THE RESEARCH OF CONSTRUCTION PROJECT MATERIALS REQUIREMENT SYSTEM

Pan Nai-Hsin [1]

[1] Dept. of Construction Engineering, National Yunlin University of Science and Technology, Taiwan.

ABSTRACT : In the construction industry, materials management is one of the most important components in construction engineering life cycle. Materials management optimization is one of the research subjects in the field of construction management. In the materials management system of a construction project, the suitability of selecting procurement planning strategy will influence the result of project completion. This study conducts literature review at first and also refers the related issue in other industry's application. Associated with the characteristics of construction project in civil engineering and the concept of object oriented design applied in the materials management, this research is aimed to establish a construction materials requirement preliminary system.

Key words : Materials Management, Project Management, Materials Requirement Planning

1. INTRODUCTION

The challenges of the construction industry nowadays, are not the need of the newest construction methods or techniques, nor are having the best engineers; more importantly are keeping up with quality and progress demands, while reducing production costs at the same time, on order to stay competitive. The costs of the construction materials always make up a major proportion of the entire construction project cost ; in the case of large scale constructions, often over 50%.Therefore the management of construction materials is an important topic in construction management that cannot be overlooked. Constructions often have to stop due to the lack of materials, causing losses; on the other hand, if the material arrives too early, the cost of stocking increases, which increases the total construction cost, thus reducing the profit. Therefore, the appropriateness of the construction procurement plan will affect the result of the construction project. Recently, the manufacturing industry are beginning to use an inventory control system – material requirement planning (MRP) concept. MRP concept is proposed by Joseph A. Orlicky in 1965, with the concept of "independent demand" and "dependent demand," the traditional methods of ordering met great challenges, and MRP systems have been developed due to the use of computers, resulting in great improvements in the production management of manufacturing and assembly industry [1]. The difference between MRP system and the traditional ordering methods is that traditional ordering methods assume that the material demands are all "independently" predictable, and MRP systems views materials with dependent demands, and cannot be predicted, conversions from BOM is required. If traditional ordering methods are applied to materials that are dependent to each other, because the demand dependence structure of the resources are not considered, unnecessary increase in inventory may occur [1]; MRP systems view material demands as "suspended types," and the demands are large at every stage. Therefore, from the above assumptions, for materials that are "dependent" to each other, MRP system is more suited for management and control of inventory in an engineering project than the traditional ordering methods. This study will survey the application of inventory control in the manufacturing industry, in accordance to the characteristics of civil and traffic construction projects, bring in MRP system that is popularly used in manufacturing industry, and investigate the feasibility of the use of MRP system in a construction project, and use Borland C++ Builder software to construct an inventory control system prototype for construction projects.

2. LITERATURES REVIEW

The concept of inventory control is started up in the manufacturing industry, increasing the efficiency of the material management in the production process; traditional inventory control system used ordering methods 1965 Orlicky proposed "independent demand" and "dependent demand," resulting in a significant improvement in the production management in manufacturing industry. In 1985 Stukhart and Bell conducted a thorough analysis on the cost-benefit analysis of construction project material management systems [4]; in 1995 Wang et al proposed a information system architecture for construction material management [1]; in 1988, Shtub proposed a professional management type combining material management and CPM, providing special management to materials from vendors that are very expensive and time demanding [4]. In 1995 Akintola combined the interpretations of several scholars on JIT, and incorporated JIT concept in construction material management system [3]; in 1995 Elzarka and Bell proposed and object-oriented technique to analyze the material management system [3]; aiming at the decision making of a material management system, Li, Shen, and Lo suggested that procedure research theory may be a solution [4] .

3. THE STRUCTURE ANALYSIS OF AN MRP SYSTEM FOR CONSTRUCTION PROJECT

From literatures on procurement methods of construction industries on inventory control, based on the dependencies of materials, the material requirement planning system is more suited for construction project type manufacturing than traditional ordering system. Therefore, this study uses MRP system theory and architecture to develop an inventory control system for a construction project. The basic flow of an MRP system is summarized below:

The basic flow of an MRP system includes the following procedures as show in Figure 1:

