ENM 308 - BIM 213

TERM PROJECT

FINAL REPORT

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1. INTRODUCTION

Material Requirements Planning (MRP) is a system to calculate the materials and components needed to produce a product. It is a computer-based inventory management system to improve efficiency of the companies. It provides flexibility and profitability to manufacturing operations. Through MRP systems, material and labor costs are minimized while product quality is improved. It also helps factory workers to be more productive. MRP system aims to make sure that the required raw material is available and that the products can be delivered to the customers as a result of the production, to keep the material and finished product stocks at minimum level and to plan the production, delivery and purchasing processes.

2. MATERIAL REQUIREMENTS PLANNING

It depends on the ability of a business to compete with its competitors, produce innovations (new products) and follow innovations, and at the same time, they must maintain this competition with quality. The enterprise can achieve this competitiveness through a system that calculates, plans and controls the amount of material and the time of supply. This needed system is provided by MRP.

MRP means material requirement planning.MRP as a term first appeared by Joseph Orlicky in his 1975 book "The New Lifestyle in Manufacturing and Inventory Management". But it was first used for the Toyota company.In just 10 years, there have been nearly 800 companies using MRP.At the beginning of the 1980s, these numbers began to approach 10 thousand.This is enough to show how useful MRP is. It was so useful that using MRP in the industry has now become almost a necessity.

MRP is used to increase productivity in production and improve services to customers by minimizing the material-based investments of businesses.Material requirements planning (MRP) is basically a computer-based inventory management system.With computer-aided programming, it reduces inventory costs and makes it easier to capture market developments.MRP aims to predict the need that may arise in the production process, to save time and cost, to make the use of Labor and equipment more effective, to automate the

production process, to produce quality products and to provide customer satisfaction.MRP systems also improve efficiency by converting data into accurate, meaningful and useful information.It takes a long time and is expensive to implement the MRP system in enterprises, as detailed planning, adequate computer support, accurate data, management support and user information are required.

2.1 Benefits Of MRP

Material Requirements Planning systems offer a number of potential benefits to manufacturing companies. Some of the main benefits;

- Determines the level at which he will use his materials.
- Reduced selling prices
- increased quality of Service
- reduced leisure time
- reduce preparation and disruption costs
- facilitates determination of critical inventory quantity
- reduce the likelihood of disruption to order requests
- ensuring the privilege of creating supply depending on demand

2.2 Data needed for MRP

In order for MRP to be performed in a business, some data must be collected.These data must be accurate data from the company's past experience.

We can list important data as follows;

- Final product created
- Material prescription: details of the materials, components and subassemblies needed to make each product.
- Shelf life of stored materials
- Labor and machine standards
- Quality and test standards
- Working cell and commands
- Lot sizing techniques

- Inventory status records

2.3 Industries Where MRP is Used

Thanks to inventory planning, companies have the opportunity to make reliable planning of their investments.Especially for enterprises based on mass production, MRP is vitally important. Order schedules can be adjusted flexibly according to the desired time period.Especially in the sector where material supply times vary, companies engaged in production use this system a lot.

Major sectors using MRP:

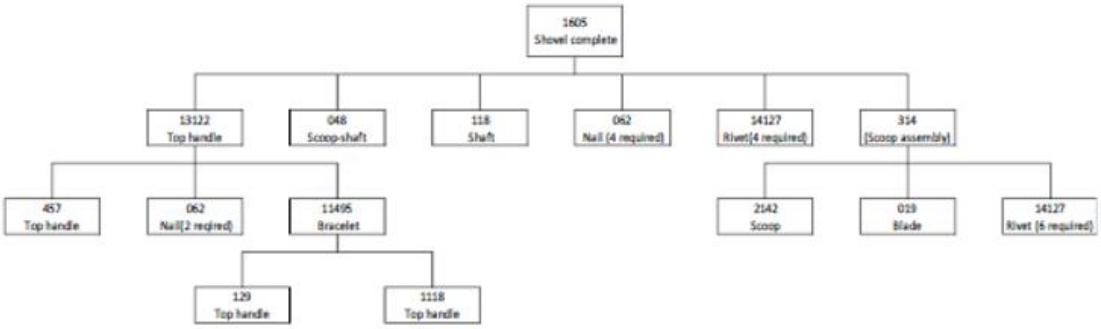
- Chemical industry
- Automotive sector
- Electronics sector
- Pharmaceutical sector
- Textile sector
- Food sector

3. PROBLEM

According to the given problem, the company should produce 60 units, 100 units, 50 units and 30 units of snow shovel (Item ID: 1605) at period 4, 5, 7, 9 respectively. In order to produce one unit of snow shovel, a unit of top handle (Item ID: 13122), a unit of scoop-shaft (Item ID: 048), a unit of shaft (Item ID: 118), four units of nail (Item ID: 062), four units of rivet (Item ID: 14127), a unit of scoop assembly (Item ID: 314) are needed. To produce one unit of scoop assembly (Item ID: 314), one unit of scoop(Item ID: 2142), one unit of blade (Item ID: 019) and six units of rivet (Item ID: 14127) are needed. One unit of top handle (Item ID: 13122) needs one unit of top handle (Item ID: 457), two units of nail (Item ID: 062) and one unit of bracelet (Item ID: 11495). To produce a unit of bracelet (Item ID: 129), one unit of top handle (Item ID: 129) and one unit of top handle (Item ID: 1118) are required.

