Purchasing and Material Requirements Planning for a Manufacturing Firm

By

Mr. Ruksak Chotimongkulsub

A Final Report of the Three - Credit Course
CE 6998 Project

Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Science
in Computer and Engineering Management
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Project Title	Purchasing and Material Requirements Planning for a Manufacturing Firm
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The Graduate School of Assumption University has approved this final report of the three-credit course, CE 6998 PROJECT, submitted in partial fulfillment of the requirements for the degree of Master of Science in Computer and Engineering Management.

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ABSTRACT

In the current economic situation, the way to survive of an organization is to increase the serviceability towards the customers and reduce the cost, so that improvement of purchasing performance is one of the ways to solve that problem.

This project is aimed to realize how Material Requirements Planning (MRP) reduces the cost of organization by using the case study from site reference at Toshiba Display Device Thailand (TDDT). The study used the comparison method between the current purchasing system and the concept and simulation of MRP system at Toshiba Display Device Thailand (TDDT).

The input data has been collected using 8 months' past record of a raw material, which is a directed material for producing Cathode Ray Tube (CRT), and compared with MRP simulation. The comparison was made between the expected benefits of MRP and actual results from simulative MRP, which showed the comparison results especially in terms of finance.

It is shown from the study that MRP system has reduced the cost of purchasing for the organization and the benefits are realized from implementing the system.

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I. INTRODUCTION

1.1 Significance of Improving Purchase Performance

Many manufacturing firms spend most of their sales revenues on purchased goods and service. The role of the purchasing function is becoming an increasingly important one. This transition can be clearly seen in the evolution of purchasing from its roots as a purely clerical function in the early part of this century, to its more traditional role of expense control through most of the century, and now its role as manager of outside manufacturing. As the nature of the function has changed, so have the requirements for improving purchase performance. This can increase the role of purchasing in making today's companies more profitable.

Not all purchasing savings come from reduced prices of purchased goods and services. The benefits companies received are from effective purchasing, other than price reductions. They resulted from finding new sources of supply, finding substitute products, making recommendations for specification changes that allowed for the use of less costly and scarce materials, and making changes in ordering and delivery patterns that resulted in lower levels of inventory.

All of these actions allowed purchasing to fulfill their role as the expense controller for the corporation and increased regard for the purchasing department as a contributor to profits.

1.2 The Statement of Problem

Inventory is one of the most expensive assets of many companies, representing as invented capital. Purchasing managers have long recognized that good inventory control is crucial. On the one hand, a firm can try to reduce costs by reducing on-hand inventory levels. On the other hand, customers become dissatisfied when frequent inventory outages (stockouts) occur. Thus companies must strike a balance between inventory

investment and customer service levels. As we would expect, cost minimization is a major factor in obtaining this delicate balance.

At present, Toshiba Display Devices Thailand does not have inventory control system properly, purchase order is placed without considering the synchronization of production, which has caused vast loss to Toshiba Display Devices Thailand such as, short supply from suppliers, and obsolete materials. So far, it has been occurring periodically.

While Inventory management (MRP) system has gained in popularity, Toshiba Display Devices Thailand still relies on traditional techniques to manage their inventories. This project will utilize Inventory management (MRP system) most appropriate for their particular situations, considering the resources, constraints and personnel available. Regardless of the inventory system, purchasers need to provide suppliers with accurate and timely information about their quantity requirements, with frequent updates, and so on, in order to keep inventory and customer priorities. This project will discuss issues that are applicable to Toshiba Display Devices Thailand.

1.3 Research Objectives

In the current economic situation, the way for an organization to survive is to increase the serviceability towards the customers and reduce the cost, so that improvement of purchasing performance is one of the ways to solve that problem.

In order to survive in the current economic situation, the production control must minimize inventory investment while remaining efficient and avoiding stockouts. Ideally, purchasing management would like to maintain just enough inventory to meet production schedules and customer requirements comfortably. Carrying excess inventories above that level is wasteful and places an undue burden on a firm's cash

flow and liquidity. There is no sufficient fund available to invest in other aspects of the business because there is no money.

This project is aimed to realize how Material Requirements Planning (MRP) reduces the cost of the organization by using the case study from site reference at Toshiba Display Device Thailand (TDDT). The study used the comparison method between the current purchasing system and the concept and simulation of MRP system at Toshiba Display Device Thailand (TDDT).

The input data has been collected using the 8 past month record of a raw material, which is a direct material for producing Cathode Ray Tube (CRT), and compared with MRP simulation. The comparison was made between the expected benefits of MRP and the actual results from simulative MRP, which showed the comparison result especially in terms of finance.

It is shown from the study that MRP system has reduced the cost of purchasing for the organization and the benefits are realized from implementing the system.

II. LITERATURE REVIEW

2.1 The Definition of Purchasing

The organizational purchasing may be defined as that function responsible for obtaining by purchasing, leasing or other legal means, equipment, materials, supplies and services required by an undertaking for use in production. In this definition, the term production is used in the economic sense of creating utilities, i.e. goods and services that satisfy wants. It is not, therefore, confined to manufacturing output but also applies to services, distributing, and providing to organizations.

2.2 The Importance of Purchasing

(1) Purchasing's share of the sales

On average, more than half of every Baht taken as income from sales of manufactured products is spent on the purchase of materials, supplies, and equipment needed to produce those goods.

In the majority of manufacturing companies, materials costs are found to be reasonably close to the average, from 40 to 60 percent of total product cost. But in special cases, purchases may range widely beyond these limits, according to the type of business and the kinds of materials used.

In the basic processing of a single raw material that makes up the bulk of the finished product, the purchase cost of material is generally a high proportion of finished product cost – up to 85 percent or more, Examples are found in those electricity industries. A high mechanization, which reduces labor cost per unit of product, also tends to make materials cost a higher percentage of the total, even though the materials themselves may be relatively low in terms of unit cost.

(2) Role of Purchasing in Organization

Efficiency in purchasing provides opportunities for making important savings and avoiding serious waste and loss. The effect on product cost is such that it may easily spell the difference between leadership in an industry and untenable competitive position. Management properly performed gives close and continuous attention to labor costs, production efficiency, and costs of distribution. Materials are sometimes taken for granted, as if they were a fixed cost and nothing could be done about them. Yet in terms of the value received in return for purchase expenditures, this factor also reflects good and poor management and performance. It is, in fact, of equal importance with other functions of industrial activity and the other element of product cost in attaining successful, profitable company operation.

(3) Profit impact

Purchasing savings affect bottom-line profits dramatically. Each Baht saved adds an extra Baht to corporate profits. For example, a purchaser who produces 10,000 Baht net savings contributes 10,000 Baht profits to the company.

(4) Effect of Purchasing on Other Costs

Direct expenditure for materials and components are not the only ways in which purchasing affects end-product costs. The effect of delays due to lack of material so that shutdowns and waiting time at machines may be charged to production costs, but the end result is the same. The situation is worse when purchased materials are on hand as needed but are not uniform in quality or dimension or are otherwise of inferior workability. Improper materials impair manufacturing efficiency and add to the so-called

hidden costs of production. In addition, they may involve extra costs for closer inspection and result in great waste and rejections. Sacrifices not only spoiled the material itself but also the time and labor expended on it.

(5) Impact on Economic Trends

Purchasing action can have significant impacts on economic trends. The major causes of great changes in buying behavior are threats to supplier. These threats to supplier can occur in all major countries when they are experiencing growth, political upheaval, war, strikes or threats of strike. When such events occur, buying behavior changes, and the change can affect economic activities.

2.3 Purchasing Objective

The purchasing objective is sometimes defined as buying materials of the right quality, in the right quantity, at the right time, at the right price, and from the right source. This is a broad generalization, indicating the scope of the purchasing function, that involves policy decisions and analyses of various alternative possibilities prior to the act of purchase.

The fundamental objective of a purchasing section for a manufacturing firm is summarized as follows:

(1) To maintain standards of quality in materials, based on suitability for use.

(2) To procure materials at the lowest cost consistent with the quality and service required.

(3) To maintain continuity of supply to support the manufacturing schedule.

(4) To do so with the minimum investment in materials inventory, consistent with safety and economic advantage.

(5) To avoid duplication, waste, and obsolescence with respect to materials.

(6) To maintain the company's competitive position in its industry and to conserve its profits, insofar as materials are concerned.

(7) To analyze and report on long-range availability and costs of major purchased items.

(8) To search the market continually for new alternative ideas, products, and materials whose adoption might improve efficiency and profitability.

2.4 Purchasing Management

A firm that decides to buy materials rather than make them or vertically integrate must manage a purchasing function. The writer will now discuss some important aspects of procurement management.

The purchasing department's task is to focus on the cost of inventory and transportation, availability of supply, and quality of suppliers. This is purchasing management.

Purchasing may be combined with various warehousing and inventory activities to form a materials management system. The purpose of materials management is to obtain efficiency of operations through the integration of all material acquisition, movement, and storage activities in the firm. When transportation and inventory costs are substantial and exist on both the input and output sides of the production process, emphasis on materials management may be appropriate. The potential for competitive advantage is found via both reduced costs and improved customer service.

(1) Vendor Relations

The competitive advantage available through purchasing is available with effective vendor relations. Viewing the supplier as an adversary is counterproductive. A long-term, close relationship with a few suppliers is a better way. A healthy vendor relationship is one in which the supplier is

committed to helping the purchaser improve its product and increase its sales. Good purchasing conveys such information to the proper personnel in the organization. The purchaser builds relationships that interest the supplier in the purchaser, its products, and its customers. Likewise, healthy relationships also include those in which the purchaser is committed to keeping the supplier informed of possible changes in product and production schedule. The purchasing function and suppliers must develop mutually advantageous relationships. Because an outstanding operations function requires excellent vendor relations, purchasing conducts a three-stage process.

(a) Vendor evaluation

The first stage, vendor evaluation, involves finding potential vendors and determining the likelihood of their becoming good suppliers. This phase requires the development of evaluation criteria, which Figure 1.1 represents such criteria. Both the criteria and the weights are dependent upon the needs of the organization. If good suppliers are not selected, then all other purchasing efforts are wasted. As firms move toward fewer longer-term suppliers, the issues of financial strength, quality, management, research, and technical ability play an increasingly important role. These attributes should be noted in the evaluation process.

(b) Vendor Development

The second stage is vendor development. Purchasing makes sure the vendor has an appreciation of quality

requirements, engineering changes, schedules and delivery, the payment system, and procurement policies. Vendor development may include everything from training, engineering and production help, to formats for electronic information transfer. Procurement policies might include issues such as percent of business done with any one supplier or with minority businesses.

