A Research on Data Modeling of Enterprises Based on Control System

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Abstract. The key to establish enterprise information system successfully is to make a comprehensive planning of enterprise data. This paper, taking large-piece one-of-a-kind production as its background, based on the analysis on enterprise objects, enterprise products and management activities according to enterprise control system elements, put forward the classification of enterprise data on enterprise state, enterprise feature, enterprise behavior and enterprise performance, and a new description frame to express them by using the quintuple expression and situation calculus from first-order predicate. The result of it records enterprise management activities, reflects enterprises' state, and offers data support for management decision-making, which is also to provide the initial data criterion for enterprise information systems.

Keywords: *Control system, Data model, Data criterion, Situation calculus, Enterprise information system (EIS)*

1. INTRODUCTION

Enterprise information systems help to describe the enterprise and its products, to record the management activities, to show the enterprise state, to guide and control enterprise behaviors and to provide support for decision-making [1].

This paper took the Large-piece One-of-a-kind Production Enterprise as study background, and got the components of enterprise control system by the ideology of cybernetics. Correspondingly, we classified the enterprise data into 4 types. Then we introduced the description method by using a quintuple expression and situation calculus [2] based on first order predicate to discuss the data on the static and dynamic sides of real business at the level of concept. With the advantage of concept base, the data model can get deduction capability. Lastly we get the result of 8 subject databases, the data in which comprise 39 state data items, 3 feature data items, 26 event data items and 16 control data items.

2. ENTERPRISE CONTROL SYSTEM

The essence of enterprise management system is a control system. From the perspective of information processing, it is also the information movement of being

collected, filtered, mined and used to implement organization goals, while the essence of information is just a series of processed valuable data. Therefore it is the point, for EISs development, to build up the enterprise-wide data model with the comprehensive planning [3-6]. Enterprise control system is as the following figure 1.

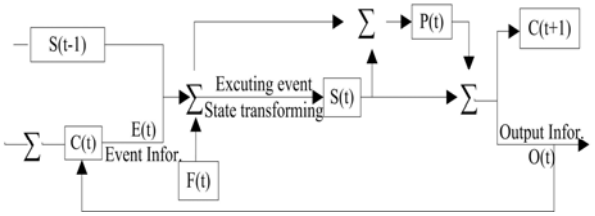

Figure 1. The Model of Enterprise Control System on Discrete Time

So one of the enterprise activities at the time of *t* can be defined as:

$$A(t) = < C(t),E(t),F(t),S(t-1),S(t),P(t),O(t) > \quad (1)$$

As seen in Fig.1, in enterprise control system enterprise behavior (C(t), E(t)) changes enterprise state (S(t)), such change is also affected by enterprise features (F(t)). The effect by enterprise behavior (C(t), E(t)) is evaluated by enterprise performance (P(t)) according to enterprise features (F(t)).

Therefore we can conclude that the components of enterprise control system include four aspects of state, feature, behavior and performance, by which we will get the four types of enterprise data to set up the enterprise-wide data model.

3. ENTERPRISE-WIDE DATA MODEL

3.1 Description Method For Enterprise-wide Data

$Enterprise\_data = \{C, A^C, R, A^R, H\}$ is a quintuple expression, where C represents a set of concepts; AC represents a collection of attribute sets, one for each concept; R represents a set of relationships; AR represents a collection of attribute sets, one for each relationship; H represents a concept hierarchy [7]. With the deep analysis on each management domain in manufacturing enterprise, such expression can be used as the main frame to capture the detailed concepts on the respect of static side of real business processes. With the captured detailed concepts, the method of situation calculus based on first order predicate is perfect to describe the dynamic side of real business processes, activities and behaviors. For the logic base of these description methods, the enterprise-wide data model can have the capability of deduction and has the potential to be evaluated, justified, improved and get more perfect [8].

3.2 Four Types of Enterprise Data

With the description methods introduced above, to expand the five elements in the quintuple expression and abstract the relevant typical situation calculus models in enterprise domains by conducting the business process analysis according to the four

components in the enterprise control system. Note that we just introduced the scope of each type of enterprise data, as for what items are included in each and how they were got and described with the detailed application of those description methods was simplified.

1. Enterprise State Data

For implementing effective control on enterprise, we firstly need to know the enterprise state and identify the state variables to describe the enterprise control system trends and get the effective decision input. Enterprise is composed of objects, the attributes of which just determine the enterprise state, which is just the description on enterprise external features at a time moment, and can be described by the states of tangible entities or objects, which are also the representation of intangible entities. They are just the existing materials including personnel, finance and materials.

2. Enterprise Feature Data

Enterprise features, also the essence of enterprise, determine the mechanism how to implement control on enterprise and what results from enterprise control behaviors. Enterprise feature data is the symbol. For manufacturing, we consider their products and manufacturing methods are the symbol to distinguish them, which are just the enterprise features. The relationship between enterprise feature data and its production type is shown as Figure 2.

