AN INVENTORY SYSTEM OF FUJI SUPERMARKET

by

Ms. Suttinee Poonphiphatana

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	An Inventory System of Fuji Supermarket
Name	Ms. Suttinee Poonphiphatana
Project Advisor	Dr. Chamnong Jungthirapanich
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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.

Approval Committee:

(Dr. Chamnong Jungthirapanich)
Dean and Advisor

(Prof.Dr. Srisakdi Charmonman)
Chairman

(Assoc.Prof. Somchai Thayarnyong)
MUA Representative

November 2001

ABSTRACT

This project aims at studying and analyzing system, to provide information of an existing system which includes problem and also proposed the system, comparison between existing system and proposed system of Fuji Supermarket.

The inventory system is one of the important parts of overall management. And it is one of the several ways to help organization increase the profit in term of cost reduction of inventory system. In the literature review part is to provide the information and knowledge of the inventory system in theory and also the concept of the inventory system, which can be supported in the project.

The information derived from the interview showed the existing system of Fuji Supermarket, the problem and also the SWOT Analysis. Fuji still has the unnecessary cost which can be reduced such as ordering cost and operation cost.

Fuji can use the computer technology to support and develop the inventory system, The proposed system for Fuji is Electronic Data Interchange (EDI) program, which can be replaced from the existing system. EDI is the worldwide system which many organizations have used and developed. The proposed system can help the organization reduce the order cost and operation cost as well. Fuji will gain the competitive advantages in term of financial concerns and improve services to the customer.

For the evaluation, the comparison between the old and proposed system has been shown. Fuji can measure the benefit of the proposed system by using the total annual cost (TAC) for calculation.

Even the changing to new system will create cost and time consumption but it is worth for investment in the long term. For the feather study , Fuji can the research and development to implement another system and also Fuji can measure the benefit by using the Inventory of Return for calculation.

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I am indebted to the following people and organizations. Without them, this project would not have been possible.

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Special appreciation is due to my family for their fervent and continuous encouragement. Above all, I am forever grateful to my parents whose willingness to invest in my future has enabled me to achieve my educational goal. And also Ms. Sakaorat Narasontipong and Ms. Vipaporn Prompruk, my special friends, who are my hidden drives, pushing me up to this position to obtain my master's degree.

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I. INTRODUCTION

1.1 Background

Due to the economic crisis few years ago, the only way to help businesses survive is cost reduction. Most organizations have to judge and pay attention to obtaining lower operations costs. Also, with the globalization of business in recent years, customer satisfaction has become a top priority. Businesses that are able to respond quickly, reliably and conveniently have more competitive advantages.

As a result, the effectiveness and efficiency of inventory management systems is one of several ways to help businesses reduce unnecessary costs that are within operation systems. Furthermore, it also helps organizations serve the fluctuating demand of customers.

Presently, the strategies of inventory management have become a critical path to achieving a successful business model and they play an important role in the organization. Also, optimizing workflow in the firm is important in warehousing or inventory for the organization's operations. All activities of an organization have to be concerned with workflow optimization.

Therefore, studying and developing an inventory management system are important for helping an organization achieve the long-term goals and benefit from competitive advantages such as cost savings and customer satisfaction. Moreover, it can help organizations avoid errors of material handling which create additional costs.

Fuji Supermarket is a Japanese style supermarket. The Fuji Supermarket is one of the supermarkets in Thailand, which offers all kinds of Japanese food products and baked goods to customers. The Fuji Supermarket located on Sukhumvit Road, is one of the most successful supermarkets in Bangkok area.

For achieving effectiveness and efficiency in inventory management, many businesses focus on and study the effectiveness of the successful systems of the Japanese. As a result, the successful inventory management of Fuji Supermarket, which is Japanese firm, is studied and analyzed by many.

In this project, I would like to study and analyze the inventory management system of Fuji Supermarket and to provide information on the success of the system in every product line. Also, I will analyze the tools that help the organization achieve effectiveness and efficiency in inventory management such as how they can utilize the resource by using the inventory management. Lastly, I will study the approaches that they use with the foreign suppliers and the problems that occur and how they are responsible for integrating the activities of all the departments within the organization.

1.2 Objectives

The objectives of analyzing the inventory system of Fuji Supermarket are as following:

(1) To gather information about the successful inventory management and distribution systems of a Japanese enterprise.

(2) To study and analyze the inventory system and distribution in the real business world.

(3) To implement the tools for a successful inventory management and distribution system.

(4) To study and analyze the problems of the inventory system.

1.3 Scope

This project is aimed to study the strategy of inventory management and distribution of Fuji Supermarket on Sukhumvit Road. The Steps involved in achieving effectiveness and efficiency will include gathering the information about the problem,

recognizing the problem and implementing the tools necessary to solve the problem in order to succeed in inventory management control and distribution. The information will be collected from both primary sources and secondary sources.

II. LITERATURE REVIEW

It is virtually impossible to find an organization that does not either use, transform, distribute, or sell materials of one kind or another. Business inventory is spread profusely throughout the economy, predominately in manufacturing, wholesaling, and retailing organization.

The effective management of materials is crucial to the performance of many organizations. It can have serious implications for the finance, production, and marketing functions of any organization. Finance is influenced through liquidity and return on investment, production through efficiency and cost of production, and marketing through sales and customer relations. Materials were thought of as cheap, readily available, and infinitely plentiful. The realties of the marketplace have changed this point of view and have added materials management to the list of major organizational functions.

When the quantity and complexity of inputs increase and when any excess inputs might never be needed, difficulties can occur and more materials management skills are required. For manufacturing organizations today, materials cost usually are the largest single expenditure. The average manufacturing firm spends over half of its sales revenue on purchased parts, components, raw materials and services (Silver, Pyke and Peterson 1998)

As we know while the merchandise is in storage we're not making any money on it, but simply paying for the cost of inventory. The effectiveness and efficiency of inventory management systems is one of several ways to help businesses or organization reduce unnecessary cost and cut the cost within the operation systems. The systems concept makes it possible to increase stock turnover.

In all organization the operation system has plays important role, which are interrelated in the overall department. If the costs of operation system in one department increase, the costs of the other will definitely increase. It will effect each other like a circle. Since the most reliable yardstick of effectiveness in industrial enterprises is the cost and profitability of operations, you have to cut through the verbiage and data when examining statistical reports in order to focus your attention on the areas that are really causing problems.

Materials Management has a tremendous influence on the ultimate cost of a product, because it handles the total flow of materials in an organization. The total flow can extend from suppliers to production and subsequently through distribution centers to customers. Encompassed in the management of the material flow is the responsibility for the planning, acquisition, storage, movement and control of materials and final products. The emphasis is primarily on planning and controlling the flow (Shafer 1997).

2.1 Inventory

We should start our discussion of inventory control by defining some of the terms used (Tersine 1994).

(1) Stock consists of all the goods and materials stored by an organization. It is a supply of items, which is kept for future use.

(2) Inventory is a list of the items held in stock

(3) An item is a single type of product which is kept in stock: it is one entry in the inventory

Now we have defined the basic terms of inventory control, we can see how these are related to actual operation. Typically, stocks are held at an intermediate point between suppliers and customers. Inventories are common to farms, manufacturing, wholesalers, retailers, hospitals, churches, prisons, local governments and etc. Indeed,

inventories are also relevant to the family unit to relation to food, clothing, medicine, toiletries, and so forth. The term inventory can be used to mean several different things, such as;

(1) The stock on hand of materials at a given time

(2) An itemized list of all physical asset

(3) To determine the quantity of items on hand

(4) The value of the stock of goods owned by organization at particular time

2.2 Reasons for Holding Stock

Every organization holds stock of some kind. These stocks will clearly have associated costs to cover tied-up capital, warehouse operations, deterioration, and so on. And obvious question, then, is "Why do organizations hold stock". These are several answers to this, but the dominant one is to allow a buffer between supply and demand.

We can demonstrate this by considering the stock of bread at a bakery. If bakery knew exactly when demands would occur, they could bake bread exactly as it is needed. This would eliminate stock, and have the advantages that every customer would have fresh bread and no bread would go stale and be wasted. Similar situations arise in many different circumstances. Consider for example two stock stations in an assembly line. If the output from the first work station is transferred immediately it is finished to start on the second work station, there are on stocks of work in progress. If, however, there is any delay before starting on the second, or if several units are transferred between work stations at the same time, there are effectively stocks of work in progress.

The main purpose of stocks is to act as a buffer between supply and demand. They allow operations to continue smoothly when the supply rate does not exactly match the demand rate and they allow a buffer against uncertainty in demand (Water 1999). We could also argue that there is inevitably some uncertainty supply caused by delays to

delivery vehicles, breakdown of equipment, disruptions to supplier's production and so on. Thus, stocks give a buffer between variable and uncertain supply and variable and uncertain demand. A fuller list of reasons for holding stock includes such as to allow for mismatches between supply and demand rates, to allow for deliveries which are delayed or too small, to take advantages of price discounts on large orders, to provide cover for emergencies and so on.

2.3 Types of Inventory

Inventory may consist of supplies, raw materials, in-process goods, and finished goods. Supplies are inventory items consumed in the normal functioning of an organization that are not a part of the final product. Raw materials are item purchased from suppliers to be used as inputs into the production process. They will be modified or transformed into finished goods. In-process goods are partially completed final products that are still in the production process. They represent both the accumulation of partially completed work and the queue of material awaiting further processing. Finished goods are the final products, available for sales, distribution, or storage. The customer for finished goods inventory may be the ultimate consumer, a retail organization, a wholesale distributor, or another manufacturer. Figure 2.1 indicates the types of inventory.

2.4 Functions of Inventory

Inventory exists because supply and demand are difficult to synchronize perfectly and it takes time to perform material-related operations. For several reasons, supply and demand frequently differ in the rates at which they respectively provide and require stock. These reasons can best be explained by four functional factors of inventory – time, discontinuity, uncertainty, and economy.

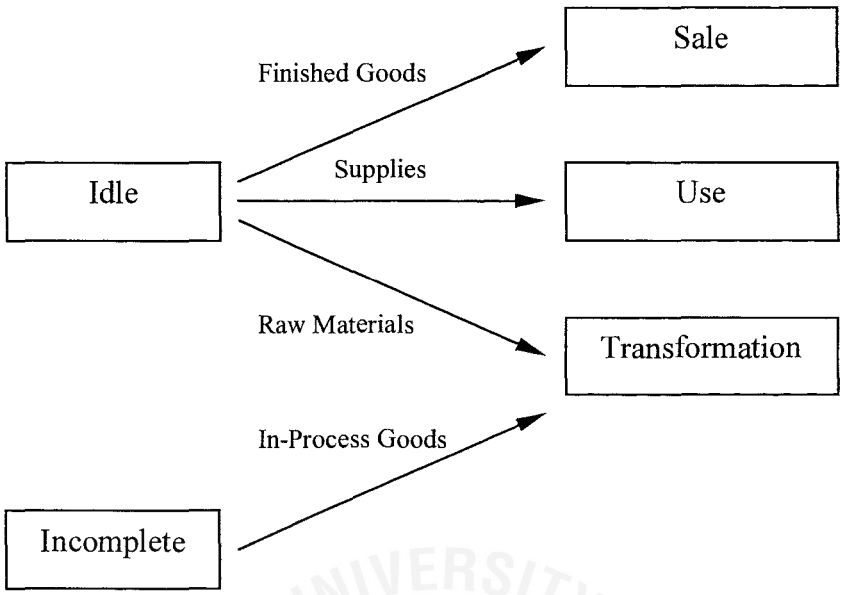

Figure 2.1. Types of Inventory (Tersine 1994).

The time factor involves the long process of production and distribution required before goods reach the final consumer. Time is required to develop the production schedule, cut raw material requisitions, ship raw materials from suppliers, inspect raw materials, produce the product, and ship the product to the wholesaler or consumer. Few consumers would be willing to wait for such an extended period of time on all their purchases. Inventory enables an organization to reduce the lead-time in meeting demand. Profitability can be enhanced by a reputation of having products available immediately or within a reasonable time.

The discontinuity factor allows the treatment of various dependent operations (retailing, distributing, warehousing, manufacturing, and purchasing in an independent and economical manner). Inventories make it unnecessary to gear production directly to consumption or to force consumption to adapt to the necessities of production. Inventories free one stage in the supply-production-distribution process from the next,

permitting each to operate more economically. Raw material inventory isolates he suppliers from the user, in-process inventory isolates production departments from each other, and finished goods inventory isolates the customer from the producer. The discontinuity factor permits the firm to schedule many operations at a more desirable performance level than if they were integrated dependently.

The uncertainty factor concerns unforeseen events that modify the original plans of the organization. It includes errors in demand estimates, variable production yields, equipment breakdowns, strikes, shipping delays and unusual weather conditions. When inventory is available, the organization has some protection from unanticipated or unplanned occurrences (Walter 1999).

The economy factor permits the organization to take advantage of cost reducing alternatives. It enables the organization to purchase or produce items in economic quantities. Bulk purchases with quantity discounts can reduce cost significantly. Per unit costs can be excessive if items are ordered separately without regard to transportation and lot size economics. Price hedging against impending material cost increases; many also favor large quantity purchases. Inventories can be used to smooth production and stabilize manpower levels in undulating and seasonal businesses.

Another way to explain the purposes inventory serves is by introducing functional classifications of inventory. Based on its utility, all inventories can be placed in one or more of the following categories: (Silver, Pyke and Peterson 1998)

Working Stock also known as cycle or lot size stock is inventory acquired and held in advance of requirements so that ordering can be done on a lot size rather than on an as needed basis. Lot sizing is done in order to minimize ordering and holding costs, achieve quantity discounts or qualify for favorable freight rates. In general, the average

amount of inventory on hand that result from lot sizes constitute an organization's working stock.