The parent/child relationships among items are shown at the following product structure tree:

Table 3. 1: *Product Structure Tree for Snow Shovel*



The inventory quantities, scheduled receipt quantities and times, the lead times and the lot sizing rules for each item are shown at the following table:

Table 3. 2: *Information for Each Item*

Period	1	2	3	4	5	6	7	8	9	10
Demand (1605)				60	100		50		30	

Item ID	Amount on Hand	Scheduled Receipt	Arrival on week	Lead Time	Lot Sizing Rule
1605	30	-	-	1	L4L
13122	-	70	3	1	Multiples of 40
048	30	-	-	3	Multiples of 30
118	-	50	2	2	L4L
062	50	100	6	2	L4L
14127	60	-	-	1	Multiples of 100
314	-	50	5	1	Multiples of 50
457	-	20	2	2	L4L
11495	120	-	-	1	Multiples of 50
129	-	100	8	4	Multiples of 40
1118	30	-	-	3	L4L
2142	80	-	-	2	Multiples of 100
019	50	40	5	2	Multiples of 50

3.1 Problem Solution

Table 3.1. 1: *MRP Solution for Item 1605*

	PERIODS		1	2	3	4	5	6	7	8	9	10
LEVEL 0	Item= 1605 LT= 1 Q= L4L	Gross Requirement				60	100		50		30	
		Scheduled Receipts	-	-	-	-	-	-	-	-	-	-
		On hand from prior period	30	30	30	30	0	0	0	0	0	0
		Net Requirements				30	100		50		30	
		Time-phased net requirement			30	100		50		30		
		Planned order releases			30	100		50		30		
		Planned order delivery				30	100		50		30	

Table 3.1. 2*: MRP Solution for Item 13122*

	PERIODS		1	2	3	4	5	6	7	8	9	10
LEVEL 1	Item= 13122 LT= 1 Q= Multiple of 40	Gross Requirement			30	100		50		30		
		Scheduled Receipts	-	-	70	-	-	-	-	-	-	-
		On hand from prior period	0	0	0	40	20	20	10	10	20	20
		Net Requirements				60		30		20		
		Time-phased net requirement			60		30		20			
		Planned order releases			80		40		40			
		Planned order delivery				80		40		40		

Table 3.1. 3: *MRP Solution for Item 048*

	PERIODS		1	2	3	4	5	6	7	8	9	10
LEVEL 1	Item=	Gross Requirement			30	100		50		30		
	048	Scheduled Receipts	-	-	-	-	-	-	-	-	-	-
	LT= 3	On hand from prior period	30	30	30	0	20	20	0	0	0	0
		Net Requirements			0	100		30		30		
	Q= Multiple of 30	Time-phased net requirement	100		30		30					
		Planned order releases	120		30		30					
		Planned order delivery				120		30		30		

Table 3.1. 4: *MRP Solution for Item 118*

	PERIODS		1	2	3	4	5	6	7	8	9	10
LEVEL 1	Item=	Gross Requirement			30	100		50		30		
	118	Scheduled Receipts	-	50	-	-	-	-	-	-	-	-
	LT= 2	On hand from prior period			50	20	0	0	0	0	0	0
		Net Requirements				80		50		30		
	Q= L4L	Time-phased net requirement		80		50		30				
		Planned order releases		80		50		30				
		Planned order delivery				80		50		30		

***Table 3.1. 5**: MRP Solution for Item 314*

	PERIODS		1	2	3	4	5	6	7	8	9	10
	Item=	Gross Requirement			30	100		50		30		
	314	Scheduled Receipts	-	-	-	-	50	-	-	-	-	-
	LT= 1	On hand from prior period	0	0	0	20	20	70	20	20	40	40
LEVEL 1		Net Requirements			30	80				10		
	Q= 50	Time-phased net requirement		30	80				10			
		Planned order releases		50	100				50			
		Planned order delivery			50	100				50		

***Table 3.1. 6:** MRP Solution for Item 457*

	PERIODS		1	2	3	4	5	6	7	8	9	10
	Item=	Gross Requirement			80		40		40			
	457	Scheduled Receipts	-	20	-	-	-	-	-	-	-	-
	LT= 2	On hand from prior period	0	0	20	0	0	0	0	0	0	0
LEVEL 2		Net Requirements			60		40		40			
	Q= L4L	Time-phased net requirement	60		40		40					
		Planned order releases	60		40		40					
		Planned order delivery			60		40		40			

