INVENTORY CONTROL FOR A MEDIUM-SIZED RESTAURANT

by

Mr. Permsak Buatongthanakarn

A Final Report of the Six-Credit Course
CE 6998 - CE 6999 Project

Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Science
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Project Title	Inventory Control for a Medium-Sized Restaurant
Name	Mr. Permsak Buatongthanakarn
Project Advisor	Dr. Chamnong Jungthirapanich
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The Graduate School of Assumption University has approved this final report of the six-credit course, CE 6998 — CE 6999 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 2002

ABSTRACT

Our restaurant was established about 10 years ago. It is a seafood restaurant located in Thonburi with a Capacity of 400 seats. It currently operates full, mostly on holidays and weekends. Target groups is family group. The operation time is 5:00 p.m. to 02:00 a.m. everyday.

At present, our restaurant faces the problem which very high percent of food cost resulting in low profit. There are many factors that may cause high percent of food cost: inventory control system is not good enough, price is not suitable, etc. However, we see that most problems occur in the inventory system that has many processes.

To solve the problem we must known the current status of inventory system for improvement correct. Data collection process is used to gather all data of the stock in a period of one month. The proposed system is to develop the inventory control system for using as a database. Turnover ratio is suitably reset according to stock policy of each group. Using the application of ABC product classification makes estimating inventory levels.

The proposed system will be developed to replace some parts of the existing system for reducing the cost of food sold. When the new system can prove that it has a lower level of inventory investment. It will help any medium-sized restaurant to improve the inventory control system.

ACKNOWNLEDGEMENTS

I would like to express sincere gratitude to my Dean, Dr. Chamnong Jungthirapanich. His patient assistance, guidance, and constant encouragement have led me from research inception to research completion. Without him, this project would not have been possible.

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I. INTRODUCTION

1.1 Background of the Study

In restaurant business, everyone knows that food is the most important thing in the business. Even though everything is the best, but if food is not good, that restaurant cannot be successful. The first thing in making good food is to have good materials. This is not concerned only with buying good materials but also include good inventory control.

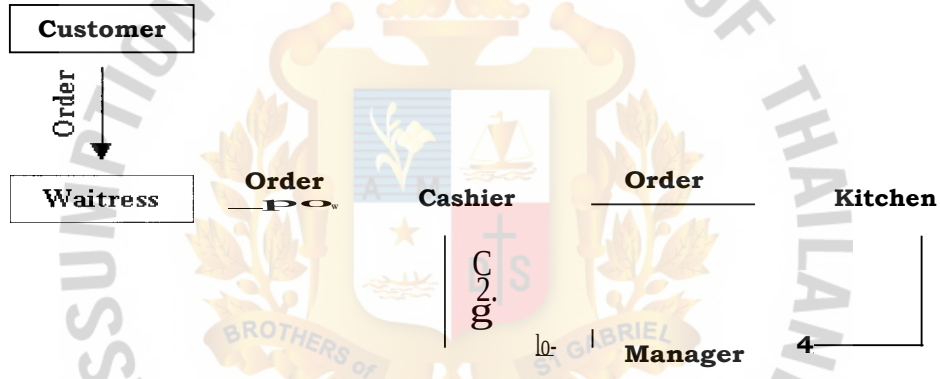

Figure 1.1. Diagram of Inventory System for Restaurant.

At present our restaurant has a satisfied amount of sale of food (not including beverage) because we have know that to use good material for cooking good food. However, for controlling the raw material to be available and fresh, we have to pay more expenses because customer's the ordered cannot be forecasted. So, we have to prepare more materials that causes waste of perishable materials. Presently, restaurant is operated on a computer-based system; that is the waitress generates the order bill for the cashier who then sends it to the kitchen. Eventually, cashier will send the sale report to

the manager, and kitchen will send food production report and inventory report to the manager. Finally, the manager will make a sale report (daily) and purchase order for preparing raw materials for the next day.

We found that big problems occur in the part of food control process. Food control process comprises of 4 processes: purchasing, receiving, storing and issuing, and food production.

Problems from these four processes would cause inefficient inventory control, which makes high food cost. Therefore, the study is carried to make an improvement in these processes by enhancing the information system.

1.2 Objectives of the Study

The objectives of this project are given below:

(1) To increase profit by reducing the cost from developing inventory control.

(2) To solve the current problems and improve inventory control system by DBMS.

(3) All processes in food production will be analyzed for development of inventory control system.

(4) Monitoring report will include inventory/sales.

1.3 Importance of the Study

After reading this study. Cognitive learning and knowledge that would be received are:

(1) To know the other system of operating inventory control for medium-sized restaurant.

(2) To eliminate general problems that always occur in a restaurant by using the computer system.

(3) To monitor and manage the inventory control systematically.

1.4 Statement of Problem

(1) Difficult to manage the inventory control to match with sales demand that causes waste of perishable material.

(2) Most problems in a medium-sized restaurant are caused by unsecured system making inspection too difficulty.

1.5 Research Methodology

(a) Data collection:

The restaurant operates on a computer-based system, so data collection can be done by using data base management system. For inventory data, data is distinguished into two parts; materials-in data and materials-out data. Materials-in data can be shown by purchase order (daily). and materials-out data can be shown by sales report and proportion of food production.

(b) Implementation:

After deriving the data, the cause of high expense will be analyzed. After that the standard of food production process is set for increasing efficiency of work of each process (purchasing, receiving, storing, and production). When the processes are cleared, we try to reduce cost of food by using inventory control method.

1.6 Scope of the Study

This project is aimed at medium-sized restaurant to reduce cost of food sold by using inventory control method. So, scope of this project focuses on how to manage inventory-controlling system of food production.

II. LITERATURE REVIEWS

2.1 Computers and Inventory Control

Before proceeding to specific control procedures and techniques, one more important topic must be introduced: computers. Today, computers perform many functions in food and beverage operations that once could be done only by manual means. Because various computer systems are more common in hotels, restaurants, and similar operations serving foods and beverages, it is necessary to understand their important role in our industry. The authors therefore recommends that any person planning a career in food and beverage operations complete at least one introductory course in computer operations. This chapter will provide some basic information about the use of computers in food and beverage cost control, including some historical perspectives and basic terms. In addition, we will describe a computer system specifically designed for use in food and beverage operations (Pual D. and Ferald G.,1994).

2.2 Computer in Food and Beverage Operations

Our industry has now been using computer for a number of years. However, it is generally agreed that hotels and restaurants were not quick to take advantage of computers and to put them into general use in this industry. In fact, except for a handful of the larger organizations and properties, it was not until the 1970s that one began to see any widespread use of computer in hotels and restaurants. Larger organizations initially used them primarily to speed certain specific bookkeeping and accounting functions, and hotels used them to process reservations. At first, even in these organizations, control applications were secondary to speedy record keeping. There were a number of reasons for this:

(1) The high cost of computer systems, designed primarily for major corporations, could not be justified by most individual hotel and restaurant units.

(2) Systems reliable enough for most industries were simply not reliable enough for hotels and restaurants, which could not tolerate the "down time" resulting from system failure.

(3) Early programs for hotels and restaurants required a level of operator sophistication that was uncommon among typical industry employees.

An Industry Example

At this point, it will be useful to provide an example to describe a typical computer system found in many of today's foodservice operations. It is not intended to describe any one particular system. It is a composite of several.

Operations proceed along the following lines. Servers arriving for work change into uniforms on a lower level (not shown on the diagram), and then proceed to their side stands in the dining room. On each of the two side stands is a small terminal with keypad and printer that dinning room personnel use to log in--in other word, they record their arrival for work much as they would with a traditional time clock. Other personnel log in terminal in the manager's office.

Guests enter the dinning room supervisor's station, leaving their coats in the coat room. The supervisor, who leaves menus at the table, seats them. Servers greet the guests and take their orders for drinks; the orders are written on ordinary white pads rather than on guest checks. Each server proceeds to a terminal and open an account in computer memory. This account is equivalent to a guest check. The process requires that the server enter a personal code, the table number, the number of guests, and a special code used for a creating a new account. With the account opened, the used a

numerical code to enter the customer's orders for drinks. This information, together with the time of the order, is stored in computer memory, which has been programmed with correct prices for all drinks.

The system is programmed to send the recorded drink orders to the bartender at the service bar, who gets the orders on a remote printer. The hard copy provided by the remote printer is an order for the bartender to prepare the drinks. This hard copy includes the server number, table number, and order time.

The bartender removes the hard copy of the order from the printer and places it on the tray with the prepared drinks, thus eliminating questions about which drinks are for which server and what time the orders were entered. At the appropriate time, the server follows similar procedures for placing food order. Different codes are used for foods and drinks. And the computer is programmed to send food order to the remote printers at the cook's station. All ordered items are stored in memory, but the only item appearing on the remote printer at any preparation station are those appropriate to that station. Thus, food orders are not sent to the service bar, and order for coffee, handled by the servers themselves, do not appear on any remote printer.

After a diner has finished the meal, the server obtains the guest check by requesting one via the terminal and printer at the sidestand. With this system, the guest check is the hard copy on the data stored in the computer, accessed by table and server number. This hard copy is torn from the printer and given to the diner. In this particular establishment, each server acts as a cashier for his or her own checks, and settlement is records for each check as the server receives cash or a credit card.

At the end of a shift, the server reports to the manager's office to turn in the cash, checks, and credit card vouchers for his sales. The manager uses her terminal to obtain summary data showing charge and cash sales for that particular server. She collects cash

and charge vouchers accordingly. Before changing out of uniform and leaving the premises, the server logs out, using the manager's terminal.

At the conclusion of business, a manager seeking a detailed breakdown of the day's business may obtain the wealth of data stored in the computer. A suitable program will provide total data sales categorized into cash sales and charge sales, with the charge sales divided by type of credit card; total dollar sales separated into food sales and beverage sales broken down into dollar sales by menu category or by individual menu items; average dollar sales per customer, per server, per seat, per table, or per hour, or any number of these; seat turnover; number of order of each food and beverage item sold (a reflection of sales mix); total dollar sales per hour; sales in any category for the period to date; total payroll cost of the day, for any part of the day, or for the period to date; and a vast amount of food and beverage cost data, including standard costs.

Using such system, managers can monitor operations at will as the day progresses. Such data at gross sales volume, number of customer served, number of checks outstanding, sale mix, number of portions of particular items sold, and any number of other possibilities may be of special interest at given times throughout the day.

Conceivably, a clerical staff could produce all of the above information. However, it should be obvious that considerable times would be needed to produce such data, and the consequent cost would be great. In addition, the time required would probably make the data hopelessly out of date before it were even produced. Finally, the very accuracy of the data might be questionable.

