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Wuhan International Conference on e-Business

5-26-2012

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Xiao fang Chen
School of Management,Wuhan University of Technology,Wuhan 430070,China

Lei Cheng
School of Management,Wuhan University of Technology,Wuhan 430070,China

Wei hua Guo
state tax bureau of xinmi,Henan 452370,China

Liang zhong Shen
University of Wen Zhou,Wenzhou 325000,China

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Xiao fangChen[1], Lei Cheng [1], Wei hua Guo [2], Liang zhong Shen [3]*

1 School of Management,Wuhan University of Technology,Wuhan 430070,China

2 state tax bureau of xinmi,Henan 452370,China

3 University of Wen Zhou,Wenzhou 325000,China

Abstract: It is an instinct requirement of the enterprise management to lower the cost so that the enterprise can optimize the asset efficiency. To enhance competition ability and enlarge the market share, enterprises must have a good inventory management system. In this paper, two solutions of inventory management based on bill of material (BOM) have been discussed. One is the accurate quantity and time that globally decided by primary equation of inventory management and the form of material requirement planning (MRP). The other is the stock requirement quantity and the detail structure which is implemented by compound BOM structure. A systematic and quantitative management method for trivial and heavy stock management had been discussed in this paper.

Keywords: quantity, inventory management, stock calculation model, compound BOM structure

1. INTRODUCTION

Under the customer-centered idea, the product is not made by pattern designed, but by the customer's demand; meanwhile, the process of business and production has to be changed and increased continuously based on the changing product and service. The customer-centered management strategy requires that the enterprise has a dynamic and elastic structure to provide products of high quality and low costs to customers in the shortest time. At the same time, the aims of implementing quantitative management system are followed: (1) improving the cash rate of customer contracts and ensuring enquiry demands of production and sale; (2) reducing capital of the stock to control the enterprise budget; (3) speeding up the turnover frequency of stock capitals to win the advance of the competion; (4) providing the accounting and analyzing on stock in order to control stock. So it is meaningful to carry out new ways of stock management.

Recently, the research achievements in this field could be divided into two parts: one mainly presented the calculation method of stock such as the literatures [1, 2, 3]which introduced the relationships and calculations between the quantities of MRP to take one kind of material for example. The other mainly presented the structure of BOM such as the literatures[5, 6, 7, 8, 9] which discussed the construction method and correlation algorithm of BOM. But both parts did not study inventory problem quantitatively and systematically from overall situation. Based on this defect, this paper put forward a new management method, a systematically and quantitative way for stock management.

2. THE MATHEMATICAL MODEL OF MATERIAL REQUIREMENT PLANNING

2.1 The basic equation of stock

The main difference between the tradition way and theories of MRP is that MRP introduced the piecewise time zone and the BOM which reflected the structure of production, and solved the difficulties of inventory management and production control, so that we can get required material for correct quantity at a proper time. It was showed in MRP Data processing logic followed.

If the MRP Data processing logic could be expressed in a specific basic equation, the basic characteristics

* Corresponding author, Email: chenglei_cl@126.com

of the manufacturing industry would be seen simply in this equation. Master production schedule represents which kind of product to be made into; BOM represents which kind of raw materials using or parts to be made into these product. Inventory records represent which kind of raw materials or parts possessing now by enterprise. So MRP means the messages expected to attain from the process of production, such as which kind of raw materials or parts still needed. If four variables were used in basic equation, X expressed Master production schedule, Y expressed BOM, Z expressed inventory records, W expressed MRP, this equation is expressed as: X*Y-Z=W.

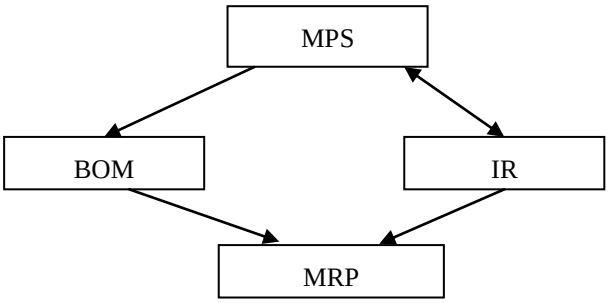

Fig1. MRP data processing logic

2.2 the material calculation model

It is extremely important to understand the mathematical model of MRP before MRP calculation. The MRP calculation involved the following quantities; "t" in bracket expresses the time-periodic that is time zone:

1 the crude demand G（t）

The quantity of certain material has to meet the production needs of all dependent parent keys in the t-th periodic. The gross requirements are obtained by the quantity of production planning of all dependent parent keys multiplying with the dosage factors of corresponding parent keys, without considering the messages about the present stock and the security stock. The calculation formula is followed:

$$G(t)=\sum_{i=1}^{n} D_i(t) \times d_i \qquad (1)$$

$D_i(t)$ indicates that material's quantity of planning put-into-production of the i-th dependent parent key at the t-th time zone, d_i indicates the dosage factors of that material's i-th parent key, n means the total number of all the material's dependent parent keys, i=1,2,…,n.