Safety Stock is inventory held in reserve to protect against the uncertainties of supply and demand. Safety Stock averages out to the amount of stock held during a replenishment cycle as a protection against stock outs.

Anticipation Stock also known as seasonal or stabilization stock is inventory built up to cope with peak seasonal demand, erratic requirements, such as promotional programs, strikes or vacation shutdown, or deficiencies in production capacity. It is supplied or produced in advance of requirements and depleted during peak demand periods to keep production rates level and stabilize the work force.

Pipeline Stock often referred to as transit stock or work in process is inventory put in transit to allow for the time it takes to receive material at the input end, send material through the production process, and deliver goods at the output end. Externally, pipeline stock is inventory on trucks, ships, and railcars or in literal pipeline. Internally, it is being processed, waiting to be processed, or being moved.

Decoupling Stock is inventory accumulated between dependent activities or stages to reduce the requirement for completely synchronized operations. It isolates one part of the system from the next to allow each to operate more independently. Thus, it acts as lubrication for the supply-production-distribution system that protects it against excessive friction.

Psychic Stock is retail display inventory carried to stimulate demand and act as a silent salesperson. It increases the chance an item is seen and considered for purchase. Full shelves increase sales by exposing customers to as much stock as possible and creating greater product visibility. Understocked shelves as well as stockouts can lead to lost sales and lost customer. While other stock categories support low cost operations,

psychic stock is a revenue generating category. It is concerned with revenue generation via demand creation versus cost minimization, which is supply oriented.

Inventory is a necessary part of doing business. While functional factors and functional classifications explain the existence of inventory, this does not mean that attempts at its reduction should not be pursued. Inventory can hide operational problems or make problems easier to live with. It is more desirable to eliminate problems than to cover them up with excess inventory. A wise strategy is to attempt to reduce inventory by minimizing or eliminating operational encumbrances, which dictate its existence.

2.5 Organization Categories

Different types of organization have different inventory management requirements. By classifing organizations as retail, wholesale and distribution, and manufacturing, the extent of inventory problems can generally delineate. In traversing from retails systems to wholesale and distribution systems to manufacturing systems, the problems of inventory increase in magnitude and complexity. Table 2.1 indicates the organizational category and the types of inventory encountered in each.

Retails systems are organizations that provide the ultimate consumer with goods and services. Inventory is purchased in a salable form and is usable without further processing or conversion. The systems that provide physical products obtain them from wholesalers or directly from factories for example store, which sell groceries, clothing, hardware and varieties of consumer products in departmentalized facilities. They have problem associated with supplies and finished goods. Retail systems that provide services to consumers experience only a supplies inventory problem. Typical organizations in this category are hospitals, financial institutions, universities and penal institutions.

Wholesale and distribution systems comprise organizations that purchase large quantities of manufactured goods for distribution to retail systems. These organizations do not usually provide goods to the ultimate consumers, but dispense their bulk purchases to retailers in smaller quantities. Therefore, wholesale and distribution systems have inventory problems confined to supplies and finished goods.

Table 2.1. The Organizational Category and the Types of Inventory Encountered (Tersine 1994).

	Type of Inventory			
	Supplies	Raw Material	In-Process Goods	Finished Goods
A. Retail system:				
1. Sale of goods	Yes			Yes
2. Sale of services	Yes			
B. Wholes distribution systems	Yes			Yes
C. Manufacturing system:				
1. Special project	Yes	Yes	Yes	
2. Intermittent process	Yes	Yes	Yes	
3. Continuous process	Yes	Yes	Yes	Yes
a. Process industries				
b. Repetitive Manufacturing				

Manufacturing systems comprise organizations that purchase raw materials and change their form to create a finished product. These systems have the most difficult and complex inventory problems. Manufacturing systems can be subdivided into special project, intermittent process, and continuous process.

Special projects are limited life, one-time events such as bridges, space satellites, and sports stadiums. Special projects usually have explicit statements of the project's goal or number of end items. Since only a specified number of the end items are produced, no additional finished goods inventory is maintained. From the number of end items the precise requirement for raw materials is obtained, and the production capability is established according to contract specifications. When the project is

completed, the project organization is either disbanded or assigned to another special project.

Intermittent processes are used for low-volume, batch, or customized production where many different products must share the capacity are grouped together into separate work stations or departments. Control of the flow of work is managed through individual work orders for each batch. General-purpose equipment is used, and skilled labor is required to perform the variety of operations required on numerous different products. Intermittent processes are flexible, but the jumbled pattern of workflow requires an elaborate planning and control system.

Continuous processes are used for high volume production of a limited number of products, typified by mass production assembly lines. The facility is designed and dedicated exclusively to its products. Each workstation is located in the sequence needed to make the products. The two types of continuous processes are process industries and repetitive manufacture. Process industry deals with fluid gases, powders, and processes involving either the chemical reactivity or blending of ingredients. Typical process industry products include oil, beer, detergents, sulfuric acid, and paper. Repetitive manufacturing deals with discrete units of output such as automobiles, televisions, refrigerators and ovens.

2.6 Inventory Problem Classifications

Inventory problems can be classified in many ways. They can be organized according to the repetitiveness of the inventory decision, the source of supply, the knowledge of demand, the knowledge of the lead-time, and the type of inventory system. The following are the inventory problem classifications:

Repetitiveness of the inventory decision refers to the frequency of orders. A single order is placed once and is not repeated, at any rate regularly. Examples of single orders

are the acquisitions of materials for the construction of an apartment building, cut trees for the Christmas season. A repeat order is placed again and again as determined by routine guidelines. Stock or units that are repetitively consumed are replenished or restocked on a recurring basis. Most of the items in supermarkets and department stores are restocked through repeat orders (Krajewski, Ritzman 1999).

The classification by the supply source is twofold: outside supply and inside supply. When an item is inside supplied, the company produces the item. In essence one part of the company orders from another part of the company, and work orders are utilized to obtain items in this manner. The issuance of internal work orders compounds the inventory problem with production scheduling problems. When the supply source is outside, items are obtained from approved supplier. Purchase orders are sent to external sources for items manufactured outside the organization.

Another inventory classification pertains to the knowledge of demand. The most common assumption about the demand distribution is that the demand is constant overtime. The demand can also follow some empirical distribution over time that is not of a standard type, or some specified distribution such as the normal, Poisson or exponential.

An additional subdivision of knowledge of demand includes independent and dependent demand. Independence means no relationship exists between the demand for an item and for any other item. In contrast, dependence means the demand for an item directly related to or the result of demand for a higher level item. End items and products are characteristically independent, while the demand for dependent items originates elsewhere, it can simply be derived or calculated from the demand for the item of which it becomes a part. Once an organization determines how many independent demand products it will make, it can calculate fairly accurately the number

of dependent items it needs. The demand for independent items is less deterministic and generally must be obtained by forecasting. Inventory problems can also be subdivided according to knowledge of lead-time. Lead-time is considered either constant or variable. If the lead-time is variable, its distribution may be determined empirically or specified.

Finally, inventory problems can be classified according to the type of inventory system. There are many varieties of systems; some of the most common are the perpetual, periodic, material requirements planning, distribution requirements planning, and single order quantity inventory systems. The perpetual inventory system orders stock every time the inventory position reaches a reorder point, so records must be maintained all inventory transactions. The perpetual updating of the recordings to reveal inventory status and historical performance is what gives the system its name. The periodic inventory system orders stock on a time cycle. The state of the system is examined only at discrete points in time, and decisions on stock replenishment are only made at these intervals. The material requirements planning system orders stock only to meet preplanned production requirements. Its mechanisms plan dependent demand requirements for end item production schedules in a time-phased format. The distribution requirements planning system orders stock to meet distribution center requirements in multi-networks. The single order quantity system orders stock to meet unique or short-lived requirement.

To help solve the problems of inventory, it is necessary to build models that describe the inventory situation. Since it is never possible to represent the real world with total accuracy, approximations and simplifications must be made during the model-building process.

2.7 Approaches to Inventory Control

There are two fundamentally different approaches, which are based on the methods of assessing demand (Tersine 1994).

Independent Demand Systems: These assume that the demand for an item is independent of the demand for any other item. Then the aggregate demand for an item is made up of many independent demands of separate customers. In these circumstances the only reasonable approach to forecasting aggregate future demand is to project historic trends. Inventory control is then based on quantitative models that relate demand and other variables, to find optimal values for order quantities, timing of orders and so on. Independent demand models can use either fixed order quantities or periodic review. Fixed order quantity systems place an order of fixed size whenever stock falls to a certain level. Periodic review systems place orders of varying size at regular intervals to raise the stock level to a specified value, supermarket shelves for example.

Dependent Demand System: These assume the demand for an item is directly related to the demand for other items. This is particularly clear when the demand for materials is related to the demand for finished products. Dependent demand systems generally use production plans to forecast demand for each item and then order enough units to satisfy this known demand. These methods are formalized into approaches such as material requirement planning and Just-in-time. This type of system is most useful for controlling the stocks of materials needed to support manufacturing.

2.8 Inventory Cost

The objective of inventory management is to have the appropriate amounts of materials in the right place, at the right time, and at low cost. Inventory costs are associated with the operation of an inventory system and result from action or lack of action on the part of management in establishing the system. They are the basic

economic parameters to any inventory decision model, and the more relevant ones to most systems are itemized as follows:

The purchase cost of an item is the units purchase price if it is obtained from an external source, or the unit production cost if it is produced internally. The unit cost should always be taken as the cost of the item as it is placed in inventory. For purchased items, it is the purchase price plus any freight cost. For manufactured items, the unit cost includes direct labor, direct material and factory overhead. The purchase cost is modified for different quantity levels when a supplier offers quantity discounts.

The order or setup cost originates from the expense of issuing a purchase order to an outside supplier or from internal production setup costs. This cost is usually assumed to vary directly with the number of orders or setups placed and not at all with the size of the order. The order cost includes such item as making requisitions, analyzing vendor, writing purchase orders, receiving materials, following up orders and doing the processing necessary to complete the transaction. The setup cost comprises the costs of changing over the production process to produce the ordered item. It usually includes preparing to shop order, scheduling the work, preproduction setup, expediting, and quality acceptance.

The holding cost or carrying cost the costs associated with investing in inventory and maintaining the physical investment in storage. It incorporates such items as capital costs, taxes, insurance, handling, storage, shrinkage, obsolescence, and deterioration. Capital cost reflects lost earning power or opportunity cost. If the funds were invested elsewhere, a return on the investment would be expected. Capital cost is a charge that accounts for this unreceived return. Insurance coverage requirements are dependent on the amount to be replaced if property is destroyed. Obsolescence is the risk that an item will lose value because of shifts in styles or consumer preference. Shrinkage is the

decrease in inventory quantities over time from loss or theft. Deterioration means a change in properties due to age or environmental degradation. The usual simplifying assumption made in inventory management is that holding costs are proportional to the size of the inventory investment. In line with this assumption is the practice of establishing the holding cost of inventory items as a percentage of their money value.

The Stockout cost is the economic consequence of an external or an internal shortage. An external shortage occurs when a customer's order is not filled; an internal shortage occurs when an order of a group or department within the organization is not filled. External shortages can incur backorder costs, present profit loss and future profit loss. Internal shortages can result in lost production and a delay in a completions date. If demand occurs for an item out of stock, the economic loss depends on whether the shortage is backordered, satisfied by substitution of another item, or canceled. The quantification of these costs has long been a difficult ad unsatisfactorily resolved issue. For this reason, many organizations avoid the estimating problem by specifying customer service levels.

An objective of inventory management is the minimization of costs. Only those costs that change as the level of inventory changes should be considered in any analysis (Walter 1999).

2.9 Forecasting Demand

2.9.1 Background to Forecasting

In modern organizational settings, looking into the future is done not just for the sake of discovery, to forebode good and evil, or to amuse the curious, but for the purpose of intelligent preparation for what it portends. Corporate planners are interested in the timing, magnitude, and effects of future events that influence their operations. For them, forecasting is the window into the future.

Forecasting is the prediction, projection, or estimation of the occurrences of uncertain future events or levels of activity. Since the future rarely is certain, some system of forecasting, implicit or explicit is necessary. Forecasting offers an organization some foresight in the premeditation of appropriate courses of action. Its purpose is to make use of the best available present information to guide future activities toward organizational goals. This function is particularly important in the allocation and use of resources. Although forecasts are never perfect, partial knowledge is better than no knowledge. While organizations cannot foresee the future exactly, they desire strong inferences about it when committing large amounts of time and resources.

Forecasting is used to predict changeable circumstances so that planning can take place to meet coming conditions. It can be used to predict revenues, costs, profits, prices, rainfall, technological changes, and a host of other variables. In organizational environments, forecasting most often pertains to predicting, or estimating future demand. (Silver, Pake and Peterson 1998)

Most organizations are not in a position to wait until orders are received before they begin to plan production facilities and processes, acquire equipment, establish manpower levels and determine materials requirements. Few consumers would be willing to wait over such a time horizon. Most successful information into factor inputs required to satisfy expected demand. For a business to survive, it must meet its customers' needs at least as quickly as its competitors do. The better management is able to estimate the future, the better it should be able to prepare for it.

Many environmental factors influence the demand for an organization's products and service. It is never possible to identify all of the factors of to measure their probable effects. It is necessary in forecasting to identify the broad, major influences and attempt to predict their direction. Some major environment factors are General business

conditions and state of economy, competitor actions and reactions, governmental legislative actions, marketplace trends- i.e. Style, fashion, product life cycles- and technology innovations.