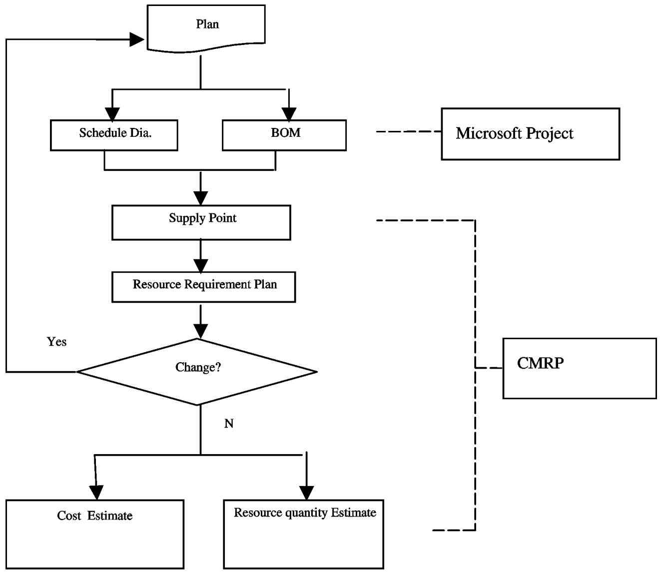
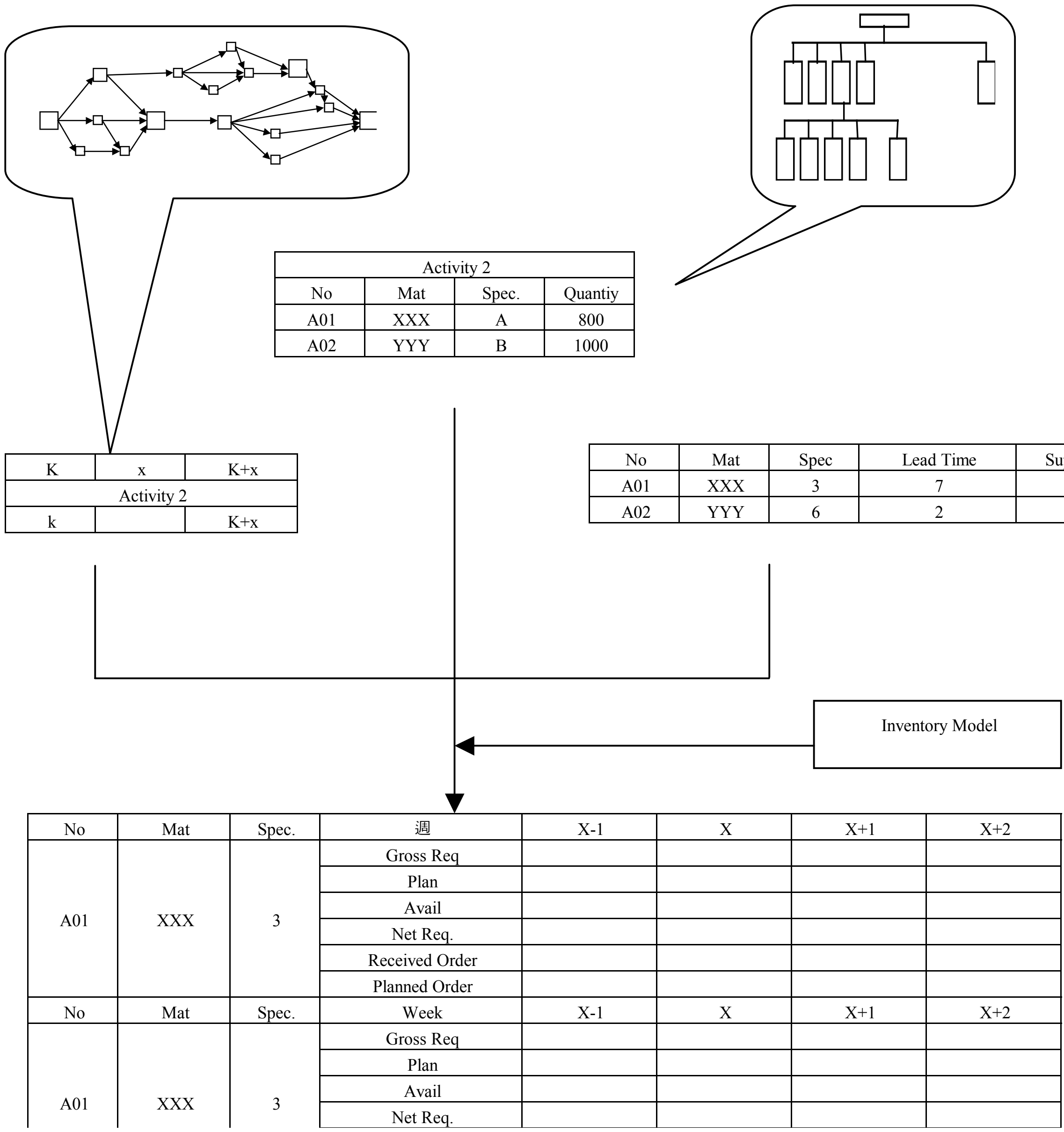


