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## The Research on Business Process Reengineering of Plant Management Based on Design Structure Matrix

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**Abstract:** This article is based on the method of equipment management business process reengineering as the research object and aiming at how to model and optimize equipment management business process. Business process reengineering of equipment management is Using quantitative analysis method, through the design structure matrix theory and calculation method of fuzzy mathematics and building the structure matrix business process model, clustering, combined with the theory of business process reengineering and method. It is verified through the spare parts from the business process and equipment and strengthened the connection between each business links, so as to reducing the waiting time which lays the theoretical foundation for the integration of management and information technology equipment management in informationization construction.

**Key words:** Supply chain management, plant management, business process reengineering

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### INTRODUCTION

With the rapid development of information technology and network technology, it's bringing development opportunity for Chinese enterprises to improve their core competitiveness. Informatization construction in equipment management so that the vast majority of enterprises to obtain the competitive advantage gradually, but there are also many enterprises in the information technology revolution have little to gain, investment has continued to increase, this problem is known as investment bottomless IT "black hole" (Jiang, 2004). Therefore, how to change the original enterprise management mode, will be the integration of management and information technology for the current Chinese enterprise information management is the most critical problem. Enterprise business process reengineering is the most effective means in order to solve this problem (Jin and Hu, 2002).

### OVERVIEW ABOUT EQUIPMENT MANAGEMENT BUSINESS PROCESS REENGINEERING

Equipment management system is composed of time dimension, space dimension, resources and functional dimensions of four-dimensional space (Li *et al.*, 2004). In the dimension of time, business process is carried out according to a linear process, in the business flow,

information flow is unidirectional, often from one event to the next, the information flow reverse only in will appear and not through the audit, resulting in information transfer in the activity the waiting and iteration problem. In the spatial dimension, the business process is composed of a number of independent sector, such as the equipment management department, warehouse department, procurement department. In the information dimension, information is followed by transmission in the business process in the link, in various activities. Input activity information, processing information and output flows to the next activity after this activity. As shown in Fig. 1.

Business Process Reengineering (BPR) is in terms of that thinking of enterprise business processes are fundamental to the design and the radical, resulting in cost, quality, service and speed the dramatic improvement (Zhang and Wang, 2005). At present, in the aspect of business process reengineering in many ways, flow chart, activity cost analysis, hierarchical colored Petri, IDEF based on the data in the process of acquiring and modeling stage, in the process of evaluation and diagnosis methods commonly used for the fishbone analysis, cognitive maps, matrix technology. These methods are evaluated by field investigation, questionnaire, statistics process activities, many are using qualitative methods to judge the redundancy in the activity flow. Therefore, how to use quantitative methods

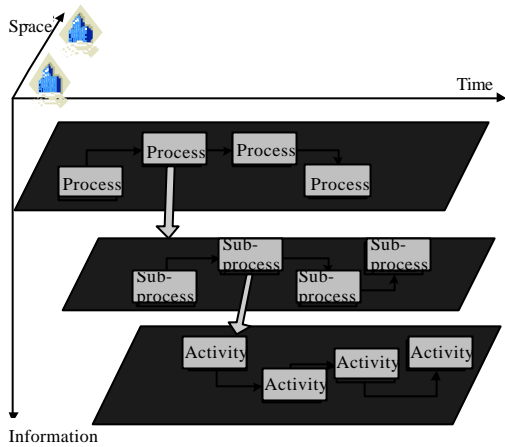


Fig. 1: PMIS business process model graph

to equipment management business process modeling and optimization is needed to solve the problems in the management of enterprise equipment process.