Given the broad spectrum of influences, many types of forecasting are used in organizations. Master forecasting, as illustrated in Figure 2.2, indicates the major decision categories, While not all organizations have the same forecasting needs, all of them have forecasting requirements. Functional forecasting, as shown in Figure 2.3, illustrates its influences on each business function. Thus, there are many plans and decisions and many different types of forecasting requirements.

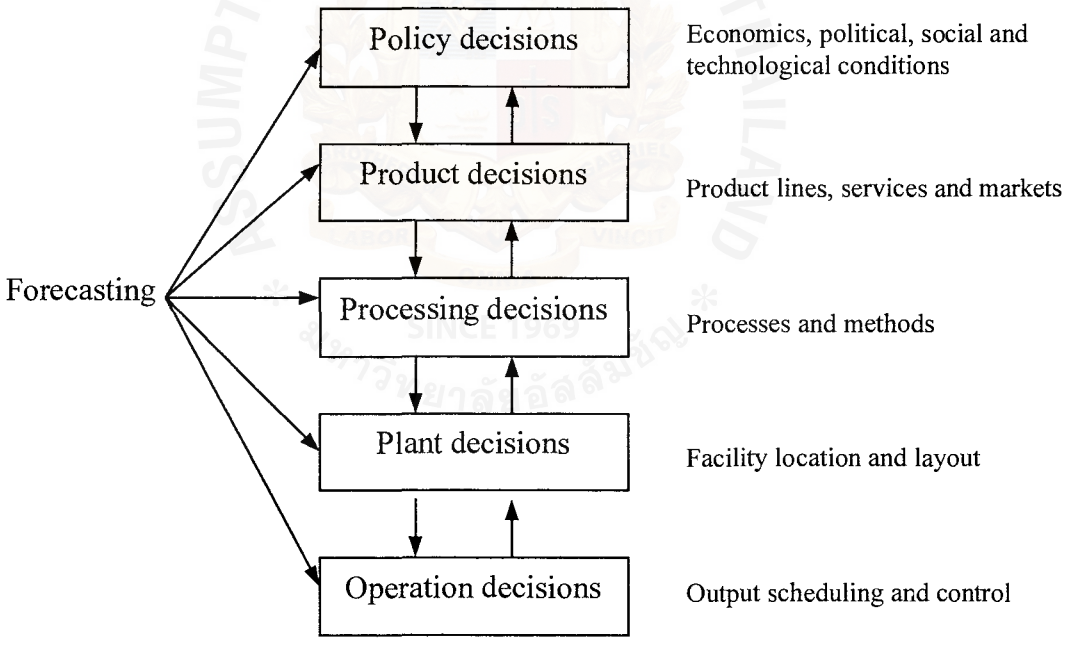

Figure 2.2. Master Forecasting (Tersine 1994).

Just as the various plans may require different types of forecasting, they also may require different forecasting bases. Revenue, physical units, cost of goods manufactured, direct labor hours, machine hours, weight, volume, and number of

customers are common ones. Almost all organizations forecast revenues. Manufacturers typically select additional forecast bases, which are more specifically to their production processes. In addition to dollars of revenue, service organizations generally forecast on the basis of the number of customers. The selection of one or more forecasting bases is dependent upon the planning which must take place.

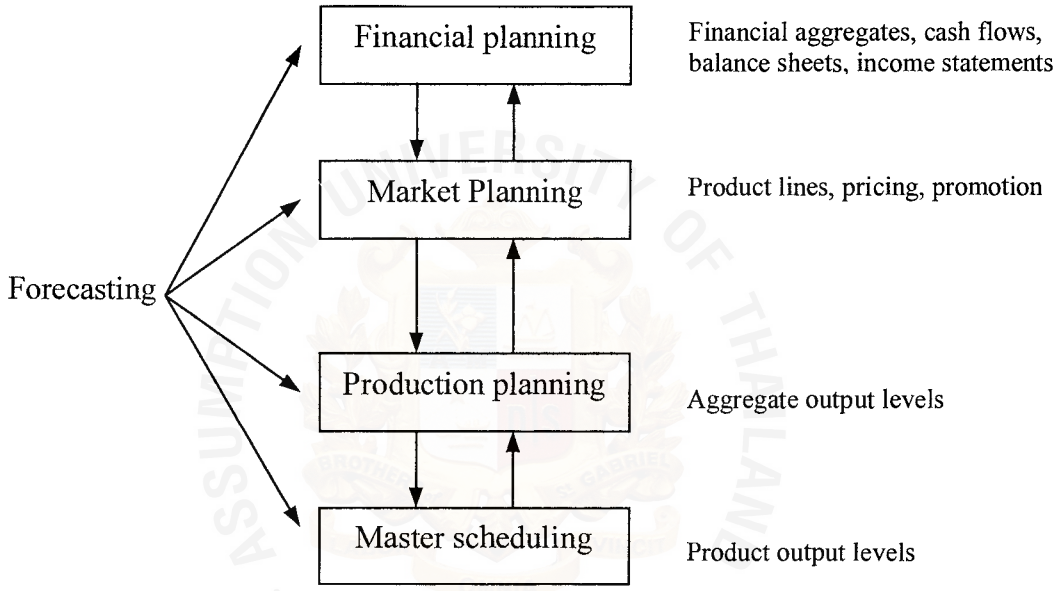

Figure 2.3. Functional Forecasting.

The most important factor in an inventory control model is usually the expected demand. This has most direct effect on the stocks held, and determines the effectiveness of the inventory system. With dependent demand systems the expected demand is found from forecasts. The problem of forecasting values for the future is not unique to inventory control. All business plans become effective at some point in the future, so they must be based on forecasts of expected conditions. In this sense, forecasting is a central part of any organization. Forecasting is a model-based information system, and

there are many models from which to choose. Not only do they differ in techniques, but also in effort and cost of implementation. Thus, the forecasting approach should fit the organizational environmental and the management expertise.

There are many methods of forecasting and our intuition might suggest that those that give best results are the most complex and expensive. In practice this is not necessarily true. Simple forecasting methods often give very good results, while complex ones can give very poor ones. It is also important to remember that inventory models are relatively insensitive to errors in data. It might be suggested, therefore, that inventory systems need simple forecasting methods, which give reasonable results. These are generally preferable to more sophisticated methods, even if the results are slightly inferior. This suggestion is reinforced by the observation that inventories often contain thousands of items, and using complex models to make regular forecasts soon becomes prohibitively expensive.

2.9.2 The Forecasting Function

The forecasting function includes the specific techniques and models, but it also highlights the significance of inputs and outputs to the subject of forecasting. To develop the forecasting function, it is first necessary to identify its outputs. The outputs can be specified by a delineation of the intended uses of the forecasts. When the users obtain the outputs, specific actions will be taken to assure that future demand will be satisfied. No matter how long a system is studied, only a few of its many inputs can be isolated. Fortunately, most systems are relatively insensitive to most of their inputs. Therefore, clearing away the extraneous inputs can reduce the size of the problem.

The selection of forecasting models depends heavily on constraints imposed on the organization by management policies, available resources, market conditions, and technology. Forecasting models can be classified several ways, such as qualitative,

formal or informal, statistical or nonstatistical, and descriptive or explanatory. Qualitative models rely on the use of historical data or associations among variables to develop forecasts. All forecasts include a degree of inaccuracy, and allowances should be made for it. In general, the forecasting model should be matched to knowledge and sophistication of the user. Some models require the user to analyze and interpret statistical measures. Thus, the forecasting approach should fit the organizational environment and the management expertise.

Forecasting usually involves the following considerations: (Tersine 1994)

(a) Item to be forecast (product, product groups, assemblies, etc.)

(b) Top-down or bottom-up forecasting

(c) Forecasting techniques (quantitative or qualitative models)

(d) Units of measure (dollars, pieces, pounds, etc.)

(e) Time interval (weeks, months, quarters, etc.)

(f) Forecast horizon (how many time intervals to include)

(g) Forecasting components (levels, trends, seasonal, cycles, and random variation)

(h) Forecast accuracy

(i) Exception reporting and special situations

(j) Revision of forecasting model parameters.

Fortunately, many items produced by an organization do not need forecasts. Dependent demand items such as components, subassemblies and services that are part of finished product can be calculated from the forecasts for the end item. Forecasts should be made only for end items and services that have an uncertain demand. There is no single forecasting technique that is superior in all cases, and the same organization can use different techniques for different products. It is difficult to ascertain the effect of

changes in selling price, product quality, marketing methods, promotion, and economic conditions on forecasts. The final forecast usually requires an additional input in the form of judgment, intuition, and experience. No organization should make a forecast and adhere to it blindly without periodic review.

2.9.3 Time Series Analysis

Time series analysis predicts the future from past data. A time series is a set of time-ordered observations on a variable during successive and equal time periods. By studying how a variable changes over time, a relationship between demand and time can be formulated and used to predict future demand levels. In time series analysis, historical data are analyzed and decomposed to identify the relevant components that influence the variable being forecasted. Time series data may contain up to five interacting components – level, trends, seasonal variations, cyclical variations, and random variations. Some or all components may be present. The components are then projected forward into the future.

The level component is present in all data and represents the central tendency of a time series at any given time. It indicates the scale of the time series. The trend component identifies the rate of growth or decline of series overtime. It is given by a smooth trend line fitted to the historical data and rarely coincides with the precise historical information. In stead, it depicts the general upward or downward movement of demand.

Seasonal variations usually consist of annually recurring movement above and below the trend line and are present when demand fluctuates in a repetitive pattern from year to year. The periodicity may be related to weather patterns, tradition, school opening, vacations, taxes, bonuses, and calendar-related customs such as holidays.

Examples of products with a seasonal pattern are antifreeze, soft drinks, ice cream, toys, textbooks, air conditioners, and greeting cards.

Cyclical variations are long term oscillations or swings about a trend line and account for some of the variation between the trend line and raw data points. The cycles may or may not be periodic but they often are the result of business cycles of expansion and contraction of economic activity over a number of years.

Random variations have no discernable patterns and often are without specific, assignable causes. They are often referred to as noise, residuals, or irregular variations, and they have such causes as measurement errors, floods, fires, wars, and other unusual conditions. Random variations represent all the influences not included in trend, seasonal, and cyclical variations. A random component is present in all data series, and its effects are part of unexplained deviations of the data.

Past trends may be good indicators of the future, but the forecaster should be alert to factors that may cause severe abruption from the past. External factors frequently have a very pronounced effect on the future, and time series analysis tends to neglect them.

2.10 Just-In-Time

2.10.1 Background

The Toyota Motor Company in Japan originally developed the concept of JIT in the mid-1970s, and it is still call the Toyota system by Japanese firms. To understand why JIT was developed, it is important to understand a little about the history and culture of Japan.

Japan is a small country with minimal resources and a large population. Thus the Japanese have always been careful not to waste resources, including space as well as time and labor. It has also been necessary for them to maintain their respect for each

other in order to work and live together smoothly and effectively. As a result, their work habits tend to reflect this philosophy is based in three primary tenets:

(1) Minimizing waste in all forms.

(2) Continually improving processes and systems

(3) Maintaining respect for all workers

During production, the Japanese studiously avoid waste of materials, space, and labor. They therefore pay significant attention to identifying and correcting problems that could potentially lead to such waste. Moreover, operation and procedures are constantly being improved and fine-tuned so as to increase productivity and yield, further eliminating waste. Equal respect is paid to all workers, and the trapping of status are minimized so that respect among all can be maintained.

JIT takes its name from the idea of replenishing material buffers just when they are needed and not before or after. This eliminates the waste of having expensive materials sit idle while awaiting processing, as well as the waste of having expensive resources wait for late materials. JIT means keeping workflow moving all the time from receipt in the plant to delivery to the customer, eliminating inventories, reducing travel distances, eliminating defects and scrap, making maximum use of precious space, and so forth.

The reason that so mach attention has been given to JIT is undoubtedly the success of Japanese manufacturing. Since the 1950s, Japan has been continuously increasing its share of world trade and is now the dominant manufacturing economy. And because of its broad name and wide range of benefits from increased market share to better quality to lower cost, JIT has become, for many companies, a major element in competitive strategy. The firm many adopt only particular or especially relevant elements of JIT or add certain other aspects or programs, but it still plays a major role in

their overall strategy. More recent adoptions of JIT have also stressed its second aspect: continuous improvements. That is, JIT is considered not simply a means of converting the transformation system from a sloppy, wasteful form to an efficient, competitive form, but also as producing continuing improvements throughout the system to keep the firm competitive and profitable in the future. The approach is known by different name, including zero inventory, stockless production, Toyota system, Japanese manufacturing, world class manufacturing and continuous flow manufacturing. (Meredith 1997)

2.10.2 The Philosophy of JIT

The goal of JIT is to remove all waste from the manufacturing environment, so that the right quantity of products is produced in the highest quality, at exactly the right time with zero inventory, zero lead time, and no queues. Waste means anything – inventory disruptions, or poor quality. In fact, any activity that disrupts the flow of products and does not contribute to making or selling them is waste. JIT seeks to eliminate all uncertainty, including machine breakdowns. In working toward these goals, particularly that of zero inventory, an organization follows a set of systematic steps (Krajewski, Ritzman 1999):

(1) The need for high levels of quality is given extreme emphasis.

(2) Set up or changeover times are reduced as much as possible.

(3) Lead times are reduced as much as possible.

(4) Lot sizes are reduced as much as possible and are standardized. Very low set up times permit the economical production of small lot sizes, and increase the utilization of equipment.