Vendor Rating Report

COMPANY — J.M HUBER CORPOTATION — TOTAL RATING

Company:	xcelle (4)	Good (3)	Fair (2)	Poor (1)
Size and/of Capacity	4			
Financial Strength		3		
Operational Profit		3		
Manufacturing Range	4			
Research Facilitie			2	
Technical Service		3		
Geographical Locations	4			
Management		3		
Labor Relations		3		
Trade Relations		3		
Total	12	18	2	
.63 x Total = 20.16				

Service				
Deliveries on Time	4			
Condition on Arrival		3		
Follow Instructions		3		
Number of Rejections	4			
Handling of Complaints		3		
Technical Assistance			2	
Emergency Aid		3		
Supply Up o Date Catalogues,Etc			2	1
Supply Price Changes Prompt	4			
Total 27	12	12	2	1
.69 x Total = 18.63				

Products:	xcelle (4)	Good (3)	Fair (2)	Poor (1)
Quality	4			
Price		3		
Packaging	4			
Uniformity		3		
Warranty	4			
Total 18	12	6		
1.25 x Total = 22.50				

Sales Personnel				
1.Knowledge				
His Company		3		
His Product	4			
Our Industry		3		
Our Company		3		
2.Sales Calls				
Properly Spaced	4			
By Appointment		3		
Planned and Prepared		3		
Mutually Productive	4			
3.Sales-Service				
Obtain Information		3		
Furnish Quotations Promptly	4			
Follow Orders		3		
Expedite Delivery		3		
Handle Complaints		3		
Total 43				
.48 x Total = 20.64				

Figure 2.1. Vendor Rating Report.

(c) Negotiations

The third stage is negotiations. Negotiation strategies are of three classic types. First is the cost-based price model. This model requires that the supplier opens its books to the purchaser. The contract price is then based on time and materials or on a fixed cost with an escalation clause to accommodate changes in the vendor's labor and materials cost. Second is the market-based price model. In this model, price is based on a published price or index. Third, one can derive a price based on competitive bidding. In many cases where suppliers are not willing to discuss costs or where near-perfect markets do not exist, competitive bidding is often appropriate. Competitive bidding is the typical policy in many firms for the majority of their purchases. A fourth negotiation technique may be some combination of the above three approaches. The suppliers and purchaser may agree on review of certain cost data, or accept some form of market data for raw material costs, or agree that the supplier will " remain competitive". The net result of a good supplier relationship must be one where both partners have established a degree of mutual trust and belief in the competence of each other.

(2) Purchasing techniques

There are many forms of purchasing techniques, which can be described as follows:

(a) Blanket orders

Blanket orders are unfilled orders with a vendor. A blanket order is contract to purchase certain items from the vendors. It is not an authorization to ship anything. Shipment is made only upon receipt of an agreed-upon document, perhaps a shipping requisition or shipment release.

(b) Invoiceless-Purchasing

Invoiceless purchasing is an extension of good purchaser-supplier relations. In an invioceless-purchasing environment, there is typically one supplier for all units of a particular product. If the supplier provides all four wheels for each lawn mower produced, then management knows how many wheels it purchased. It just multiplies the quantity of lawn mowers produced times four and issues a check to the supplier for that amount.

(c) Electronic Ordering and Funds Transfer

Electronic ordering and funds transfer reduce paper transactions. Paper transactions consist of a purchase order, a purchase release, a receiving document, authorization to pay an invoice (which is matched with the approved receiving report), and finally the issuance of a check. Purchasing section can reduce this barrage of paper work by electronic ordering, acceptance of all parts as 100% good, and electronic funds transfer to pay for units received. Many firms expect to save billions of dollars over the next few years through exactly this kind of electronic transfer. Transactions between firms are

increasingly done via electronic data interchange. Electronic data interchange (EDI) is a standardized data transmittal format for computerized communications between organizations. EDI provides data transfer for virtually any business application, including purchasing. Data are transmitted directly from electronic media of the sender via a third party (usually via phone) to electronic media of the receiver. Not only can electronic ordering reduce paperwork, but it also speeds up the traditionally long procurement cycle.

(d) Stockless Purchasing

The term stockless purchasing has come to mean that the supplier maintains the inventory for the purchaser. If the supplier can maintain the stock of inventory for a variety for customers who use the same product or whose differences are very minor, say perhaps at the packaging stage, then there may be a net savings.

(e) Standardization

The purchasing section should make special efforts toward increased levels of standardization. That is, rather than obtaining a variety of very similar components with labeling, coloring, packaging, or perhaps even slightly different engineering specifications, the purchasing agent should endeavor to have those components standardized.

2.5 Purchase Performance and Improving Purchase Performance / Material Management

The standard statement of the overall purchase performance is that it should obtain:

(1) The right materials (meeting quality requirements), in (2);

(2) The right quality, for delivery at the (3);

(3) The right time and;

(4) The right place at (5);

(5) The right source (a vendor who is reliable and will meet its commitments in a timely fashion), with (6);

(6) The right service (both before and after the sale), and;

(7) At the right price.

The purchasing decision-marker might be linked to several concerns at the same time, and the purchaser must achieve several goals simultaneously- the seven previously listed.

It is not efficient to buy at the lowest price if the goods delivered are unsatisfactory from a quality/performance standpoint, or if they arrive two weeks behind schedule, causing a shutdown of a production line. On the other hand, the right price may be a much-higher-than-normal price if the item in question is an emergency requirement on which the buyer cannot afford the luxury of adhering to the normal lead-time. The purchasing decision-maker attempts to balance out the often-conflicting objectives and makes trade-off to obtain the optimum mix of these seven rights.

In order to improve purchase performance a more specific statement of the purchasing would include the following nine items:

(1) Provide an Uninterrupted Flow of Materials, Supplies, and Service Required to Operate the Organization

Stock outs of raw materials and production parts would shut down an operation and be extremely costly in terms of lost production, escalation of operating costs due to fixed cost, and inability to satisfy delivery promises to customers.

(2) Keeping Inventory Investment and Loss at a Minimum

One way to assure an uninterrupted material flow is to keep large inventory banks. But inventory assets require use of capital, which cannot be invested elsewhere, so that reduction in inventory represents a saving.

(3) Maintain Adequate Quality Standards

To produce the desired product or service, a certain quality level is required for each material input; otherwise the end product or service will not meet expectations or will result in higher-than-acceptable production costs.

(4) Find or Develop Competent Vendors

In the final analysis, the success of the purchasing section depends on its skill in locating or developing vendors, analyzing vendor capabilities, and then selecting the appropriate vendor. Only if the final selection results in vendors who are both responsive and responsible will the firm obtain the items it needs at the lowest ultimate cost.

(5) Standardize, where Possible, the Items Bought

The best item possible, from an overall company viewpoint, for the intended application should be bought. If purchasing can buy a quantity of one item to do the job that two or three different items previously did, the organization may gain efficient advantages through a lower initial price resulting from a quantity discount, lower total inventory investment without

lowering service levels, reduced costs of personnel training and maintenance costs in the use of equipment, and increased competition among suppliers.

(6) Purchase Required Items and Services the Lowest Ultimate Price

The purchase activity in the typical organization consumes the largest share of that organization's Baht resources. In addition, the profit-leverage effect of the purchasing activity can be very significant. While the term "price buyer" has a derogatory connotation, suggesting that the only factor purchasing considers is price, the purchasing section should strive to obtain needed items and services at the lowest-possible price, assuming that the quality, delivery, and service requirements also are satisfied.

(7) Maintain the Organization's Competitive Position

An organization will be competitive only if it can control costs in order to protect profit margins. Purchase costs are the largest single element in the operation of many organizations. Additionally, product design and manufacturing methods changes are needed to keep pace with changing technology and production environments; the purchasing section can supply information to product design and manufacturing engineering on new products available and what changes are occurring and are likely to occur in production technology. Finally, the purchasing section is responsible for assuring the smooth flow of materials necessary to enable the production of products and provision of services as required to meet delivery commitments to customers; in the long run, the success of any organization is dependent on its ability to create and maintain a customer satisfaction.

(8) Achieve Harmonious, Productive Working Relationships With other

Departments in the Organization

Purchasing actions cannot be effectively accomplished solely by the efforts of the purchasing section; cooperation with other departments and individuals within the firm is vital to success.

For example, the purchasing departments and production control must provide information on material requirements in a timely fashion if purchasing is to have the lead time needed to locate competent vendors and make advantageous purchase agreements. Engineering and production must be willing to consider the possible economic advantages of using substitute materials and different vendors. Purchasing must work closely with quality control in determining inspection procedures for incoming materials, in communicating to vendors the changes needed in the event that quality problems are found, and assisting in evaluating the performance of current vendors. Accounting must pay vendors in a timely fashion, to take advantage of quantity discounts and maintain good ling-term vendor relations. If there is a problem with the flow of information from purchasing, receiving, or incoming inspection which is necessary for making payment to vendors, it is purchasing's responsibility to correct the problem for the vendor does not deal directly with accounting, receiving, or incoming inspection. Instead, the vendor deals with purchasing and expects to be paid on schedule.

(9) Accomplish the Purchasing Objectives at the Lowest Possible Level of Administrative Costs

It takes resources to operate the purchasing department: salaries, telephone and postage expense, supplies, travel costs, and accompanying

overhead. If purchasing procedures are not efficient, purchasing administrative cost will be excessive. The objectives of purchasing should be achieved as efficiently and economically as possible, which requires that the purchasing manager continually reviews the operation to assure that it is cost effective. If the firm is not realizing its purchasing objectives due to inadequate analysis and planning, perhaps additional personnel are needed. But the firm should be continually alert to improvements possible in purchasing methods, procedures and techniques. Perhaps, unneeded steps in processing purchasing paperwork could be eliminated; perhaps the computer could be used to make the storage and recall of necessary data more efficiently.

2.6 Material Requirements Planning (MRP)

Material requirements planning (MRP) is a management technique that goes beyond the traditional bases for determining quantity requirements. Thus it directly affects purchasing schedules. In an MRP system the (dependent) demand for components of a manufactured product depends on the forecasted (independent) demand for the finished product. Thus demand for components is calculable based on demand for the end product.

In other words, assuming that demand for one item was independent of the demand for another item, for example, the demand for refrigerators may be independent of the demand for dishwashers; and, by dependent, we mean the demand for one item is related to the demand for another item. Consider an auto manufacturer for 1,000 wagons, we need 4,000 wheels, 1,000bodies, 2,000 axles, and so forth. Demand for items is dependent when the relationship between the items can be determined. This is true for all component parts, subassemblies, and suppliers when a schedule is known.

When dependent techniques are used in a production environment, they are called Material Requirement Planning (MRP).

(1) Dependent Inventory Model Requirements

In order to understand MRP clearly, we need to examine the requirements of dependent inventory models. And we need to look at how to use these models. Anyway, we will discuss each of these requirements in the context of material requirement planning (MRP) sequentially. Effective use of dependent inventory models requires that the operations manager know the master production schedule.

(a) Master Production Schedule (what is to be made and when)

A master production schedule specifies what is to be made and when. The schedule must be in accordance with a production plan. The production plan is derived from the aggregate planning techniques. Such pans include a variety of inputs, including financial plans, customer demand, engineering capabilities, labor availability, inventory fluctuations, supplier performance, and other considerations. Each contributes in its own way to the production plan, as shown in Figure 2.2, which shows the planning process from the production plan to execution. Each of the lower-level plans must be feasible. When it is not, feedback to the next higher level is used to make the necessary adjustment. One major strength of MRP is its ability to determine precisely the feasibility of a schedule within capacity constraints. The production plan sets the upper and lower bounds on the master production schedule.