**ANALYSIS OF EQUIPMENT MANAGEMENT BASED ON BUSINESS PROCESS OF DSM MODEL AND RECONSTRUCTION METHOD**

The Design Structure Matrix (DSM) was first proposed by American scholar Dr. Steward, for planning and analysis of product development process matrix tool (Steward, 1981). Design structure matrix is the modeling of the system in the form of a matrix, a tool (Huang *et al.*, 2008.) and describe each part of the system relations, because has the following advantages, the 90's and the DSM have been more extensive research and application (Qian *et al.*, 2008):

- describes the composition and structure of the system, especially the coupling and circulation structure
- It is simple, compact, strong visualization, easy to communicate with the user
- Through the matrix form, make the qualitative analysis and quantitative algorithm combining, more conducive to the process system optimization (Chen and Ju, 2011)
- Equipment management business process information is a general term for various activities of the equipment management knowledge, data, charts, data, file. Information interactive equipment management business process is the equipment management activities in the transfer of information between equipment management department or organization. Based on the analysis of characteristics

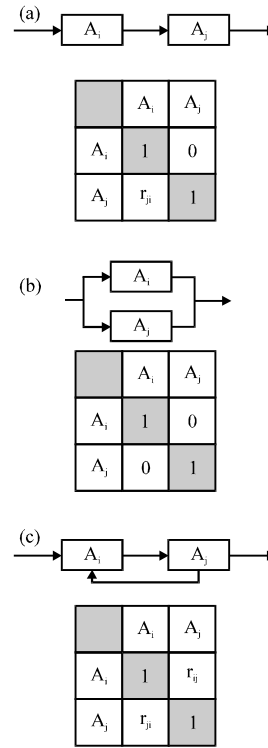


Fig. 2(a-c): Business process model of basic pattern information interaction (a) Basic patterns (b) Boolean and (c) Matrix structure

of the equipment management process activities, according to the interaction information between different activities, the basic structure of movable equipment management process model can be divided into serial, parallel and coupling of three kinds of basic patterns and Boolean matrix structure (Gao, 2009), as shown in Fig. 2

**Building structure matrix business process model:**

According to the business process management work, the process is divided into three levels: primary flow, level two and level three process flows. A collection of processes describe the relevant main business equipment in the management of the entire process flow. The process description of stage two will be a business process after further refinement, activities and the relationship between business process. The three sub process description of all activities of a certain business involved in the. All the processes, two processes and three processes are not confined to the functional departments of enterprises. As shown in Fig. 3.

Hierarchical structure of equipment management business process representation above, in accordance with the layer by layer hierarchical decomposition layers