(5) Work in process inventory is removed from the stockroom and put on the factory floor, where if is visible. Therefore, work-in-process are immediately evident and can be counted quickly.

(6) Once the plant is in reasonable balance inventory is systematically reduced. Each reduction usually leads to the identification of a problem area. When the problem is discovered, inventory is temporality increased so that production will continue smoothly until the problem is solved.

(7) The problem is resolved in a cost-effective fashion for example, by procedural changes, equipment adjustment, etc.

Step 6 and 7 are repeated over and over until no further improvements can be realized or until zero inventory is achieved between pairs of work centers. In the later case, the possibility of automated piece-by-piece transfer between the two centers is considered.

2.10.3 The Kanban Control System

JIT systems try to eliminate all wastage within on organization. Their aim is to meet production targets using the minimum amount of materials, with the minimum amount of equipment, the smallest number of operators and so on. JIT system organize materials to arrive just as they are needed, we must suggest ways in which this can be arranged.

The principles of JIT may appear attractive, but it can only be used if there is some practical way if implementing and controlling the system. JIT production is appropriate in a high-volume, repetitive manufacturing environment. The different stages of production are tightly linked with very little in-process inventories. Final assembly needs dictate the inflow of subassemblies, triggering the production of new subassemblies and so on. Each feeding work center produces only what its following work center uses to satisfy the assembly schedule. The associated manual information system is known as Kanban. The amount of in-process inventory between any two-work centers is strictly controllable by the number of cards assigned to that particular pair of

centers. Kanban therefore operates in a pull mode. Pull implies that production is initiated at a given work center only when its output is needed by the next stage of production. It the next stage is slow for some reason, the upstream center does not produce.

2.10.4 Requirement for Kanban Control

Kanban Control is not appropriate in many environments, even if the JIT philosophy is. For Kanban to be truly effective, several conditions must first exist or be developed. These include the following:

(1) Employee motivation and mutual trust between workers and management, are qualities that are extremely difficult to develop, and can take years if there has been a culture of mistrust. New and heavy responsibilities are put on the individual workers.

(2) A multi-skilled work force provides flexibility in scheduling.

(3) Good relationships with suppliers make join improvement efforts possible. Suppliers have significant impact on cost, quality and delivery performance of end products.

(4) Extremely high levels of quality ensure that production will not be interrupted due to parts with poor quality.

(5) Low set up times, and therefore small batch sizes, reduce capacity loss. Without low setup times, any effort to reduce catch sizes will be doomed because too much capacity will be lost in setups. Small batch sizes reduce average cycle stock, and provide faster feedback on quality problems. The later point holds because often a work center discovers quality problems created by its immediate predecessor. If a large batch is run before the problem is found, many parts have to be repaired or discarded.

(6) Highly reliable equipment is needed so that a low inventory system will not be forced to shut down while repairs are made.

(7) A stable master production schedule allows a daily production rate to be set and followed.

(8) High volume, repetitive manufacturing is needed, because this environment is likely to be conductive to the previous seven requirements.

(9) Some excess capacity allows variability to be me without constantly injecting more Kanban into system. This also permits time for the workers to experiments with ways to eliminate wastes.

2.10.5 Relation with Suppliers

Traditionally, there has been some friction between suppliers and customers. Because one pays money directly to the other, there is a common belief that one can only benefit at the expense of the other, Suppliers are often rigid in their conditions and, as there is little customer loyalty, they try to make as much profit as possible form each sale. The result is uncertainty among suppliers about items being ordered, the size of likely orders, the time when orders will be placed, the possibility of repeat orders, and so on.

JIT recognizes that customer and suppliers have the same objective, which is a mutually beneficial trading arrangement. The primary equipment is for an organization to find a single supplier who can best meet their customer. These conditions are quite demanding and include items of perfectly reliable quality, with small frequent deliveries and at reasonable cost. In return for meeting these conditions, organization with JIT was using single sourcing. This means they buy each item exclusively from one supplier and agree long-term contracts to ensure stability. JIT recognizes the importance of stability

to suppliers. It knows that they are geared to work with present operations and any changes will inevitably cause disruption.

JIT aims for closer cooperation between a customer and its suppliers. This cooperation can be used to help suppliers adapt to the requirements of JIT and even install JIT in their own operations. It also allows suppliers to make suggestion for improvement to customer.

2.10.6 Respect for Employees

We have mentioned several times the kind of relationship JIT expects with employees. Quality at source, for example, expects employees to be responsible for their own quality. At the same time JIT gives each employee the authority to stop a process if they see a fault, everyone is expected to suggest ways of improving operation, and so on. The respect for employees is particularly relevant to JIT, where it has a number of consequences. JIT suggests that all employees are concerned with the success of an organization, and they should, therefore, all be treated equally. Another aspect of this respect for employees is the approach to improving a process.

One problem with JIT, which is only recently getting attention, is the increased stress it can put on the workforce, There is some evidence that employees who work on JIT assembly lines are subject to higher levels of stress than those who work on traditional lines.

2.10.7 Benefit and Weakness of JIT

There are many benefits to a successful implementation of JIT. These include (Walter 1999):

(a) Reduced work-in-process inventory, and therefore less space and cost

(b) Higher quality, due to continuous improvement efforts and to small lot sizes.

(c) Higher productivity

(d) Short lead times

(e) Low control costs due to the decentralized nature of the system

(f) Less paperwork

(g) Higher reliability of production because problems are visible

(h) Visible, predictable amounts of inventory, because inventory records of work-in-process and materials can be updated only when finished goods have been recorded into stock, so there is no need for complex work-in-process inventory tracking systems.

Expanding on these benefits, if lead times are reduced using continuous improvement, firms that make-to-stock can sometimes change to make-to-order and therefore become more responsive to customers. Also, if lead times are short, there is less need to track inventory as it progresses through the factory. Further, production planning is much simpler if schedules are level, because the planning problem is simply to find the best level schedule. Shop floor control is easier because schedules are predictable and constant. Likewise, scheduling workers is not necessary. They have assigned tasks and they are trained to help if an adjacent workstation falls behind.

Some weakness and warning must be mentioned, however. Probably the most compelling warning is not really a weakness of JIT at all. Rather, it is the tendency for production managers to implement the system where it does not fit. A student intern from a local university suggested implementing JIT because "JIT means high quality, low setup times, and low inventory". Fortunately, managers realized that these are prerequisites to JIT, not the certain result of it. In a less encouraging case, JIT was implemented in a large job shop without first reducing long setup times. This factory soon developed huge backlogs due to capacity lost to frequent setups.

It should be clear that JIT is not appropriate in job shops where products are made to order variability is high, and demand is extremely non-stationary. Production is not smooth because bottlenecks shift continually. The high levels of variability imply high levels of inventory, but it is difficult to know exactly what inventory to put into the system when products are all made to order. How do managers know how many Kanban cards to use? Also, it is possible that some Kanbans will be inserted into the system for a product that will not be produced again for a long time, and work-in-process will be held unnecessarily.

JIT is also not appropriate in continuous process industries where stages of production are tightly linked. There is no need for Kanbans to control movement of materials because the entire facility operates as a single machine. Finally, because JIT is a reactive pull system it is not appropriate for environments in which demand can fluctuate widely, but can be forecast.

Other weaknesses include:

(a) JIT is vulnerable to plant shutdown, demand surges, and other uncertain events, primarily because of the low levels of inventory. There is no method of adjusting capacity within a given time frame – usually one to six months except within narrow limits.

(b) JIT cannot accommodate frequent new product introductions because of the need to introduce Kanban cards for all the components and parts.

(c) Frequent deliveries of small lots can generate highway congestion, a phenomenon that has been observed in crowded cities a Japan.

(d) Some writers point to enormous improvements from JIT at a number of firms. However, that much of the research is quite shoddy in that it attempts to assign all improvements to JIT programs. No attempt is made to discern

phenomenon is often found in systems in which large numbers of different items are maintained. It is also in evidence in marketing, where a small number of customers represent the bulk of the sales, in complaint departments, where a large volume of complaints come from a relatively small group and so forth.

Table 2.2. Inventory Value by Item (Krajewski, Ritzman 1999).

Annual Quantity Used	Percentage of Total Items	Annual Dollar Purchases	Percentage of Total Purchases
521	4.8	$15,400,000	50.7
574	5.3	6,200,000	20.4
1023	9.4	3,600,000	11.8
1145	10.5	2,300,000	7.6
3754	34.0	1,800,000	5.9
3096	36.0	1,100,000	3.6
10923	100.0	30,400,000	100.0

The three classifications used in the ABC system are:

(a) A. High-value items: The 15 to 20 percent of the items that account for 75 to 80 percent of the total annual inventory value.

(b) B. Medium-value items: The 30 to 40 percent of the items that account for approximately 15 percent of the total annual inventory value.

(c) C. Low-value items: The 40 to 50 percent of the items that account for 10 to 15 percent of the annual inventory value.

The classification is shown in Figure 2.4, which gives the cumulative distribution of the dollar value of inventory items. In practice, the A items are identified first, then the C items and what is left is usually considered to represent the B items. Of course, at

times it may be appropriate to reclassify an item classification on the basis of other criteria. For example, a B item that has especially long lead times or is considered critical can be elevated to category A.

The goal of ABC Analysis is to identify the inventory levels of class A items and enable management to control them tightly by using the levers just discussed. The analyst begins by multiplying the annual demand rate for one item by the dollar value of one unit to determine its dollar usage. The dividing lines in Figure 2.4. between classes are inexact. Class A items could be somewhat higher or lower than 20 percent of all items, but normally account for the bulk of the dollar usage.

A manager can direct that class A items be reviewed frequently to reduce the average lot size and keep inventory records current. If the records show an on-hand balance of 100 units but the actual balance is 200 units, costly inventory is being carried needlessly. If a class A item is bought outside the firm, purchasing may be able to reduce its cost through centralized buying, switching supplier, or more effective contract negotiation.

For class C items, much looser control is appropriate. A stockout of a class C item can be ad crucial as for a class A item, but the inventory holding cost of class C items tends to be low. These features suggest that higher inventory levels can be tolerated and that more safety stock, larger lot sizes, and perhaps even a visual system, which may suffice for class C items.

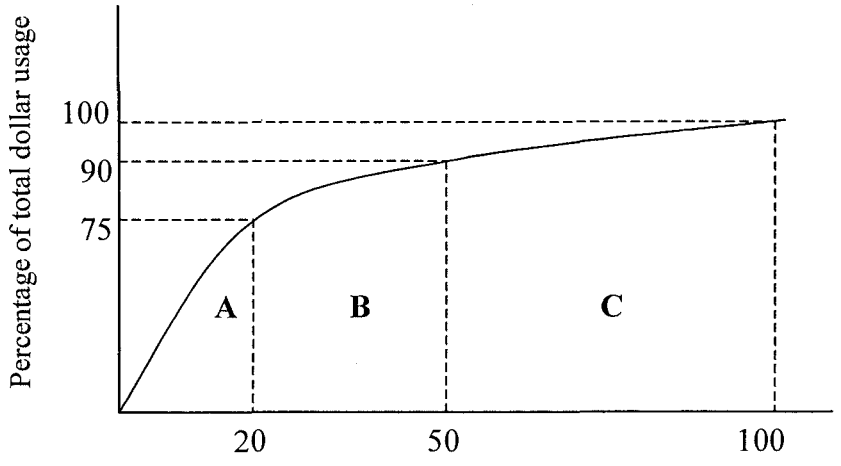

Figure 2.4. ABC Analysis (Shapter 1997).

The ABC classification is management's guide to the priorities of inventory items. The A items should be subject to the tightest control, with detailed inventory records and accurate, updated values of order quantities and reorder points. B items are subject to normal control, with order quantities set by EOQ but with less frequent updating of records and review of order quantities and reorder points. C items are subject to little control must be exercised and inventory records can be kept simple. Essentially, the time and effort saved by not controlling C items is used to tighten control of A items.

2.12 The Economic Order Quantity (EOQ)

The concept of economic order quantity (EOQ) applies to inventory items that are replenished in batches or orders and are not produced and delivered continuously. Although we have identified a number of costs associated with inventory decisions, only two categories, carrying cost and ordering cost, are considered in the basic EOQ model. Shortage costs and capacity-associated costs are not relevant, because shortage and changes in capacity should not occur if demand is constant. The cost of the goods is

considered to be fix and does not alter the decisions as to when inventory should be reordered or how much should be ordered.

More specifically, we assume that following in the EOQ model:

(a) Rate of demand is constant such as 50 units per day

(b) Shortages are not allowed

(c) Stock replenishment can be scheduled to arrive exactly when the inventory drops to zero

(d) Purchase price, ordering cost and per unit holding cost are independent of quantity ordered.

(e) Items are ordered independently of each other.

2.12.1 The Economic Production Quantity (EPQ) Model

The economic production quantity model is used when the replenishment does not arrive exactly as the inventory drops to zero. Rather, in these cases the inventory level is built is gradually as the product is produced internally. Thus, with its assumption of instantaneous replenishment, the EOQ model is more appropriate for situations, in which the product is purchased, whereas the EPQ model is appropriate for situation in which the product is made in-house. With internal products, the inventory level is gradually increased as additional units of the product are completed. Also, with internally produced items, an equipment setup cost (C_s) is incurred as opposed to an ordering cost (C_o). The inventory pattern is shown in Figure 2.5.