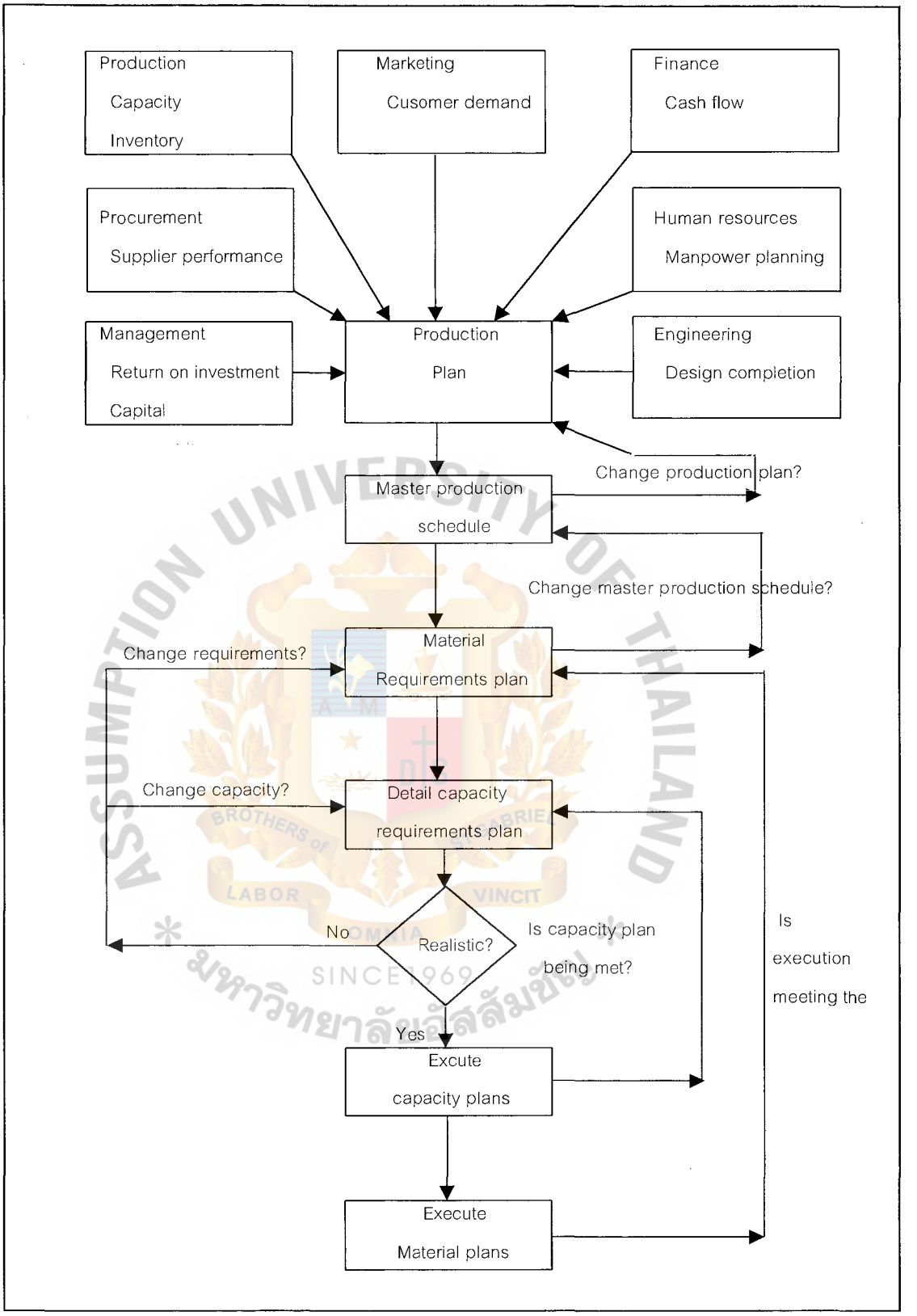

Figure 2.2. The Planning Process.

The master production schedule tells us what is required to satisfy demand and meet the production plan. This schedule establishes what items to make and when.

Many organizations establish a master production schedule and then " fix" the near-term portion of the plan. The fixed portion of the schedule is then referred to as the "fixed," "firm," or "frozen" schedule. Only changes beyond the fixed schedule are permitted. The master production schedule is a statement of production, not a forecast of demand. It shows the units that are to be produced.

(b) Specifications or Bill-of-Material (how to make the product)

Table 2.1. Master Production Schedule for Product XXX and YYY.

GROSS REQUIREMENTS FOR PRODUCT XXX											
Week	6	7	8	9	10	11	12	13	14	and so on	
Amount	50		100	47	60		110	75			
GROSS REQUIREMENTS FOR PRODUCT YYY											
Week	7	8	9	10	11	12	13	14	15	16	and so on
Amount	100	200	150			60	75		100		

Units to be produced are often specified via a bill-of-material (BOM), which is a list of quantities of components, ingredients, and materials required to make a product. A home kitchen recipe specifies ingredients and quantities, for example. In Table 2.3, a bill-of-material for item A consists of items B and C. Items above any level are called parents; items below any

level are called components or children. A bill-of-material provides the product structure. Table 2.3 shows how to develop the product structure and "explode" it to reveal the requirements for each component.

Bill-of-material not only specify requirements, but are also useful for costing, and they can serve as a list of items to be issued to production or assembly personnel. When bills-of material (BOM) are used in this way, they are usually called pick lists.

(c) Inventory Availability (what is in stock)

Knowledge of what is in sock is the result of good inventory management. Good inventory management is an absolute necessity for an MRP system to work. If the firm has not yet achieved record accuracy, then material requirements planning (MRP) will not work.

(d) Purchase Orders Outstanding (what is on order)

Knowledge of outstanding orders should exist as a by-product of well-managed purchasing and inventory control department. When purchase orders are executed, records of those orders and their scheduled delivery date must be available to production personnel. Only with good purchasing data, managers can prepare good production plans and effectively execute a MRP system.

(e) Lead Times (how long it takes to get various components)

Management must determine when products are needed. Only then can it be determined when to purchase, produce, or assemble.

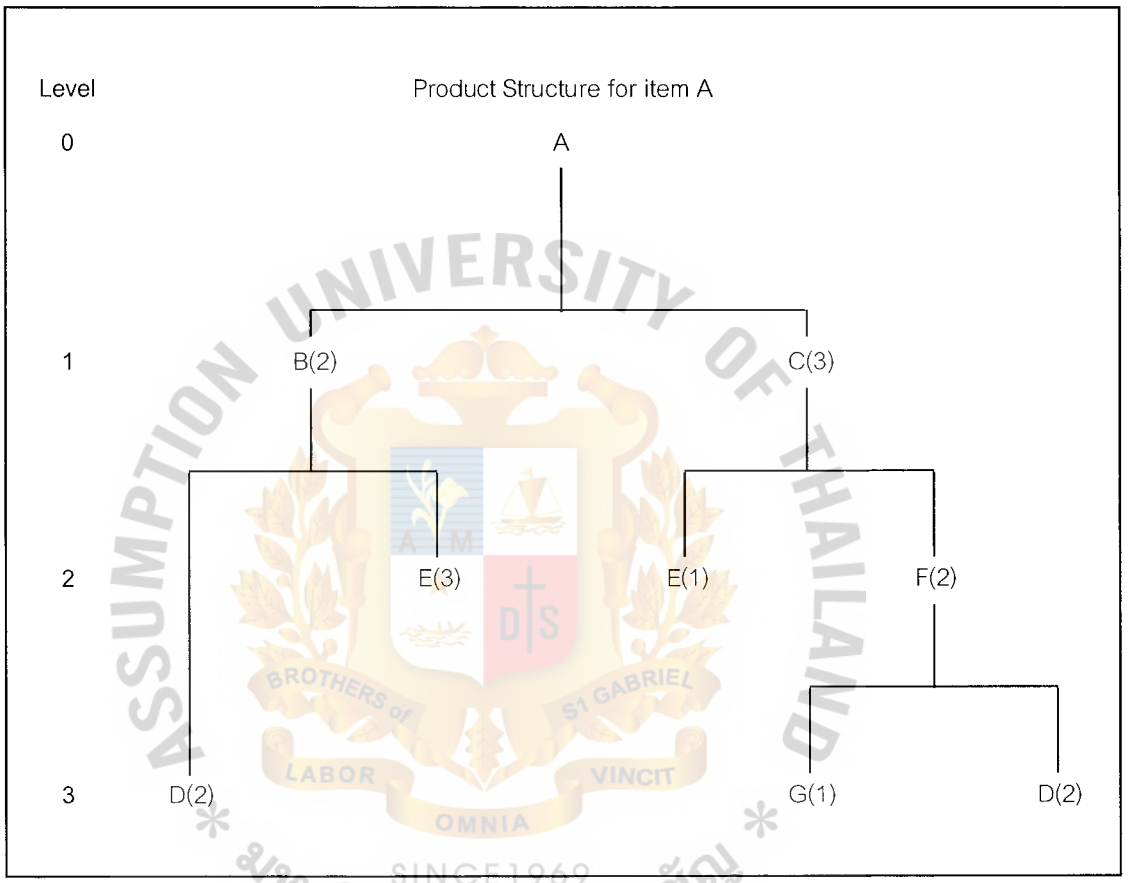

Figure 2.3. The Product Structure.

This means operations personnel determine wait, move queue, setup, and run times for each component. When grouped together, these times are called Lead times. Lead times for item A are shown in Table 2.2

When the bill-of-material for item A is turned on its side, and lead times (in Figure 2.4) are added to each component (illustrated on the horizontal axis), then we have a time phased product structure.

2.7 Benefits of MRP

While dependent demand makes inventory scheduling and planning more complex, it also makes it more beneficial. Major benefits resulting from MRP include the following:

(1) Increased customer service and satisfaction

(2) Improved Utilization of Facilities and Labor

(3) Faster Response to Market Changes and Shifts

(4) Reductions in Inventory

Table 2.2. Lead Time for Product A.

COMPONENT	LEAD TIME
A	1 week
B	2 weeks
C	1 week
D	1 week
E	2 weeks
F	3 weeks
G	2 weeks

(5) Improved Productivity (The material is more likely to be there when needed.)