2 The predicted reservoir inflow R (t)

It means the amount of the received orders (including the work sheet in process at the shop for processing pieces and the purchased order for purchasing pieces) which has been transferred and operated at the t-th time zone. That is the system's input messages.

3 The planning output quantity Q（t）

It means the amount which the material produce has to meet the net requirements at the t-th time zone. When output quantity was calculated, different order and production strategies matched with different calculation formulas with considering the sizing principles. The calculation formula was followed by the multiple sizing principles:

$$Q(t) = M \times Q, \text{ satisfy with } (M-1) \times Q < N(t) \le Q(t) \quad (2)$$

4 The planning order quantity $D(t)$

It means a certain time and quantity of purchase or manufacturing based on the purchase or manufacturing lead time. The calculation formula was followed:

$$D(t)=\begin{cases} Q(t+LT) & , \quad t=1,2\cdots,m-LT \\ \text{uncertain} & , \quad \text{other} \end{cases} \qquad (3)$$

LT expresses the purchase or manufacturing lead time, m expresses the total number of time zones in the whole planning prospect period.

5 The current inventory volume A(t)

It means the available inventory volume at the end of some time zone. The calculation formula was followed:

$$A(t)=\begin{cases} A_0 & , \quad t=0 \\ A(t-1)+R(t)-G(t)+Q(t) & , \quad t\neq 0 \end{cases} \qquad (4)$$

A_0 indicates the available inventory volume (which deducts the distributed quantity for other usages)at the beginning of the whole planning prospect period.

2.3 The calculation of MRP table

The MRP system's data processing logic was shown in the tab1 , which was obtained by the above material's calculation model. The inventory records in MRP was called MRP table including the planning factor, the crude demand, the predicted reservoir inflow, the current inventory volume and the planning send-out order quantity ,etc. the future demand was divided and shown by time zones one by one. Usually the week is the unit in this time zone.

Tab 1. MRP inventory record of component c

date（week）	1	2	3	4	5	6	7	8
Type A		150					150	
Type B					120			120

If the product batch of commodity c is 230, and the product period is 2 weeks, the quantity of different period is followed by table 2.

Tab 2. the quantity of different period

date（week）	1	2	3	4	5	6	7	8
crude demand	150			120		150	120	
intending warehousing	230				120			
Present storage	127	127	127	7	127	-23	-143	
planning order						23	143	
planning				230				

indent								

3. THE PRODUCT STRUCTURE TREE

The problem that a certain quantity needed at the right time was solved by MRP operation. But according to the former time of material demand, the time zone and the production quantity is not derived with the handworked calculation, because of heavy and cockamamie work, lack of effectiveness and systematic management. The calculation of material demands by computer can shorten the time consuming and greatly improve the accuracy in calculating.

BOM was a kind of technical document to define the product's structure， which transformed the material's product structure tree into some data formats, and also was called the product structure tree or BOM Table. The Fig2 followed was the product structure tree of X. According BOM's multiple levels ergodicity, the structure of materials (including standard parts, parts and raw materials) and the subordination and quantity relations between these materials in forming could be clearly found in the product. Meanwhile, the BOM ergodic results are the basis with compiling production plan, matching the product, tracing material requisitions and processing. At the same time, it is the reference for enterprise calculating product costs in market quotes. What's more, the BOM ergodicity can make the design of enterprise's product serialized, standardized and generalized.