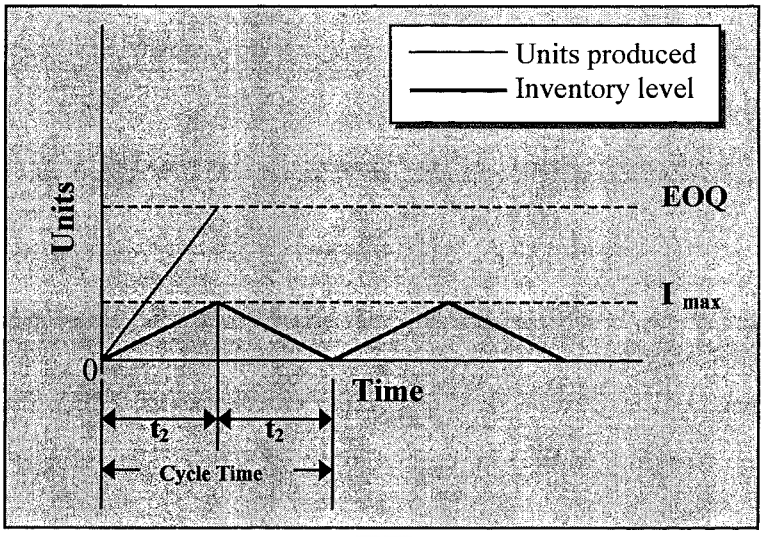

Figure 2.5. Inventory Pattern for Internally Produced Items (Shapter 1997).

In Figure 2.5, one inventory cycle takes $t_1 + t_2$ time units. This cycle consists of two parts: the period when the product is being made and the period from time t_1 to time $t_1 + t_2$ when production has ceased and inventory is being used to meet demand. The length of t_1 and t_2 depends on the production rate (P) and usage rate (U). In the formulas below we use Q_{EPQ} to distinguish the EPQ from the economic order quantity Q.

$$t_1 = \frac{Q_{EPQ}}{P}$$

$$t_2 = \frac{I_{max}}{U}$$

$$\text{Cycle time} = t_1 + t_2 = \frac{Q_{EPQ}}{U}$$

In summary, t_1 is the time required to produce Q_{EPQ} units given a production rate of P; t_2 is the time it takes to use up the accumulated inventory given a usage rate U; and cycle time $(t_1 + t_2)$ is the time it takes to use up the Q_{EPQ} units produced.

2.12.2 The EOQ Model with Quantity Discounts

In the basic EOQ model, the unit purchase price is assumed to be independent of the quantity ordered. However, in many situations suppliers offer discounts to encourage their customers to purchase in larger quantities. In these cases, the order quantity affects the annual purchase cost in addition to the annual ordering and annual carrying cost. Letting C_p represent the unit price, the total annual cost is computed as:

$$TAC = (Q/2)\, C_H + (U/Q)\, C_O + UC_P$$

Unfortunately, we cannot develop a simple formula to determine the optimal order quantity in this situation. Instead, we use the following four-step procedure:

(1) Calculate the EOQ, ignoring quantity discounts for the time being

(2) If the calculated EOQ qualifies for the lowest unit price, this is the optimal order quantity. If the calculated EOQ does not qualify for the lowest unit price, go to step 3.

(3) Calculate TAC for the EOQ quantity. Also, calculate TAC for all order quantities that occur at price breaks offering a lower unit price.

(4) Select the order quantity that has the lowest TAC.

2.12.3 Cautions regarding EOQ

The EOQ is a computed minimum-cost order quantity. As with any model or formula, the GIGO (garbage in, garbage out) rule applies. If the values used in computing EOQ are inaccurate, the EOQ will be inaccurate-though, as mentioned

previously, a slight error will not increase costs significantly. EOQ relies heavily on two variables that is subject to considerable misinterpretation. These are the two cost elements: Holding cost (C_H) and order cost (C_O). In the derivation of EOQ, we assumed that by ordering fewer units per order the cost of holding inventory would be reduced. Similarly, it was assumed that by reducing the number of orders placed each year the cost of ordering could be proportionately reduced. Both assumptions must be thoroughly questioned in looking at each cost element that is included in both C_H and C_O.

Note also that C_H and C_O are controllable costs. That is, they can be reduced, if this is advantageous. This is exactly what the Japanese recognized. The problems they saw with holding inventory were (Meridith 1997):

(a) Product defects becomes hidden in the inventory, thereby increasing scrap and rework later in the production system, when defects are harder to repair. Just as important, the problem in the system that led to the defective part cannot be tracked down so easily later on.

(b) Storage space takes up precious room and separates all the company's functions and equipment, thereby increasing problems with communication.

(c) More inventory in the plant means that more control is needed, more planning is required, larger systems are required to move all that stock, and in general more hassle is created, which leads to errors, defects, missed deliveries, long lead time, and more difficulty in product changeovers.

2.13 Supply Chain Management (SCM)

Supply Chain Management is the term used to describe the management of materials and information across the entire supply chain, from supplier to component

producers to final assemblers to distribution (warehouse and retailers) and ultimately to consumer. Figure 2.6 is a schematic of supply chain.

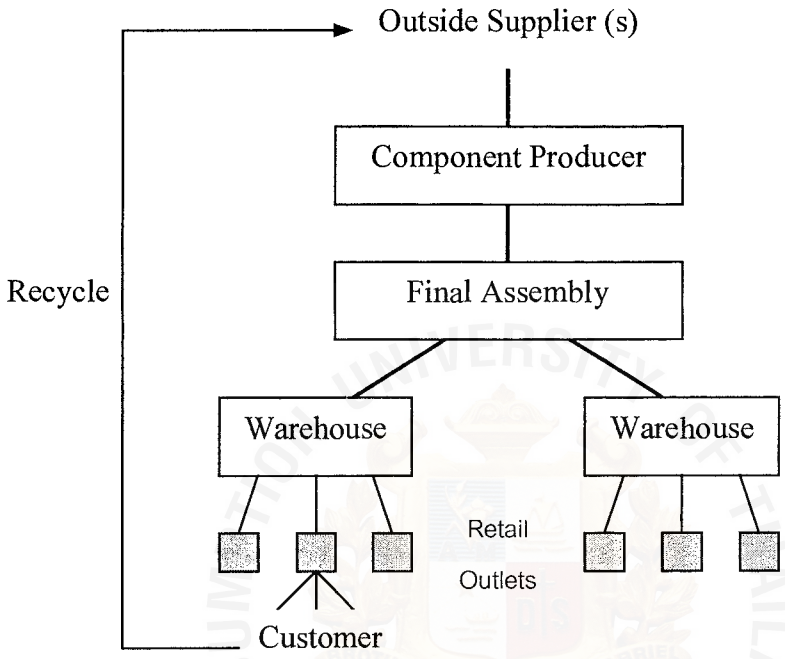

Figure 2.6. Schematic of Supply Chain (Silver, Pyke, Peterson 1998).

In these days of intense worldwide competition, supply chain management is taking on significantly more importance, as it accounts for a greater and greater proportion of the total cost of all products. Labor cost is dropping but the acquisition on distribution have remained about the same (Silver, Meredith 1997). Firms are increasingly thinking in terms of competing as part of a supply chain against other supply chains, rather than as a single firm. Also, as firms successfully streamline their own operations, the next opportunity for improvement is through better coordination with their suppliers and customers. The variability increases in moving up the supply chain from consumer grocery store to distribution center to central warehouse to

factory, a phenomenon that is often called the bullwhip effect (Silver, Pyke, Peterson 1998).

Some recent innovations, such as increased communication about consumer demand via electronic data interchange (EDI), can mitigate the bullwhip effect. Most large companies require customers and supplier to communicate using EDI.

2.14 Measuring the Productivity of Inventory

Planning, scheduling and controlling production are functions that are necessary regardless of the size of the operation involved. The profitability of your expertise may very well rest on how well you are is guided be the data available to you. In the first place, look at the reliability of decisions made by management in these particular areas of concern (Allegri 1993):

(1) The precision with which human work can be measured

(2) The timeliness of the reports that are available to management

(3) The methods used to study the work that is being performed

(4) The reporting method.

Historical records or past experience, which is often used as a basis for predicting the work effort of the plant, is at best a very crude and often unreliable method for predicting the amount of work to be expected from an individual or the work force as a whole.

Using method studies, for your plant to be well-organized and administered, you should have job descriptions for every functional area of the plant. The time element, therefore, is an important consideration in putting together the staffing tables of the plant and preparing the budgets for the year in which the number of employees to handle a given volume of production becomes a necessary element of the total package.

Relying on historical experience to determine the staffing for the facility is often not conducive to profitability. Therefore, to increase profits without being of speed up or any other abusive forms of unenlightened management, a method study for each for the tasks is necessary. Methods study attempts to improve the methods used to achieve a stated goal by eliminating, combining or changing motions. The primary purpose is to eliminate all wasted motions and effort.

2.15 Management Action Based on Operating Statistics

There are certain symptoms that can be gleaned from the operating statistics and the require corrective action on your part (Allegri 1993):

(1) Declining profit due to higher distribution cost.

In this the symptoms to watch for are higher indirect labor costs and all of the concomitant waste in distributive operations that have not been periodically scrutinized from the systems standpoint.

(2) Inventory control problem.

One of the ways to cure this problem is to review the data indicating the way in which items in inventory move or turn over.

(3) Improving customer service

When the response time is shortened, customer satisfaction invariably improves. One of the best ways is to make sure that your inventory levels of all stocks are appropriate to the demand.

(4) Maintenance costs that continue to rise

(5) Last due-ins

(6) Faulty materials flow

(7) Integrating Functions

III. THE EXISTING SYSTEM

3.1 Company Information

UFM Fuji Super Co., Ltd. - A modern supermarket chain was established in 1986 with a paid-up capital of 100 million Baht as a joint venture between Metro Co., Ltd., UFM Food Center Co., Ltd., and Fuji Citio, one of Japan's leading supermarket operations, which operates over 300 supermarket and convenience stores in Japan.

UFM Fuji Supermarket has 2 locations, which are located at Sukhumvit 33 Road and Sukhumvit 39 Road. The two places of the supermarket are in the main road and in the center of the city. Due to the limitation of the space of the supermarket and location at center of the city, they did not have large storeroom. They have one storeroom at Sukhumvit 33 because there is more space than Supermarket at Soi 39. They will deliver the product from the head office or at Sukhumvit 33 to another every morning.

3.2 Target Market

The target market of the supermarket is the Japanese people and foreigners who live nearby Sukhumvit Road. In the past, Japanese food was not so popular among Thai people because of taste and price concerns. But during few years ago, Thai people changed their eating behavior towards Japanese food because there are many choices of Japanese restaurants and this made the price go down. Therefore, Thai consumers towards Japanese food is one important target market.

And also Japanese people nearby the country such as Singapore, Lao, Pakistan, Mienma, these people are target market of supermarket. They will order Japanese foods through Fuji Supermarket.

3.3 Direct and Indirect Competitors

At present, the competitor of supermarket has increased from the past 5 years. As mentioned above, people have more interest in Japanese food and product so a lot of Japanese supermarket had established. Isetan Supermarket, Sogo, Zen supermarket are direct competitors. These competitors mainly sold Japanese food and product. They are also located in center of the city that can capture a lot of foreign people from the city. Villa supermarket, Foodland supermarket are indirect competitors because they provided international food not only Japanese food such as western food and product for European people. Foodland, order products by themselves because they have many store rooms. They take no risk in distributing the product to their branch. The branch will order the product when they need. This is the same as Just In Time approach.

3.4 Characteristic of the Product

Generally, kind of products are simply the same as other supermarket. It depends on each supermarket which products are they stressing. In Fuji supermarket, they have a variety of products which can divided into:

(1) Perishable or fresh food such as fish, meat

(2) Dry food such as Canned Food, Noodle

(3) General products such as kitchenware.

Fuji emphasized on Japanese product in both perishable and non-perishable product. For fresh food such as vegetable, fruit almost ordered locally but the rest will order from Japan. They have different approach for each product type.

Since Fuji has daily order, Fuji is seriously concerned with Food Order and Storage. The following are Fuji's Policy towards those concerns.

For the goods and services:

(1) The goods should be fresh all the time.

(2) A variety of goods mean more opportunity to sell and reach customer.

(3) The goods should be enough in shelf for the customer.

(4) The goods should be suitable for the right time and right quantity.

(5) Quick Service, no queuing

(6) Highest Satisfaction towards customer demand

(7) Lowest carry cost

(8) No or lowest defective goods

(9) Reduce handling cost

From above mentioned policy, it is shown that Fuji has strict policy and is always punctual in order to keep freshness of food and prompt delivery to the customers.

Fuji realizes the importance of keeping and delivery because it can affect to the cost of food and then to the company. Therefore, to have good and effective inventory management will help reducing unnecessary cost such as if Holding Expenses due to over size order. Inventory Management can help calculating the actual order.

3.5 Type of Inventory of Fuji Supermarket

Inventory of Fuji supermarket consists of raw materials and finished goods. Raw Material mostly is flavor for bread. Finished goods are mostly fresh product and general products which will be ordered for stock. The order of each finished goods will be varied depending on the type of goods as follows:

3.5.1 Fresh Food

In order to keep freshness, they will order goods day by day because of the Policies of head office at Japan because they would like to keep image of the organization.

3.5.2 Seasonal Fresh Food

Seasonal Special Order: They have statistic and survey records done by Japanese Manager and will order the goods seasonally.

3.5.3 Dry Food

They will order by not stocking more than one month. When the quantity reach the reorder point, they will order the goods from the supplier. All type of goods as mentioned, Fuji will do statistic record at point in graph form. They will compare from historical record by day, month and year. They have statistic graph for the whole year and break down by day.