(6) Reduction in Parts Shortages

(7) Improved Inventory Accuracy Levels

(8) Better planning and communication of future needs to suppliers

(8) Improved distribution efficiency

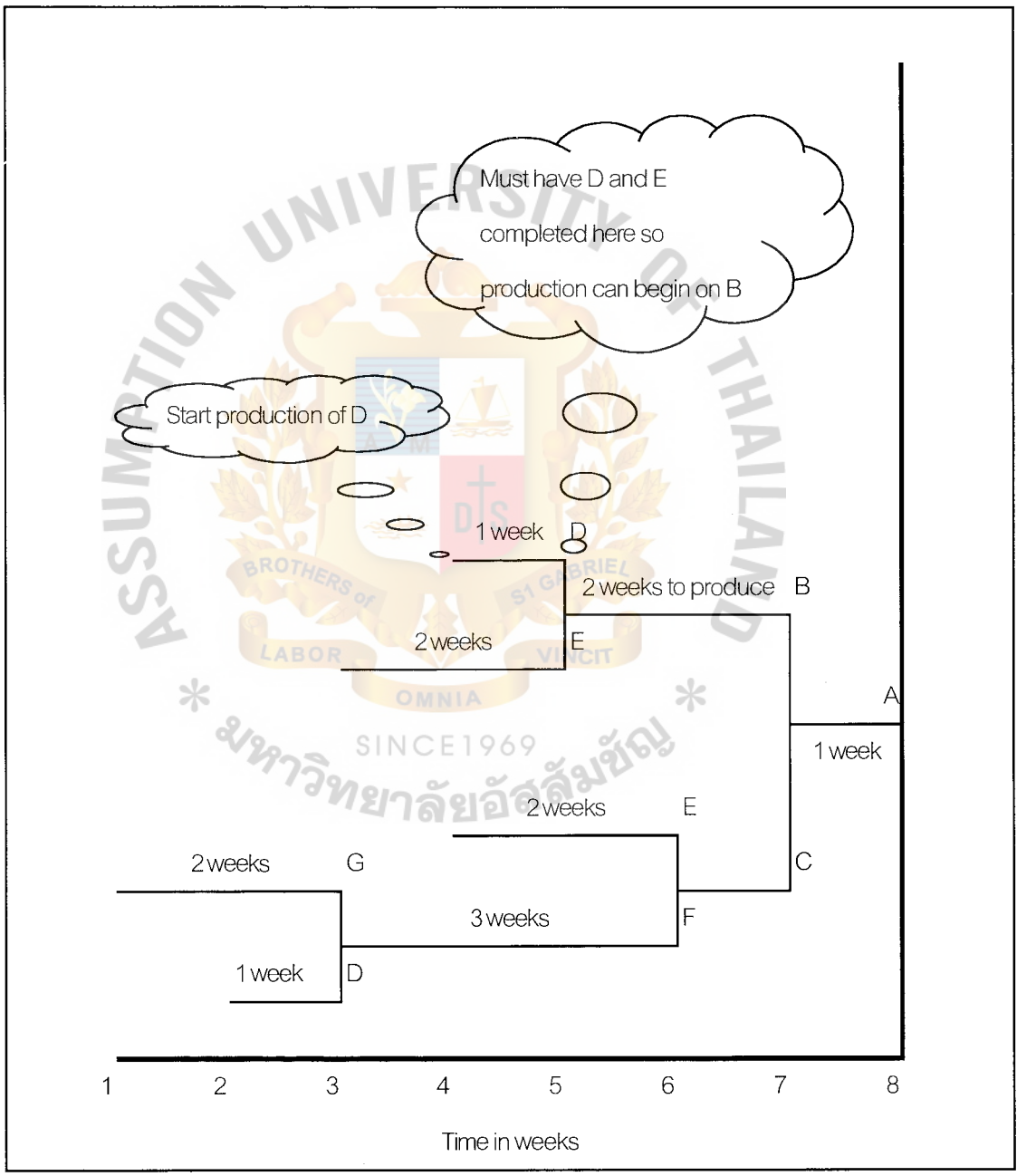

Figure 2.4. Time-Phased Product Structure.

III. RESEARCH METHODOLOGY

3.1 Introduction

Firstly, researcher would like to introduce company profile of Toshiba Display Device Thailand (TDDT) and our vendor (K.U. NOMURA THAI); who has been supplying Convergence Purity Magnet (C.P.M.) to Toshiba Display Device Thailand (TDDT).

(1) Toshiba Display Device Thailand (TDDT)'s Company Profile

Toshiba Display Device (Thailand) Co., Ltd. was established on August29, 1988 at 142 Moo 5, Bangkadi Industrial Park, Tivanoond Road Pathumtani 12000 with 2,000 Million Baht capital. Employees are estimated to be 3,000 persons (Japanese 34 persons) approximately. Shareholders consist of Toshiba corporation 93%, others 7%. Toshiba Display Device Thailand (TDDT) manufactures CRT tube; color picture tubes for T.Vs and color display tubes for computer monitors. The sales amount of Toshiba Display Device Thailand (TDDT) is shown below.

Sales amount:	'90	'91	'92	'93	'94	'95	'96	'97
(Billion Baht)	1.1	1.4	2.5	4.2	5.1	8.5	8.5	9.7

(2) K.U. NOMURA THAI LTD. 's Company Profile

K.U.NOMORA THAI LTD. who has been supplying Convergence Purity Magnet (C.P.M.) to Toshiba Display Device Thailand (TDDT) was established on June15, 1989 at Lat-krabang Industrial Estate 3. with 10 mil.Baht capital. The major shareholders are Japanese (49%) and Thai (51%) respectively. Meanwhile, their main products are Gasket, Magnet for Gasket, PVC-Tube, and Convergence Purity Magnet (C.P.M.) for CRT tube.

(3) Definition of Product (CRT) and Component (Convergence Purity Magnet: C.P.M.

CRT stands for cathode ray tube. CRT that display text and graphics are in common use today. Most CRT tubes use a technology called raster-scan technology. The backing of the screen CRT has a phosphorous coating, which will glow whenever it is hit by a beam of electrons. There have been 2 CRT standards, relating particularly to usage. The first CRT is CPT (CPT stands for Color Picture Tube), which is used for TV. The second CRT is CDT (CDT stands for Color Display Tube), which is used for computer monitor.

Convergence Purity Magnet stands for C.P.M. It is a part of CRT tube. CPM is inserted into the neck of CRT tube in order to adjust the beam of electrons. Its quality depends on how good its evasion to electrons is.

(4) Purchasing Procedures Toward Vendor

At present, we receive Purchase Requisition (PR) from Material control section every 10th of the month, then we are able to place Purchase Order (PO) to K.U NOMURA THAI every 11th for the next month's delivery. Meanwhile, we submit our procurement 4 months plus forecast to K.U NOMURA THAI as well. Our procurement 4 months plus forecast is made based on the latest production plan. After sending PO, then there is no longer daily delivery for the next month from K.U NOMURA THAI is submitted to Toshiba Display Device Thailand (TDDT).

According to the preceding procedures toward K.U NOMURA THAI, the researcher aimed that it should be reviewed and improved by using Material Requirement Planning (MRP) technique. At present, the

purchasing procedure is not proper to proceed in the economic crisis because as the researcher mentioned inventories are considered current assets on the balance sheet. However, having too many or the wrong items can increase the cost of doing business. Inventories also require physical space to store them. Thus, a progressive firm such as Toshiba Display Device Thailand (TDDT) should take steps to safeguard these assets. While minimizing the inventory, we should also take customer satisfaction into our consideration by providing sufficient inventories when fluctuation of demand occurs.

3.2 Research Design

This research has been designed by using researcher's experience and theory of purchasing together. The researcher relies on how to improve the current task by using the proper technique. Moreover, the main purpose of purchasing is to minimize organizational cost as much as possible. In this, price negotiation is aimed to be prior task for the purchaser, but in terms of minimizing fund for the firm, it does not mean only price negotiation. On the other hand, purchasing 's responsibility for inventory management can also increase profit or decrease cost of goods sold.

However, researcher has classified steps toward this research into several steps, which are cited as follows.

(1) Data collection

Firstly, the researcher has collected significant input of MRP over the past 8 months, such as order lead-time, minimum order quantity, bill of material, master production schedule, planned order receipts, inventory on hand, etc. However, the researcher has gathered data by interviewing, and sending questionnaires to concerned persons. Especially, the design of the

questionnaire has been drawn by using the researcher's experience working as purchasing officer at Toshiba Display Device Thailand (TDDT).

(2) Expected Benefit from the Implementation of MRP

Many MRP publishers mentioned the benefit from the implementation of MRP. Thus, the researcher also expects benefits from MRP. In this step, the inventory holding cost and total 8 months' costs are estimated. However, we would be able to know whether or not the inventory holding cost, and the total 8 months' costs are decreased by making trial and error solution, which are based on the theory of MRP technique.

(3) Trial Simulation of Non-MRP System in the past 8 Months

Since, data have been gathered, the researcher also made trial simulation of non- MRP with 8 months past data, and analyzed what has been happened during the past 8 months.

(4) Trial Simulation of MRP System during the past 8 Months

In order to judge whether or not the implementation of MRP would be helpful to the firm, the researcher has a simulation of the past 8 months' data by using the MRP technique, so that in this step, we will be able to see the difference between the proceeding without MRP and the MRP implementation. Mainly, the researcher will explain how to fit order quantity step by step.

(5) Analysis of Result

Since we have made trial and error implementation of MRP, in this step we will calculate and compare the cost holding inventory, and the total cost in terms of financial comparison and quantity by using mathematical calculation. Eventually, we will be able to see how good MRP clearly is.

3.3 Sample Population

The sample size has been collected by interviewing and questionnaire submitted from the concerned persons over the past 8 months. Moreover, the population in this research means personnel from Toshiba Display Device Thailand (TDDT) and K.U. NOMURA THAI.

3.4 Data Collection

(1) Data Collection

Data collection is one of the most important steps toward this research. Prior to simulating MRP, we need to get components of MRP such as order lead-time, minimum order quantity, bill of material, master production schedule, planned order receipts, inventory on hand, etc. However, the researcher has gathered data by interviewing, and questionnaire submission. Especially, the design of the questionnaire has been drawn from the researcher's experience working as purchasing officer at Toshiba Display Device Thailand (TDDT). The researcher will discuss the way to get the data in the next step.

(2) Order Lead-Time

In order to implement the MRP system to our organization, first of all, we do need to investigate order lead-time from our vendor. At present, Toshiba Display Device Thailand (TDDT) does not have a format of vendor lead-time survey so that researcher designed the format of vendor lead-time survey for collecting lead-time data from our vendor. This is illustrated in Appendix A:

VENDOR LEAD TIME SURVEY

SURVEY NO: 001/99 DATE:18/JUN/99

VENDOR NAME: K.U NOMURA THAI LTD.
ADDRESS: 265 CHALONGKRUNG ROAD LAMPLATEW LATKRABANG BANGKOK 10520, THAILAND.