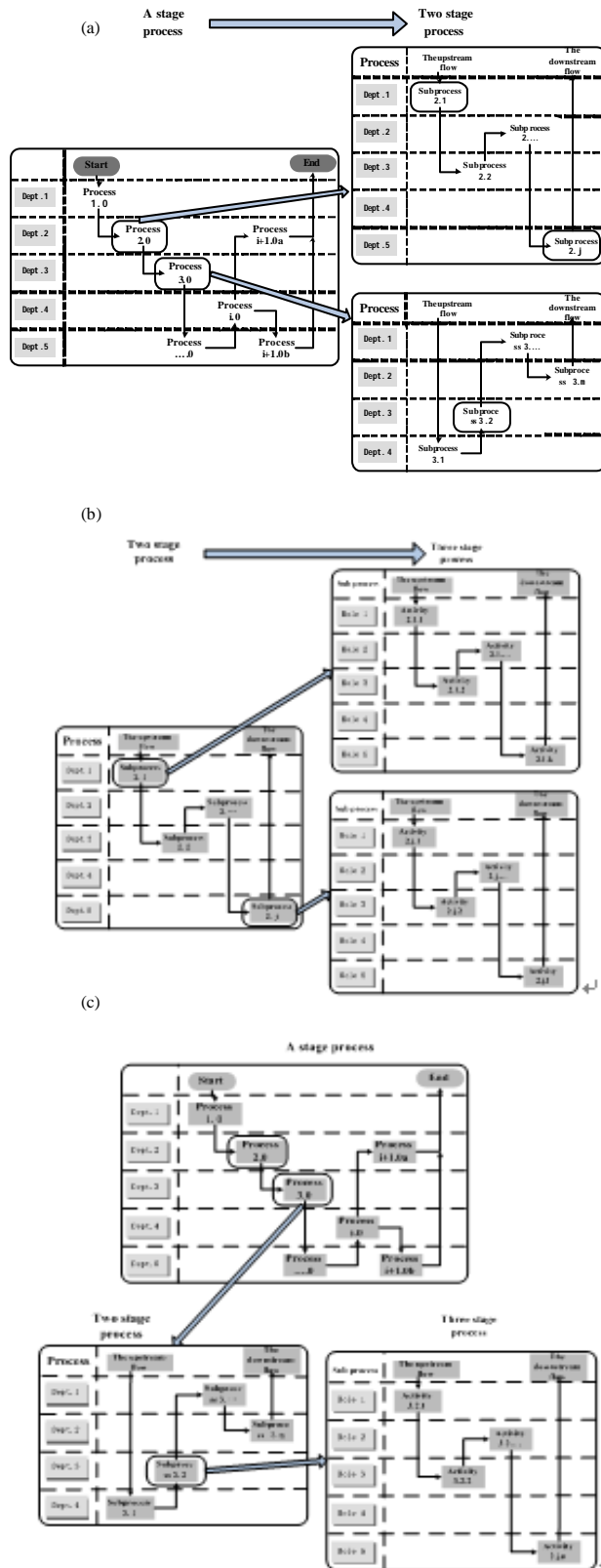


Fig. 3: Equipment management business process hierarchy diagram

structure matrix, the structure matrix to the interrelated sub matrix, the representation is as follows:

$$F_0 = \{M_1, M_2, \dots, M_i\}, i \in N$$

F0 is the total process structure matrix and Mi as the general flow of F0 matrix. Through the business process information that connect between construction process matrix. If the matrix M1, Ai, Aj respectively for the two activities the same process, Rij says the activity dependent on the activity of Ai Aj.

In the serial mode, it can be seen from Fig. 2, activities of Aj receive activity Ai output information, namely activity Aj depends on the activity of the Ai information, matrix model:

$$M_1 = [m(A_i, A_j)] = \begin{bmatrix} 0 & 0 \\ r_{ji} & 0 \end{bmatrix}$$

In parallel mode, there is no information on the relationship between the activities, the matrix model:

$$M_2 = [m(A_i, A_j)] = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

For coupled mode, activity of Aj for the existence of information dependency activity Ai and activity Ai for activity Aj has information dependence. Matrix model can be expressed as:

$$M_2 = [m(A_i, A_j)] = \begin{bmatrix} 0 & r_{ij} \\ r_{ji} & 0 \end{bmatrix}$$

$$i, j = 1, 2^\circ$$

**The analysis based on the method of DSM model and business process reengineering:** The enterprise device management can be seen as a set of business processes, equipment management information by each department and each link, finally get the equipment managers need information. In order to express and study, make the following assumptions on equipment management business process:

- Each process is composed of a number of business activities
- Business processes in all business activities are discrete
- Each business activity can be seen as a data processor
- The information interaction can be expressed in terms of their relationship with the numerical strength

- This study only from the equipment management information dimension of the business process, without considering other factors

The above assumptions in (1) to a series of activities can be multistage process refinement, excluding the discussion between processes, complex network of relations. (2) and (3) is assumed to be the business process by the business activities of the directed graph representation. Assumption (4) is convenient for quantifying information interaction and can use the theory of fuzzy mathematics to calculate. Assume that (5) the effect of multiple factors in the process of business to business activities.

**The definition of fuzzy relations:** Definition: a Fuzzy verdict on domain U set refers to (Li and Wang, 1993): for any  $u \in U$ , specify a number corresponding to the  $1] \in [0, 1]$  and it is called the subordinative degree on (degree of membership). To construct a mapping:

This mapping is called the membership function of A.

For a process structure model has been established to construct the corresponding process structure matrix structure, the relationship between activities is a fuzzy relation, expressed as a relation matrix. The relationship of membership degree to express dependencies between activities, dependence structure and activity to understand the process and the intensity dependent which can effectively process optimization and reengineering.

