Reduce the Complexity of Material Requirement Planning on Excel by an Algorithm

Sumitra Nuanmeesri and Kanate Ploydanai

Abstract—Many companies have excel, it is economy and well perform to use in material requirement planning (MRP) on excel. For several products, it, however, is complex problem to link the relationship between the tables of products because the relationship depends on bill of material (BOM). This paper presents algorithm to create MRP on excel, and links relationship between tables. The study reveals MRP that is created by the algorithm which is easier and faster than MRP that created by human. By this technique, MRP on excel might be good ways to improve a productivity of companies.

Keywords—Material requirement planning, Algorithm, Spreadsheet.

I. INTRODUCTION

MRP was firstly introduced in 1970s [1]. It is well-performed in term of improving productivity in many companies; for example, liquid crystal display (LCD) industry [2]. Even though, it is focused on the deterministic constraint, it is developed under uncertain constraints [3] and fuzzy constraints [4]. This method can reduce the inventory cost and the back order cost [5]. Many researchers have focused on developing new MRP techniques from the 1970s to now a day. Nakagiri [6] presented a new priority rule for it. This rule bases on the due-date of products. His experiment compared between the new priority rule and other priority rules. The result reduces the time of due-date delay and the time of production re-planning.

Mirmohammadi [7] applied branch and bound algorithm to find the optimal lot size for single item in MRP environment. He studied quadratic discount problem to determine the optimal lot size. Later, Grubbstrum [8] found the optimal lot size with MRP theory framework too.

For other researches, Sadeghian [1] identified that MRP has a weakness because the value of processing time is discrete. He presented that the time should be continuous variables. The new approach is called continuous material requirement planning (CMRP). When the variables are continuous, the integration technique can be applied to MRP formula. The benefit of CMRP is extent that it can perform well for continuous process industries. For example gas, oil, and water

S. Nuanmeesri is with the faculty of science and technology, Suansunandha Rajabhat University, Bangkok, Thailand (e-mail: nongnent@hotmail.com).

K. Ploydanai is with the Department of industrial engineering and management, faculty of engineering and industrial technology, Silpakorn University Sanamchandha place campus, Nakon Pathom, Thailand. (e-mail: kanate.engineer@gmail.com).

industries.

There are many techniques for MRP system, but it is not easy for implementation MRP to a regular company. Chee [9] studied the variables to affect MRP by advancing statistical technique, named Alternating Coordinal Expectations (ACE). This technique is used to find the relation between the successful implementation and its determinant variables. The variables include company size, type of project organization, and initiator on MRP effort, degree of data accuracy, top management support, clear goals, training and education on MRP, marketing management support, and project management support.

MRP is an essential tool for many companies to prevent the lack of material and the lack of other product components, withdrawal by unprepared plan. It focuses on the future periods. One company environment differs from the other company environments. That means MRP should be adjusted for each individual company [10]. It might be a good technique if MRP is developed by using Ms-Excel because each company could apply it to be suitable with their own environments.

MRP on Excel is easy to adjust and modify the production reports because Ms-Excel is well-known by many office workers. They can create formula for tables by themselves. When using MRP on Excel, it can save cost of computer programming.

The obstacles for implementation MRP on Excel might occur in the factory which has several products. For example, there are 100 product items in the factory. Planners spend many times to link the data between many tables. Moreover, the error might occur in some cases. This approach focuses on developing an algorithm to create relation (formula) for all tables. This is a way to reduce working time and to reduce the human error by using MRP on Excel to calculate production planning in the factory.

II. METHODOLOGY

A. MRP Formula

Firstly, the detail of MRP on Excel is briefly presented. It is a tool to control product part components and materials in factories. Typically, one product resembles many parts of component. One table is designed for one product and other table is designed for one component separately.

A table of MRP includes Gross requirement(D_t), Scheduled receipts(E_t), Project on hand (H_t), Net requirement (N_t), Lot size (S), Lead Time (L), and Planed order release (PO_t). The

Data will be calculated by the formula as following:

$$N_t = Max(0, Roundup\left\{\frac{D_t - E_t - H_{t-1}}{S}\right\}, 0) \quad (1)$$

$$H_t = H_{t+1} + E_t + N_t - D_t \quad (2)$$

$$PO_t = Choose(L, N_{t+1}, N_{t+2}, N_{t+3}, N_{t+4}, ...) \quad (3)$$

The words "Max", "Roundup", and "Choose" are function on Excel. Max is a function to return the largest value. Roundup is a function to round number up. Choose is a function to select value based on index number. For MRP table, Gross requirement, Scheduled receipts, Lead time and Lot size are input variables. In addition, Project on hand, Net requirement, and Planed order release are output variables.