VENDOR'S SIGNATURE & TITLE

DESCRIPTION OF VENDOR'S PRODUCT: C.P.M.
TYPE NAME: SM-M2(H)
MINIMIUM ORDER Q'TY: 50,000 PC(S)

SURVEYOR'S SIGNATURE & TITLE

VENDOR MATERIAL PROCUREMENT LEAD TIME

NO.	LIST OF MATEIALS	MATERIALS MAKERS		TYPE OF MATERIALS		LEAD TIME(W)
		NAME	PLACE	COMMON	SPECIAL	
1	HOLDER	G.E PLAS	JAPAN		/	3
2	LOCK RING	G.E PLAS	JAPAN		/	3
3	SPACER	G.E PLAS	JAPAN		/	3
4	4 POLE	G.E PLAS	JAPAN		/	3
5	6 POLE	G.E PLAS	JAPAN		/	3

(A) VENDOR MATERIAL PROCUREMENT LEAD TIME IS PICKED OUT- FROM LONGEST LEAD TIME OF SPECIAL MATERIALS. → 3 WEEK(S)

MANUFACTURING LEAD TIME

NO.	DESCRIPTION OF PROCESS	EXPLANATION OF PROCESS	LEAD TIME(W)
1	ASSEMBLY C.P.M.& PACKING	ASSEMBLY AND PACKING C.P.M BY -	0.0297619
2		WORKERS	
3			
4			
5			

(B) TOTAL MANUFACTURING LEAD TIME IS CALCULATED FROM - FIRST PROCESS UNTIL FINAL PROCESS. → 0.0297619 WEEK(S)

TRANSPORATION LEAD TIME FROM VENDOR TO CUSTOMER(US).

NO.	TRANSPORTATION METHODS	LEAD TIME(W)
1	TRUCK FROM FACTORY TO CUSTOMER.	0.0595238
2		

(C) TRANSPORATION LEAD TIME IS CALCULATED FROM FIRST TRANSPORTATION METHODS TO CUSTOMER(US). → 0.0595238 WEEK(S)

#RESULT#

TOTAL ORDER LEAD TIME IS EQUAL (A) + (B) + (C) = 3.00892857WEEK(S)

Figure 3.1. Vendor Lead Time Survey (Answer).

The researcher has sent vendor lead time survey to K.U NOMURA THAI, and received answers from K.U NOMURA THAI, as shown in Figure 3.1

Naturally, lead-time towards manufacturing consists of 3 main steps. The first step is procurement lead-time (materials are bought for firm for producing goods). The second step is manufacturing lead-time (lead-time for changing the form of raw material to the finished goods). Finally, Transportation lead-time is the interval for vendor to deliver finished goods to customers. Thus, the researcher has recognized that in order to find out the total order lead-time from the vendor, the purchaser does need to gather these lead-times from the vendor.

According to the vendor's answer, we then can summarize that all of their materials are imported from Japan. The total order lead-time is equal to 3.00892857 weeks, but it is convenient for calculating this lead-time in terms of integer, then the order lead-time for use in this researching is equal to 3 weeks. Further more, the minimum quantity for ordering also has been cited. The minimum order quantity for one time is 50,000 pieces. It was mentioned by K.U. NOMURA THAI production officer.

(3) Bill of Material (BOM)

The bill of material is one of the most important documents in manufacturing company. Therefore, the researcher has gathered the Bill of material of Convergence Purity Magnet (C.P.M.) by interviewing the deputy manager of the material control section who is responsible for distributing Convergence Purity Magnet (C.P.M.) of all the factories. Anyway, the

researcher has drawn the Bill of material of Convergence Purity Magnet (C.P.M) as show in Figure 3.2

The structure has 1 level: 0 and 1. There is one parent, that is CRT tube, and CRT tube has one level below it. In other words, Convergence Purity Magnet (C.P.M.) is a component of CRT tube.

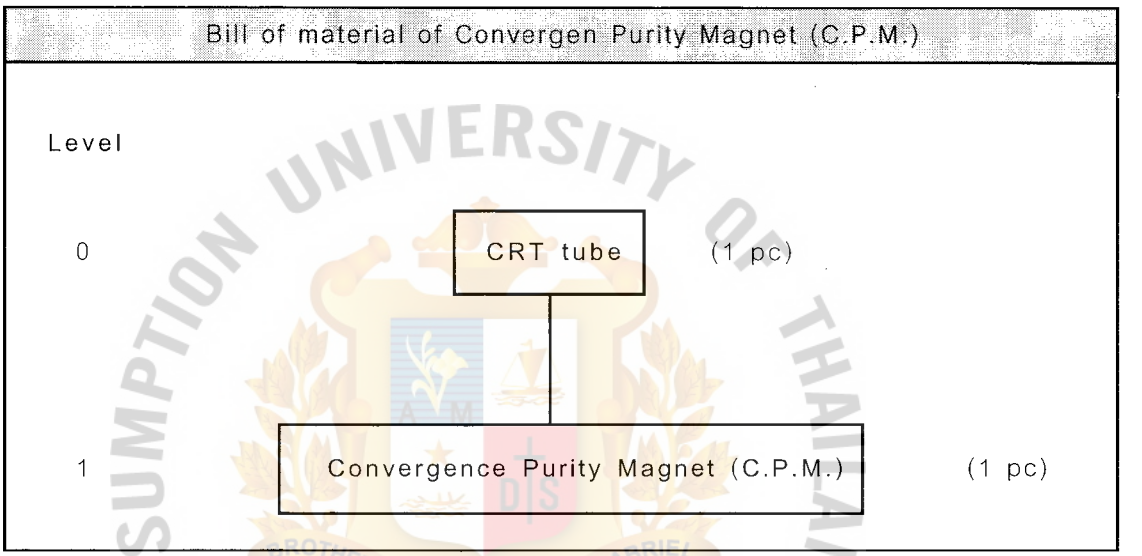

Figure 3.2. Bill of Material of Convergence Purity Magnet (C.P.M.).

The number in parentheses indicates how many units of that particular item are needed to make the item immediately above it. Thus, Convergence Purity Magnet (C.P.M.) takes 1 unit of it for every unit of CRT tube. For example, if demand for CRT tube is 10 units then we will need 10 units of Convergence Purity Magnet (C.P.M.) as well.

(4) Master Production Schedule

The master production schedule is a statement of which end items are to be produced, the quantity of each, and the dates they are to be completed.

With reference once to Figure 3.2, one piece of Convergence Purity Magnet (C.P.M.) is used for manufacturing 1 CRT Tube. Master production schedule for this research has been collected by sending questionnaire to production control officer of Toshiba Display Device Thailand (TDDT). A form of the questionnaire is shown in Appendix B:

An actual Master production schedule of CRT Tube has been filled out by the production control officer for over the past 8 months as shown in Table 3.1

Table 3.1. Master Production Schedule of CRT Tube.

	Master production schedule of CRT Tube; PC(S)				
	1st week	2nd week	3rd week	4th week	Total
Oct'98	36,277	38,964	24,635	23,589	123,465
Nov'98	40,991	36,984	38,227	44,013	160,215
Dec'98	41,131	45,238	43,030	60,926	190,325
Jan'99	5,167	52,039	57,131	70,161	184,498
Feb'99	65,945	69,416	74,013	72,474	281,848
Mar'99	66,652	71,632	76,320	91,061	305,665
Apr'99	63,082	36,497	22,681	93,417	215,677
May'99	35,418	74,099	72,359	87,497	269,373

Referring to the Master production schedule of CRT Tube data. Consumption of Convergence Purity Magnet is the same as that of the Master production schedule of CRT Tube, with which the researcher has explained above.

(5) Planned Order Receipts

Fortunately, the researcher has been working as a purchasing officer of Convergence Purity Magnet (C.P.M.) at Toshiba Display Device Thailand (TDDT). Thus, the researcher is able to collect planned order receipts over the past 8 months (during Oct'98 till May'99). In Table 3.2 is the planned order receipts of Convergence Purity Magnet (C.P.M.) over the past 8 months.

3.5 Expected Benefits from MRP Implementation

The researcher believes that after MRP has been put into the organization, it would be beneficial to the organization.

Table 3.2. Planned Order Receipts of C.P.M.

	Planned order receipts of C.P.M; PC(S)				
	1st week	2nd week	3rd week	4th week	Total
Oct'98	39,000	11,100	22,500	69,600	142,200
Nov'98	49,800	35,700	42,000	34,200	161,700
Dec'98	47,400	33,900	63,900	61,500	206,700
Jan'99	27,000	48,000	55,500	82,500	213,000
Feb'99	40,500	69,000	51,000	84,000	244,500
Mar'99	58,500	94,500	81,000	90,000	324,000
Apr'99	82,500	40,500	42,000	78,900	243,900
May'99	42,000	67,200	70,500	56,400	236,100

The expected benefits from MRP implementation can be measured by using mathematical calculations. The calculation methods will be explained in this project later.

Table 3.3. Expected Benefits from MRP Implementation.

Expected benefits from MRP implementation		
No.	Expected benefits from MRP	Result
1	Inventory holding cost	Decreased
2	Inventory turnover	Increased
3	Total 8 months' cost	Decreased

With the following steps, we will make trial simulation of the non-MRP system by using the data that have been gathered in the previous section.

3.6 Trial Simulation of Non-MRP System during the Past 8 Months (Oct'98-May'99)

With reference to the data collection section that we interviewed and sent questionnaires to concerned persons, in this section we will make a trial simulation of the non-MRP system by using the collected data. However, due to inventory on hand at the beginning was not cited, it was assumed to be 100,000 pieces. Table 3.4 shows the trial simulation of the non-MRP system.

Table 3.4, we could see the Gross requirements, Projected on hand, Planned order receipts, and Planned order Releases by weekly over the past 8 months. Anyway, we may not be able to see beneficial differences if we do not simulate MRP system. Therefore, with the following step, we will make trial simulation of MRP system by using similar data.

3.7 Trial Simulation of MRP System during the Past 8 Months (Oct'98-May'99)

From the preceding section, we may understand the benefit of the MRP system roughly. In order to see profitable differences between the non-implementation of MRP and the implementation of MRP clearly, we do need to simulate. Therefore, the researcher has done a trial simulation of MRP system by using the collected data. However, due to the inventory on hand at the beginning was not cited, it was assumed to be 100,000 pieces. This is illustrated in Table 3.5

In Tables 3.4 and 3.5, first we might see that after the implementation of MRP, our inventories have been reduced if compared with that of the non-MRP system. Therefore, in the next section, we will interpret and analyze the benefit we have expected more from MRP.

3.8 Analysis of Results

(1) Inventory Holding Cost

A major reason for minimizing the inventory is that it costs money to hold inventories.

Holding costs include all expenses incurred by a company because of inventory. These costs consist of interest costs, taxes, insurance, obsolescence, deterioration, storage, and handling charges.

Interest or capital costs are those costs in inventory that could be invested elsewhere or that in many cases represent the cost of borrowing funds.

Taxes include any city, or county taxes on inventory.

Insurance Inventories are assets and must be covered by insurance policies much like the policies carried for individual homes and their contents.

Table 3.4. Trial Simulation of Non-MRP System during the Past 8 Months.