Table 3.1. 7: *MRP Solution for Item 11495*

	PERIODS		1	2	3	4	5	6	7	8	9	10
	Item=	Gross Requirement			80		40		40			
	11495	Scheduled Receipts	-	-	-	-	-	-	-	-	-	-
	LT= 1	On hand from prior period	120	120	120	40	40	0	0	10	10	10
LEVEL 2		Net Requirements					0		40			
	Q= 50	Time-phased net requirement						40				
		Planned order releases						50				
		Planned order delivery							50			

Table 3.1. 8: *MRP Solution for Item 2142*

	PERIODS		1	2	3	4	5	6	7	8	9	10
	Item=	Gross Requirement		50	100				50			
	2142	Scheduled Receipts	-	-	-	-	-	-	-	-	-	-
	LT= 2	On hand from prior period	80	80	30	30	30	30	30	80	80	80
LEVEL 2		Net Requirements			70				20			
	Q=100	Time-phased net requirement	70				20					
		Planned order releases	100				100					
		Planned order delivery			100				100			

***Table 3.1. 9**: MRP Solution for Item 019*

		PERIODS	1	2	3	4	5	6	7	8	9	10
	Item=	Gross Requirement		50	100				50			
	019	Scheduled Receipts	-	-	-	-	40	-	-	-	-	-
	LT= 2	On hand from prior period	50	50	0	0	0	40	40	40	40	40
LEVEL 2		Net Requirements		0	100				10			
	Q=50	Time-phased net requirement	100				10					
		Planned order releases	100				50					
		Planned order delivery			100				50			

***Table 3.1. 10:** MRP Solution for Item 129*

		PERIODS	1	2	3	4	5	6	7	8	9	10
	Item=	Gross Requirement						50				
	129	Scheduled Receipts	-	-	-	-	-	-	-	100	-	-
	LT= 4	On hand from prior period	0	0	0	0	0	0	30	30	130	130
LEVEL 3		Net Requirements						50				
	Q= 40	Time-phased net requirement		50								
		Planned order releases		80								
		Planned order delivery						80				

Table 3.1. 11: *MRP Solution for Item 1118*

		PERIODS	1	2	3	4	5	6	7	8	9	10
LEVEL 3	Item= 1118	Gross Requirement						50				
		Scheduled Receipts	-	-	-	-	-	-	-	-	-	-
	LT= 3	On hand from prior period	30	30	30	30	30	30	0	0	0	0
		Net Requirements						20				
	Q= L4L	Time-phased net requirement			20							
		Planned order releases			20							
		Planned order delivery						20				

Table 3.1. 12*: MRP Solution for Item 062*

		PERIODS	1	2	3	4	5	6	7	8	9	10
LEVEL1 / LEVEL2	Item= 062	Gross Requirement			280	400	80	200	80	120		
		Scheduled Receipts	-	-	-	-	-	100	-	-	-	-
	LT= 2	On hand from prior period	50	50	50	0	0	0	0	0	0	0
		Net Requirements			230	400	80	100	80	120		
	Q= L4L	Time-phased net requirement	230	400	80	100	80	120				
		Planned order releases	230	400	80	100	80	120				
		Planned order delivery			230	400	80	100	80	120		

***Table 3.1. 13**: MRP Solution for Item 14127*

		PERIODS	1	2	3	4	5	6	7	8	9	10
LEVEL1 / LEVEL2	Item=	Gross Requirement		300	720	400		200	300	120		
	14127	Scheduled Receipts	-	-	-	-	-	-	-	-	-	-
	LT= 1	On hand from prior period	60	60	60	40	40	40	40	40	20	20
		Net Requirements		240	660	360		160	260	80		
	Q= 100	Time-phased net requirement	240	660	360		160	260	80			
		Planned order releases	300	700	400		200	300	100			
		Planned order delivery		300	700	400		200	300	100		