This chapter briefly traced the development of data processing equipment, from early uses through those recent advances that have brought computers within the reach of large numbers of foodservice operations. By using the simple analogy of the restaurant cashier, we provided an explanation of the way that computers process data

and introduced a number of terms that foodservice managers should become familiar with as computers become more a part of everyday life in foodservice operations. We illustrated and explained the operation of a system resembling some currently used in foodservice and suggested some applications for larger, centralized systems in organizations more complex than the restaurant owned and operated by a single individual. Finally, we indicate two keys to management selection of appropriate computer systems for foodservice establishments.

2.3 Cost and Sales Concepts

However, in spite of the apparently favorable sales comparison, the restaurant profit for the Rush Hour Inn is only a small fraction of the restaurant profit generated by the Graduate Restaurant. Since the between sales and restaurant profit on each statement of income is represented by costs of various kinds, we can infer that some part of the difficulty with the Rush Hour Inn in somehow related to cost. The cost of operation are somehow in more favorable proportion to sales in the Graduate Restaurant. Initially, it is to the nature of these cost and their relations to sales that we must look to uncover the difference between the two establishments. It is possible that the costs of operation are not well regulated, or controlled, in the Rush Hour Inn. It is also possible that sales are not were controlled and that, if Larry Rusher is going to increase his profit to a desirable level, he must begin by exercising greater control over the several kinds of operating costs, as well as over sales.

The statement of income from the Graduate Restaurant suggests that Jim Young has kept both costs and sales under control, and, as we shall see, this is critically important to the success of his business. Comparative investigation of the two restaurants would reveal that Jim Young had instituted various control procedures in the Graduate Restaurant that would be noticeably absent in Larry Rusher's business. These

have enabled Jim to manage his business more effectively. It will be important, therefore, to look closely at the nature and effect of these control procedures in succeeding chapters. However, before proceeding, it will first be useful to establish clear definitions of the terms **cost, sales, and control.** Cost and sales will be defined and discussed in this chapter; control will be covered in the next chapter.

Cost Concept:

Definition of Cost: Accountants define a cost as a reduction in the value of an asset for the purpose of securing benefit or gain. That definition, while technically correct, is not very useful in a basic discussion of controls, so we will modify it somewhat.

As we use the term in our discussion of cost control in the food and beverage business, cost is defined as the expense to a hotel or restaurant of goods or services when the goods are consumed or the services rendered.

Foods and beverages are considered "consumed" when they have been used, wastefully or otherwise, and are no longer available for the purposes for which they were acquired. Thus, the cost of a piece of meat is incurred when the piece is no longer available for the purpose for which it was purchased because it has been cooked, served, or thrown away because it has spoiled, or even because it has been stolen. The cost of labor is incurred when people are on duty, whether or not they are working and whether they are paid at the end of a shift or at some later date.

The cost of any item may be expressed in a variety of units: weight, volume, or total value. The cost of meat, for example, can be expressed as a value per piece, per pound, or per individual portion. The cost of liquor can be expressed as a value per bottle, per drink, or per ounce. Labor costs can be expressed as value per hour (an hour wage, for example) or value per week (a weekly salary).

Costs can be viewed in a number of different ways, and it will be useful to identify some of them before proceeding.

Fixed and Variable Costs

The terms fixed and variable are used to distinguish between those costs that have no direct relationship to business volume and those that do.

Fixed Costs: Fixed costs are those that are normally unaffected by changes in sales volume. They are said to have little direct relationship to the business volume because they do not change significantly when the number of sales increases or decreases. Insurance premiums, real estate taxes, and depreciation equipment are all examples of fixed costs. Real estate taxes, after all, are set by governmental authorities and are based on government's need for a determined amount of total revenue. The taxes for an individual establishment are based on the appraised value of the assessed property as real estate. Real estate do not change when the sales volume in an establishment change.

All fixed costs change over time, of course, increasing, sometimes decreasing. However, change in fixed costs are not normally related to short-term volume changes. For example, an increase in the cost of insurance premiums may be attributable to an insurance company's perception of increased risk with higher volume. Even though the increase in insurance cost is somehow related to an increase in volume, the cost of insurance is still considered a fixed cost. Advertising expense is another example. Larger establishments tend to spend more on adverting because their larger sales volume make larger amount of money available for the purpose, but advertising expense is still considered a fixed cost.

The term "fixed" should never be taken to mean static or unchanging, but merely to indicate that any changes that may occur in such costs are related only indirectly or

distantly to change in volume, as with real estate taxes. Other example of costs that are generally considered fixed include repairs and maintenance, rent or occupancy costs, most utility cost, and the cost of professional services, such as accounting.

Variable Cost: Variable costs are those that are clearly related to business volume. As business volume increases, variable costs will increase; as volume decreases, variable costs should decrease, too. The obvious examples of variable costs are food, beverage and labor. However, there are significant differences between the behavior of food and beverage costs on the one hand and labor costs on the other.

Food and beverage costs are considered directly variable costs. **Directly variable costs** are those that are directly linked to volume of business, such that every increase and decrease in volume brings a corresponding increase or decrease in cost. Every time sells an order of steak; it incurs a cost of the meat. Similarly, each sale of a bottle of beer at the bar brings about a cost for the beer. Total directly variable costs, then, increase or decrease—or at least *should* increase or decrease—in direct proportion to sales volume.

Payroll costs (including salaries and wages and employee benefits, and often referred to as **labor costs)** present an interesting contrast. Foodservice employee may be divided into two categories—those whose numbers will remain constant despite normal fluctuations in business volume, and those whose numbers and consequent total costs should logically (and often will) vary with normal changes in business volume. The first category includes such personnel as the manager, bookkeeper, chef, and cashier. In terms of the above definition, they are fixed cost personnel. Their numbers and costs may change, but not because of short-term changes in business volume. The second category would include the servers, or the waitstaff. As business volume changes, their numbers and total costs can be expected to increase or decrease accordingly.

Both fixed cost and variable-cost employees are included in one category on the statement of income: "Salaries and Wages." Because payroll cost has both the fixed element and the variable element, it is known as a **semi-variable cost,** meaning that a portion of it should change with short-term changes in business volume, and another portion should not.

It must be noted that each individual establishment must make its own determination of which employees should be fixed cost personnel and which should be variable cost. In some specialized cases, it is possible for payroll to consist entirely of either fixed cost variable-cost personnel. For example, there are some restaurants in which the entire staff works for hourly wages. In these cases, numbers of hours worked and consequent cost are almost wholly related to business volume. Conversely, in some smaller restaurants employees may all be on regular salaries, in which case labor cost would be considered fixed.

Controllable and Noncontrollable Costs

Costs may also be labeled **controllable** and **noncontrollable. Controllable costs** are those that can be changed in the short term. Variable costs are normally controllable. The cost of food or beverage, for example, can be changed in several ways—by changing portion sizes, by changing ingredients, or by changing both of these. The cost of labor can be increased or decreased in the short term by hiring additional employees or by laying some off, by increasing or decreasing the hours of work, or, in some instances, by increasing or decreasing wages.

In addition, certain fixed costs are controllable, including advertising and promotion, utilities, repairs and maintenance, and administrative and general expenses, a category that includes office supplies, postage, and telephone expenses, among others.

It is possible for owners or managers to make decisions that will change any of these in the short term.

By contrast, non-controllable costs are those that cannot normally be changed in the short term. These are usually fixed costs, and a list of the more common ones would include rent, interest on a mortgage, real estate taxes, license fees, and depreciation. Managers do not normally have the ability to change any of these in the near term.

2.3.1 Sales Concepts

The term sale is used in a number of ways among professionals in the foodservice industry. In order for the term to be meaningful, one must be specific about the context in which it is used. It will therefore be useful to define the term and to explore some of the many ways it is used in the industry.

(a) Sales Defined

In general, the term sales is defined as revenue resulting from the exchange of products and services for value. In our industry, food and beverage sales are exchanges of the products and services of a restaurant, bar, or related enterprise for value. We normally express sales in monetary terms, although there are other possibilities. Actually, there are two basic groups of terms normally used in food and beverage operations to express sales concept: monetary and non-monetary.

(b) Monetary Terms

Total Sales: Total sales is a term that refers to the total volume of sales expressed in dollar terms. This may be for any given time period, such as a week, a month, or a year. For example, total dollar sales for the Rush Hour Inn was expressed as $658,000 for the year ending December 31, 1 9XX.

By Category: Examples of total dollar sales by category are total food sales or total beverage sales, referring to the total dollar volume of sales for all items in one category. By extension, we might see such terms as total steak sales or total seafood sales, referring to the total dollar volume of sales for all items in those particular categories.

By Server: Sales per server is total dollar volume of sales for which a given server has been responsible in a given time period, such as a meal period, a day, or a week. These figures are sometimes used by management to make judgments about the comparative performance of two or more employees. It might be helpful, for example, to identify those servers responsible for the greatest and for the least dollar sales in a given period.

By Seat: A sale per seat is the total dollar sales for a given time period divided by the number of seats in the restaurant. The normal time period used is one year. This figure is most frequently used by chain operations as a means for comparing sales results from one unit with those of another. In addition, the National Restaurant Association determines this average nationally so that individual operators may compare their results with those of other similar restaurant.

Sale Price; **Sales price** refers to the amount charged each customer purchasing one unit of a particular item. The unit may be a single item (an appetizer or an entrée) or an entire meal, depending on the manner in which a restaurant prices its products. The sum of all sales prices charged for all items sold in a given time period will be total dollar sales from that time period.

Average Sale: An **average sale** in business is determined by adding individual sales to determine a total and then dividing that total by the number of individual sales. There are two such averages commonly calculated in food and beverage operations: **average sale per customer** and **average sale per server.**

Per Customer: Average sale per customer is the result of dividing total dollar sales by the number of sales or customers. For example, if total dollar sales for a given day in a restaurant were $1,258 and the restaurant had served 183 customers, the n the average dollar sale would be $6.87. The average dollar sale concept is also expressed as the average covers, which are synonymous terms in our industry. The average dollar sale is used by foodservice operators to compare the sales performance of one employee with another, to identify sales trends, and to compare the effectiveness of various menus, menu listings, or sales promotions.

Per Server: Average sale per server is total dollar sales for an individual server divided by the number of customers served by that individual. This, too, indicator of the sales ability of a particular individual because, unlike total sales per server, it eliminates difference caused by variations in the numbers of persons served.

All of there monetary sales concepts are common in the industry and are likely to be encountered quickly by those seeking careers in food and beverage management. At the same time, there are a number of nonmonetary sales concepts and terms that also should be understood.