Relation between data in table depends on bill of material (BOM). For example, Product uses two components of part X and product B uses one component of part X. That means, if we need one A, and ten B, we need 2(1) +1(10) = 12 items of part X. The complication in formula grows up when number of products increase and products use many part components Next, the technique to create MRP on spreadsheet is described by four steps as following:

- To create standard table and to create formula.
- To copy standard table and to input production data to table.
- To link relation between Po and demand of tables.
- To implement all tables for all products and to observe the result.

First step is to create standard table and to create formula of (H_t), (N_t) and (PO_t). Second step is to copy standard table for other products. After that, planer inputs all production data. Then, data are recalculated automatically by spreadsheet operation. Next, third step is to link relation between product tables and component tables. In general, 3th step spends long time because bill of material is complicated and its formula depends on bill of material. The last step is to use tables for all products and all components.

Before an algorithm will be presented, the used data is described. An algorithm requires points (locations) to access tables of products. The data shows in Fig. 1. Column A contains names of product and component. Column B contains names of sheet where products tables are in. Column C and D contain location of products. For example, item A is contain in a sheet, namely product on at cell "2B". It will be accessed when an algorithm runs to create the formula.

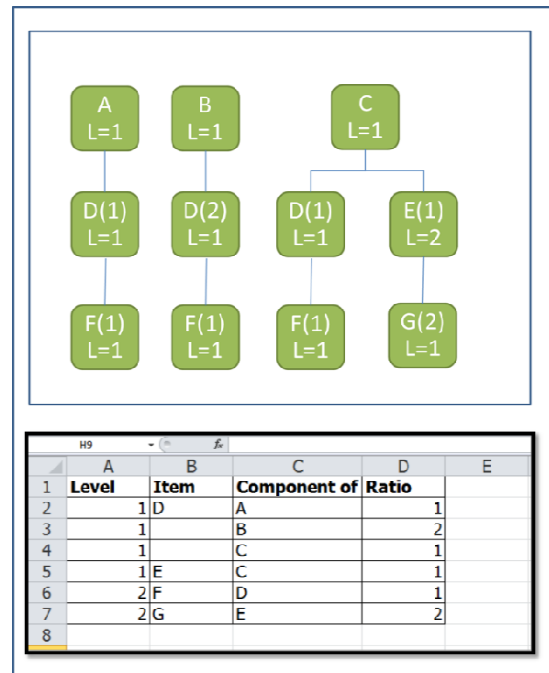|	A	B	C	D
1	**Item**	**Sheet**	**Rows**	**Column**
2	**A**	product	2	B
3	**B**	product	8	B
4	**C**	product	14	B
5	**D**	product	20	B
6	**E**	product	26	B
7	**F**	product	32	B
8	**END**			

Fig. 1 The location of product and component

Fig. 2 The detail of BillofMaterial

Next, an algorithm requires data to represent the bill of material, which is shown above in Fig. 2. In this approach, we use this table to represent bill of material for computer programing. The first column is the level of component. The second column is the name of component and the third column is the name of product, which uses the component. For example, the 2nd row shows product uses product D to assemble. The last column is the ratio of component per one product. The computer program reads all data and decodes them in to Bill of Material. For example, in this table, item D is a component of A B and C. Item E is a component of C. item F is a component of D and Item G is a component of E. For several products and many components, planners spend long time to create this formula. It looks easy when creating formulas for all tables by using Visual Basic Application (VBA) on Excel. Next, algorithm to link data is described.

B. An Algorithm to Link Table

To reduce the complexity of creating formula, an algorithm in this approach is presented. The details are shown in Fig. 3. For the first step, component is selected to create a formula. For example, component D (in Fig. 2) is selected. Next step is to find the product that uses component D. From the table in Fig. 2, product A is found. The ratio between product A and D is 1 (1:1). After that, the formula is created. It equals to "=1*E2". E2, the location of Po for product A (data read from Fig. 1 Row 2). Next on flow chart, an algorithm checks whether or not all products are already in the formula. In this case, from table in Fig. 2, it is not already in. An algorithm finds the next product. Product B is selected with ratio 2:1 from Fig. 1 (3rd row), Po of product B is at "8E". The formula is changed to "=1*E2+2*E8". The iteration recurs again and

again, until all products that use D are added to formula, which is "=2*E2+2*E8+1*E14".