Figure 1. MRP process



Activity 2			
No	Mat	Spec.	Quantiy
A01	XXX	A	800
A02	YYY	B	1000

K	x	K+x
Activity 2		
k		K+x

No	Mat	Spec	Lead Time	Supplier
A01	XXX	3	7	A
A02	YYY	6	2	A

No	Mat	Spec.	週	X-1	X	X+1	X+2
A01	XXX	3	Gross Req				
			Plan				
			Avail				
			Net Req.				
			Received Order				
			Planned Order				
No	Mat	Spec.	Week	X-1	X	X+1	X+2
A01	XXX	3	Gross Req				
			Plan				
			Avail				
			Net Req.				

Figure 2. CMRP Structure

1. Specify a master production schedule (MPS)
2. Decide the major demands of inventory items
3. Decide the total demands of inventory items
4. Specify an appropriate ordering method, from the due date of demand, calculate the date for ordering. The demands information of MRP will be based on the components needed for assembly (BOM), MPS, amount of components ordered or production time, and the current inventory status.

Based on the architecture, the time schedule is decided by MPS, in the case of construction projects MPS is replaced by the projected construction progress plan as the schedule, therefore the MRP architecture is shown in Figure 2. In a construction MRP architecture, there are three major components: construction progress plan, project material database, and inventory database. The relationship between the three components and its flow are as follow: from the construction progress plan, find the supply point of all materials for each operation, get the information required for each operation from the project material database, and find the safety reserve, current inventory, date of purchase, specifications of each material in the inventory database. From the material requirement plan and the time slot for each material request, the ordering can be made via appropriate calculations.

Because the construction progress plan is not the emphasis of this research, therefore we assume the currently available data is valid; the emphasis of this research is on the analysis of BOM database, construction of the inventory database, and selection of calculations, and develops a construction project inventory control system prototype based on the above modules.

4. THE DEVELOPMENT OF A CONSTRUCTION SITE INVENTORY CONTROL SYSTEM

From the above discussion, MRP is more suited for construction projects; therefore MRP is the principal focus of this research.

4.1 Categorization of construction materials:

Based on the material demand characteristics of an MRP system, only the materials most suitable for MRP application are chosen for analysis, due to the time and manpower constraint. There are many types of material in a construction project, and the differences between each other are large, therefore the construction project method of production cannot fulfill the requirements [3]. Therefore, the categorization is based on the following criterion:

1. Degree of "dependency"
2. Demand in time
3. How it may affect the construction progress

4.2 BOM database design

This research categorize from up to down, first categorizing based on the major systems in a construction project, then classified into finer categories, based on the "inventory control system" aspect to define the items, and develop a BOM database prototype. There are many types of materials used in a construction project, due to the constraint in time and manpower; this research will focus only on some items as the object of study.

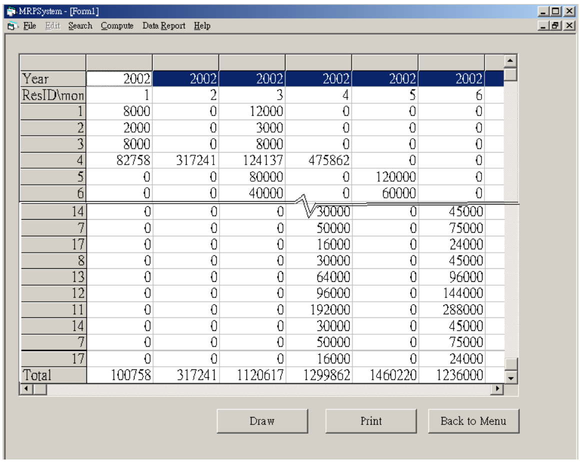
4.3 Deciding a suitable procurement plan

The difference in purchase plan will affect the inventory; holding and ordering costs; production capabilities and usefulness; and delivery. Factors that will influence ordering decisions include levels of BOM, holding and ordering costs, efficiency of computer processing, and so on. This research focus on the "definite" demand of a particular material, and its "change" in demand through time, select two methods, and compare:

1. Heuristic ordering method
2. Dynamic or Wagner-Whiten method

4.4 Develop a construction project inventory control system prototype:

Based on the developed BOM database, best purchase methods, and the inventory database, a prototype is developed using Borland C++ Builder. Some figures of finished system are shown as figure 3, 4 and 5.



