANCE EFFICIENCY IN PETROCHEMICAL PLANTS—AN EVALUATION

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Abstract: This study used the manufacturing process in the petrochemical industries as an example and developed a dedicated maintenance programme and executive information system (EIS) for this industry. The software for EIS was established on a CMMS platform, with logical and extractive analysis used to store the information in a KPI databank. The system developed can provide plant managers and engineers with a complete summary of information and keep them updated regarding the present status of their maintenance efforts. The objective of this study was to establish a management system for maintaining knowledge in the petrochemical industries, such as the management of standard operating procedures (SOPs), historical records and the analysis of data for the facility. To design the software, a review of petrochemical facility was purposed to enhance the maintenance efforts and facilitate the decision-making process. The main functions of the system include asset reliability analysis, failure analysis and maintenance benefit cost analysis. For the petrochemical industry, the impact of safety and environment caused by equipment malfunction is more substantial than that of other industries. If executives can manage essential points effectively and make decisions according to a key performance index, risks to safety and environment, which result from equipment malfunction, can be decreased and safety can be enhanced for petrochemical refineries.

Keywords: executive information system (EIS); computerized maintenance management system (CMMS); key performance indicator (KPI); reliability analysis; failure analysis.

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INTRODUCTION

In recent years, serious accidents have sporadically occurred in process plants in Taiwan that have alarmed both the government and the general public (Chang *et al.*, 2000). According to the inspections conducted by the Chemical Manufacturers Association (Lorenzo, 1990), industrial accidents could be roughly attributed to the following causes: people for 40%, equipment for 40%, and the manufacturing process for 20%. In addition, more than half of the accidents led to injury and death due to limited automation of the manufacturing process and poorly designed facilities. Accordingly, human errors were inevitable (Errington and Bullemer, 1998). As offices and plants focus more and more on automation and technological development, the application of a CMMS in maintaining the on-going integrity of the plant facilities has become a necessity. To minimize human errors during a manufacturing process and maximize the efficiency of industrial facilities, process management has been used to alleviate hazards in a plant.

This new approach helped create a manufacturing system at larger scale and with more functions. The result was heavy work loads incurred by operations and management. Hence, the inter-relationship between manufacturing and modern facilities appears to be more complicated than before. Despite the safety goals, cost and effect, analysis and optimization life cycle, enterprise and industry execute their activities depending on all the historical records of facilities' functioning period. Fortunately, the CMMS has recorded the distribution of funds and the availability of facilities during the operation of manufacturers and the maintenance of assets. Consequently, we have to simultaneously realize the inter-relationship between operation and maintenance for decision making as well as for good distribution of basic costs (Waeyenbergh and Pintelon, 2002). A computer information system enables us to perform many kinds of statistical analyses and may provide diagrams to allow decision-makers to more efficiently obtain the important information for better decision making. The current maintenance information system only emphasizes manufacturing maintenance but currently lacks analysis capability for creation of professional maintenance knowledge of petrochemical plants, specific facilities, special tests, and so on. The main reason is that most maintenance information software has been designed by foreign software companies and often been marketed by regional agents not familiar with the unique characteristics of petrochemical plants. Consequently, the application of most commercial software cannot fully meet the professional demands of petrochemical plants.

The biggest challenge for maintenance staff has been a lack of sufficient maintenance data for analysis. In addition, with information scattered around in many different systems and idiosyncratic personal recording habits, maintenance staff have often been frustrated while conducting failure and cost analyses. An excellent maintenance management information system should be well equipped with sufficient analytical data and a shared common language for easy access and reference. The integration of a comprehensive information database depends on reliable management software which provides all kinds of intersectional statistical analysis for different organizations, factories, facilities, and processes, and so on. The statistical analyses include analysis and statistics of maintenance cost, reliability analysis of facilities and factories, statistical analysis of maintenance failure categories, and different analyses in the factory, facilities type, failure type, and so on (Pintelon and Wassenfove, 1990). Therefore, a comprehensive management statistical database not only improves areas in management, organization and processing, but also provides complete statistical results pertaining to cost, failure causes and reliability of facilities as important reference for maintenance or managerial staff.

RESEARCH STRUCTURE

Definition

The maintenance management of facilities should have an overall perspective. If an integration platform is lacking, the facility reliability could be problematic in view of the fact that evaluation was made with single information or characteristics from a single system. Accordingly, the derived maintenance strategies may not be sound. The ultimate goal is thus to enhance reliability and remain competitive.

The application of facility maintenance history information is extremely important in terms of the improvement of plant management. However, in the past it was often difficult to establish various analyses and metrics within traditional and non-relational databases. In addition, common reliable analysis tools, such as mean time between failures (MTBF), or mean time to failure (MTTF), were not fully compatible with all the analyses of manufacturing facilities of a petrochemical plant. Generally speaking, in light of maintenance facilities, each plant should be well equipped with its own management system to manage facility recording, maintenance records, maintenance job orders, maintenance resources and spaces, and so on. In addition, all kinds of data used in daily work should be transformed into calculable files for management tier analysis and decision-making. As a minimum the following standard forms should be provided: mean time to repair (MTTR), MTTF, mean time between maintenance (MTBM), maintenance cost analysis, material cost analysis, failure analysis and performance measurement analysis (Chien *et al.*, 2000).

In this study, the EIS for a petrochemical plant was established based on the CMMS, with emphasis on maintenance history handling information and efficiency of improving maintenance procedure. The best regular maintenance and preventative maintenance/service strategy planning were made based on individual key performance measurement indices. They focused on providing decision-makers with fast and effective and meaningful key information, which was efficiently screened and controlled in order to save time for data collection.

The system functioned to capture and save information from databases via logical and diagram selection. After users selected and calculated, the asset status and facility category were arranged from the bottom up to the very top tier according to proposed facility items and actual equipment costs to oversee an overall analysis approach as follows:

(1) It was compared according to work unit, asset structure and sketched time period (certain period of time each year) since all executives aimed to obtain the value of a certain ‘period of time’. The vertical axis was designed for ‘period of time’.
(2) After the vertical axis of the definition diagram, a rectangular bar appeared, indicating the statistical table of the first 10 items. Stated differently, it pointed out the worst actual facility item or work unit in accordance with the serious conditions. In addition, this system provided constraints on how to use a computer mouse to select the correct keys to conveniently change the appearance of tables.
(3) A simple mouse operational function is used to print diagram content. Similarly, once the correct keys are pressed, the files can be transformed into MS-Excel files.

Index Establishment and Preliminary Design

In recent years, many enterprises in Taiwan have invested in automatic facilities and put more reliance on facilities. By investing more money in automatic facilities, they should investigate the impact of maintenance period on production manufacturing system and analyse its relevant cost in order to use as KPI mode to solve relevant problems. In addition, the problem of maintenance strategy planning for a production-manufacturing system should be further investigated and solved (Mather, 2002). Finally, the best regular maintenance and preventive maintenance/service strategy planning for the minimum expected total production cost should be obtained in order to determine when regular maintenance and preventative maintenance/service work should be conducted during a production period. Hence, the basic scale performance of a production manufacturing period could be maximized, and so would the total effect of the production manufacturing period be upgraded. As a result, the maximum benefit of the enterprise is obtained (Levitt, 2003). The system was organized into asset management,