Next step is to check whether or not all components are already created in formula. When E, F and G are already done, an algorithm terminates. In MS-Excel, planners can create computer programs to create formulas for all cells. In other way, planners can create one cell and copy to other cells. By this technique, planners can apply MRP to factory so fast and easily. It is not complicated when there are many products in factory. That is all details of flow chart in Fig. 3. The next section will be the experiment that shows the efficiency of an algorithm to improve the productivity in term of time and complexity to use.
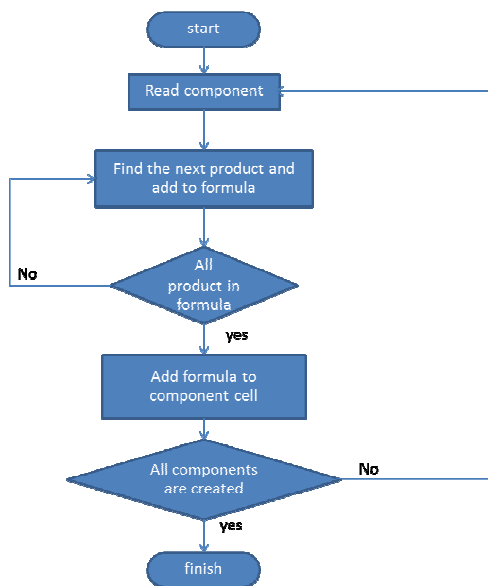

Fig. 3 The flow chart of algorithm

III. RESULT AND CRITIQUE

According to the experiment, done by many experiences from the industries, the time to create formula is trouble for implementation MRP on Excel. It is interesting to solve and apply new technique in this approach. In addition, the experiment shows the result of MRP from computer compares to the result of MRP by human working.

Firstly, we determine time to create formula by human. After that, we determine time to create by computer. The time from computer should be faster than the time from human. The experiment shows a huge different value time between of them. This experiment shows why MRP should be created by computer because it is a good way to implement it for industries.

The experiment starts from two levels, five products and one part component. Next we vary quantities of product from five products decreasing to two products. Table I shows the standard time to create the formula. Each row contains the standard time of replicates. The last row presents the average time to create per one product (example: 34.01/5=6.80 and

25.42/4=6.36).

TABLE I
THE STANDARD TIME TO CREATE FORMULA BY HUMAN

Replicates	Ratio			
	5:1	4:1	3:1	2:1
1	38.19	23.24	21.53	16.41
2	31.89	25.13	19.53	19.43
3	32.39	27.14	21.98	14.26
4	33.56	26.18	21.07	15.55
Avg.	34.01	25.42	21.03	16.41
Avg./Part	6.80	6.36	7.01	8.21

The time to create one part component from this formula is approximate to 7.09 seconds ((6.8+6.36+7.01+8.21)/4). From Table I, the time to create formula for one part component with five products by computer is less than one second. When we try again with 5 components, the result is less than one second too. To compare time between human and computer, the study might gain a lot of large size problems (the increasing numbers of product).

When increasing numbers of product, tables cannot be created by human, because of limited time. The result from human must be the estimated value. In this experiment, the time to create by human is approximate to (4). By A is an average time to create formula per one table (product) and n is a number of tables. N is represented by (5). Note that, c is a number of components per one level and B is a number of levels of the problem.

$$T_t = A x N \qquad (4)$$

$$N = C^{B-1} \qquad (5)$$

Actually, the time which is created by human is longer than the estimated time because human cannot concentrate all the time and sometime human error might occur. That causes the wasting time. For example, when we try to find the standard time in table 1, there are 6 time errors out of 22 times. Because of this, the time to create by human is absolutely greater than the estimate value.

The experiment assumes that the numbers of component for each level exponentially grow by (5). Table II compares times to create formula between human and computer. The first column is level. The second column shows numbers of component in each level. For example, for 3 levels, 5 components, the quantity of table is 5(3-1) = 25 and for 3 levels 10 components, the quantity is 10(3-1) =100. The table shows numbers of table in each level. It is not cumulative number of table. The fourth and the fifth column show the time to create table by computer and by human respectively. The last column shows the different comparison time of them in hour unit.