Year	2002	2002	2002	2002	2002	2002
ResID\mon	1	2	3	4	5	6
1	8000	0	12000	0	0	0
2	2000	0	3000	0	0	0
3	8000	0	8000	0	0	0
4	82758	317241	124137	475862	0	0
5	0	0	80000	0	120000	0
6	0	0	40000	0	60000	0
14	0	0	0	30000	0	45000
7	0	0	0	50000	0	75000
17	0	0	0	16000	0	24000
8	0	0	0	30000	0	45000
13	0	0	0	64000	0	96000
12	0	0	0	96000	0	144000
11	0	0	0	192000	0	288000
14	0	0	0	30000	0	45000
7	0	0	0	50000	0	75000
17	0	0	0	16000	0	24000
Total	100758	317241	1120617	1299862	1460220	1236000

Figure 3. One of CMRP's figures

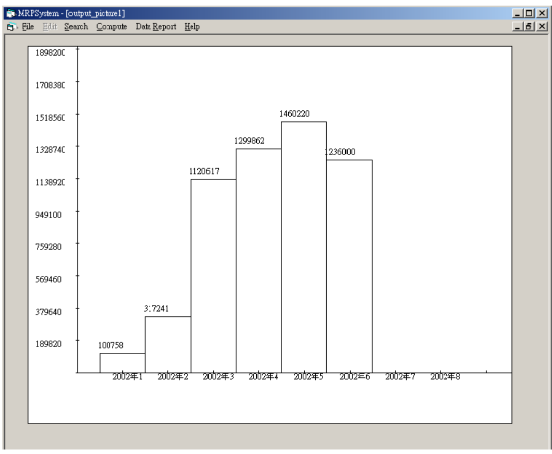
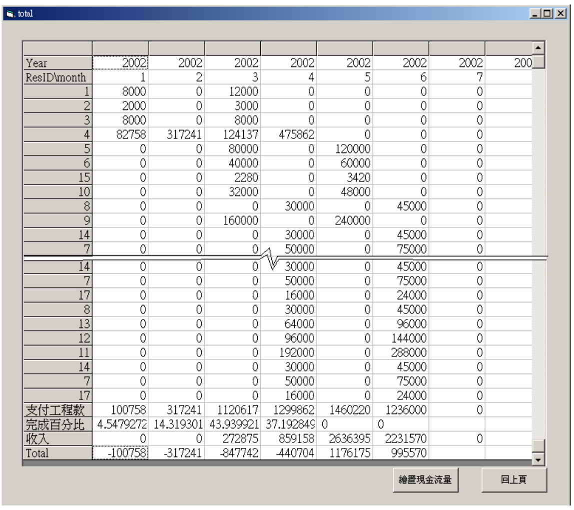


Figure 4. One of CMRP's figures



total

Year	2002	2002	2002	2002	2002	2002	2002	200
ResID\month	1	2	3	4	5	6	7	
1	8000	0	12000	0	0	0	0	
2	2000	0	3000	0	0	0	0	
3	8000	0	8000	0	0	0	0	
4	82758	317241	124137	475862	0	0	0	
5	0	0	80000	0	120000	0	0	
6	0	0	40000	0	60000	0	0	
15	0	0	2280	0	3420	0	0	
10	0	0	32000	0	48000	0	0	
8	0	0	0	30000	0	45000	0	
9	0	0	160000	0	240000	0	0	
14	0	0	0	30000	0	45000	0	
7	0	0	0	50000	0	75000	0	
14	0	0	0	30000	0	45000	0	
7	0	0	0	50000	0	75000	0	
17	0	0	0	16000	0	24000	0	
8	0	0	0	30000	0	45000	0	
13	0	0	0	64000	0	96000	0	
12	0	0	0	96000	0	144000	0	
11	0	0	0	192000	0	288000	0	
14	0	0	0	30000	0	45000	0	
7	0	0	0	50000	0	75000	0	
17	0	0	0	16000	0	24000	0	
支付工程款	100758	317241	1120617	1299862	1460220	1236000	0	
完成百分比	4.5479272	14.319301	43.939921	37.192849	0	0		
收入	0	0	272875	859158	2636395	2231570	0	
Total	-100758	-317241	-847742	-440704	1176175	995570		

Figure 5. One of CMRP's figures

5. CONCLUSION AND RECOMMENDATIONS

This project investigates the current material procurement procedures in construction industry, and compares it with procedures in manufacturing industry, investigate the MRP system application in a construction project, analyze the types of material and properly categorize them, analyze and design an MRP system structure, BOM database, and purchase database. A MRP prototype system is developed using Borland C++ Builder. Since there are many materials used in a construction site, and the constrain of time and manpower of this research, only items that are higher dependencies and higher unit cost are investigated. In research implementation, since we cannot actually make management decisions and some data cannot be easily obtained, deductions were made via simulation based on the feedback of industry members, rational estimate and assumptions.

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