4. MRP PROGRAM ON JAVA

4.1 Flow chart

Diagram 4.1. 1*: Flow Chart-1*

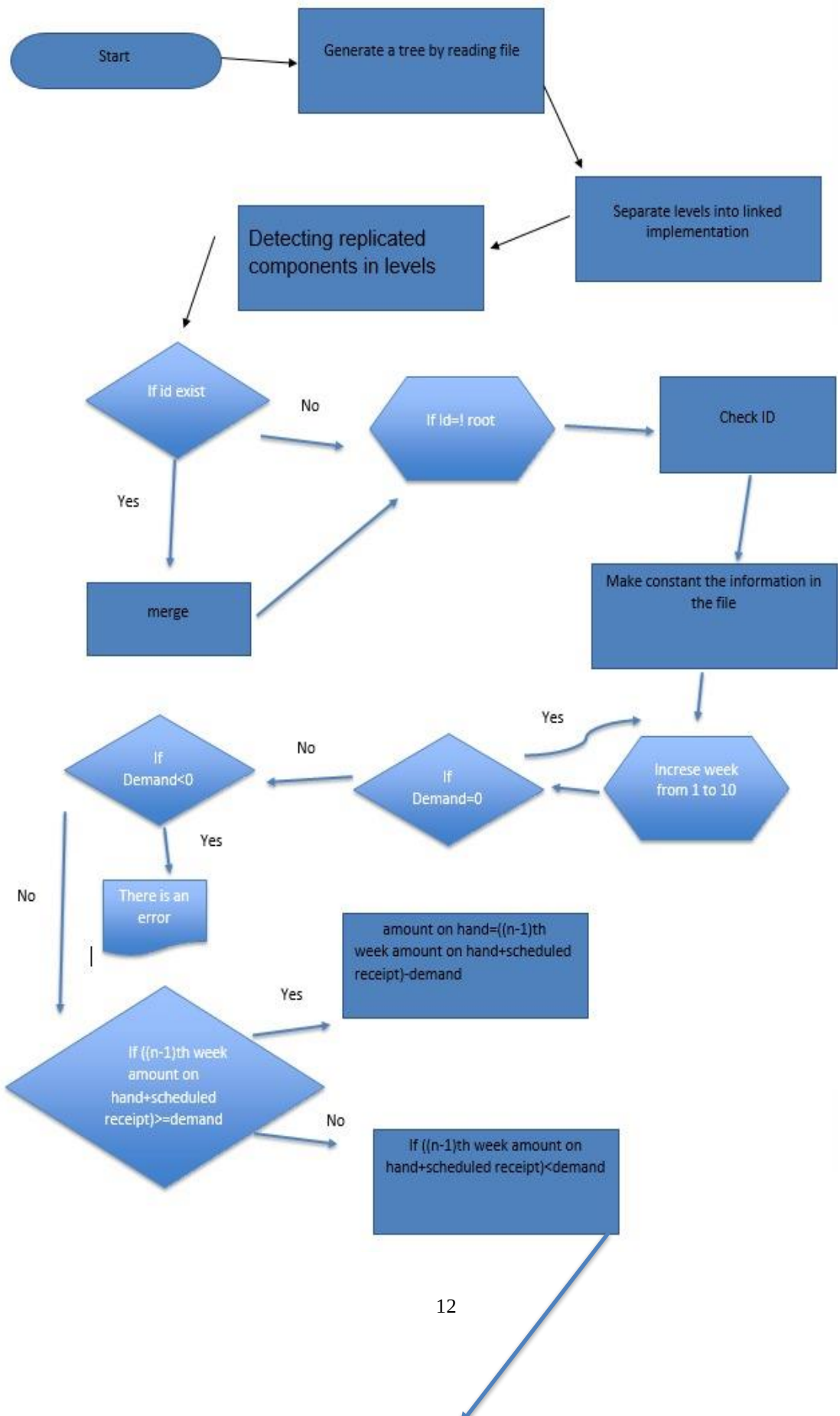
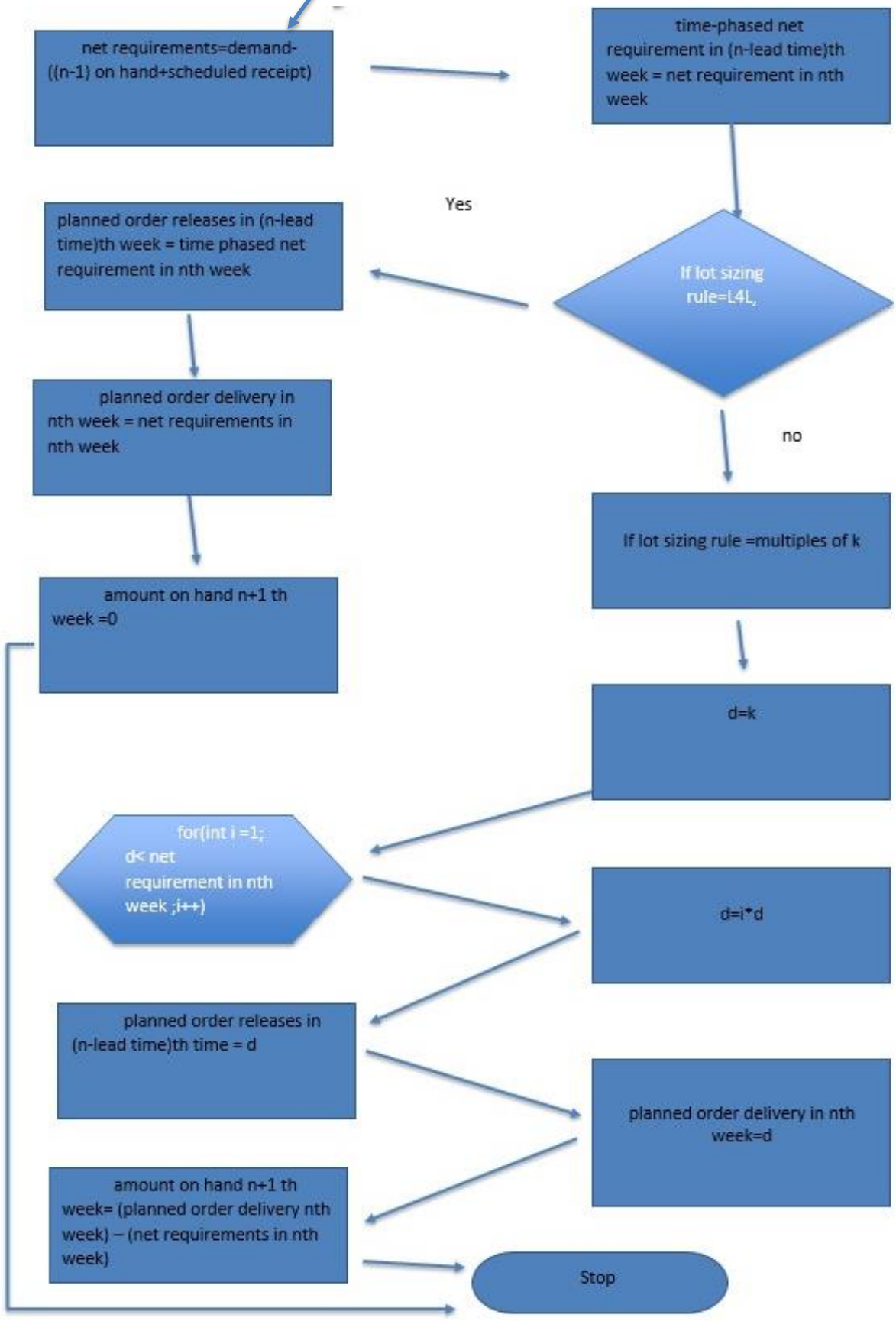