(c) Non-monetary Terms

Total Number Sold: Total number sold refers to the total number of steaks, shrimp cocktails, or any other menu item sold in a given time period. This figure is useful in a number of ways. For example, foodservice managers use total number sold to identify unpopular menu items, in order to eliminate such items from the menu. Additionally, historical records of total numbers of specific items sold are useful for forecasting sales. Such forecasts are useful for making decisions about purchasing and production. Total number of specific item sold is a figure used to make judgment about quantities inventory and about sales records.

Cover: Cover is a term used in our industry to describe one diner, regardless of the quantity of food he or she consumes. An individual consuming a continental breakfast in a hotel coffee shop is counted as one cover. So is another individual in the same coffee shop who orders a full breakfast consisting of juice, eggs, bacon, toast, and coffee. These two are counted as two covers.

Total covers: Total covers refers to the total number of customers served in a given period—an hour, a meal period, a day, a week, or some other. Foodservice managers are usually particularly interested in these figures, which are compared with figures for similar periods in the past so that judgments can be made about business trends.

Average covers: An average number of covers is determined by dividing the total number of covers for a given time period by some other number. That number may be a number hours in a meal period, the number of days the establishment is open per week, or the number of the servers on

duty during the time period, among many other possibilities. The following are some of the more common.

$$\text{Covers per Hour} = \frac{\text{Total Covers}}{\text{Number of Hours of Operation}}$$

$$\text{Covers per Day} = \frac{\text{Total Covers}}{\text{Number of Day of Operation}}$$

$$\text{Covers per Server} = \frac{\text{Total Covers}}{\text{Number of Servers}}$$

The average so derived can be of considerable help to a manager attempting to make judgments about such common questions as the efficiency of service in the dining room, the effectiveness of some promotional campaign, or the effectiveness of a particular server.

Seat Turnover: **Seat turnover,** most often called simply **turnover** or **turn,** refers to the number of seats occupied during a given period (or the number of customers served during that period) divided by the number of seats available. For example, if 150 persons were served luncheon in a dining room with 50 seats, seat turnover would be calculated as 3, obviously meaning that, on average, each seat had been used 3 times during the period. Seat turnover may be calculated for any period, but is most often calculated for a given meal period.

Sales Mix: **Sales mix** is a term used to describe the relative quantity sold of any menu item compared to other items in the same category. The relative quantities are normally percentages of total unit sales and always total 100%.

2.4 ABC Classification

The type of inventory-control applies to every item in inventory. If no adjustment is made, every item is transfer. Also, every item in stock is checked constantly or periodically for its lever. However, inventory investment operating costs can be kept down if we recognize that not every item in inventory deserves the same attention or requires the same level of stock availability to satisfy customers. The marketing considerations are not the same across an entire product line. Some products may be in a more competitive market than others, may be more profitable that others, may have customers that require service more than others. This suggests that before a firm policy for inventory control can be established each product should be classified according to its requirements.

The ABC classification scheme based on the 80-20 principle serves our purposes quite well. Recall that the 80-20 principle refers to 20 percent of a product line accounting for 80 percent of the sales. The entire product line can be ranked from the item with the highest sales to the one with the lowest. The products are then placed into two or more groups such as AB, ABC, and ABCD. Judgment plays a large role in how far down the item lists are designated as A items, B items, etc. However, a 20-30-50 percent breakdown would retain the idea behind the 80-20 principle. Different service levels could be established for the different classes (for example, 99 percent for A items, 95 percent for B items, and 85 percent for C items) to reduce overall inventory investment (recall Figure 11-4), or different methods of control could be used to minimize the stock-keeping effort.

Example: A few years ago the Markem Company, a leading manufacturer of specialized marking equipment, was overhauling its inventory-control system. An "ABC" approach was used to classify its products for inventory-control purposes. All inventory items

were listed in descending order by annual dollar usage. Items could then be easily grouped into one of the following classes:

Table 2.1. Example of ABC-Classification.

Class	Basis of Classification	% of Total Value	Orders/Year
A	The first 100 items in the annual dollar usage list	35	6
B	All items with over $500 annual dollar usage except A	33	4
C	All items with over $100 annual dollar usage except A/B	25	2
D	All items with less that $100 annual dollar usage	5	not more than 2
E	All new items until annual dollar usage can be determined	2	

Price and Transportation-Rate Breaks

Price and transportation-rate breaks can alter ordering patterns so dramatically at times that they deserve special mention. In fact, we can develop a guiding principle that says that quantity to be ordered is more likely to occur at a rate-break quantity than at any other quantity value. This stresses the point that rate breaks should always be explored carefully before finalizing the inventory policy for an item.

To illustrate what these rate breaks mean to inventory policy, consider the same data for the problem used in control-system design. In addition, suppose the

transportation tariff schedule shows the following quantity-rate breaks for shipping the product item to the inventory location.

Table 2.2. Transportation Rate VS Quantity.

Quantity (Units)	**Transportation Rate** ($/Unit)
Less than 500	$0.15
500 to 700	0.10
More than 700	0.07

The savings in freight costs must be balanced against the costs of procurement and carrying. Let's assume, to keep the illustration simple, that both lead time and demand are known for sure. The total cost expression becomes:

TC = (transportation rate) (annual demand)
+ (procurement cost) (annual demand/order quantity)
+ (carrying cost) (item value) (order quantity/2)

To determine the lowest-cost ordering quantity, we want to check the total cost at each of the rate-break quantities as well as the minimum-order quantity without regard to the rate breaks. Illustrating the cost calculations, consider the previously determined order quantity of 650 units

TC = (0.10) (100 x 52) + (20) (100 x 52/650) + (.25) (2) (650/2)
= $842.50

Repeating this for the end-point quantities in the transportation-rate-break schedule and other selected quantities, the following table can be developed:

Table 2.3. Order Quantity.

	ORDER QUANTITY			
	499	650	701	800
Transportation cost	$780	$520	$364	$364
Procurement cost	208.4	160	148.4	130
Carrying cost	124.8	162.5	175.3	200
Total	$1113.2	$842.5	$687.6*	$694

*Minimum-cost quantity

The optimum order quantity is 701 units, which is the minimum quantity in the minimum-transportation-cost category. To increase the order quantity beyond this point simply raise the carrying cost and the total cost above the minimum value. (Ballou, Ronald H.)

Price-discount schedules are evaluated in the same fashion as transportation-rate breaks. Both price discounts and transportation-rate breaks may exist at the same time. Both price and transportation costs would be worked into the total-cost formula in the following way:

TC = (unit price + transportation rate) (annual demand)
+ (procurement cost) (annual demand/order quantity)
+ (carrying cost) (item value) (order quantity/2)

2.5 AGGREGATE CONTROL OF INVENTORIES

Top management is frequently more interested in the total amount of money tied up in inventories and the service levels for broad groups of items than in the control of individual item. Although carefully setting the policy for each item does provide precise control of individual item inventories as well as inventories in the aggregate, management at this level of detail for general planning purposes becomes too cumbersome. Therefore, methods that collectively control items in group have had a place among inventory control procedure.

Turnover Ratios

Perhaps the most popular aggregate inventory control procedure is the turnover ratio. It is a ratio of the annual sales on inventory to the average investment in inventory for the same time period as sales, where sales and inventory investment are valued at the echelon in the logistics channel where the items are held in inventory. That is

$$\text{Turnover ratio} = \frac{\text{Annual sales at inventory cost}}{\text{Average inventory investment}}$$

The popularity of the measure undoubtedly stems from the ready availability of data (the company's stock status report is a common source) and the simplicity of the measure itself. Different turnover ratios may be specified for different classes of products, or for the entire inventory. As a point of reference, manufacturers, wholesalers, and retailers have an inventory turnover ratio of 7.65 (Statistical Abstract of the United States: 1989).

By specifying turnover ratio to be achieved, the overall inventory in investment is controlled relative to the level of sales. It is appealing to have inventory investment change with the level of sales; however, the turnover ratio causes inventories to vary

directly with sales. This is a disadvantage since we normally expect that inventories increase at a decreasing rate due to economies of scale. There is a price to be paid for simplicity!

ABC Product Classification

A common practice in aggregate inventory control is to differentiate product into a limited number of categories and then to apply a separate inventory control policy to each. This makes sense since all products are not of equal importance to a firm in such terms as sales, profits, market share, or competitiveness. By selectively applying inventory policy to these different groups, inventory service goals can be achieved with lower inventory levels than with a single policy applied to all products.

It is well known that product sales display a life-cycle phenomenon where sales begin at product introduction with low levels, increase rapidly at some point, level off, and finally decline. The products of a firm are usually in various stages of their life cycle and, therefore, are contributing a high proportion of the sales volume. This disproportional between the percent of items in inventory and the percent of sales has generally been referred to as the 80-20 principle, although rarely do exactly 20 percent of the basis for the ABC classification of items. A items are typically the fast movers, B items the medium movers, and C items the slow movers. There is no precise way that the items are grouped into one category or another, or even of determining the number of categories to use. However, rank ordering the items can then be reassigned to other categories as their importance dictates. Inventory service levels can then be given to each category.

For inventory control reasons, suppose we wish to classify these items into three groups. The A items are to represent approximately the top 10 percent of dollar sales, B items are to be about the next 40 percent, and the C items are the remaining 50 percent

of sales. We sort the previous table according to dollar sales. Computing the cumulative percent of items and the cumulative percent of sales on the sorted data yields the following table 2.Scanning down the cumulative percent of items column until approximately 10 percent of the items are accumulated will represent the A item category. Due to the small number of items, we cannot find exactly 10 percent. We may choose to round up. Next if the break point for B items, which is where the cumulative percent of items is 50 percent, we can now see that A items, or 11 percent of the items, account for 92% - 49% = 43% of the sales. C items, representing 50 percent of the items, account for only 100% -92% = 8% of the sales. Service levels can be for these categories according to the importance of each to the company and to its customers.

Table 2.4. Items Classification.

	Item Number	Cum. Percent of Items	Volume,	Cum.Percent of Sales	Item Class
GUFLO	1	5.56%	7,115,000	29.04%	
REGUFLO	2	11.11%	5,000,000	20.40%	:A
CENTRI-CATCH	3	16.67%	3,500,000	14.28%	
INTRASET	4	22.22%	2,500,000	10.20%	
IV-SET	5	27.78%	1,000,000	4.08%	
SUBCLAVIAN	6	33.33%	975,000	3.98%	B
Pressure Cuff	7	38.89%	972,000	3.97%	
Pressure Tubing	8	44.44%	825,000	3.37%	
CSP	9	50.00%	750,000	3.06%	
COLLECTAL Lin	10	55.56%	727,000	2.97%	
VACUFLO	11	61.11%	350,000	1.43%	
JUGULAR II	12	66.67%	300,000	1.22%	
CATHASPEC	13	72.22%	150,000	0.61%	
SUBCLAVIAN II	14	77.78%	137,000	0.56%	
IV-12	15	83.33%	74,700	0.30%	
EXE-FLO	16	88.89%	65,100	0.27%	
COLLECTAL Can	17	94.44%	54,800	0.22%	
INTRAVAL	18	100.00%	8,300	0.03%	
			24,503,900		

2.6 Inventory Objectives

Inventory management involves balancing product availability, or customer service, on the one hand with the costs of providing a given level of product availability on the other. Since there may be more than one way of meeting the customer service let us begin the development of the methodology to control inventories with a way to define product availability and an identification of the costs relevant to managing inventory levels.