3.6 Function of Inventory of Fuji Supermarket

3.6.1 Working Stock or Lot Size Stock

Fuji will order dry food in quantity of Lot Size. They have statistic of which product has good sale volume such as Japanese Instant Noodle, Japanese Sauce, etc. In general, those products will be order once in a month because the space of storeroom is quite small. For other products which can be found in other supermarket will be ordered once in two months because it has low sale volume among Japanese customers. Japanese people are nationalistic so they need products from Japan. So products from Japan will be ordered once in a month.

Fuji Supermarket has a schedule from every supplier either Japan or Thailand supplier so they can check the lead time and delivery time from the supplier.

3.6.2 Safety Stock

They will order for stock in the inventory only on houseware, kitchenware but not for perishable goods. Because image of the supermarket is very important for them the perishable goods will be ordered day by day.

3.6.3 Anticipation Stock

Almost all are the special goods such as fish, which have seasonal favorite. Food festival or popular food in Japan will influence the demand of Japanese people around the world. The Japan Head Office will automatically order depending to the festival of food by evaluating demand from past record. Supplier from Japan will help Fuji forecast demand of the customer by looking at the trend of Japanese people in Japan.

3.7 Organization Category

Fuji Supermarket is a retail system, which provides goods and services to the customer. Inventory is purchased in a salable form and is usable without further processing. Most problems concerning with the inventory are associated with supplier and finished goods.

3.8 Problem Classifications

3.8.1 Repetitiveness

They do not stock the goods more than 1 month in the inventory and for the perishable goods they order day by day. The problem of repetitiveness occurred with the special perishable goods such as seasonal perishable goods. Last year, they had to reorder the goods many times because Thai people are interested to eat Japanese food more than in the past so the goods are not enough.

3.8.2 Supplier

Fuji has one supplier to order Japanese goods from Japan. Head office in Japan chose the supplier for Fuji in Thailand. No problem from the Japanese supplier but most of the problem came from supplier in Thailand. The Japanese supplier will distribute goods to both at Sukhumvit 33 and 39 location. Fuji do not have to check the quantity before distributing to their branch. Japanese trust their home country supplier more than Thai supplier.

Because of many Thai suppliers, they cause a lot of problems such as delay delivery, goods has low quality from the order, etc. Japan Head office would like head office of the supermarket in Thai check quality of all goods before selling because they do not trust Thai people. Thai Supplier will deliver all goods to head office to check the quality and then head office will deliver all goods. Therefore, the cost of delivery is occurred. The supplier distribution process from Japanese and Thai is shown in Figure 3.1 and 3.2 respectively.

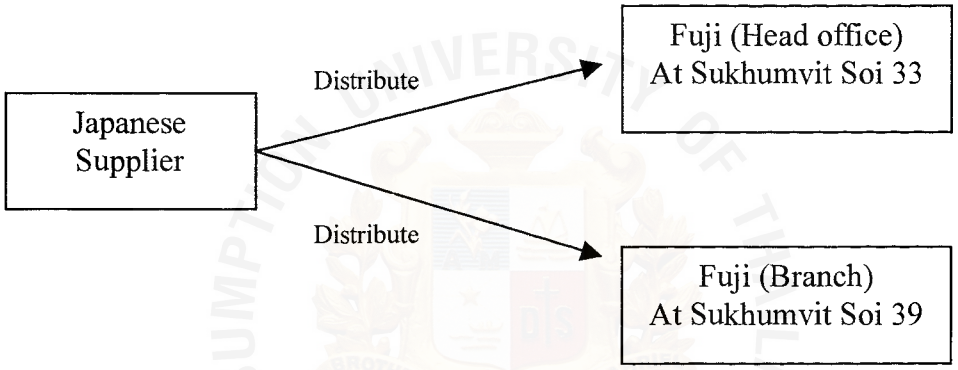

Figure 3.1. Japanese Supplier Distribution Process.

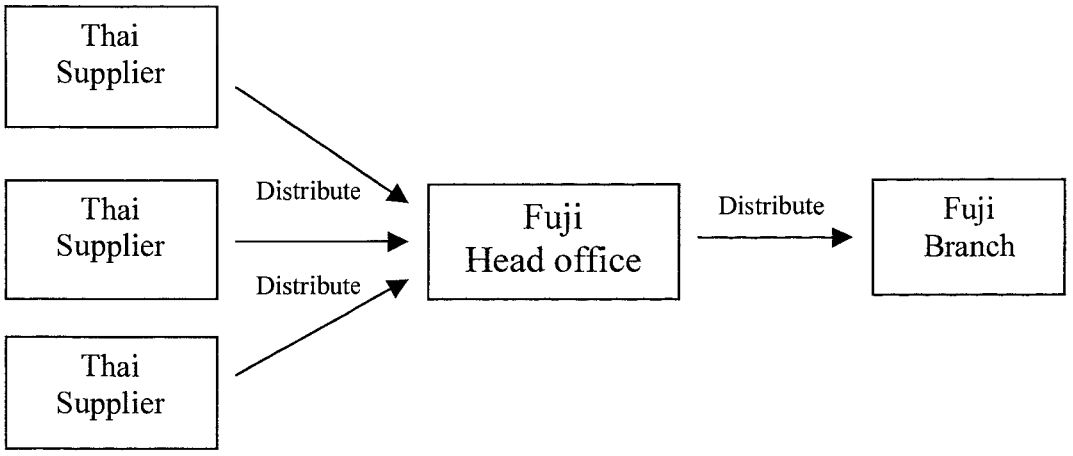

Figure 3.2. Thai Supplier Distribution Process.

Fuji uses the periodic inventory system by ordering stock on time cycle. This system place orders of varying size at regular intervals to raise the stock level by using the past record. Fuji uses 3 years past record of each goods to forecast and order the goods.

3.9 POS System of Fuji Supermarket

POS stands for Point of Sales. Fuji uses this system only with general goods and dry foods but not for perishable goods. The process of this system is when the customer selects the goods and takes to the cashier, Cashier will use bar code and scan to the computer. The computer system will cut the item to the stock automatically. The data will show in the computer how many goods are available on shelve at that time. If the goods is low, staff will put the goods to their shelve. By the end of the day, all data will be printed out to keep in record and study that the goods quantity is reach the reorder point or not. They will put in statistic and point into graph form.

Because the head office will order all goods and distribute to their branch, the POS system has linked the data of two locations. The system is online between two locations. When the customer buy goods from branch and scan with bar code at cashier, the system will cut the stock as well and link the information with the head office. The POS system helps the head office to check stock or inventory. They will have record from two locations by the end of the day.

3.10 Inventory Cost of Fuji Supermarket

The following are the cost of inventory of Fuji Supermarket: Tables 1.1 Cost Analysis: showing type of cost and percentage of each cost from overall costs.

3.10.1The Purchase Cost

This is the purchase price plus freight cost of goods to store in the supermarket. Fuji imported goods from Japan so the price of goods and freight cost is high when

compared with other supermarkets especially with freight cost of Fresh food or perishable food.

3.10.2 The Order Cost

Fuji has a lot of expense of issuing the purchase order to the supplier. Fuji stills using the old system for order to goods to the supplier. They use fax and telephone to order the goods rather than use computer online system. They will waste time for preparing the purchase order and set up time as well such as time to prepare the documents, working process for order goods from the supplier especially from Japan.

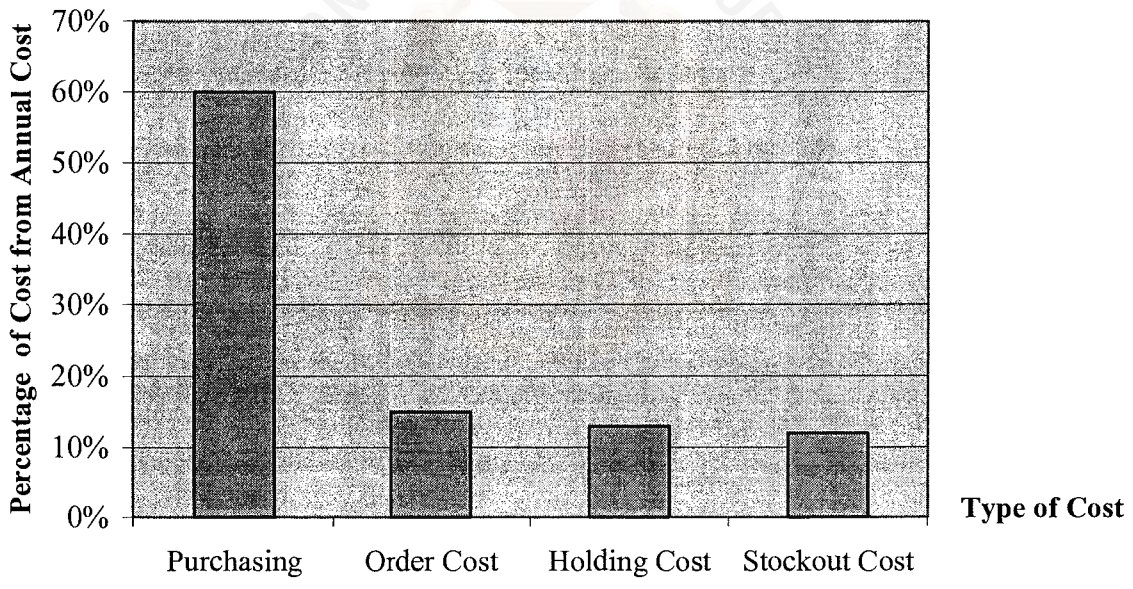

Figure 3.3. Cost Analysis of Fuji Supermarket.

3.10.3 The Holding or Carry Cost

Since Fuji has limited space of storeroom, they will not order goods in large quantities and will not stock the goods in the store more than 1 month. Therefore, the holding cost is not their problem.

3.10.4 Stockout Cost

This type of cost occurred when the demand of the fresh food is out of stock. The reason comes from the shipment delay from the supplier and the unexpected demand from Thai consumers. So the company would expedite an emergency backorder for an item and assume any extra costs charged. But this type of cost is not much for Fuji Supermarket.

3.11 Forecasting Demand System

Fuji put more emphasis on the forecasting demand. All budgets are set from the historical record. To reach the organization's objective of satisfy all demand of the customer, information and forecasting is very important. Fuji forecast demand of the customer on the basis of the Time series analysis. Fuji uses qualitative model, which relies on the use of historical data and also based on seasonal factor. The periodicity related on the tradition in Japan especially with the fresh foods such as fish. The forecast demand by using graph indicated by past record and break down day by day.

For example, if the demand of January 2000 is high, this year Fuji forecast that the demand would be high also but depends on type of goods such as Japanese food. Because the interest in Japanese food from Thai people is increasing Fuji forecast demand for year 2001 will be increased from the past.

3.12 Just In Time (JIT) of Fuji Supermarket

Fuji uses Just In Time method for ordering goods. They do not use JIT for fresh food because Fuji will order fresh food day by day. The goals of the organization are to remove all waste or have low waste so the right quantity of goods will be ordered. Fuji uses the method only with general product such as dry foods, frozen food, and houseware. The limitation of the storeroom is another reason why Fuji uses JIT method to order goods.

To know the lead-time for delivery goods, Fuji has all schedules from all of their supplier. The supplier has to do contract or agreement with Fuji especially with Thai supplier. If they miss the schedule of delivery and the quality of the goods is not same as mentioned in their contact, Fuji can cancel the order to the supplier. When the supplier misses the schedule of delivery, Fuji head office cannot deliver the product to their branch as well. But for Japanese supplier, they always work following with the schedule. The Japan head office has control their supplier by themselves. They will review supplier performance by looking at the response when order and the delivery should be on time in order to avoid cost.

3.13 SWOT Analysis of Inventory System for Fuji Supermarket

The problem of Fuji begins by clarifying which problems are involved, so the solution can focus on that problem. The following are the SWOT Analysis of the system of Fuji Supermarket.

3.13.1 Strengths

There are many strengths to successful inventory system for Fuji. These include:

(1) The good control by Japan Head Office who has high working discipline.

(2) Has online system when checking the stock from 2 locations therefore, the system for stock checking is fast.

(3) Use computer for checking stock, the computer will alarm when the quantity of the goods reaches the reorder point. So, the order system is fast.

(4) Has a good and honest supplier from Japan.

(5) They have supplier performance reviewed per week.

(6) Has forecasting system from Japan.

3.13.2 Weakness

The following are the weakness of the system:

(1) High cost for ordering goods from supplier because there are a lot of suppliers in Thailand.

(2) Thai supplier has little loyalty with the organization.

(3) Still using fax and telephone for ordering goods (old system) so it creates many task and have operation cost for order goods

(4) Has high delivery cost because they have to order fresh foods day by day and the head office has to deliver goods to their branch by themselves.

(5) Even the Japanese Manager stays at the supermarket in Thailand to control the system but he is not Thai so the forecasting demand from Thai consumer behavior is not good as Thai. Another reason is he will stay in Thailand only 1 year and then Japan will send another one to control the supermarket.

3.13.3 Opportunities

There are some opportunities for the system, which are:

(1) Today is the world of globalization, computer technology has many effects to every organization. Therefore, there are a lot of computer programs for helping organization order goods from the supplier such as EDI or etc.

(2) There are a lot of suppliers in the market so Fuji can select supplier from several sources and can easily change supplier if the supplier has not good performance.

(3) The consumer behavior is changing from the past. Many consumers are now more concerned with purchasing "solution" to their food problem and Thai customer changed their eating behavior towards Japanese food.

3.13.4 Threats

The following are threats of the inventory system:

(1) Government tax for imported product is high so the cost of delivery and cost of product is increased.