Diagram 4.1. 2: Flow Chart-2



4.2 Pseudo code

```
START
Generate a tree by reading file
Seperate levels into linked implementation
c = coefficient of child component
Child's demand = c * planned order releases of parent
FOR level = 0 to depth
   compare ID of items between levels
   IF ID exists
      merge them
WHILE (ID =! root)
      Check ID of item
Make constant the information in the file
FOR week = 1 to 10 by increment week one by one
      IF demand = 0
            go to previous step
      ELSE IF demand < 0
            Print (There is an error)
      ELSE IF ((n-1)th week amount on hand+scheduled receipt) >= demand
            amount on hand = ((n-1)th week amount on hand + scheduled receipt) -
demand
      ELSE IF ((n-1)th week amount on hand+scheduled receipt) < demand
            net requirements = demand - ((n-1) on hand + scheduled receipt)
            time-phased net requirement in (n-lead time)th week = net requirement in nth
week
            IF lot sizing rule = L4L
                  planned order releases in (n-lead time)th week = time phased net
requirement in nth week
                  planned order delivery in nth week = net requirements in nth week
                  amount on hand n+1 th week = 0
            ELSE IF lot sizing rule = multiples of k
                  d = k
```

FOR (int i = 1; d < net requirement in nth week ;i++)

d = i * d

planned order releases in (n-lead time)th time = d

planned order delivery in nth week = d

amount on hand n+1 th week = (planned order delivery nth week) – (net requirements in nth week)

STOP

4.3 Program Explanation

According to the MRP explanation of the Industrial Engineering team, the program that calculates the MRP outputs is written in Java. To write the code, the algorithm is created firstly with pseudocode. After that, the pseudocode is visualized by using the flowchart. According to the flowchart and the pseudocode, the created algorithm is tried to implemented in Java. While Java code is written, some differences between the planned pseudocode and the created Java program. In progress report, tree data structure and linked implementation were planned to be used. However, array data structure is used in the final program.

Item ID, amount on hand, scheduled receipt, arrival on week, lead time, and lot sizing rule are read from text file which is named "Constants" and they are assigned them into an array. The demands of subcomponents depend on the planned order releases of parents and the coefficients of subcomponents to produce the parent component, this data should be kept for next calculations. There are 4 static arrays which store planned order releases of Item 1605, Item 13122, Item 314, Item 11495. Since these items have subitems (children), these items are stored in static arrays. The planned order releases of the children items which have no subitem are not saved. 10 weeks demand of Item 1605 (snow shovel-root) is taken from user by scanner and it is assigned into arrays. Also, constants are used and steps that are presented in the pseudocode in progress report are applied. The same steps in applied 'tableMaker' method are applied, they are not invoked. Since the demand of item 1605 is taken from the user by scanner and the demands of other items depend on the final product, which is item 1605, planned order releases of the parent product is used while determining the demands of the children in ‘tableMaker’ method.