Product Availability

A primary objective of inventory management is to assure that product is available at the time and in the quantities desired. This is commonly judged on the basis of the probability of being able 1 to fill a request for a product from current stock. This probability, or item fill rate, is referred to as the service level, and, for a single item, can be defined as

$$\text{Service level} = 1 - \frac{\text{Expected number of units out of stock annually}}{\text{Total annual demand}}$$

Service level is expressed as a value between 0 and 1.Because a target service level is typically specified, our task is to control the expected number of units out of stock.

We will see that controlling the service level for single items is computationally convenient. However, customers frequently request more than one item at a time. Therefore, the probability of filling the customer order completely can be of greater concern than single-item service levels. For example, suppose that five items are requested on an order where each item has a service level of 0.95, that is, only a 5 percent chance of not being in stock. Filling the entire order without any item being out of stock would be the probability of filling the order completely is somewhat less than the individual item probabilities as given.

$$0.95 * 0.95 * 0.95 * 0.95 * 0.95 = 0.77$$

A number of orders from many customers will show that a mixture of items can appear on any one order. The service level is then more properly expressed as a *weighted average fill rage* (WAFR). The WAFR is found by multiplying the frequency with which each combination of items appears on the order by the probability of filling the order completely, given the number of items on the order. If a target WAFR is specified, then the service levels for each item must be adjusted so as to achieve this desired WAFR.

Procurement Costs

Costs associated with the acquisition of goods for the replenishment of inventories are often a significant economic force that determines the reorder quantities. When a stock replenishment order is placed, a number of costs are incurred that are related to the processing, setup, transmitting, handling, and purchase of the order. More specifically, procurement costs may include the price, or manufacturing cost, of the product for various order sizes; the cost for setting up the production process; the cost of processing an order through the accounting and purchasing departments; the cost of transmitting the order to the supply point, usually by mail or electronic means; the cost of transporting the order when transportation charges are not included in the price of the purchased goods; and the cost of any materials handling or processing of the goods at the receiving point. When the firm is self-supplied, as in the case of a factory production setup costs, transportation costs may not be relevant if a delivered pricing policy is in effect.

Some of these procurement costs are fixed per order and do not vary with the order size. Others, such as transportation, manufacturing, and materials-handling costs, vary to a degree with order size. Each requires slightly different analytical treatment.

Carrying Cost

Inventory carrying costs result from storing, or holding goods for a period of time and are roughly proportional to the average quantity of goods on hand. These costs can be collected into four classes: space costs, capital costs, inventory service costs, and inventory risk costs.

Space Cost: Space costs are charges made for the use of the cubic footage inside the storage building. When the space is rented, storage rates are typically charged by weight for a period of time, for example, $/cwt./month. If the space is privately owned or contracted, space costs are light, as well as fixed costs, such as building and storage equipment cost, on a volume-stored basis. Space costs are irrelevant when calculating carrying costs for in-transit inventories.

Capital Costs: Capital costs refer to the cost of the money tied up in inventory. This cost may represent more than 80 percent of total inventory cost (see table 5.2), yet it is the most intangible and subjective of all the carrying cost elements. There are two reasons for this. First, inventory represents a mixture of short-term and long-term assets, as some stocks may serve seasonal needs and others are held to meet longer-term demand patterns. Second, the cost of capital may vary from the prime rate of return on the most lucrative investments forgone by the firm.

Inventory Service Costs: Insurance and taxes are also a part of inventory carrying costs because their level roughly depends on the amount of inventory on hand. Insurance coverage is carried as a protection against losses from fire, storm, or theft. Inventory taxes are levied on the inventory levels found on the day of assessment. Although the inventory at the point in time of the tax assessment only crudely reflects the average inventory level experienced throughout the year, taxes typically represent

only a small portion of total carrying cost. Tax rates are readily available from accounting or public cost.

Inventory Risk Costs: Costs associated with deterioration, shrinkage (theft), damage, or obsolescence make up the final category of carrying costs. In the course of maintaining inventories, a certain portion of the stock will become contaminated, damaged, spoiled, pilfered, or otherwise unfit or unavailable for sale. The costs associated with such stock may be estimated as the direct loss of product value, as the cost of reworking the product, or as the cost of supplying it from a secondary location.

Out-of-Stock Costs

Out-of-stock costs are incurred when a order is placed but cannot be filled from the inventory to which the order is normally assigned. It presupposes certain actions on the part of the customer, and, because of their intangible nature, they are difficult to measure accurately.

A lost sales cost occurs when the customer, faced with as out-of-stock situation, chooses to withdraw his or her request for the product. The cost is the profit that would have been made on this particular sale and may also include an additional cost for the negative effect that the stockout may have on future sales. Products for which the customer is very willing to substitute competing brands, such as bread, gasoline, or soft drinks, are those that are most likely to incur lost sales.

The 80-20 Curve

The logistic problem of any firm is the total of the individual product problems. The product line of the typical firm is made up of individual products at different stages of their respective life cycles and with different degrees of sales success. At any point in time, this creates a product phenomenon known as the 80-20 curves, a particularly valuable concept for logistic planning

The 80-20 concept is derived after observation of product patterns in many firms, from the fact that the bulk of the sales are generated from relatively few products in the product line and from principle known as Pareto's law'. That is, 80 percent of a firm's sales are generated by 20 percent of the product line items. An exact 80-20 ratio is rarely observed, but the disproportional between sales and the number of items is generally true. (Pareto 1897)

The 80-20 concept is particularly useful in distribution planning when the products are grouped or classified by their sales activity. The top 20 percent might be called A items, the next 30 percent B items, and the remainder C items. Each category of items could be distributed differently. For example, A items might receive wide geographic distribution through many warehouses with high levels of stock availability, whereas C lower total stocking levels than for the A item. B items would have a intermediate distribution strategy where few regional warehouses are used.

Another frequent use of the 80-20 concept and ABC classification is to group the products in a warehouse, or other stocking point, in a limited number of categories where they are then managed with different levels of stock availability. The product classifications are arbitrary. The point is that not all product items should receive equal logistics treatment. The 80-20 concept with a resulting product classification provides a scheme, based on sales activity, to determine which products will receive various levels of logistics treatment.

For analytical purposes, it is useful to describe the 80-20-curve mathematically. Although a number of mathematical equations might be used, the following relationship has been suggested.

$$Y = \frac{(1+A)\,X}{A+X}$$

Where

Y = cumulative fraction of sales.

X = cumulative fraction of items.

A = constant to be determined.

The constant A my be found by manipulating this equation to give

$$A = \frac{X(1-Y)}{(Y-X)}$$

III. EXISTING SYSTEM

3.1 Existing Business Function

At present our restaurant has a satisfied amount of sale of food (not including beverage) because we have know that to use good material for cooking good food. However, for controlling the raw material to be available and fresh, we have to pay more expenses because customer's the ordered cannot be forecasted. So, we have to prepare more materials that cause waste of perishable materials. Presently, restaurant is operated on a computer-based system; that is the waitress generates the order bill for the cashier who then sends it to the kitchen. Eventually, cashier will send the sale report to the manager, and kitchen will send food production report and inventory report to the manager. Finally, the manager will make a sale report (daily) and purchase order for preparing raw materials for the next day.

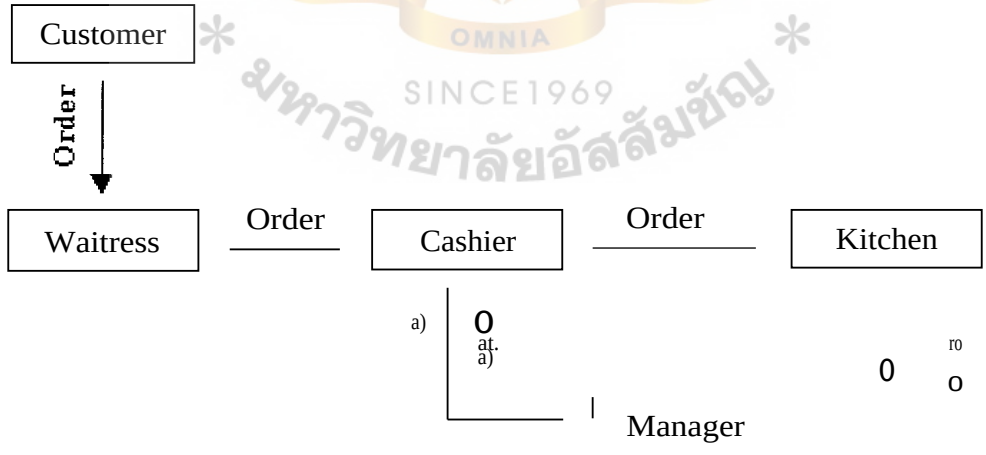

Figure 3.1. Functional Process.

Although, our restaurant is a seafood restaurant and most of menu is seafood that is comprises of shrimp, shell, crab, and fish, the nature of medium sized restaurant make it necessary to have more menus for serving the demands of consumers, so leaf menus are for ordered food that may have pork, chicken, or beef Additionally in food production process, there are still many items of raw materials for food production contained in the menu. Therefore, we can realize what we want to prepare for serving the customers.

3.2 Existing Inventory Control System

From the functional process in Figure 3.1, when the ordered is sent from the cashier to the kitchen, the chief will prepare the items (the quantity of each item is specific for each menu) for food production process according to the order. And at the end of working day, before the chief prepares the inventory report, he must do the following process.

(1) Checking issued items (according to the bill). Chef has to monitor that each item issued is for food production according to the ordered from the cashier.

(2) Verifying all items, which are in stock, and the items to be sold each day. When it is sure that all issued items are used for food production according to the order bill (by chef), the remaining items in the stock will be checked (to know the issued items). Then the chief from his experience will know which items have to be refilled for the next days.

(3) Making P.O. (purchase order) for refilling the remaining items for preparing of the next day's sales. Purchase order has to be made every working-day.

(4) Summarizing inventory report (to monitor sales report) for the manager. Inventory report consists of food production report and purchase order. So

that the manager can monitor whether the food production report matches with the sales report from the cashier or not.