(2) Due to the economic crisis, Thai Baht currency is increasing sharply. The imported goods have effected because the price of the goods is increasing.

IV. THE PROPOSED INVENTORY SYSTEM

Since the major concern of all managers is to assure the profitability of the organization, when the data collection functions are operating smoothly in all areas, it is up to the manager to make sure that they are properly utilized. Another phrase for profitability is the least total cost of material handling and documentation, which consists of all of the handling and clerical functions performed within the distribution center.

4.1 Problem Classification

The problems of Fuji can be classified into 2 problems:

(1) Supplier

To have good and loyalty supplier can make a lot of benefits and reduce cost to the organization. Fuji has many Thai suppliers to order goods. Many suppliers cause many problems and cost. Fuji has to order from many sources, which means increase cost of order, set up cost, operation cost and etc.

(2) Order cost

When we look at the cost of the supermarket, we can see that the highest cost is come from purchase cost, order cost, carry cost and stockout cost respectively. If we can reduce cost or minimize the cost, which happened, we would increase the organization profit. The type of cost that can reduce or minimize for Fuji Supermarket is the order cost.

Order Cost occurred when we use the old order system such as order by fax or phone. Telephone call, fax paper, purchase order documents and

orders follow-up expenses are expenses occurred from old order system. Using computer can reduce those expenses.

(3) Delivery cost

Fuji has delivery cost because head office wills delivery goods by themselves. In order to avoid waste time of turn back good and reorder, they do not allow Thai supplier delivery good to their branch. They check quality and quantity for all of items before sending to the branch.

4.2 Purposed Solutions

(1) Solution for problem of supplier

Fuji should try to reduce number of Thai supplier. Supplier must be few and deliver virtually 100% good products. The good supplier should be:

(a) Fewer but better suppliers

(b) Long term partnerships with a few suppliers

(c) Quality at the source by preventing defects

(d) Frequent delivery of goods directly to the point of use.

In order to have a good supplier's performance, Fuji should find the supplier which have:

(a) Deliveries are made on time and are of the quality and in the quantity specified. This maintains the consistent flow of processing operations for the purchasing organization.

(b) Prices are fair and efforts are made to hold or reduce the price.

(c) Supplier is able to react to unforeseen changes such as increase or decrease demand, quality or delivery schedule which all frequent occurrences in operations.

(d) Supplier continually improves product and services.

Fuji should evaluate through all of the above mentioned characteristics by meeting with potential and exiting supplier and then cut off the supplier who do not reach the standard of performance which have been set. Fuji should have long-term relationship with supplier in order to get the discount or better price, delivery and quality.

(2) Solution for reduce delivery cost

Fuji should allow Thai supplier deliver goods to their branch and let their branch check quality and quantity by themselves. And another way is if they can find suppliers which we mentioned in the above, they will have 100% correct goods from the supplier. The time for checking stock and operation cost will reduce.

(3) Solution to reduce order cost

(a) Electronic Data Interchange (EDI)

In the past few decades high technology concepts developed in other fields have been successfully adopted to help move product from the shipping floor and to eliminate the bane of every warehouse and distribution center-excessive paperwork. One of the ways to decrease paperwork is increase the communications effectiveness among supplier, and the distribution center and its branches has been the technology of Electronic Data Interchange or EDI.

Advantages of the EDI concept are as follow:

(1) Electronic purchase order rather than use old system

(2) Electronic Invoicing

(3) Automatic data collection

(4) Tracking Shipment

Another benefit of EDI is that each time a retailer sells an item, the barcode tag, which is attached, is scanned by the cashier by using the barcode scanner. This data is transmitted via computer directly to the Head Office in Japan for stock replenishment. By this method inventories can be kept to a minimum with a subsequent reduction in cost.

When Fuji order goods from the supplier in Japan, they can use the computer technology instead of use fax or telephone. EDI program will help Fuji to solve the problem. The program should be set at the head office in Thailand and in Japan to link to data. Fuji can order goods by opening the program and using Internet to send data or quotation or purchase order. All ordered goods will be typed in the form in the program and click send when finished. Then when the data is sent to Japan, they will send back the order confirmation to Thailand to print out and also it includes date of delivery number of invoice. Then when the goods are sent, the invoice will be sent through the EDI program. Same as when doing for the quotation, the process is the same as ordering the goods. They will know how many items in the stock at Japan and can order goods at the proper time.

A computer sends the order directly to the supplier. The supplier's computer checks the buyer's credit and determines that the items are available. The supplier's warehouse and shipping departments are notified electronically, and the items are ready for shipment.

Barcode, which is attached, at the product will be scanned from the cashier both from branch and head office, then the stock will be reduced automatically. The stock is linked to Japan head office therefore, the stock can be double-checked by Thailand and Japan. When the stock reaches order point, Japan can order the goods without waiting for the purchase order from Thailand. And Japan can send the invoice and order confirmation document to Thailand by computer program.

The progression of E-commerce to the Internet will make the advantages of EDI more accessible to a larger number of companies. The implications for supply chain management are: reduced order cost, less time to process a purchase order and potential involvement of large number of supplier in the supply chain.

The basic EDI tools that Fuji should be considering before using EDI are:

(1) EDI standards, standards are the agreements among EDI users as to what is an acceptable EDI communication. There are two types of EDI standards: formatting standards and communication standards.

(2) EDI Software, the EDI standards provide a common language, in term of formatting and syntax, for the development of electronic communication. While the standards are flexible enough to accommodate numerous needs and requirements of different companies, it would be highly unusual for a company to have its internal database set up in the same format as the standard. Just as every company has its own paper form on which information is

placed, every company has its own unique format and structure for its database. Therefore, some method must be used to take the information from the company-specific database and translate it to EDI standard format for transmission.

(3) EDI Networks, EDI documents are transmitted electronically through phone or data lines from one computer to another. In a direct EDI network the computers of the trading partners are linked directly, usually through dial-up modems.

Hence, Fuji should study and provide this type of service to their customers because EDI is one of the fast becoming standard ways of exchanging business documents among Fuji, customers and their suppliers. EDI provides a faster, more accurate, less costly method of communication than do traditional methods of business communications such mail, telephone, and personal delivery.

(b) ABC Concept for Fuji Product

Fuji should analyze product in the supermarket by classifying and leveling the product. They can be level the product by rating them by dollar value of profit. They can classify the product by using ABC Concept.

Product class A

The product of the supermarket can be the product, which have high volume of sale such as imported food or goods from Japan. This type of product presents high volume of sale to the supermarket. Fuji should put tightest control with detail of inventory record and accurate updated value of order quantities and reorder points.

Product class B

This class product can be Thai foods or the product from local which has lower sales volume than product class A. Class B product can switch supplier until it gets the best supplier or effective one. Product in class B can have less frequent updating of records and review of order quantities and reorder point.

Product class C

The product of this class can be the product, which has lowest volume of sales such as general product, kitchenware. Fuji has little control and inventory reorder can be kept simple.

4.3 How to Determine the Effectiveness of Inventory System

Consistent with the systems approach to achieving the least cost of supermarket operations is the need to know how effectively the functions of your organization are being performed. The organization can see as the following points:

(1) The least total cost may mean that one or two departments are incurring increased costs in order that other departments may achieve greater saving.

(2) Since each department in the organization is sacred to the department head, he or she isn't about to let the cost of the department rise, just to benefit another department.

(3) Since the summation of the various departments' costs influences company profits, you have to find out how well your warehousing and distribution operations are being carried out.

(4) The best way to find out how well you are doing is to order a meticulous industrial engineering study of operations.

4.3.1 Improve Materials Handling in the Receiving Department

The following are the guidelines on improving material handling in the receiving department:

(1) Be aware and pay attention that packing lists from certain suppliers may be difficult to work with when checking incoming materials.

(2) Tighten supervision of piece counting where necessary to ensure that the company is getting what it paid for.

(3) Set up a procedure to reporting shortages or incorrect amounts.

(4) Coordinate of inspection and quality control.

4.3.2 Using Computers in Receiving for Cash Paybacks

A computer terminal in the receiving office will enable the receiving clerk to enter packing list information directly to the online receiving system. When this happens the computer can print automatically the product list. Even barcode information can be produced to make data entry and processing of the due-ins faster or can eliminate all of the manual transcription errors that can occur.

Once the information has been entered to the computer, the account department can appraised the receipt of the material, purchasing department can check status of the material or etc.

V. COMPARATIVE EVALUATION BETWEEN THE EXISTING AND THE PROPOSED INVENTORY SYSTEM

5.1 Problem Classification

In the first stage of change, the problem will always happen. The problem can be classified as following:

5.1.1 Cost

For finding out the best supplier, it can create cost for searching and cost of meeting with the supplier. The cost of hiring committee to review and searching wills occur in this stage.

For using the computer technology help for ordering goods to supplier instead of using the old system, the cost of buying new program will occur. The program should be set at head office and branch in Thailand and also in Japan. The cost also consists of cost of computer, EDI program, operation cost for set up and etc. There are all costs of investment for the organization. Even though there are high costs in the first time it will help the organization reduce the order cost in the long run.

5.1.2 Time consumption

For the supplier problem, Fuji will take too much time to find out the best supplier and reduce number of supplier. They have to meet individual supplier and make a performance comparison for each supplier.

At first for changing to the new system, the program should be learned by the employee. It will take time for learning the program but the EDI program is not very complex. The employee will not take too much time to learn. The program can be used by only one person. There will be some problems at the first time when using the program but these problems will gradually disappear after the user gets used to the program.

Table 5.1. Comparison Benefit and Cost between Old System and Purposed system.

Old System for order goods	Proposed system for order goods
1. Simple use.	1. A little bit complex than old system.
2. High order cost.	2. Reduce order cost.
3. Have high set up time and purchase time.	3. Reduce set up and operation cost.
4. A lot of paper work.	4. Reduce paper work.
5. Put a lot of employee or officer to management.	5. Faster system.
	6. Put a few employee or officer to management the system.
	7. Easily management the system.

EDI allowing organization to exchange information even if they have different hardware and software components. Invoice, purchase orders, and payments are some of the routine documents that EDI can handle-it replaces the phone call or mailed document or either fax. The benefit of changing to the new system will be as follows:

5.2 Benefits for Using New Proposed System

The following benefits are commonly associated with traditional EDI and Figure 5.1 show the processing of the old system purchasing system and also Figure 5.2 show the processing of the new proposed system:

5.2.1 Improved Process Quality

Better record keeping, fewer data errors, reduced processing time, less reliance on human interpretation of data, and minimized unproductive time all contribute to increased process quality.

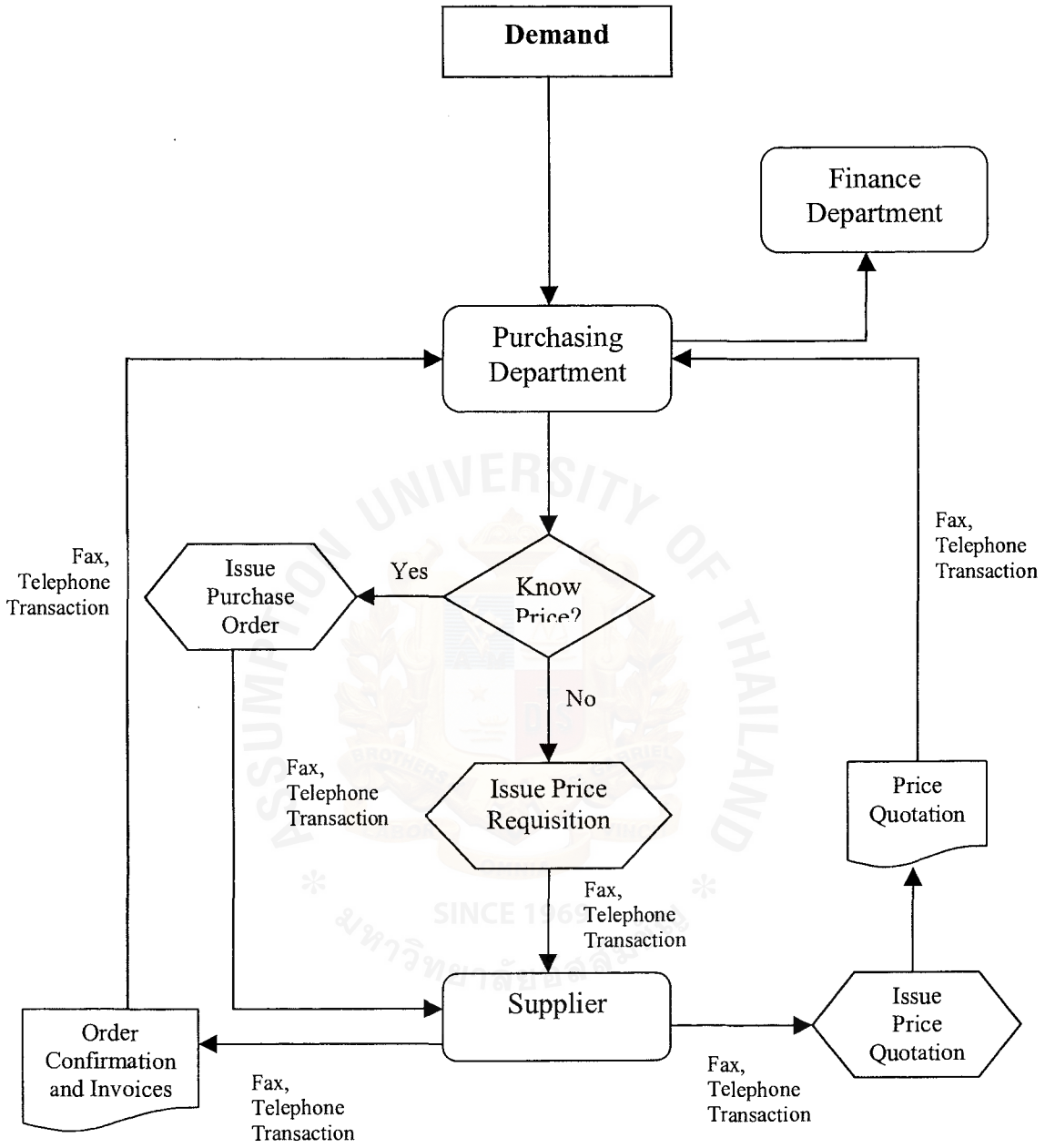

Figure 5.1. Processing of the Old Purchasing System.