There is a method named 'tableMaker' which is in 'subItems' class. In main method, after printing information of Item 1605, 'tableMaker' method is invoked in a loop for all other subitems. When the method is invoked, it takes parameter that is item_ID_ofDemanded that exists in constants array. For repeated components, both parents's planned order releases are taken. They are added with coefficients and assigned into child's demand. Then, if summation of scheduled receipt and previous week's amount on hand is greater than or equal to demand, amount on hand is calculated by subtracting demand from summation of scheduled receipt and previous week's amount on hand. Else, that summation is subtracted from demand and assigned to net requirements. Time phased net requirement is calculated according to lead time. If lot sizing rule is not L4L which means thats is multiples of k, planned order releases are calculated according to lead time and planned order delivery. Considering these calculations, amount on hand is updated. If lot sizing rule is L4L, planned order releases are assigned to time phased net requirement and planned order delivery to planned order releases according to lead time. Before printing table, planned order releases of parent components are copied.

4.4 MRP Outputs of the Program and the Comparisons with the MRP Tables

After the outputs of the MRP tables are determined manually by Industrial Engineering team, the Computer Engineering team has created a computer-based program with Java. According to the created program, the outputs of MRP are following:

Picture 4.4. 1*: Program Output for Item 1605*

```
Demand of 1605 is :                        [0, 0, 0, 60, 100, 0, 50, 0, 30, 0]
Scheduled receipt of 1605 is :             [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
On Hand of 1605 is :                       [30, 30, 30, 30, 0, 0, 0, 0, 0, 0]
Net Requirement of 1605 is :               [0, 0, 0, 30, 100, 0, 50, 0, 30, 0]
Time-Phased Net Requirement of 1605 is :[0, 0, 30, 100, 0, 50, 0, 30, 0, 0]
Planned Order Releases of 1605 is :        [0, 0, 30, 100, 0, 50, 0, 30, 0, 0]
Planned Order Delivery of 1605 is :        [0, 0, 0, 30, 100, 0, 50, 0, 30, 0]
```

***Picture 4.4. 2**: Program Output for Item 13122*

```
Demand of 13122 is :                        [0, 0, 30, 100, 0, 50, 0, 30, 0, 0]
Scheduled receipt of 13122 is :             [0, 0, 70, 0, 0, 0, 0, 0, 0, 0]
On Hand of 13122 is :                       [0, 0, 0, 40, 20, 20, 10, 10, 20, 20]
Net Requirement of 13122 is :               [0, 0, 0, 60, 0, 30, 0, 20, 0, 0]
Time-Phased Net Requirement of 13122 is :[0, 0, 60, 0, 30, 0, 20, 0, 0, 0]
Planned Order Releases of 13122 is :        [0, 0, 80, 0, 40, 0, 40, 0, 0, 0]
Planned Order Delivery of 13122 is :        [0, 0, 0, 80, 0, 40, 0, 40, 0, 0]
```

***Picture 4.4. 3:** Program Output for Item 118*

```
Demand of 118 is :                          [0, 0, 30, 100, 0, 50, 0, 30, 0, 0]
Scheduled receipt of 118 is :               [0, 50, 0, 0, 0, 0, 0, 0, 0, 0]
On Hand of 118 is :                         [0, 0, 50, 20, 0, 0, 0, 0, 0, 0]
Net Requirement of 118 is :                 [0, 0, 0, 80, 0, 50, 0, 30, 0, 0]
Time-Phased Net Requirement of 118 is :[0, 80, 0, 50, 0, 30, 0, 0, 0, 0]
Planned Order Releases of 118 is :          [0, 80, 0, 50, 0, 30, 0, 0, 0, 0]
Planned Order Delivery of 118 is :          [0, 0, 0, 80, 0, 50, 0, 30, 0, 0]
```

***Picture 4.4. 4:** Program Output for Item 314*

```
Demand of 314 is :                        [0, 0, 30, 100, 0, 50, 0, 30, 0, 0]
Scheduled receipt of 314 is :             [0, 0, 0, 0, 50, 0, 0, 0, 0, 0]
On Hand of 314 is :                       [0, 0, 0, 20, 20, 70, 20, 20, 40, 40]
Net Requirement of 314 is :               [0, 0, 30, 80, 0, 0, 0, 10, 0, 0]
Time-Phased Net Requirement of 314 is :[0, 30, 80, 0, 0, 0, 10, 0, 0, 0]
Planned Order Releases of 314 is :        [0, 50, 100, 0, 0, 0, 50, 0, 0, 0]
Planned Order Delivery of 314 is :        [0, 0, 50, 100, 0, 0, 0, 50, 0, 0]
```