The quantity of each item and the new items made for P.O. will be prepared according to the experience of the chief (This is may be the main reason why this project is done).

3.3 Current Problems and Area for Improvement

We realize that the general big problems occurred in the part of food control process. The food control processes compose of 4 processes: purchasing, receiving, storing and issuing, and food production. The problems from these four process would cause inefficiently inventory control which is making high food cost.

Purchasing: This is very important process in restaurant business, as this process directly affects to food cost. So, in this process the restaurant owner has to monitor the price of each item by himself The purchaser will buy the items according to the P.O.

Receiving: For this process the chef will check the purchased items are according to the P.O. or not.

Storing and Issuing: In restaurant business most raw materials are perishable, so storing process is important. For instance, it is necessary to store meat in a freezer while vegetable must be stored in cold temperature. Issuing process will be monitored by the chef (he has to report to the manager everyday.).

Food production: This process may not be exactly practiced in a medium-sized restaurant, so the issuing item must be closely monitored. Since the formula of most menus depends on the skill and experience of the cook quantity of the main item in each menu is just specified.

Finally, after attempting to monitor and conduct each functional process, it could be identified that most of the problems are caused by inefficient inventory management

which makes food cost high. It can be seen that the current problems in inventory are basic problems, which occur in most restaurants. The problems can be defined in detail as follows:

(1) The quantity of each item will be identified by P.O. by the chef, may not be proper for sales.

(2) How much quantity of raw material is proper for sales to reduce inventory cost so that there is not waste in materials?

(3) Some items are few quantities, how about the stock policies.

(4) There are no raw material stock policies.

(5) Which items of less demand should be canceled?

IV. THE PROPOSED SYSTEM OF INVENTORYCONTROL

4.1 Data Collection

We attempt to collect the data on the basis of how many items go into the store and how much of them go into the store in one time. So, data is collected on items received at the store everyday, and are recorded by quantities and amount of each item. Most items in the general menu are produced with raw materials that can be separated into 3 types: perishable materials, fruits and vegetables, and non-perishable materials.

Thus, data collection is done in the form as shown in Table 4.1. In this form the data recorded are item, quantity, unit, and price.

Item: all items in food production process must be identified in data collection form. It is necessary to know the to progress in quantity of each item.

Quantity: Quantity is recorded for knowing how many materials to purchase in one time.

Unit: Unit has to be specified for each item because there are different units in the same item.

Price: Price will be an indicator to measure the amount of each item; expensive item will be sold less than the cheap item.

An attempt is made to collect data in one month for knowing the precise demand of consumer in one business period.

Table 4.1. Data Collection Form (Perishable Items).

Perishable Items! Materials									
A'141J	11E11111	innu	mix,	1101	d141J	I11.11111	innu	milu	rim
01	If151143),91,11				29	1111			
02	1401111011				30	11111113,1			
03	1134.3T1-1				31	1,4113:11a0fl			
04	ifif111dall				32	Lefillliliti			
05	411113,1				33	MeIliJ			
06	fl51,11/11,°;'				34	1110'11fllflTlE1			
07	VISES				35	61			
08	371111`U1				36	61114			
09	f101)13,,1				37	VIvrtli			
10	1141-1				38	lifl1611)			
11	/1D&1111				39	11 1f1V1^111Afl			
12	111OLIMflait13				40	liflifr,1111111			
13	111D61-1111				41	lifl12(1			
14	It15111Ni]				42	lifl1911`.',131fl			
15	111111				43	1,1311			
16	111f;				44	11:VInfl			
17	1f11011141f1				45	9jl9iflO1			
18	1600,11				46	1M114{1111			
19	111`MIS				47	ilandifl1101J			
20	ilalialun				48	11-1011			
21	3inli01,11114,				49	11D61			
22	ilmqi				50	viaen4115116)6Afl			
23	lifliqfleill				51	11061111511433114fij			
24	11111111140				52	11D014'311.1			
25	111113A1A1				53	11D011f151			
26	113j1101.1				54	14no11kinlf,,i			
27	1111;111				55	1100iflt1			
28	fl1J								

Table 4.2. Data Collection Form (Vegetable/Fruit Items).

Vegetables/Fruits									
Alaii	Iltin11	4nma	iii-hti	lim	dlifu	5 1E11111"	i114114	rni ii	Iini
56	itillt,'"i				92	Linlil			
57	Itollii				93	illovill			
58	ifailD				94	tranvillii			
59	kig:,azflO				95	rittPq			
60	rifl				96	91181			
61	ifuti				97	11nin11u6au			
62	liniil				98	1131ra			
63	mrinitifil				99	80qm:till			
64	itolfivi				100	till n			
65	an i				101	illiDllifluil			
66	anis'eJT1				102	flInsitall			
67	Iiiniimidum				103	EID Ailvio			
68	1l3n 7u'vmdrlien				104	fl5nri5i			
69	ranillittol				105	T145zril			
70	NafilliSDA				106	liJuznzo			
71	vantiin				107	liaDliittj			
72	vaniltnn				108	iildati			
73	tiiv				109	Ii1			
74	6161iwn				110	:61			
75	111:1410013				111	Aniou			
76	ti'Antni				112	gliV			
77	annivnlau				113	155,',			
78	rInniolni				114	Iza:¦nviii			
79	an fl Ai				115	flInflitamol			
80	fiiniMird				116	TilfiD1			
81	InvriOrnil				117	oulifo			
82	ain't.]				118	vantrilill			
83	miDlairli)				119	rafittn4trio			
84	14tvi1				120	V73nitnliiien			
85	Lif15011				121	rrinItimh			
86	ovfmn441				122	vu3nihiljuill			
87	lilioti				123	ranivalitafi			
88	91aIn5				124	14D3Jia4			
89	mailltilin				125	n5ztiriaLCAn			
90	M,5tir111i				126	ontifitallitii			
91	van'ivitidpu				127	vanivitidou			

Table 4.3. Data Collection Form (Non-Perishable Items).

Non-Perishable Items									
	llt1f711	trirm				11M111	trim	Walt'	litll
128					164	87 11101			
129					165	junaTism			
130					166	11191Thilit1			
131	11466115				167	filV116111W1			
132					168				
133					169				
134					170	171r1110			
135	1011-1141 14				171	6119111011			
136	ilamsou				172	ntU			
137	115116411				173	%Iff			
138	11100111				174	lnSoFITI			
139					175	117 J in			
140	143.714				176	1.11A"-A'la			
141	Aina				177	611A'101¯a			
142	In144111mo				178				
143					179	ilg¯d1111			
144					180	Touvrmal			
145	varanuilu				181				
146	LituNBJ				182	11¯niumati			
147					183	u111f11			
148	t r				184	14312(0			
149	anunalon				185	900f1956			
150					186				
151	I015̈01E.11911				187	'110111			
152	910'21411V				188	&Him			
153					189	1fl0~1ix 11			
154	ini6fl								
155	1,1,11,Ao					qtinlal			
156	liZurr&				diXti	-nom	ii114114	mhu	51f11
157	&7t4]				190	LLD'dflDffa cl			
158	nu:an:Alm				191	111°,;q1111,4006¯			
159	thA̋111011150f̈101				192	IlAhAfl			
160	11 16fl0v				193	TIA111111t11			
161	67=610fl50 101				194	illlin Z			
162	tai̇mini-31				195	¥fou			
163	P1405°C111				196	illGutff,			

4.2 Inventory-to-Demand Relationship

Inventory management can be improved by using one or more of the following techniques: ABC analysis, forecasting, inventory models, and advanced order processing systems.

ABC Items Classification

A common practice in aggregate inventory control is to differentiate products into a limited number of categories and then to apply a separate inventory control policy to each. This makes sense since all products are not of equal importance to a firm in such terms as sales, profits, market share, or competitiveness by selectively applying inventory policy to these than with a single policy applied to all products.

The 80-20 principal, well-known principle, serves as a basis for the ABC classification of items. **A** items are typically the fast movers, **B** items are typically the medium movers, and C items are typically the slow movers. That is, 80 percent of a firm's sales are generated by 20 percent of the product line items.

From our data collection in one month, data was gathered to make the database worksheet as shown in Tables 4.4 - 4.6. The data is ranked from high volume to low volume. And the column cumulative percent of items is derived from dividing **the item number** by **total item number.** The column cumulative percent of amount is derived from dividing **cumulative of amount** by **total of amount.** These two columns are shown in percentage, and these percentages are then plotted, as in Figures 4.1-4.3, which shows the characteristic 80-20 curve.

Once the curve is derived, we try to fit the curve by three straight line, different slope, the intersections of each two lines on the curve will be categorize A, B, and C items

However, in this particular case, three groups of data (perishable item, fruits& vegetables, and non-perishable) are about 35 percent of the items accounting for 80 percent of sales, as shown in Tables 4.4 — 4.6.

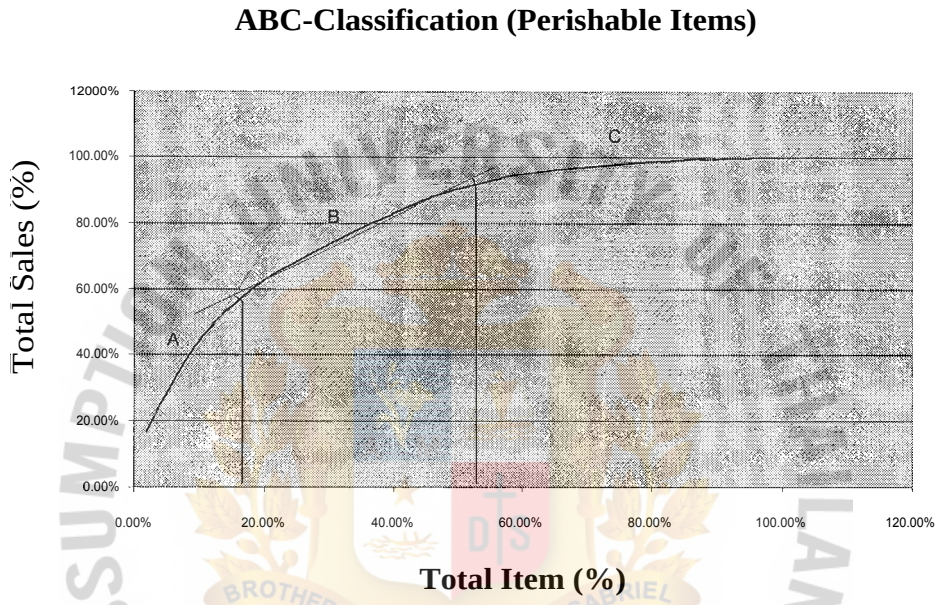

Figure 4.1. ABC-Classification (Perishable Items).