**Clustering:** According to the equipment management business process refined, draw the business flow directed graph and set up the structural matrix, then between the various business activities in the business process of information exchange between the numerical calculation. In a business process model, the number of ranks of elements of a cluster contains the cluster size. In order to cluster the reasonable, make the following assumptions:

- The weight of information flow and connection between elements is proportional to the ranks
- In the smaller cluster column elements between large-scale cluster management more easily
- To low the same internal cluster ranks elements contact management more difficult than between different clustering element contact management difficulty
- Cluster with the number of elements contained in the ranks of cluster growth larger between management difficulty

Clustering methods based on clustering row column transform. First of all, in order to prevent the excessive influence of weak ties on the results of clustering, in numerical value of weak connection tear process structure matrix in the model, in order to reduce the complexity of clustering; secondly, after a weak connection tear model, the independent elements are separated; and then, to the ranks of matrix transform model obtained through the above two steps after the treatment, the diagonal position in a model with non-zero cell as close as possible to the model; again, the weak link, independent elements added to the model; finally, according to the non zero cell matrix model obtained in previous steps intensive degree is divided into a number of clustering.

**THE METHOD OF BUSINESS PROCESS REENGINEERING**

In the structure of the matrix diagram, process reengineering need to cluster the ranks of elements for the analysis of similar elements in the ranks of the structure matrix. For clustering, the result is not the only. The structure matrix clustering treated were analyzed, combined with the business process reengineering theory, the structure matrix after clustering using the following method of BPR:

**Business process integration:** By clustering structure matrix appear as shown in Fig. 4 can be distinguished between the activities of information waiting and iteration problem, need to adopt the method of BPR business process integration.

In the model, the non-zero elements are concentrated in the diagonal line near  $A_{i-1}$ ,  $A_i$ ,  $A_{i+1}$ , these three business activities are divided into the same class. In the clustering of  $A_{i-1}$  and activities of  $A_i$  is coupling relation. The coupling relationship of the activity will make information generated wait and repetitive work in activity, so from the perspective of process optimization should minimize the coupling relationship between activities.

- In the management of equipment, belonging to the coupling between the activities for the examination and approval links. Too much of the work of examination and approval and greatly reduce the efficiency of daily management of equipment, so the scope of enterprise management within the allowed to reduce audit, approval activity. Such as purchasing, according to the amount of the size setting audit, approval, the amount exceeds a certain set of audit activities and beyond a certain amount set approval activity
- The coupling between the activities of the integration of the business process according to the actual situation of enterprise equipment

	$A_i$	...	$A_{i-1}$	$A_i$	$A_{i+1}$	...
$A_i$						
...						
$A_{i-1}$				×		
$A_i$			×			
$A_{i+1}$			×	×		
...						

Fig. 4: Information dependency structure model

	$A_i$	...	$A_{i-1}$	$A_i$	$A_{i+1}$	...
$A_i$						
...						
$A_{i-1}$				×		
$A_i$			×			
$A_{i+1}$			×	×		
...						

Fig. 5: Complete information dependency structure model

avoiding the coupling relation from the activities of the whole process. For example, the use of information technology, the cross department coordination work and combined with practical work activities in equipment management, duplication of work with the process, reduce repeat handover, handover process between the single point, so that smooth flow

**Business process streamlining:** After clustering structure matrix appears as shown in Fig. 5. It is identified as complete information dependence.

In the picture, can see the activity  $A_i$  is received by the activities of  $A_{i-1}$  output information, activities of  $A_{i+1}$  receiving  $A_{i-1}$  output information, so the activity of  $A_i$  without information output. In the existing processes, business process is under  $A_{i-1}$ ,  $A_i$ ,  $A_{i+1}$  series, so, we can analyze, the business activity  $A_i$  is the  $A_{i-1}$  output information directly to the business activity  $A_{i+1}$ , but it's management, not for information processing. In the transformation of business processes, for the non value added steps can be reduced according to the need of.

### CONCLUSION

This study analyzes the equipment management business process, proposed the DSM theory and calculation methods of fuzzy mathematics, the structure matrix to construct business process model, the clustering, combined with the business process reengineering theories and methods, to reengineer the business process. So in no organization adjustment principle, the matching equipment management information system daily operation and business processes to maximize the realization of the whole system, shared data, the computer play a statistical analysis of the data processing function, greatly improve the working efficiency of equipment management personnel.

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