Trial Simulation of Non-MRP System during the Past 8 Months (Oct'98-May'99)

Item: C.P.M, Level :1, Lead time 3W		Oct'98				Nov'98			
Minimum order Q'ty = ???? Pcs	PD	1W	2W	3W	4W	1W	2W	3W	4W
Gross Requirements		36,277	38,964	24,635	23,589	40,991	36,984	38,227	44,013
Schedule Receipts									
Project On Hand	100,000	102,723	74,859	72,724	118,735	127,544	126,260	130,033	120,220
Net Requirement									
Planned Order Receipts		39,000	11,100	22,500	69,600	49,800	35,700	42,000	34,200
Planned Order Releases	142,200		161,700				206,700		
Item: C.P.M, Level :1, Lead time 3W		Dec'98				Jan'99			
Minimum order Q'ty = ???? Pcs	PD	1W	2W	3W	4W	1W	2W	3W	4W
Gross Requirements		41,131	45,238	43,030	60,926	5,167	52,039	57,131	70,161
Schedule Receipts									
Project On Hand	120,220	126,489	115,151	136,021	136,595	158,428	154,389	152,758	165,097
Net Requirement									
Planned Order Receipts		47,400	33,900	63,900	61,500	27,000	48,000	55,500	82,500
Planned Order Releases			213,000				244,500		
Item: C.P.M, Level :1, Lead time 3W		Feb'99				Mar'99			
Minimum order Q'ty = ???? Pcs	PD	1W	2W	3W	4W	1W	2W	3W	4W
Gross Requirements		65,945	69,416	74,013	72,474	66,652	71,632	76,320	91,061
Schedule Receipts									
Project On Hand	165,097	139,652	139,236	116,223	127,749	119,597	142,465	147,145	146,084
Net Requirement									
Planned Order Receipts		40,500	69,000	51,000	84,000	58,500	94,500	81,000	90,000
Planned Order Releases			324,000				243,900		
Item: C.P.M, Level :1, Lead time 3W		Apr'99				May'99			
Minimum order Q'ty = ???? Pcs	PD	1W	2W	3W	4W	1W	2W	3W	4W
Gross Requirements		63,082	36,497	22,681	93,417	35,418	74,099	72,359	87,497
Schedule Receipts									
Project On Hand	146,084	165,502	169,505	188,824	174,307	180,889	173,990	172,131	141,034
Net Requirement									
Planned Order Receipts		82,500	40,500	42,000	78,900	42,000	67,200	70,500	56,400
Planned Order Releases			236,100						

Table 3.5. Trial Simulation of MRP System during the Past 8 Months.

Trial simulation of MRP system during the Past 8 Months (Oct'98-May'99)

Item: C.P.M, Level :1, Lead time 3W		Oct'98				Nov'98			
Minimum order Q'ty = 50,000Pcs	PD	1W	2W	3W	4W	1W	2W	3W	4W
Gross Requirements		36,277	38,964	24,635	23,589	40,991	36,984	38,227	44,013
Schedule Receipts									
Project On Hand	100,000	63,723	24,759	124	26,535	35,544	48,560	10,333	16,320
Net Requirement		0	0	0	23,465	14,456	1,440	0	33,680
Planned Order Receipts		0	0	0	50,000	50,000	50,000	0	50,000
Planned Order Releases		50,000	50,000	50,000	0	50,000	50,000	50,000	50,000
Item: C.P.M, Level :1, Lead time 3W		Dec'98				Jan'99			
Minimum order Q'ty = 50,000Pcs	PD	1W	2W	3W	4W	1W	2W	3W	4W
Gross Requirements		41,131	45,238	43,030	60,926	5,167	52,039	57,131	70,161
Schedule Receipts									
Project On Hand	16,320	25,189	29,951	36,921	25,995	20,828	18,789	11,658	41,497
Net Requirement		24,811	20,049	13,079	24,005	0	31,211	38,342	58,503
Planned Order Receipts		50,000	50,000	50,000	50,000	0	50,000	50,000	100,000
Planned Order Releases		50,000	0	50,000	50,000	100,000	50,000	50,000	100,000
Item: C.P.M, Level :1, Lead time 3W		Feb'99				Mar'99			
Minimum order Q'ty = 50,000Pcs	PD	1W	2W	3W	4W	1W	2W	3W	4W
Gross Requirements		65,945	69,416	74,013	72,474	66,652	71,632	76,320	91,061
Schedule Receipts									
Project On Hand	41,497	25,552	6,136	32,123	9,649	42,997	21,365	45,045	3,984
Net Requirement		24,448	43,864	67,877	40,351	57,003	28,635	54,955	46,016
Planned Order Receipts		50,000	50,000	100,000	50,000	100,000	50,000	100,000	50,000
Planned Order Releases		50,000	100,000	50,000	100,000	50,000	100,000	0	50,000
Item: C.P.M, Level :1, Lead time 3W		Apr'99				May'99			
Minimum order Q'ty = 50,000Pcs	PD	1W	2W	3W	4W	1W	2W	3W	4W
Gross Requirements		63,082	36,497	22,681	93,417	35,418	74,099	72,359	87,497
Schedule Receipts									
Project On Hand	3,984	40,902	4,405	31,724	38,307	2,889	28,790	6,431	18,934
Net Requirement		59,098	0	18,276	61,693	0	71,210	43,569	81,066
Planned Order Receipts		100,000	0	50,000	100,000	0	100,000	50,000	100,000
Planned Order Releases		100,000	0	100,000	50,000	100,000	0	0	

Obsolescence refers to inventory, which is no longer desirable owing to customer preferences or design changes.

Deterioration occurs with a product when the shelf life expires, the dates of sales expire, or the product gets spoils. If any of these occur, the product must be discarded; thus expense is incurred.

Shrinkage occurs when the inventory is lost, stolen, or otherwise misplaced.

Storage and handling charges directly relate to the space used to store the inventory and to the personnel time used to track records of inventory, move material, and so forth. Calculating inventory holding costs for a particular operation can be accomplished by obtaining these figures. They represent the total inventory costs, which when divided by the total purchased expenditures will produce an inventory cost percentage.

So that, the total inventory cost can be defined, you can see the formula of the inventory costs as shown below.

Inventory costs = Interest or capital cost + Taxes + Insurance +
Obsolescence + Deterioration + Shrinkage + Storage &
Handling charges.

In this research, Taxes, Insurance, Obsolescence, Deterioration, and Shrinkage are difficult to determine. Therefore, we will discuss only Interest or capital cost and Storage & Handling charges, and we will calculate each costs as follows:

Interest or capital cost can be estimated as 12% per year (compounded 4 monthly). Since our research has been analyzed on a 4 monthly basic,

interest or capital cost should be equal (12 % / 3 months) to 4 % per 4 months.

Storage & handling charges are dependent on each firm's estimation. Fortunately, Toshiba Display Device Thailand hires subcontractor to keep the finished goods and raw materials. The researcher interviewed Material control officer, who is responsible for the warehouse expense. She told the researcher that storage for raw material is equal to 5.5 Baht / 1,200 pieces / Day. In other words, let say 38.5 Baht / 1,200 pieces / Week.

Before, we calculate Inventory holding cost, the researcher would like to review the inventory comparison between the Non-MRP and the MRP systems again, Table 3.6

In Table 3.6, shows the total inventory of the non-MRP system to be 2,018,026 pieces from October 1998 until January 1999 and from February 1999 to May 1999 2,444,333 pieces. The unit price of Convergence Purity Magnet (C.P.M.) is confidential, thus it was assumed to be 13 Baht / piece. Thus, the Inventory cost of the non-MRP system can be calculated by adding Interest or Capital cost and Storage & Handling charges together.

The present worth of the inventory cost of the non-MRP system = the present worth of interest or capital cost + the present worth of storage & handling charges.

The present worth of interest or capital cost of the non MRP system = $(26,234,338 \text{ X } (1/(1+0.04)^1) + (31,776,329 \text{ X } (1/(1+0.04)^2)$

$= 25,214,700.98+29,380,393.79$

$= 54,595,094.77$ Baht (Oct'98-May'99)

Table 3.6. Weekly Inventory Comparison between Non-MRP and MRP.

	Oct'98				Nov'98			
	1 W	2 W	3 W	4 W	1 W	2 W	3 W	4 W
Non-MRP	102,723	74,859	72,724	118,735	127,544	126,260	130,033	120,220
MRP	63,723	24,759	124	26,535	35,544	48,560	10,333	16,320
Difference	39,000	50,100	72,600	92,200	92,000	77,700	119,700	103,900
	Dec'98				Jan'99			
	1 W	2 W	3 W	4 W	1 W	2 W	3 W	4 W
Non-MRP	126,489	115,151	136,021	136,595	158,428	154,389	152,758	165,097
MRP	25,189	29,951	36,921	25,995	20,828	18,789	11,658	41,497
Difference	101,300	85,200	99,100	110,600	137,600	135,600	141,100	123,600
	Feb'99				Mar'99			
	1 W	2 W	3 W	4 W	1 W	2 W	3 W	4 W
Non-MRP	139,652	139,236	116,223	127,749	119,597	142,465	147,145	146,084
MRP	25,552	6,136	32,123	9,649	42,997	21,365	45,045	3,984
Difference	114,100	133,100	84,100	118,100	76,600	121,100	102,100	142,100
	Apr'99				May'99			
	1 W	2 W	3 W	4 W	1 W	2 W	3 W	4 W
Non-MRP	165,502	169,505	188,824	174,307	180,889	173,990	172,131	141,034
MRP	40,902	4,405	31,724	38,307	2,889	28,790	6,431	18,934
Difference	124,600	165,100	157,100	136,000	178,000	145,200	165,700	122,100

	Summary (Oct'98-May'99)				
	1 W	2 W	3 W	4 W	Total
Non-MRP	1,120,824	1,095,855	1,115,859	1,129,821	4,462,359
MRP	257,624	182,755	174,359	181,221	795,959
Difference	863,200	913,100	941,500	948,600	3,666,400

The present worth of storage & handling charges of the non MRP system =

$((2,018,026/1,200) \times (1/(1+0.04)^1) + ((2,444,333/1,200) \times (1/(1+0.04)^2)$

$= 62,252.32+72509.30$

$= 134,761.62$ Baht (Oct'98-May'99)

Thus, present worth of the inventory cost of the non MRP system = 54,595,094.77 + 134,761.62 = 54,729,856.39 Baht (Oct'98-May'99)

In Table3.6, shows that the total inventory of the MRP system from October 1998 until January 1999 was 436,726 pieces and from February 1999 until May 1999 was 359,233 pieces. The unit price of Convergence Purity Magnet (C.P.M.) is confidential, thus it was assumed to be 13 Baht / piece. Thus, the present worth of the inventory cost of the MRP system = The present worth of interest or capital cost + The present worth of storage & handling charges

The present worth of the interest or the capital cost of the MRP system = $(5,677,438 \text{ X } (1/(1+0.04)^1) + (4,670,029 \text{ X } (1/(1+0.04)^2)$

= 5,458,856.64+4,317,908.81

= 9,776,765.45 Baht (Oct'98-May'99)

The present worth of storage & handling charges of the MRP system = $((436,726/1,200) \text{ X } (1/(1+0.04)^1) + ((359,233/1,200) \text{ X } (1/(1+0.04)^2)$

= 349.93+276.79

= 626.72 Baht (Oct'98-May'99)

Thus, the present worth of the inventory cost of MRP system = 9,776,765.45 + 626.72 = 9,777,392.17 Baht (Oct'98-May'99)

Therefore, the present worth of saving inventory cost according to implementation of the non-MRP and the MRP system can be calculated as follows:

The present worth of saving inventory cost = (The present worth of inventory cost of the non MRP system) – (The present worth of inventory cost of the MRP system)

The present worth of saving inventory cost = 54,729,856.39 – 9,777,392.17 = 44,952,464.22Baht / 8 months (Oct'98-May'99)

(2) Inventory Turnover

Inventory turnover is a measure of the velocity at which inventory moves through a particular system. Generally, the higher the turnover, the less inventory one maintains in stock. Inventory turnover can be defined as the annual Baht usage divided by the average Baht in inventory. Other commonly used measures of inventory turnover include sales divided by average inventory and cost of goods sold divided by average inventory.