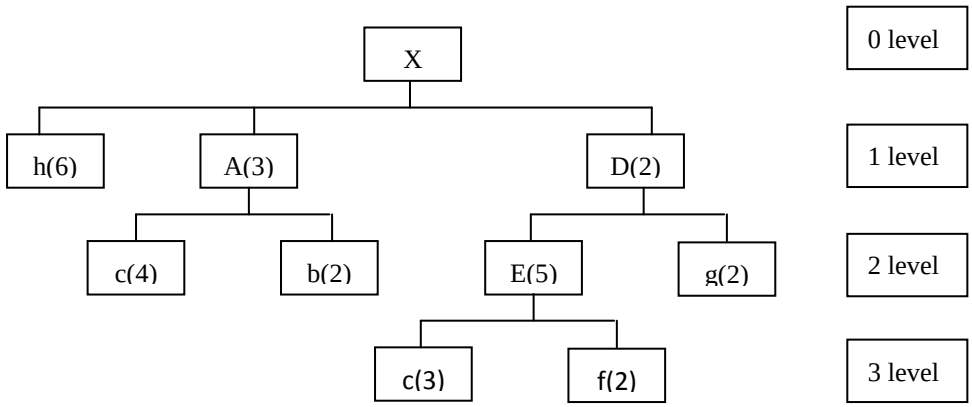

Fig2. Structure tree of product X

3.1 The research on the compound structure of BOM

A product usually has a multilayered structure, such as the above Fig2, which had four levels. There are plenty of ways to study the structure of BOM. For example, the multilayered structure which the data structure of "one parent key to plentiful sub keys" had a detailed record about the product's structure. The data records which did not influence each other were convenient to maintain, but they are too redundant; One-level structure with the data structure of "one parent key to one sub key" only was recorded corresponding relations between parent keys and sub keys. This structure was beneficial to reduce the data redundancy and not reflected the structure message of the whole product; the network structure of BOM which used the Matrix to represent the complex structure of the product was fully displayed the composition relations of the materials, which was helpful to flexible product configuration. But this structure which had plenty of data and complex hierarchical relations was made big problems to the operation of the system.

This paper chooses the compound structure of BOM which is transformed the multilayered structure to many one-level structures in order to simplify BOM's storage formats and to express the product message by the analysis on the BOM structure. In BOM, each relation which was defined as "parent key – sub key" was

supplied the dosage factors of sub keys to the corresponding parent keys. Meanwhile a sub key in one relation can be a parent key in lower relation. A set about the product's "parent keys-sub keys" relations can completely represent the structure of the product. As Fig3 followe

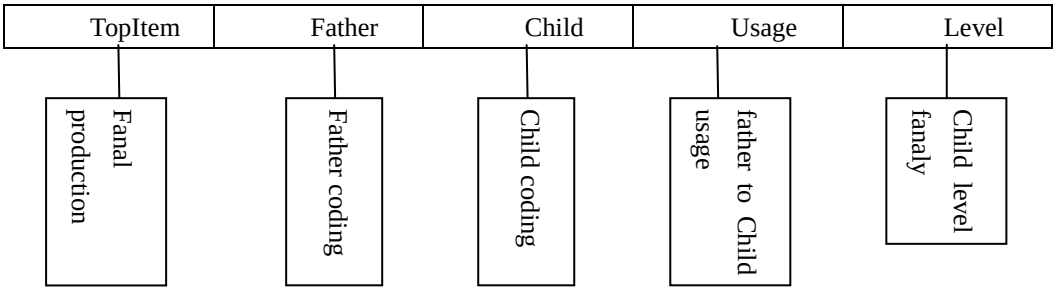

Fig3. Record structure of BOM

3.2 The BOM structure table

In the record structure of Fig3, there was detailed information about the related materials stored independently in material's master file. While in the BOM table the parent keys and the sub keys were recorded by the material coding which had a corresponding relation with the material record in material's master file. If the product's structure was expressed by material coding in Fig2, the BOM of product X's structure was represented in Tab3. It is easy for computer to come true this material compiling, which could accelerate the decomposition of the BOM table and improve the efficiency.

Tab 3. Bill of material of product X

TopItem	Father	Child	Usage	Level
X	X	h	6	1
X	X	A	3	1
X	X	D	2	1
X	A	c	4	2
X	A	b	2	2
X	D	E	5	2
X	D	g	2	2
X	E	c	3	3
X	E	f	2	3

4. CONCLUSIONS

This paper designed the MRP table based on the MRP's data processing model and material calculation model. By the MRP data processing logic the relation of commodity c is definitive, and by the function of calculation model the detailed demand quantity is definitive. The quantitative process is ready for data storage design. On the other hand, this paper analyzed the different structures of BOM and obtained the popular compound structure of BOM. The new storage mode is presented in the data array, which is clear and simple for maintaining the product's structure. At the same time the storage structure of BOM in the computer is demonstrated according to Structure tree of product X. In microscopic scales, MRP which realized the computer

management of the complex and tedious materials was reached the requirement of inventory management and met the customers' demands, achieved the target of inventory management, using only one set of BOM in a system.

Both of the quantization of material demands by material calculation model in part one and the realization of the material's computer management in BOM in part two are contributed to the distinction and systematization of the material's inventory management.

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