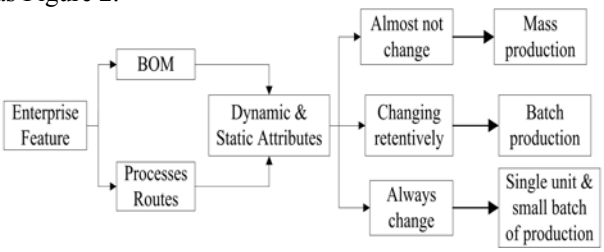

Figure 2. Enterprise Feature Data

So, we can educe the following proposition:

Ⅰ: For manufacturing enterprises, the difference among them is just their different products, that is to say the product data represents the most essential feature of the enterprise;

Ⅱ: For the same production type of manufacturing enterprises, their differences are made up of the ones between their BOMs and between their processes routings;

III: The production type, a manufacturing enterprise belongs to, is determined by the dynamic and static attributes of BOM and processes routings;

Meanwhile BOMs and processes routings are also the key for such enterprise to implement ERP successfully. To analyze why many enterprises failed implementing ERP on the aspect of technique, the reason is just the disordered organization and description of enterprise feature data, which is important to develop data criterion for information integration and data exchange between ERP and CAD/CAPP/PDM.

3. Enterprise Behavior Data

Enterprises change their states by executing enterprise behaviors. Enterprise behavior data is to describe management activities and connect the states and behaviors. According to the principle whether the enterprise behavior data change its state directly or indirectly, we classified the behavior data into 16 control data items

and 26 event data items. Control data is the gist to execute enterprise behaviors and drive a series of operation indirectly. It is also a certain constraints for enterprise events, for example the developed plan or standards etc. To build up the enterprise behavior data model, it is necessary to identify the enterprise structure and business activities, just the dynamic aspect of business happened on the enterprise entities or objects.

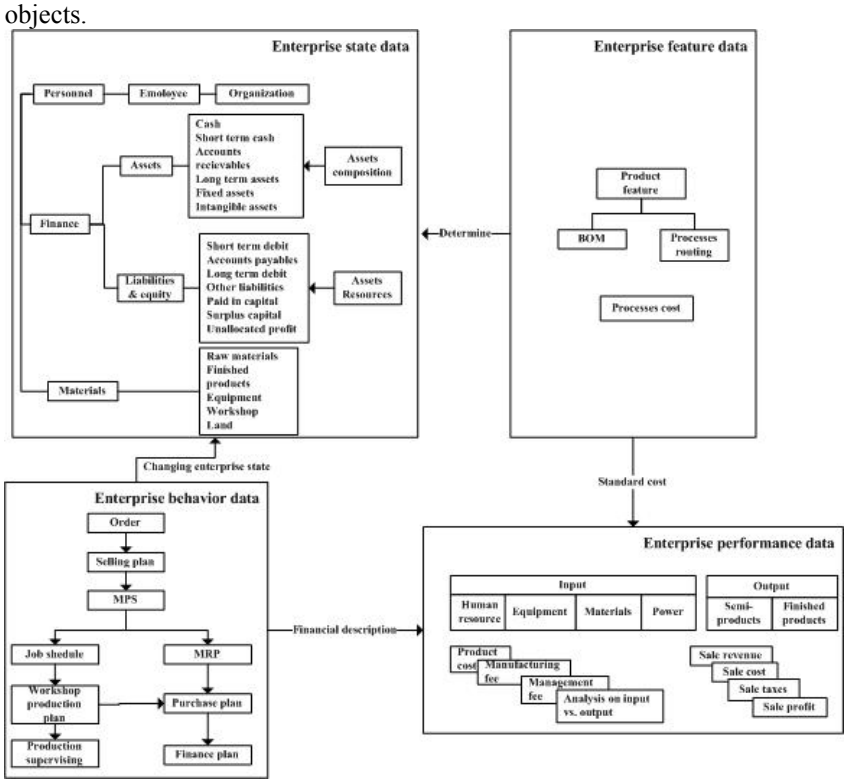

Figure 3. Relationship in Enterprise State, Feature, Behavior and Performance Data

4. Enterprise Performance Data

Enterprise performance data is to describe its business results. By the statistics on enterprise products, including the quantity calculation on semi-products and finished products and on labor hours, materials, power and accessorial staff spent in the production, we can get the cost in the production and its revenues. Enterprise performance data is obtained by analysis and calculation on state data, feature data and behavior data. The management can adjust its control behaviors according to the performance data to realize the business goal.

There is such a relationship among enterprise state data, feature data, behavior data and performance data as shown in Figure 3.

3.3 Enterprise-wide Data Model

After analyzing the management processes and activities of large-piece okp enterprise, we got the data models on different domains, including Sale & Marketing department, R & D department, Material department, Production department, Accounting and finance department, Human resources department. Meanwhile we collected the enterprise entities, represented them unified, classified them into four main data types and finally formed the 8 subject databases, the data in which comprise 39 state data items, 3 feature data items, 26 event data items and 16 control data items [1]. They are represented as:

EDM = [S, F, E, C]
S = [S1, S2, S3,…, S39]
F = [F1, F2, F3]
E = [E1, E2, E3,…, E26]
C = [C1, C2, C3,…, C16]

4. CONCLUSIONS

Such enterprise-wide data model got in the paper has been applied in the ERP product, developed by JinZhou software ltd., which is implemented successfully in China Shipbuilding Industry Corporation and more than 10 subsidiaries. From the perspective of enterprise data description, the other manufacturing mode or production type can be viewed as a special example of large-piece OKP with simple BOM and unchanging processes routings. Therefore the study report also can serve the EIS for other types of enterprises. Research on enterprise data model and data standard can promote the upgrade of EIS and its wide application.

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