There are many inventory turnover formulas, commonly accepted measure of the inventory turnover can be defined as follows.

$$\frac{\text{Sales}}{\text{Average inventory}}$$

$$\frac{\text{Cost of goods sold}}{\text{Average inventory}}$$

$$\frac{\text{Annual purchase Baht expenditure}}{\text{Average inventory}}$$

$$\frac{\text{52 weeks per year}}{\text{Turnover}} = \text{Week's supply}$$

First we will find out inventory turnover of Non-MRP system for Oct'98-May'99.

In order to find out 8 months' purchase Baht expense, unit price of Convergence Purity Magnet (C.P.M.) is confidential for revealing, thus it was assumed to be 13 Baht / Piece.

Meanwhile, purchase quantity over 8 months (Oct'98-May'99) for non-MRP system was 1,772,100 pieces (142,200 + 161,700 + 206,700 + 213,000 + 244,509 + 324,000 + 243,900 + 236,100).

And, average inventory over 8 months (Oct'98-May'99) for non-MRP system was 557,794.88 pieces (4,462,359 / 8months).

Thus, the inventory turnover of Non-MRP system for Oct'98-May'99 can be calculated by one of the inventory turnover formulas as shown below:

$$\text{Inventory turnover of Non-MRP} = \frac{\text{Purchase Baht expenditure (Oct-May'99)}}{\text{Average inventory}}$$

$$= \frac{13 \text{ X } 1{,}772{,}100}{557{,}794.88}$$

$$= 41.30 \text{ (Oct'98-May'99)}$$

Next, we will calculate the inventory turnover of MRP system for Oct'98-May'99.

Unit price was still assumed to be 13 Baht / piece, but the purchase quantity over 8 months (Oct'98-May'99) for MRP system was 1,650,000 pieces (50,000 + 50,000 + 50,000 + 50,000 + 50,000 + 50,000 +50,000 +50,000 + 50,000 + 50,000 + 100,000 + 50,000 + 50,000 + 100,000 + 50,000 + 100,000 + 50,000 + 100,000 + 50,000 + 100,000 + 50,000 + 100,000 + 100,000 + 50,000 + 100,000).

And, Average inventory over 8 months (Oct'98-May'99) for MRP system was 99,494.88 pieces (795,959 / 8months).

Thus, the inventory turnover of MRP system for Oct'98-May'99 can be calculated as shown below.

$$\text{Inventory turnover of MRP} = \frac{\text{Purchase Baht expenditure (Oct-May'99)}}{\text{Average inventory}}$$

$$= \frac{13 \text{ X } 1{,}650{,}000}{99{,}494.88}$$

$$= 215.59 \text{ (Oct'98-May'99)}$$

Eventually, comparison inventory turnover of non-MRP and MRP system can be calculated as shown below.

Increasing percentage of inventory turnover between non-MRP and MRP system is 422% approximately.

(3) Economic Order Quantity (EOQ)

Because quantity is a mathematical figure, there have been many attempts to develop a formula for determining the most economical ordering quantity. Besides the basic need, there are many factors to be taken into consideration-unit cost of the item in various lot sizes, the average inventory resulting from purchases in different quantities, the number of orders issued, cost of negotiating and issuing a purchasing order, and cost of carrying materials in inventory.

A number of practical working formulae have been developed, based on known factors. The problem can be worked out to determine the economic ordering quantity. The economic order quantity (EOQ) is essentially the balance point between acquisition (purchase order) costs and

And, Average inventory over 8 months (Oct'98-May'99) for MRP system was 99,494.88 pieces (795,959 / 8months).

Thus, the inventory turnover of MRP system for Oct'98-May'99 can be calculated as shown below.

$$\text{Inventory turnover of MRP} = \frac{\text{Purchase Baht expenditure (Oct-May'99)}}{\text{Average inventory}}$$

$$= \frac{13 \text{ X } 1{,}650{,}000}{99{,}494.88}$$

$$= 215.59 \text{ (Oct'98-May'99)}$$

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Thus, the inventory turnover of MRP system for Oct'98-May'99 can be calculated as shown below.

$$\text{Inventory turnover of MRP} = \frac{\text{Purchase Baht expenditure (Oct-May'99)}}{\text{Average inventory}}$$

$$= \frac{13 \text{ X } 1{,}650{,}000}{99{,}494.88}$$

$$= 215.59 \text{ (Oct'98-May'99)}$$

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A number of practical working formulae have been developed, based on known factors. The problem can be worked out to determine the economic ordering quantity. The economic order quantity (EOQ) is essentially the balance point between acquisition (purchase order) costs and

carrying costs. In other words, carrying costs (holding costs) increase as the quantity of items purchased increases. Meanwhile, the larger the order, the lower the order costs (as fewer orders need to be placed). The balance point represents the point where the sums of the two costs are minimized.

The EOQ formula is represented as follows:

$$EOQ = \sqrt{\frac{2 \times \text{annual usage} \times \text{order cost}}{\text{Unit cost} \times \text{carrying cost}}}$$

Or in abbreviated form,

$$EOQ = \sqrt{\frac{2\,dB}{cI}}$$

Where EOQ = economic ordering quantity

d = annual usage in units.

B = order cost in Baht.

c = unit cost in Baht.

I = carrying cost as a percentage of inventory value.

For more interpretation of the EOQ, as the order quantity increases, the average inventory and the annual cost of the inventory handling increases; but the number of order per year and the ordering cost decrease. It is a bit like a seesaw where one cost can be reduced but only at the expense of increasing the other.

The trick is to find the particular order quantity where the total cost of inventory handling and the cost of ordering will be a minimum. Based on EOQ, we are also able to find out total order cost. Let's determine the

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present worth of total 8 months' costs between the non-MRP and the MRP system.

The present worth of the total 8 months' costs = 8 months' ordering cost + 8 months' inventory handling cost.

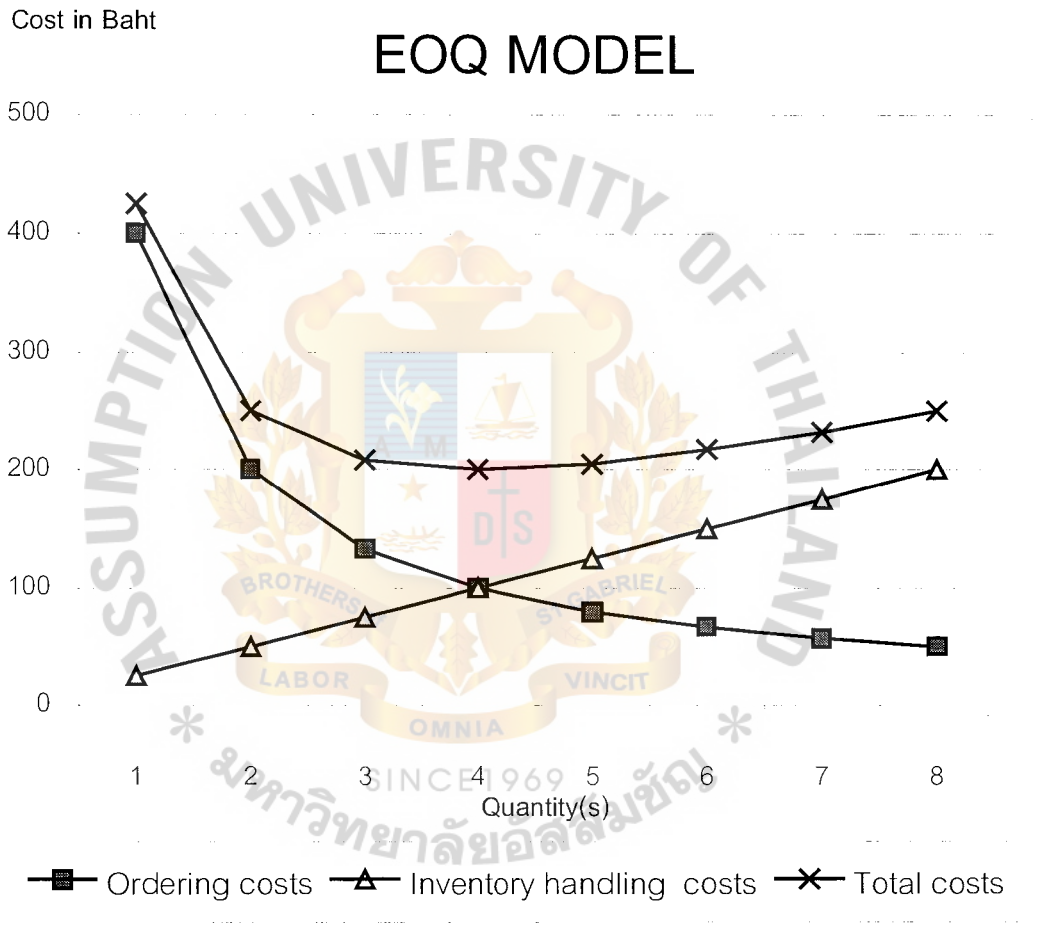

Figure 3.3. Economic Order Quantity.

The present worth of 8 months' ordering cost = (number of orders X costs per order) X $1/(1+r)^n$)

The present worth of 8 months' inventory cost = Interest or capital cost + Storage & Handling charges.

First we should know the costs per order; thus the researcher interviewed the purchasing manager, who is responsible for control purchasing section of Toshiba display Device Thailand (TDDT). It was estimated as 1,500 Baht/order.

So that next step is to find out the number of orders between the non-MRP and the MRP system. Since we have made trial simulation of MRP we could know the number of orders of the non-MRP and the MRP systems. The total number of orders of the non - MRP system from October 1998 until January 1999 was 4, and from February 1999 until May 1999 was 3. The total number of orders of the MRP system was 14, and from February 1999 until May 1999 was 11.

Eventually, we have already calculated the present worth of the inventory costs, which were 54,729,856.39 and 9,777,392.17, the present worth of the inventory costs of the non-MRP system and the present worth of inventory costs of MRP system respectively.