Table 4.4. ABC Classification of Perishable Items.

Item No	Curti. of Item	Item Name	Unit	Qty	Amount	% of Amount	Cum. of Amount	Cum. % of Amount	ABC Classification
	1.89%	11441111i1j	kg.	74.7	18,780	16.64%	18,780	16.64%	A
2	3.77%	1i~]1Thin		171	8,646	7.66%	27,426	24.30%	A
3	5.66%		kg.	41	7,455	6.61%	34,881	30.91%	A
4	7.55%	ilfl¯rniincnon	kg.	73.2	7,210	6.39%	42,091	37.30%	A
5	9.43%	ilainnyllmuj	kg.	10	6,273	5.56%	48,364	42.85%	A
6	11.32%	fi14111111111	kg.	30	5,520	4.89%	53,884	47.74%	A
7	13.21%	110611f114	kg.	104	4,680	4.15%	58,564	51.89%	A
8	15.09%	11nim.;14111Afl	PTO	56	3,701	3.28%	62,265	55.17%	A
9	16.98%	luo1,	kg.	9	3,610	3.20%	65,875	58.37%	
10	18.87%	IIDE1141151.19i1111q	piq	195	3,315	2.94%	69,190	61.31%	
11	20.75%		kg.	25	2,750	2.44%	71,940	63.74%	
12	22.64%	ifillmjsi	kg.	130	2,600	2.30%	74,540	66.05%	
13	24.53%	Veld	kg.	35	2,310	2.05%	76,850	68.09%	
14	26.42%			124	2,230	1.98%	79,080	70.07%	
15	28.30%		612	42	2,219	1.97%	81,299	72.04%	
16	30.19%	1 1 1 6 14 LID fl	kg.	32.2	2,187	1.94%	83,486	73.97%	
17	32.08%	1117410	01")	22	2,110	1.87%	85,596	75.84%	
18	33.96%	11:11i001	612	30	2,072	1.84%	87,668	77.68%	
19	35.85%	11N11411511411'dn		20	2,000	1.77%	89,668	79.45%	
20	37.74%	wafp	kg.	12	1,930	1.71%	91,598	81.16%	
21	39.62%		kg.	135	1,890	1.67%	93,488	82.84%	
22	41.51%	Lau	kg.	27.5	1,858	1.65%	95,346	84.48%	
23	43.40%	i1~r11 11	(912	10	1,700	1.51%	97,046	85.99%	
24	45.28%		kg.	12	1,620	1.44%	98,666	87.42%	
25	47.17%	11 0 1114	kg.	11	1,520	1.35%	100,186	88.77%	
26	49.06%	mootaolti	kg.	55	1,375	1.22%	101,561	89.99%	
27	50.94%	tiforhilu	kg.	10	1,100	0.97%	102,661	90.96%	
28	52.83%	116fl	E	5	1,100	0.97%	103,761	91.94%	
29	54.72%			19	1,056	0.94%	104,817	92.88%	
30	56.60%	ilf151 949p911411		8	960	0.85%	105,777	93.73%	
31	58.49%	111DFM714	kg.	8	880	0.78%	106,657	94.51%	
32	60.38%	na,ii	kg.	29	616	0.55%	107,273	95.05%	

Table 4.4. ABC Classification of Perishable Items. (Continued)

Item No	Cum. of Item	**Item Name:**	Unit	Qty	Amount	% of AMount	Cuin. of Amount	Cum. % of Amount	ABC Classir-cation
33	62.26%		kg.	5.5	610	0.54%	107,883	95.59%	C
34	64.15%	gulfi		7	480	0.43%	108,363	96.02%	C
35	66.04%		kg.	8.8	462	0.41%	108,825	96.43%	C
36	67.92%	AU	kg.	5.4	456	0.40%	109,281	96.83%	C
37	69.81%		kg.	4	384	0.34%	109,665	97.17%	C
38	71.70%	fiamj		4.4	352	0.31%	110,017	97.48%	C
39	73.58%	Aubitij	kg.	27	351	0.31%	110,368	97.79%	C
40	75.47%	fiDitoothl		3.2	350	0.31%	110,718	98.10%	C
41	77.36%	5 5 91111,11ADA		70	315	0.28%	111,033	98.38%	C
42	79.25%	Ifilvn	kg.	4	300	0.27%	111,333	98.65%	C
43	81.13%			4.2	286	0.25%	111,619	98.90%	C
44	83.02%	islf151dDu		3.2	205	0.18%	111,824	99.08%	C
45	84.91%	ad UU140		2	200	0.18%	112,024	99.26%	C
46	86.79%	Iiimj	kg.	5	190	0.17%	112,214	99.43%	C
47	88.68%	9,111g11		2	130	0.12%	112,344	99.54%	C
48	90.57%	17114111'1	kg.	4	120	0.11%	112,464	99.65%	C
49	92.45%	Ufl	kg.	2	120	0.11%	112,584	99.76%	C
50	94.34%	Finjili		1	90	0.08%	112,674	99.84%	C
51	96.23%		kg.	0.5	90	0.08%	112,764	99.92%	C
52	98.11%	nunsE1	kg.	2	83	0.07%	112,847	99.99%	C
53	100.00	IR,11f1111,0	kg.	0.5	11	0.01%	112,858	100.00%	C
54		<l		0	0	0.00%	112,858	100.00%	C
55		`Mtn		0	0	0.00%	112,858	100.00%	C
56				0	0	0.00%	112,858	100.00%	C
57				0	0	0.00%	112,858	100.00%	C
58		iJapioulTiqj		0	0	0.00%	112,858	100.00%	C
59		Ilnignqu		0	0	0.00%	112,858	100.00%	C
60				0	0	0.00%	112,858	100.00%	C
61				0	0	0.00%	112,858	100.00%	C
62		ti		0	0	0.00%	112,858	100.00%	C
63		61av		0	0	0.00%	112,858	100.00%	C
64		Altl9f		0	0	0.00%	112,858	100.00%	
65			0T9		0	0.00%	112,858	100.00%	
		Total			112,858		112,858	100.00	

As shown in Table 4.4, about 15% of items, 8 items, are A items, the next 35% of items, 20 items, are **B** items, and the remainder C items. We can observe that the first item is very high in volume because the price of this item is expensive and it is the component in many popular menus.

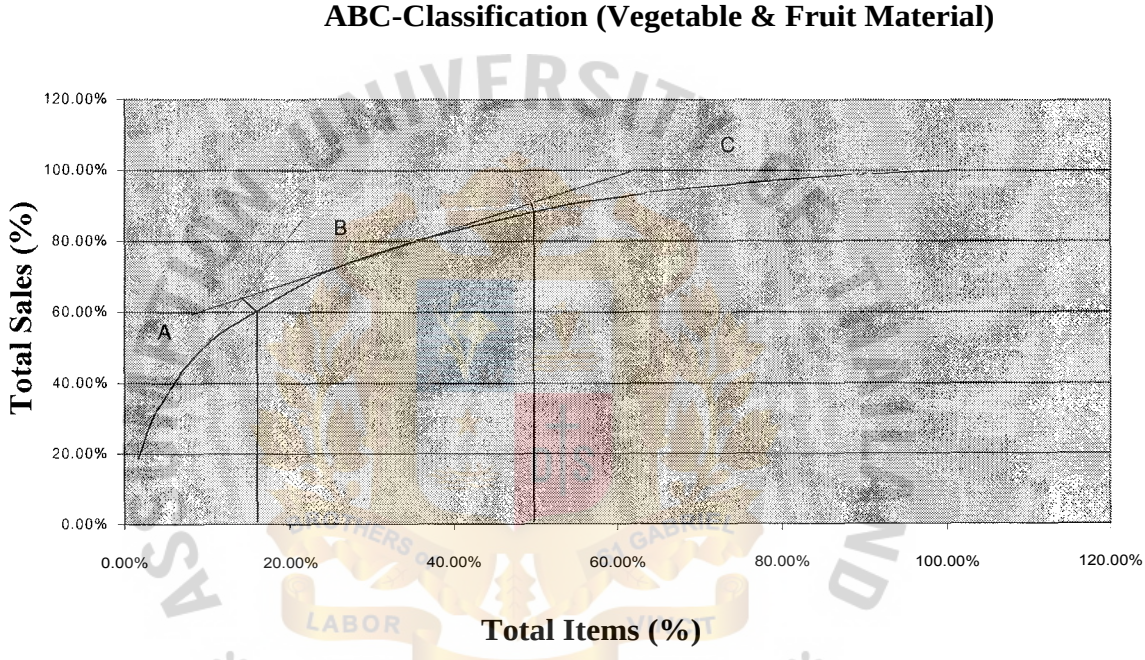

Figure 4.2. ABC-Classification (Vegetable & Fruit Material).

Table 4.5. ABC-Classification of Vegetable and Fruit Items.

Item No	Cum. of item	Item name	tint	Qty	AMOtlfli	% of kmount	Cum. of Amount	Cum. % of Amount	ABC Classifi-cation
1	1.69%	1.J1,1'12	n	2670	4,950	18.82%	4,950	18.82%	A
	3.39%	LfWn1	kg.	44.5	2,982	11.34%	7,932	30.16%	A
3	5.08%	esin wu;?i-)	kg.	85	1,685	6.41%	9,617	36.57%	A
	6.78%	TIS MIA10i£1`)	kg.	17.2	1,606	6.11%	11,223	42.68%	A
	8.47%	Kii·±;	Qn	71	1,198	4.56%	12,421	47.24%	A

Table 4.5. ABC-Classification of Vegetable and Fruit Items. (Continued)