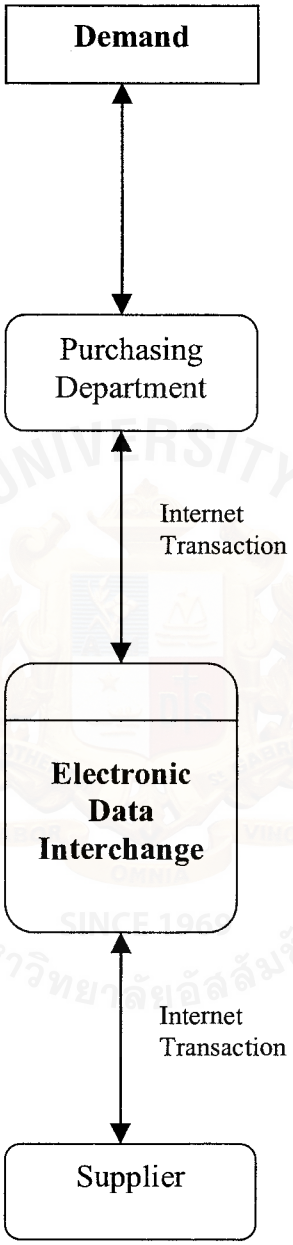

Figure 5.2. Processing of the Proposed Purchasing System.

5.2.2 Reduced Order Cycle Time

Faster, more accurate, order fulfillment reduces inventory "safety stock" levels, can help to establish automated inventory replenishment, and increases customer satisfaction.

5.2.3 Lower Document Distribution Costs

Reduction in mailroom sorting/distribution time, elimination of lost or misplaced physical documents, a reduction in postage, and other related costs all result from digital data exchanges. Instead of having a ton of papers for preparing quotation paper, doing the purchase order, doing the invoice or etc, the EDI can help organization solve this problem. Fuji will reduce number of paperwork, cost of paper or etc. These can increase benefit to the organization. It is easier to think of this future as a paperless system than it is to try to determine how individual paper items will be replaced by the computer. When all the systems are on the computer, then the manual interfacing can be eliminated.

5.2.4 Faster Settlement

Since orders can be filled and delivered sooner, and billing and related documents processed faster, settlement can also occur sooner allowing buyers to take advantage of "early payment" discounts and improving suppliers' cash flows.

5.2.5 Improved Information Management

Accurate information and transactional audit trails enable better decision support and can allow businesses to identify areas offering greatest potential for continuous improvement or other cost reduction efforts.

5.2.6 Reduce the Order Cost

EDI save the cost of opening mail, directing it to the right department, checking the document for accuracy, and reentering the information in a computer system.

Savings are considerable in light of the hundreds to thousands of documents many firms typically handle easily and it can replace manual operation.

5.2.7 Reduce set up and Operation Cost

As using the old system, the workers have to use many times to prepare the documents, typing, sending the fax or invoicing. EDI can help the inventory system reduce time in this area. All data will update in the computer and it can also check up the stock in the inventory. The worker who does this job can be places or transfers to another responsibility and can reduce number of worker.

5.2.8 Reduce Number of Worker

The number of worker can reduce because of using the new computer to order the goods. Because of the simple usage of the program, the worker can do multitask and the program can help and reduce work in many functions such as invoicing, purchasing or so forth.

5.2.9 Cost Effective Document Distribution

In order to achieve universal acceptance throughout the supply chain, a solution is needed that will be cost effective for everyone. Forcing trading partners to invest in a proprietary system that does not bring them real benefit, even if it were possible to do so universally, would only result in the suppliers' increased costs ultimately being passed back to the buying organization.

5.2.10 Real Time Data Transmission

Although batch processing delays may not be too problematic for exchanges of non-time sensitive data, in order to shorten order cycle times even further and allow for strategies such as JIT to be successfully implemented, trading partners want the availability of virtually instantaneous end-to-end data transmission.

5.3 Measure of Capacity

Replacement of proposed system in Fuji supermarket, the capacity can be measured in term of cost reduction. What percentage of cost will be reduced when using new system? The time consumption for order product and the cost should be reduced but the performance and accuracy of the process should be increased. The Table 5.2. indicates the comparison of old system and proposed system between the cost occurred and time consumption. And Table 5.3. indicates the approximate cost saving summary for Fuji Supermarket.

Table 5.2. Comparison of Old System and Proposed System between the Cost Occurred and Time Consumption.

Type of Cost	Old System	Proposed System
Purchasing paper cost	Yes	No
Quotation paper cost	Yes	No
Telephone cost	Yes	No
Fax cost	Yes	No
Internet cost	No	Yes
Labor cost	Yes	Yes
Set up cost	Yes (High)	Yes (Low)
Time Consumption	Yes (High)	Yes (Low)

Table 5.3. Cost Saving Summary for Fuji Supermarket (approximately) as interviewed with Fuji.

Type of Cost	Old System (Monthly)	Proposed System (Monthly)
Purchasing paper cost	7,200 Bahts	-
Quotation paper cost	5,000 Bahts	-
Telephone cost	4,000 Bahts	-
Fax cost	7,000 Bahts	-
Internet cost	-	300 Bahts
Labor cost	8,000 Bahts	8,000 Bahts
Set up cost	4,000 Bahts	1,000 Bahts
Time Consumption	20 Hours.	10 Hours.

Assumed that Fuji sells the 12,000 imported instant noodle food per year and purchases in quantities of 2,000 Bahts per order. Lead-time for the receipt of an order is six days. The cost accounting department has analyzed inventory costs and has determined that the cost the placing an order is 2,000 Bahts and the annual cost of holding one item in the inventory are 20 Bahts. What is Fuji's total annual inventory cost?

Formula is Annual Ordering Cost = $\frac{U}{Q} \times C_O$

Where Q = Order quantity

U = Annual usage

C_O = Order Cost per Order

C_H = Annual holding cost per unit.

The ordering cost is determined by C_O, the cost to place one order (2,000 Bahts) and the number of orders placed per year. Since Fuji sells 12,000 instant foods per year and order 2,000 per order, it must place 6 orders per year (that is, 12,000/2,000) for a total ordering cost of 12,000 Bahts (6 orders per year x 2,000 per order).

The annual holding cost is determined by C_H, the cost of holding cost one item is 100 Baht for one year and the number of instant food held as cycle stock. Notice that the inventory level is constantly changing and that no single item ever remains in the inventory for entire year.

If there are 1,000 instant noodle in inventory over the entire year then the annual inventory holding cost is 20,000 Bahts (50 per item x 1,000 units). Or, in our general notation,

$$\text{Formula is} \qquad \text{Annual Holding Cost} = \frac{Q \times C_H}{2}$$

Adding annual ordering cost and annual holding cost give the following equation for the total annual cost (TAC):

$$TAC = \left(\frac{Q}{2}\right) \times C_H + \left(\frac{U}{Q}\right) \times C_O$$

For Fuji, TAC is 12,000 Bahts + 20,000 Bahts = 32,000 Bahts.

Therefore, if one type of cost reduces, the TAC would be reducing as well. In this proposed system, the order cost or set up cost to place order will be reduced because of reduction of paper or telephone cost. So, if the cost of placing an order is 500 Baht, TAC is reducing to be 23,000 Bahts (3,000 Bahts for annual ordering cost and 20,000 Bahts for annual holding cost.

We can see that in this assumption, the TAC for the proposed system is reducing 28% from the old system.

VI. CONCUSIONS AND RECOMMENDATIONS

6.1 Conclusions

To increase the profit of the organization, one of the ways is to reduce the unnecessary cost. Studying and developing the inventory system can help the organization achieve the goals.

Fuji Supermarket, the exiting inventory system has a weakness point which are high ordering cost for order goods from supplier because there are a lot of suppliers in Thailand. Fuji still uses fax and telephone for order good (old system) so it creates many tasks and have set up and operation cost for ordering goods and so forth.

In the project, we have suggested the proposed inventory system to help Fuji reduce the ordering cost and also set up and operation cost. Its mean that the Total Annual Cost will be reduced.

The EDI computer program is the proposed systems to help and develop the system of ordering the goods. EDI allowing organization to exchange information even if they have different hardware and software components. Invoice, purchase orders, and payments are some of the routine documents that EDI can handle-it replaces the phone call or mailed document or either fax. The benefit of EDI are reduce paper work, reduce order cost, reduce set up and operation cost and also reduce number of worker.

The EDI can help using paperless because when all the systems are on the computer, then the manual interfacing can be eliminated. The order or setup cost originates from the expense of issuing a purchase order to an outside supplier or from internal production setup costs. The order cost includes such item as making requisitions, writing purchase orders, doing the processing necessary to complete the transaction. The order cost and the set up cost can be reduced by EDI because the

program can do all of the process by use a few people to do all the process. EDI provides a faster, more accurate, less costly method of communication than do traditional methods of business communications such as mail, telephone, and personal delivery.

For measuring the effectiveness and efficiency of the proposed system, Fuji can look at the reduction of the Total Annual Cost. As the assumption of the cost of Fuji, the TAC cost will be reducing 28% from the existing system. This means that Fuji will have more profit or the profit of the organization will be increased.

6.2 Recommendations

For most organizations, the ultimate aim is to reduce the cost of the organization. For the proposed inventory system as mentioned, it is one of the several ways to help the organization reduce the cost. In the long term, Fuji can develop the supply chain management system into their inventory system.

The benefit of fast, on-time deliveries also apply to the inventory system because the organization demands quick, dependable deliveries from their suppliers to minimizing inventory levels. Three criteria most often considered by firms selecting new supplier are price, quality and delivery. Because firms spend a large percentage of their total income on purchased items, finding suppliers that charge low price with best quality is a key objective.

The progression of technology to the Internet will make the advantages of EDI more accessible to a larger number of companies. The implications for supply chain management are reducing ordering cost, less time to process a purchase order, and potential involvement of large number of supplier in the supply chain. Effective supply chain management requires a deep understanding of a limited number of suppliers.

For measuring the performance of the proposed system, the TAC is not the only way to determine or evaluated the cost reduction while changing to the new system. Fuji can also use the Inventory Turnover to measure and compare the cost. The Inventory Turnover is an inventory measure obtained by dividing annual sales at cost by the average aggregate inventory value maintained during the year or:

$$\text{Inventory Turnover} = \frac{\text{Annual Sales (at cost)}}{\text{Average Aggregate Inventory Value}}$$

Inventory should be considered an investment because it is created for future use. However, it ties up funds that might be used more profitably in other operations. Managing the supply chain so as to reduce the aggregate inventory value will be reflected in the current assets portion of a firm's balance sheet. Decreasing weeks of supply or increasing inventory turns reduces the pressure on working capital by reducing inventories. Increasing the percentage of on-time deliveries will increase revenue because satisfied customers will buy more products or services from the firm.

Furthermore, Fuji should do the research and development (R&D), which creates new knowledge of materials and technologies and then applies them to create and induce new system and services to the organization. Fuji, should do applied research attempt to solve the practical problems in turning ideas or innovation into best services.

Moreover, the proposed system is not only an option for the organization. Fuji should develop and find out the best system for them. Even if it will take a long time to develop but it is worth and increases the profit to the organization in the long run.

APPENDIX A

INTERVIEW QUESTIONS

INTERVEIW QUESTIONS

(1) What is the organization background?

(2) What are the objectives regarding the inventory system of your organization?

(3) What is the characteristics of product?

(4) Do you classify your product? If, How?

(5) Who is your competitor?

(6) How do you classify your competitor?

(7) What is the characteristics of each competitor?

(8) Who is your target market?

(9) What is the process of ordering the goods?

(10) How do you order the goods?

(11) How many suppliers do you have?

(12) How do you select supplier?

(13) Do you review supplier performance?

(14) Do you use Just-In-time system in your inventory?

(15) How do you design process of your inventory system?

(16) When is your reorder point and how do you know when the stock reaches the reorder point?

(17) What is the system for stocking the goods in your limited storeroom?

(18) What is the type of forecasting demand technique?

(19) Is your forecast made for Short, Medium, Long term?

(20) What is your data for forecast demand? From where?

(21) How you determine the lot size for each product? (Small, large)?

(22) Do you have problem of order goods and what?

(23) Do you have problem of delivering the goods and what?

(24) Do you have problem with your supplier and what?

(25) How many times and how do you checking your stock?

(26) What is your system for checking your stock?

(27) What is your cost of the inventory system occurrence and which one is highest?

(28) Do you have problem with stockout cost and how frequently?

(29) At present, what is your problem in the inventory system?

(30) How do you solve the problem?

(31) What is your measuring tool for measuring your inventory system?

(32) Do you have a plan to develop computer technology in your system?

(33) Do you have cost for purchasing order in your purchasing department and how many for each cost (purchase order paper or etc.)

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