In the following step we will compare the present worth of the total 8 months' costs between non-MRP and MRP system as calculated below:

The present worth of the total 8 months costs of the non-MRP system = $((4 \times 1{,}500) \times 1/(1.04)^1) + ((3 \times 1{,}500) \times 1/(1.04)^2) + (54{,}729{,}856.39)$

= 54,739,786.09 Baht (Oct-May'99)

The present worth of the total 8 months' costs of the MRP system = $((14 \times 1{,}500) \times 1/(1.04)^1) + ((11 \times 1{,}500) \times 1/(1.04)^2) + (9{,}777{,}392.17)$

= 9,812,839.57 Baht (Oct-May'99)

Thus, the present worth of the total 8 months' costs of the non-MRP and the MRP system can be compared as 54,739,786.09 – 9,812,839.57 = 44,926,946.52 Baht (October 1998 - May 1999).

IV. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

Material requirement planning (MRP), it should be remembered, is not simply a method of inventory management but an entire system It requires an enormous amount of planning, highly accurate bills of material, complete and up-to-the minute inventory records, and a precisely realistic master schedule. Lack of any items, MRP would not be achieved. Therefore, it must be coordinated with the organization and operation of several other departments in the company.

This project is aimed to educate how purchase theory improves performance and reduces the cost of organization by studying from site reference at Toshiba Display Device Thailand (TDDT). Furthermore, MRP has been simulated as we have seen whether MRP could be beneficial to the firm. Anyway, let examine the estimated benefits and the simulated results as shown in Table 3.7 below:

Table 4.1. Expected Benefits and Simulative MRP.

Expected benefits from MRP implementation			After MRP implemetation has been simulated (Oct98-May'99)			
No.	Expected benefits from MRP	Results	Non-MRP system	MRP system	Benefits	Results
1	Inventory holding cost	Decreased	54,729,856.39 B.	9,777,392.17 B.	44,952,464.22 B.	Decreased
2	Inventory turnover	Increased	41.30%	215.59%	422%	Increased
3	Total 8 months cost	Decreased	54,739,786.09 B.	9,812,839.57 B.	44,926,946.52 B.	Decreased

Inventory holding costs: it was expected to be decreased. Similarly, simulated result shows that the inventory holding costs of the non-MRP was 156,018.94 Baht. And the inventory holding costs of MRP system was 27,829.38 Baht. The benefits are 128,189.56 Baht as the researcher has expected.

Inventory turnover was expected to increase. Inventory turnover for non-MRP system was 41.30% and 215.59% for MRP system. Inventory turnover has been increased 422 % in accordance with the researcher's expectation.

The total 8 months' cost was predicted to decrease. The non-MRP system was 168,018.94 Baht. On the other hand the MRP system gained 65,329.38 Baht, so we could confirm the researcher's expectation.

4.2 Recommendations

In the current economic situation, competition in business is very crucial. Not only can increase in serviceability towards the customer increase order from customer, but reduction of cost of goods sold is also one of the ways to survive in this situation. This research shows the benefit from simulative operation of the MRP system. Using the MRP systems can clearly reduce the cost of goods. Therefore, the writer hopes every company will realize the importance of the MRP systems.

In order to run the MRP systems smoothly with complexity of bill of material, the computer systems should be implemented for purchasing plan. Moreover, order lead time is one of the most important variables that the purchaser should review with vendors frequently. Especially, purchaser should negotiate to reduce order lead time from vendors as much as possible for the benefit of improving purchasing performance.

Furthermore, the writer realizes that the MRP is one of the best tools that can be advantageous to the firm so the firm should aim to give significance to the MRP system in order to cope with the competitive rivals.

So far, this research has shown the advantages of the MRP system. However, the MRP system has weaknesses as well. The weaknesses of the MRP system are discussed as follows.

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In order to run the MRP systems smoothly with complexity of bill of material, the computer systems should be implemented for purchasing plan. Moreover, order lead time is one of the most important variables that the purchaser should review with vendors frequently. Especially, purchaser should negotiate to reduce order lead time from vendors as much as possible for the benefit of improving purchasing performance.

Furthermore, the writer realizes that the MRP is one of the best tools that can be advantageous to the firm so the firm should aim to give significance to the MRP system in order to cope with the competitive rivals.

So far, this research has shown the advantages of the MRP system. However, the MRP system has weaknesses as well. The weaknesses of the MRP system are discussed as follows.

MRP has been a remarkably powerful and pervasive tool in industry. It should be clear that firms, facing chaos because of the complexity of bills of materials, can benefit tremendously from the control and order provided by MRP. When demand exhibits significant seasonality, or when demand can surge or decline, MRP' s ability to plan ahead provides clear benefits, Successful implementations of MRP are seen in thousands of manufacturing firms. Nevertheless, MRP has some significant drawbacks that should be mentioned. We highlight the primary weaknesses as shown below.

(a) Lead Times

For the purposes of lead-time offsetting, the MRP system is given a lead-time by the user for each component and part. MRP takes this lead-time to be deterministic. The lead-time is an attribute of the part, rather than of the condition of the shop. We know that the lead-time for, say wheels will certainly not always be one week, but will vary depending on how busy the people and machines are at the department. If multiple parts are required by that department, or if the batch size is unusually large, the lead-time will be longer than one week. If the department is not busy, or the batch size is small, the lead-time will be shorter than one week. How do users adjust to variable lead times? Clearly, the most common solution is to inflate the lead-time given to MRP so that orders are rarely delivered late. This implies, of course, that orders are most often delivered early, which increases work in process and finished goods inventory.

(b) Lot Sizes

Multi-item and multilevel lot sizing is an extremely difficult problem for which optimal solutions are typically not available. Therefore, users must rely on heuristics that may not apply to their situations. In an informal

survey of MRP vendors, we discovered that most MRP systems do not provide extensive support to any lot-sizing rules other than EOQ. Even if the support is available, most users seem to rely on simple rules that may generate higher cost than is possible by pursuing other rules.

(c) Safety Stock

MRP systems, again, do not typically support safety stock. In fact, the user is required to input the desired safety stock values for each item and component at each stage of production. Because there is little known about appropriate levels of safety stock at the component level, users must guess at good values. As in the case of lead times, users may protect against costly stockouts by unnecessarily inflating safety stock levels.

(d) Incentives for Improvement

One of the weaknesses of MRP is directly related to the previous three. Because of the significant effort required to gather and input data such as safety stock levels, lot sizes and lead times, people are reluctant to make regular changes to these values. In fact, as MRP is being installed, it is often desirable to inflate all these values to avoid startup problems. The pitfall arises when MRP is running smoothly, and the firm has gained control over its schedules. There is now little incentive for digging into the system to change values that are working well. The fact that these values reside on a computer only aggravates the problem because people often assume that the numbers given by a computer must be correct.

(e) Data

Data consistency is a common problem with MRP. Many firms do not have closes: warehouses, so that nearly any employee can remove

components. The inventory levels recorded on the computer did not match the actual levels in the facility. If the data are not accurate, MRP' s schedules will be of questionable value. Of course, this issue has often been cited as a major benefit of MRP because the firm must take control of inventories, schedules, and data accuracy.

(f) Design Changes

Often a new product is changed in small ways once it is in production. Unfortunately, most design changes must be accounted for in the MRP system. This is an added burden but if neglected, the MRP system will be inaccurate.

(g) Data Input

Every change that must be recorded in MRP, and every new product that must be added to the system, put a load on data input personnel. In fact, shop floor workers frequently neglected to input data to the MRP system, creating high levels of frustration in the department responsible for maintaining the system.

(h) Data Output

MRP can generate reams of paper when printing reports. Handling the large amounts of data can be a significant task.

(i) Completed Work

MRP does not recognize completed work until an inventory transaction is made. If a customer cancels an order, it is possible that finished units will be available, but will not appear in the system. Along the same lines, when a large batch is partially completed, some units may be

available to satisfy some customers' needs. Left alone, MRP does not recognize this availability.

(j) Implementation

Implementing closed loop MRP is a complex task that requires political savvy and technical expertise. The results, and the process itself, can be beneficial, but you should not ignore the difficulties of the implementation process.

(k) Where MRP applies

Too often, consultants and software developers sell a system that is not applicable to their client's production process. MRP has certainly fallen into this trap.

APPENDIX A

VENDOR LEAD TIME SURVEY

VENDOR LEAD TIME SURVEY

SURVEY NO:..... DATE:.....

VENDOR NAME:.....
ADDRESS:.....
.....

VENDOR'S SIGNATURE & TITLE

DESCRIPTION OF VENDOR'S PRODUCT:.....
TYPE NAME:.....
MINIMIUM ORDER Q'TY:.....PC(S)

SURVEYOR'S SIGNATURE & TITLE

VENDOR MATERIAL PROCUREMENT LEAD TIME

NO.	LIST OF MATEIALS	MATERIALS MAKERS		TYPE OF MATERIALS		LEAD TIME(W)
		NAME	PLACE	COMMON	SPECIAL	
1						
2						
3						
4						
5						

(A) VENDOR MATERIAL PROCUREMENT LEAD TIME IS PICKED OUT- → _____ WEEK(S)
FROM LONGEST LEAD TIME OF SPECIAL MATERIALS.

MANUFACTURING LEAD TIME

NO.	DESCRIPTION OF PROCESS	EXPLANATION OF PROCESS	LEAD TIME(W)
1			
2			
3			
4			
5			

(B) TOTAL MANUFACTURING LEAD TIME IS CALCULATED FROM - → _____ WEEK(S)
FIRST PROCESS UNTIL FINAL PROCESS.

TRANSPORATION LEAD TIME FROM VENDOR TO CUSTOMER(US).

NO.	TRANSPORTATION METHODS	LEAD TIME(W)
1		
2		

(C) TRANSPORATION LEAD TIME IS CALCULATED FROM → _____ WEEK(S)
FIRST TRANSPORTATION METHODS TO CUSTOMER(US).

#RESULT#

TOTAL ORDER LEAD TIME IS EQUAL (A) + (B) + (C) = ... WEEK(S)

Figure A.1. Vendor Lead Time Survey.

APPENDIX B

REQUISITION FOR MASTER PRODUCTION SCHEDULE OF CRT TUBE

Requisition for Master production schedule of CRT Tube

To: Production control section

Fr: Mr.Ruksak Chotimongkulsub

This requested Master production schedule of CRT Tube for partial fulfillment of the requirements for the degree; Master of science in computer and engineering management only, with which the researcher would be glad if you can fill out Master production schedule of CRT Tube as shown in the following blanks.

	Master production schedule of CRT Tube; PC(S)				
	1st week	2nd week	3rd week	4th week	Total
Oct'98					
Nov'98					
Dec'98					
Jan'99					
Feb'99					
Mar'99					
Apr'99					
May'99					

Thank you very much for your cooperation.

Best regards,

Mr.Ruksak Chotimongkulsub

Figure B.1. Requisition for Master Production Schedule of CRT Tube.

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