Item No	Cum. of item	item name	Unit	Qty	Amount	% of Amount	Cuni. of Amount	Cum. % of Amount	ABC Classifi-cation
6	10.17%		kg.	25	1,070	4.07%	13,491	51.31%	A
7	11.86%	nszAn.ilvinj	kg.	25	830	3.16%	14,321	54.46%	A
8	13.56%	Vi%11,1,21	kg.	53	676	2.57%	14,997	57.03%	A
9	15.25%	1,6P111nu	kg.	76	626	2.38%	15,623	59.41%	A
10	16.95%	11351,tP1	of	33	621	2.36%	16,244	61.77%	A
11	18.64%	PLIVI`a 3.1	kg.	30	621	2.36%	16,865	64.14%	A
12	20.34%	nr,-,AmAn	kg.	14	620	2.36%	17,485	66.49%	A
13	22.03%		kg.	52	572	2.18%	18,057	68.67%	
14	23.73%		kg.	11	550	2.09%	18,607	70.76%	
15	25.42%	vismnsiv,uvil	kg.	4	420	1.60%	19,027	72.36%	
16	27.12%	yi3nPiroi,aLim	kg.	16	413	1.57%	19,440	73.93%	
17	28.81%		kg.	17	366	1.39%	19,806	75.32%	
18	30.51%		kg.	24	351	1.33%	20,157	76.65%	
19	32.20%	3.13;,fl3,11fl	kg.	16	333	1.27%	20,490	77.92%	
20	33.90%	1.134a1,11P1	kg.	33	321	1.22%	20,811	79.14%	
21	35.59%	eTrinnovm1.1	kg.	32	294	1.12%	21,105	80.26%	
22	37.29%	1.1.ATOVI	kg.	6.9	276	1.05%	21,381	81.31%	
23	38.98%		kg.	21.5	265	1.01%	21,645	82.31%	
24	40.68%	3.13',fl`3111litn	kg.	21.7	260	0.99%	21,905	83.30%	
25	42.37%	eTrArEl	kg.	7.5	258	0.98%	22,163	84.28%	
26	44.07%	mmnz.,i11,1	of	41	254	0.97%	22,417	85.25%	
27	45.76%	c6rrinN1Loll	kg	11.5	243	0.92%	22,660	86.17%	
28	47.46%		awi91	36	240	0.91%	22,900	87.09%	
29	49.15%		kg.	9	231	0.88%	23,131	87.97%	
30	50.85%	r.5viA-nA	kg.	28	224	0.85%	23,355	88.82%	
31	52.54%	WineT2telm	kg.	5	215	0.82%	23,570	89.64%	
32	54.24%		aTm	22	202	0.77%	23,772	90.40%	
33	55.93%	69i4nEno	kg.	16	185	0.70%	23,957	91.11%	
34	57.63%	inD11.1eJT1	kg.	7	154	0.59%	24,111	91.69%	
35	59.32%	EramingITym	tqJ	15	150	0.57%	24,261	92.26%	
36	61.02%	van 66n11]-1	kg.	3	145	0.55%	24,406	92.81%	

Table 4.5. ABC-Classification of Vegetable and Fruit Items. (Continued)

Item No	Cum. of item	Item name	Unit	tY	Amount	% of Amount	Cum. of Amount	Cum. % of Amount	ABC Classification
37	62.71%	ovN3nvitnndN	kg.	5	140	0.53%	24,546	93.35%	
38	64.41%		kg.	7	140	0.53%	24,686	93.88%	
39	66.10%	mnnrAn	kg.	6	111	0.42%	24,797	94.30%	
40	67.80%		kg.	4.7	108	0.41%	24,905	94.71%	
41	69.49%	1311.1 13fri'au	kg.	4.2	105	0.40%	25,010	95.11%	
42	71.19%		kg.	13	101	0.38%	25,111	95.50%	
43	72.88%	Al-A151,1,14		15	99	0.38%	25,210	95.87%	
44	74.58%			3.5	96	0.37%	25,306	96.24%	
45	76.27%		kg.	10.5	95	0.36%	25,401	96.60%	
46	77.97%		rig	30	92	0.35%	25,493	96.95%	
47	79.66%	nstLiiim-AN	kg.	3	91	0.35%	25,584	97.29%	
48	81.36%	v,	kg.	8.5	91	0.34%	25,675	97.64%	
49	83.05%	IvisnAn		24	78	0.30%	25,753	97.94%	
50	84.75%			2.5	75	0.29%	25,828	98.22%	
51	86.44%			1	75	0.29%	25,903	98.51%	
52	88.14%	11_13.1:',11'11.1 MA		8.3	67	0.25%	25,970	98.76%	
53	89.83%	IinAL-nzm		11	66	0.25%	26,036	99.01%	
54	91.53%	iAIln lAN	kg.	1.5	56	0.21%	26,092	99.22%	
55	93.22%			6	53	0.20%	26,145	99.43%	
56	94.92%	141		5	50	0.19%	26,195	99.62%	
57	96.61%	Akim		1	37	0.14%	26,232	99.76%	
58	98.31%	1,u1mE		14	36	0.14%	26,268	99.89%	
59	100.00%			1	28	0.11%	26,296	100.00%	
60		A1,ITfl		0		0.00%	26,296	100.00%	
61						0.00%	26,296	100.00%	
62		°112.11d				0.00%	26,296	100.00%	
63		1.1:11.191				0.00%	26,296	100.00%	
64						0.00%	26,296	100.00%	
65		1/13111AE1911				0.00%	26,296	100.00%	
66		3.1;LikE1`19				0.00%	26,296	100.00%	
67		t_I A1.12.51AIY10		0	0	0.00%	26,296	100.00%	

Table 4.5. ABC-Classification of Vegetable and Fruit Items. (Continued)

Item No	Cum. of item'	limn name	Unit	Qty	Amount	% of Amount	Cum. of Amount	Cum. % of Amount	ABC Classifi-cation
68		viTTA			0	0.00%	26,296	100.00%	
69		ii n			0	0.00%	26,296	100.00%	
70		14n;nau			0	0.00%	26,296	100.00%	
71		f12'D1			0	0.00%	26,296	100.00%	
72					0	0.00%	26,296	100.00%	
73		Ten Lavul		0	0	0.00%	26,296	100.00%	
74		Yi3nu,n1trim		0		0.00%	26,296	100.00%	
75		vrinurillA119		0		0.00%	26,296	100.00%	
76		va'nLinA4		0		0.00%	26,296	100.00%	
77		lAi3n1mtydms		0		0.00%	26,296	100.00%	
					26,296		26,296	100.00%	
		Total		3786	52591				

As shown in Table 4.5, about 20% of items, 12 items, are A items, the next 30% items, 18 items, are B items, and the remainder C items. We can observed that there are many items to be A items in this group, because the price of each item is not expensive and there are many items in this group are used in food production process.

ABC-Classification (Non-Perishable Items)

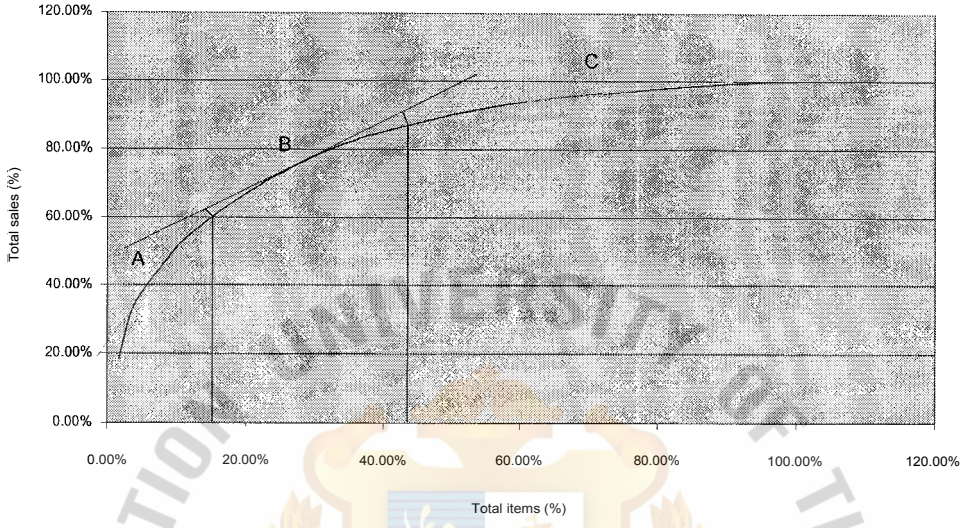

Figure 4.3. ABC-Classification (Non-Perishable Items).

Table 4.6. ABC-Classification Non-Perishable Items.

item No	Cum. of item " ')/.	Bon : tante	Unit	Qty	Amount	% of Amount	Cum: of Amount	Cum % of Amount	ABC Classifiea-tion
1	1.69%	1:1`11:11,A1111	Th	12	4,660	18.52%	4,660	18.52%	A
2	3.39%	Imari	ON	1750	3,381	13.44%	8,041	31.95%	A
3	5.08%	cl:rniM	Al	8	1,541	6.12%	9,582	38.08%	A
4	6.78%	1,1A111,1		8	1,172	4.66%	10,754	42.73%	A
5	8.47%	TO/11,m	nic.',11161	7	1,113	4.42%	11,867	47.16%	A
6	10.17%	ISiM1J,1.191	kg.	5	1,085	4.31%	12,952	51.47%	A
7	11.86%	1141k		18	852	3.39%	13,804	54.85%	A
8	13.56%	141.14M	ns-Al	42	702	2.79%	14,506	57.64%	A
9	15.25%	1:1'1V1`1 1(15-1U		1	685	2.72%	15,191	60.37%	B
10	16.95%	qiUliAi3T1	"1191	24	660	2.62%	15,851	62.99%	B
11	18.64%	ffleil	kg.	2	560	2.23%	16,411	65.21%	B

Table 4.6. ABC-Classification Non-Perishable Items. (Continued)

Item No	Cum. of item	Item name	Unit		.Amount	% of Amount	Cum. of &mount	Cum. % of Amount	ABC Classifi-cation
12	20.34%	Tri wtod		13	552	2.19%	16,963	67.41%	
13	22.03%	'IJ'arrIrl9	°NM	18	550	2.19%	17,513	69.59%	
14	23.73%	11,111°1114,1911		24	524	2.08%	18,037	71.67%	
15	25.42%			1	450	1.79%	18,487	73.46%	
16	27.12%	1,F13.11,AVI'M	iinma	10	442	1.76%	18,929	75.22%	
17	28.81%	lifl'1141f1911,1,1)11	kg.	2.5	440	1.75%	19,369	76.97%	
18	30.51%	lAnn3ATItin	kg.	20	420	1.67%	19,789	78.64%	
19	32.20%	1.1&)irmi	Kr)	2	350	1.39%	20,139	80.03%	
20	33.90%	1V0?,/,,,11,111V1`a		12	336	1.34%	20,475	81.36%	
21	35.59%	14'11,1 141'1			300	1.19%	20,775	82.56%	
22	37.29%		kg.	20	300	1.19%	21,075	83.75%	
23	38.98%	VIM			235	0.93%	21,310	84.68%	B
24	40.68%	1,n91.11,n		6	235	0.93%	21,545	85.61%	
25	42.37%		Vifl	24	224	0.89%	21,769	86.51%	
26	44.07%	1J8¯Insvu		3	220	0.87%	21,989	87.38%	
27	45.76%	9,413.11,AZflM		1	200	0.79%	22,189	88.17%	
28	47.46%	ifjf1TIM		6	200	0.79%	22,389	88.97%	
29	49.15%	(InT9	tJ M	9	194	0.77%	22,583	89.74%	
30	50.85%	C.11nsz¯ A1	f1 9M	6	192	0.76%	22,775	90.50%	
31	52.54%	-	611261	8	178	0.71%	22,953	91.21%	
32	54.24%	1T?ōnm		1	175	0.70%	23,128	91.91%	
33	55.93%	vag4,1_]u		1	165	0.66%	23,293	92.56%	
34	57.63%	grginv		6	148	0.59%	23,441	93.15%	
35	59.32%	eirJA41Au		3	120	0.48%	23,561	93.63%	
36	61.02%	Criuwannsnlal			120	0.48%	23,681	94.10%	
37	62.71%	t,11'f u		5	1b4	0.41%	23,785	94.52%	
38	64.41%			12	99	0.39%	23,884	94.91%	
39	66.10%			12	96	0.38%	23,980	95.29%	
40	67.80%	01`11,9trd		3	87	0.35%	24,067	95.64%	
41	69.49%	1.113.1coNsmen		2	80	0.32%	24,147	95.95%	
42	71.19%	tv11.11.'kmj		50	80	0.32%	24,227	96.27%	