TABLE II
THE COMPARISON OF TIME TO CREATE FORMULA

Level	Component	Table	Com (sec.)	Human (sec)	Different (hr.)
3	5	25	0	850	0.24
3	10	100	1	3400	0.94
3	15	225	2	7650	2.12
3	20	400	3	13600	3.78
3	50	2500	26	85000	23.60
3	75	5625	62	191000	53.11
4	5	125	1	4250	1.18
4	10	1000	9	34000	9.44
4	15	3375	31	115000	31.87
4	20	8000	85	272000	75.53
5	5	625	6	21200	5.90
5	10	10000	105	340000	94.42

Table II demonstrates that human creates data very slowly. It is a good idea to create MRP by using computer programming on Excel. Next, the computer time from table II is sorted by numbers of table to find the relation of data using linear regression model. The result graph shows in Fig. 4.

The data y_i might be presented by linear regression model $(y_i = ax_i + b)$ for linear regression model, slope equals to 0.01 and constant B equals to 0.01 and xi is the number of table. It might be concluded that 0.01 second for setting up program and 0.01 second is the time for creating formula per one table. That is shorter time when compares with human working time (34.01 sec for 5 products in formula).
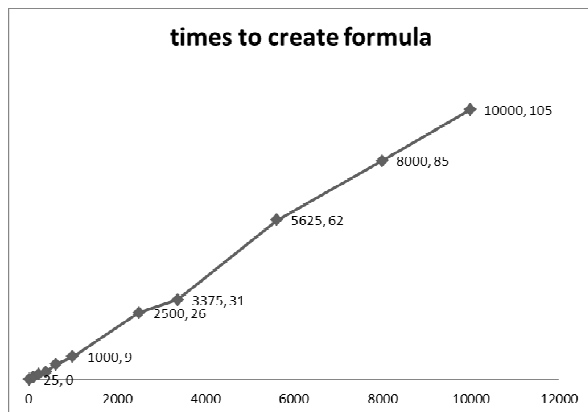

Fig. 4 The computer time

IV. CONCLUSION

In brief, this approach focuses on the development of an algorithm to reduce the time to create MRP table on Excel when companies have a lot of data to handle. This technique demonstrates that an algorithm is easy and less-time consume. That means it is more convenient to create and cheaper than hiring programmers because this program is so small and compact. The time to create table by human and by computer are too different. This might be a good way to apply MRP to factories with cheap cost and well performance.

REFERENCES

[1] R.Sadeghian,"Continuous materials requirements planning (CMRP) approach when order type is lot for lot and safety stock is zero and its applications.", Int. J. Applied Soft Computing, vol. 11, pp. 5621-5629, 2011.
[2] J. T. Lin, T. LiChen and Y. TingLin, "Critical material planning for TFT-LCD production industry.", Int. J. Production Economics, vol. 122, pp. 639-655, 2009.
[3] J. Mula, R. Polerand et.al.,"A review Models for production planning under uncertainty.,. Int. J. Production Economics, vol. 103, pp. 271-285, 2006.
[4] J. Mula, R. Poler, and J.P. Garcia-Sabater,"Material Requirement Planning with fuzzy constraints and fuzzy Coefficients.", Int. J. Fuzzy Sets and Systems, Vol. 158, pp. 783-793, 2007.
[5] J. M. Spitter and et.al., "Negenman. Linear programming models with planned lead times for supply chain operations planning. European J. Operational Research, vol. 163, pp. 706–720,2005.
[6] D. Nakagiri and S Kuriyama,"A study of production management system with MRP.",Int.J.Production Economics, vol. 44, pp. 27–33, 1996.
[7] S. HamidMirmohammadi,S. Shadrokh and F Kianfar,"An efficientoptimalalgorithmforthequantitydiscountprobleminmaterial requirement planning." Computers and OperationsResearch., vol. 36, pp.1780-1788, 2009.
[8] R.W.Grubbstro, M.Bogatajand L.Bogataj,"Optimal lotsizing within MRP Theory.", Annual Reviews in Control, vol. 34, pp. 89–100, 2010.
[9] C. C. Sum,S.A.Quek and H. E. Lim,"Analysing interaction expectson MRP implementation using ACE.",Int.J.Production Economics, vol. 58, pp. 303–318, 1999.
[10] P.Jonsson,"Exploring problems related to the materials planning user environment.", Int.J.Production Economics, vol.113, pp. 383–400, 2008.