***Picture 4.4. 5:** Program Output for Item 048*

```
Demand of 48 is :                         [0, 0, 30, 100, 0, 50, 0, 30, 0, 0]
Scheduled receipt of 48 is :              [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
On Hand of 48 is :                        [30, 30, 30, 0, 20, 20, 0, 0, 0, 0]
Net Requirement of 48 is :                [0, 0, 0, 100, 0, 30, 0, 30, 0, 0]
Time-Phased Net Requirement of 48 is :[100, 0, 30, 0, 30, 0, 0, 0, 0, 0]
Planned Order Releases of 48 is :         [120, 0, 30, 0, 30, 0, 0, 0, 0, 0]
Planned Order Delivery of 48 is :         [0, 0, 0, 120, 0, 30, 0, 30, 0, 0]
```

Picture 4.4. 6: *Program Output for Item 457*

```
Demand of 457 is :                          [0, 0, 80, 0, 40, 0, 40, 0, 0, 0]
Scheduled receipt of 457 is :               [0, 20, 0, 0, 0, 0, 0, 0, 0, 0]
On Hand of 457 is :                         [0, 0, 20, 0, 0, 0, 0, 0, 0, 0]
Net Requirement of 457 is :                 [0, 0, 60, 0, 40, 0, 40, 0, 0, 0]
Time-Phased Net Requirement of 457 is :[60, 0, 40, 0, 40, 0, 0, 0, 0, 0]
Planned Order Releases of 457 is :          [60, 0, 40, 0, 40, 0, 0, 0, 0, 0]
Planned Order Delivery of 457 is :          [0, 0, 60, 0, 40, 0, 40, 0, 0, 0]
```

Picture 4.4. 7: *Program Output for Item 11495*

```
Demand of 11495 is :                        [0, 0, 80, 0, 40, 0, 40, 0, 0, 0]
Scheduled receipt of 11495 is :             [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
On Hand of 11495 is :                       [120, 120, 120, 40, 40, 0, 0, 10, 10, 10]
Net Requirement of 11495 is :               [0, 0, 0, 0, 0, 0, 40, 0, 0, 0]
Time-Phased Net Requirement of 11495 is :[0, 0, 0, 0, 0, 40, 0, 0, 0, 0]
Planned Order Releases of 11495 is :        [0, 0, 0, 0, 0, 50, 0, 0, 0, 0]
Planned Order Delivery of 11495 is :        [0, 0, 0, 0, 0, 0, 50, 0, 0, 0]
```

Picture 4.4. 8: *Program Output for Item 2142*

```
Demand of 2142 is :                         [0, 50, 100, 0, 0, 0, 50, 0, 0, 0]
Scheduled receipt of 2142 is :              [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
On Hand of 2142 is :                        [80, 80, 30, 30, 30, 30, 30, 80, 80, 80]
Net Requirement of 2142 is :                [0, 0, 70, 0, 0, 0, 20, 0, 0, 0]
Time-Phased Net Requirement of 2142 is :[70, 0, 0, 0, 20, 0, 0, 0, 0, 0]
Planned Order Releases of 2142 is :         [100, 0, 0, 0, 100, 0, 0, 0, 0, 0]
Planned Order Delivery of 2142 is :         [0, 0, 100, 0, 0, 0, 100, 0, 0, 0]
```

Picture 4.4. 9*: Program Output for Item 019*

```
Demand of 19 is :                           [0, 50, 100, 0, 0, 0, 50, 0, 0, 0]
Scheduled receipt of 19 is :                [0, 0, 0, 0, 40, 0, 0, 0, 0, 0]
On Hand of 19 is :                          [50, 50, 0, 0, 0, 40, 40, 40, 40, 40]
Net Requirement of 19 is :                  [0, 0, 100, 0, 0, 0, 10, 0, 0, 0]
Time-Phased Net Requirement of 19 is :[100, 0, 0, 0, 10, 0, 0, 0, 0, 0]
Planned Order Releases of 19 is :           [100, 0, 0, 0, 50, 0, 0, 0, 0, 0]
Planned Order Delivery of 19 is :           [0, 0, 100, 0, 0, 0, 50, 0, 0, 0]
```

Picture 4.4. 10: *Program Output for Item 129*

```
Demand of 129 is :                          [0, 0, 0, 0, 0, 50, 0, 0, 0, 0]
Scheduled receipt of 129 is :               [0, 0, 0, 0, 0, 0, 0, 100, 0, 0]
On Hand of 129 is :                         [0, 0, 0, 0, 0, 0, 30, 30, 130, 130]
Net Requirement of 129 is :                 [0, 0, 0, 0, 0, 50, 0, 0, 0, 0]
Time-Phased Net Requirement of 129 is :[0, 50, 0, 0, 0, 0, 0, 0, 0, 0]
Planned Order Releases of 129 is :          [0, 80, 0, 0, 0, 0, 0, 0, 0, 0]
Planned Order Delivery of 129 is :          [0, 0, 0, 0, 0, 80, 0, 0, 0, 0]
```

Picture 4.4. 11: *Program Output for Item 1118*

```
Demand of 1118 is :                         [0, 0, 0, 0, 0, 50, 0, 0, 0, 0]
Scheduled receipt of 1118 is :              [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
On Hand of 1118 is :                        [30, 30, 30, 30, 30, 30, 0, 0, 0, 0]
Net Requirement of 1118 is :                [0, 0, 0, 0, 0, 20, 0, 0, 0, 0]
Time-Phased Net Requirement of 1118 is :[0, 0, 20, 0, 0, 0, 0, 0, 0, 0]
Planned Order Releases of 1118 is :         [0, 0, 20, 0, 0, 0, 0, 0, 0, 0]
Planned Order Delivery of 1118 is :         [0, 0, 0, 0, 0, 20, 0, 0, 0, 0]
```

Picture 4.4. 12: *Program Output for Item 062*

```
Demand of 62 is :                           [0, 0, 280, 400, 80, 200, 80, 120, 0, 0]
Scheduled receipt of 62 is :                [0, 0, 0, 0, 0, 100, 0, 0, 0, 0]
On Hand of 62 is :                          [50, 50, 50, 0, 0, 0, 0, 0, 0, 0]
Net Requirement of 62 is :                  [0, 0, 230, 400, 80, 100, 80, 120, 0, 0]
Time-Phased Net Requirement of 62 is :[230, 400, 80, 100, 80, 120, 0, 0, 0, 0]
Planned Order Releases of 62 is :           [230, 400, 80, 100, 80, 120, 0, 0, 0, 0]
Planned Order Delivery of 62 is :           [0, 0, 230, 400, 80, 100, 80, 120, 0, 0]
```

Picture 4.4. 13: *Program Output for Item 14127*

```
Demand of 14127 is :                        [0, 300, 720, 400, 0, 200, 300, 120, 0, 0]
Scheduled receipt of 14127 is :             [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
On Hand of 14127 is :                       [60, 60, 60, 40, 40, 40, 40, 40, 20, 20]
Net Requirement of 14127 is :               [0, 240, 660, 360, 0, 160, 260, 80, 0, 0]
Time-Phased Net Requirement of 14127 is :[240, 660, 360, 0, 160, 260, 80, 0, 0, 0]
Planned Order Releases of 14127 is :        [300, 700, 400, 0, 200, 300, 100, 0, 0, 0]
Planned Order Delivery of 14127 is :        [0, 300, 700, 400, 0, 200, 300, 100, 0, 0]
```

As decided in the first part of the project, MRP program is created on Java. That program solves MRP problems instead of solving by hand. When MRP tables which are created by Industrial Engineering Team and the MRP program outputs which are created by the Computer Engineering team, we have observed that the demands, the scheduled receipts, the inventories, the net requirements, the time-phased net requirements, the planned order releases and the planned order deliveries for each item are matched. The quantities and the periods of each title are same in the program outputs and the MRP tables. That result shows us the Computer Engineering team's computer-based MRP program works as desired. The algorithm created for the MRP program is implemented correctly and the MRP tables are calculated accurately.

5. CONCLUSION

The given problem is solved and the MRP outputs are created by the Industrial Engineering Team. As creating the MRP outputs, the Industrial Engineering Team considered demands, inventory quantities, and scheduled receipts of each item. When inventories and scheduled receipts do not meet the demand, lead times and lot sizing rules are considered for each item to produce the product on scheduled time. In order to create MRP outputs, relationships among items are used.

The Industrial Engineering Team explained how an MRP system works to the Computer Engineering Team. According to the Industrial Engineering Team's explanations, the Computer Engineering Team aimed creating a program on Java that solves MRP problems instead of solving by hand. Flow chart and pseudo code are prepared to use in the coding phase of the project by the Computer Engineering Team. The flow chart and the pseudo code related to the MRP guided the Computer Engineering Team as writing the code of desired MRP program. In Java program, array data structure is utilized. Some of them are static arrays. The static arrays are determined according to parent items.

In companies which have various numbers of products and product components, calculating the MRP outputs by hand is a huge problem and it might cause the miscalculations chaos. That's why, computer-based MRP programs are needed in industrial applications. In this study, the Industrial Engineering and the Computer Engineering

dicsiplines worked together to make a small implementation for a practical solution. In the end of this study, we understood that manual results and program results match by using the small sized-data. So, using computer-based programs are reliable and easier to use in companies MRP applicaitons.

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