Table 4.6. ABC-Classification Non-Perishable Items. (Continued)

Item No	Cum. of item	item name	Unit •	QtY	Amount	% of Amount	Cum. of Amount	Cuni. % of Amount	ABC Classifi-cation
43	72.88%			1	78	0.31%	24,305	96.58%	
44	74.58%	quLiito	kg.	1	75	0.30%	24,380	96.88%	
45	76.27%	n';-1.1		1	75	0.30%	24,455	97.18%	
46	77.97%	INLITy)	kg.	0.3	75	0.30%	24,530	97.48%	
47	79.66%	Lauvia		1	72	0.29%	24,602	97.76%	
48	81.36%		614	2	70	0.28%	24,672	98.04%	
49	83.05%	tvhiLgn		200	69	0.27%	24,741	98.32%	
50	84.75%	1A1LA34		20	68	0.27%	24,809	98.59%	
51	86.44%			9	63	0.25%	24,872	98.84%	
52	88.14%	qni,no	kg.	0.5	60	0.24%	24,932	99.07%	
53	89.83%		'119	2	58	0.23%	24,990	99.30%	
54	91.53%	14lung		1	44	0.17%	25,034	99.48%	
55	93.22%	rig&awrininlal		3	42	0.17%	25,076	99.65%	
56	94.92%	Lo11.11-nImm		1	30	0.12%	25,106	99.77%	
57	96.61%	1110q1)12`1U		1	25	0.10%	25,131	99.86%	
58	98.31%	Lrig'6rs&		4	24	0.10%	25,155	99.96%	
59	100.00%	1r1Pralli'M	vka	1	10	0.04%	25,165	100.00%	
60		11]		0	0	0.00%	25,165	100.00%	
61		1:711.6J92-11		0		0.00%	25,165	100.00%	
62				0		0.00%	25,165	100.00%	
63		wyv&Iti		0		0.00%	25,165	100.00%	
64		varlym		0		0.00%	25,165	100.00%	
65		yi3n1:vitnha		0		0.00%	25,165	100.00%	
66		2,21		0		0.00%	25,165	100.00%	
67				0		0.00%	25,165	100.00%	
68				0		0.00%	25,165	100.00%	
69		yr&		0	0	0.00%	25,165	100.00%	
70				0	0	0.00%	25,165	100.00%	
71		68LIU		0	0	0.00%	25,165	100.00%	
72		P119.1E1		0	0	0.00%	25,165	100.00%	
73		Lilpropl.1		0	0	0.00%	25,165	100.00%	

Table 4.6. ABC-Classification Non-Perishable Items. (Continued)

Item No	Cum. of item %	Item name	Unit	Qty	Amount	% of Amount	Cum. of Amount	Cum. % of Amount	ABC classification
74		Tni		0	0	0.00%	25,165	100.00%	C
75		1:1/1 6'101'1'D		0	0	0.00%	25,165	100.00%	C
76		Mar') MN	nin,In	0	0	0.00%	25,165	100.00%	C
77		amEn6		0	0	0.00%	25,165	100.00%	C
78		mnr1bidalP1		0	0	0.00%	25,165	100.00%	C
79		tIllitiz-,		0	0	0.00%	25,165	100.00%	C
		SQ2.1		**2,409**	**25,165**				

As shown in Table 4.6, about 14% of the items, 8 items, are A items, the next 30% items, 17 items, are B items, and the rest are C items. We can observe that the first two items are very high in volume because they are important component in most of the menus.

4.3 Estimating Inventory Levels

4.3.1 Turnover Ratio

Perhaps the most popular aggregate inventory control procedure is the turnover ratio. It is a ratio of the annual sales on inventory to the average investment in inventory for the same time period as sales, where sales and inventory investment are valued at the echelon in the logistics channel where the items are held in inventory. That is:

$$\textbf{Turnover ratio} = \frac{\textbf{Annual sales at inventory cost}}{\textbf{Annual inventory investment}}$$

The popularity of the measure undoubtedly stems from the ready availability of data (the company's stock status report is a common source) and the simplicity of the measure itself. Different turnover ratios may be specified for different

classes of products, or for the entire inventory. As a point of reference, manufacturers, wholesalers, and retailers have an inventory turnover ratio of 7.65 (Statistical Abstract of the United States: 1989).

By specifying turnover ratio to be achieved, the overall inventory in investment is controlled relative to the level of sales. It is appealing to have inventory investment change with the level of sales; however, the turnover ratio causes inventories to vary **directly** with sales. This is a disadvantage since we normally expect that inventories increase at a decreasing rate due to economies of scale. There is a price to be paid for simplicity!

To specify the turnover ratio there are many factors that we have to realize such as expiry range, ABC item classification, inventory policy, etc. For our project, we try to specify the turnover ratio of each item by dividing all items into three groups perishable material, non-perishable, vegetable and fruit (with respect to data collection). Each group has different expiry range. Perishable material and vegetable and fruit have short time to expire, so turnover ratio will be higher that of other groups. Additionally, from ABC item classification, A items are typically fast movers, B items medium movers, and C items slow movers. The items with high demand create high turnover ratio always requiring new and fresh material: this is one important objective of inventory policy.

Before specifying turnover ratio of each item we have to set the inventory policies by realizing the following factors:

(1) What type of items

(2) Which group, A, B, or, C

(3) Length of expiry range

(4) Others, such as season, price, etc

Table 4.7 shows specific turnover ratio (monthly) of perishable materials (from Table 4.4). Different inventory policy is maintained for different product groups. Turnover ratio for A items is 15 to 1. However, there is one item (shell) that will have turnover ratio of 30 to ldue to its need of freshness.

Table 4.7. Turnover Ratio of the Proposed System (Perishable Items).

item No	Cum. of Item	Item Name	Unit		Amount	Eot:isting Turnover Ratio	Proposed Turnover Ratio	ABC Classifica-tion
1	1.89%	rj1A0114fl1	kg.	74.7	18,780	14	15	A
2	3.77%	tifinlitiagn	pia	171	8,646	19	15	A
3	5.66%	Igh	kg.	41	7,455	9	15	A
4	7.55%	11mmilnwav	kg.	73.2	7,210	11	15	A
5	9.43%	1.1flltlnl4114t11	kg.	10	6,273	10	15	A
6	11.32%	Fi4fc'11411711.1	kg.	30	5,520	9	15	A
7	13.21%	MULLA21	kg.	104	4,680	26	30	A
8	15.09%	91a'Irr51111An	pia	56	3,701	11	15	A
9	16.98%	tuaij	kg.	9	3,610	2	10	
10	18.87%	vrautrosukivinj	cia	195	3,315	16	20	
11	20.75%		kg.	25	2,750	5	10	
12	22.64%	Imswkrpl	kg.	130	2,600	26	30	
13	24.53%		kg.	35	2,310	25	30	
14	26.42%	11wInEin4		124	2,230	13	10	
15	28.30%			42	2,219	8	10	
16	30.19%	vajal"o.,pan	kg.	32.2	2,187	13	10	
17	32.08%	1.1.mm	Rio	22	2,110	4	10	
18	33.96%	1,11,11mal	Ar)	30	2,072	2	10	
19	35.85%	mutronikan		20	2,000	20	20	
20	37.74%		kg.	12	1,930	12	10	
21	39.62%	IA51111111	kg.	135	1,890	27	30	
22	41.51%	vkigu	kg.	27.5	1,858	21	20	
23	43.40%	vnom-,I4	no	10	1,700	1	10	
24	45.28%	1littlfl1r1S9£1	kg.	12	1,620	12	15	
25	47.17%	lAtEIVIT114	kg.	11	1,520	5	10	
26	49.06%		kg.	55	1,375	26	30	
27	50.94%	luaXuiu	kg.	10	1,100	10	10	
28	52.83%	aJan	ua	5	1,100	4	10	
29	54.72%	aianlm		19	1,056	5	5	
30	56.60%	#itms4aakiLL1111114	1A	8	960	4	5	
31	58.49%	LIAGIM1.114	kg.	8	880	8	10	
32	60.38%		kg.	29	616	26	30	

Table 4.7. Turnover Ratio of the Proposed System (Perishable Items). (Continued)

Item No	Cuni. of item	Item Name	Unit	Qty	Athount	Ekisting Turnover Ratio	Proposed TurnoVer Ration	ABC cation
	62.26%	A111931	kg.	5.5	610	6	5	C
	64.15%	tauTh		7	480	5	5	C
	66.04%	viki34u	kg.	8.8	462	2	5	C
	67.92%	nu	kg.	5.4	456	4	5	C
	69.81%	lb%	kg.	4	384	2	5	C
	71.70%	AtInj		4.4	352	2	5	C
	73.58%	tAulmaj	kg.	27	351	27	30	C
	75.47%	61A66GIMlgEY9		3.2	350	3	5	C
	77.36%	tAlta'01	swan	70	315	7	10	C
	79.25%	unsan	kg.	4	300	4	5	C
	81.13%	nrzLwrz		4.2	286	3	5	C
	83.02%	illmsw6tu		3.2	205	3	5	C
	84.91%	uvranAa		2	200	2	5	C
	86.79%	lhad	kg.	5	190	1	3	C
	88.68%	majual		2	130	2	3	C
	90.57%		kg.	4	120	4	5	C
	92.45%	un	kg.	2	120	1	3	C
	94.34%			1	90	1	3	C
	96.23%	1,91 16114190114	kg.	0.5	90		3	C
	98.11%	WaEIMU	kg.	2	83	2	3	C
	100.00%	1.1:591iTrr	kg.	0.5	11	1	3	C
		61fl19		0	0	0	0	C
		Iriuq		0	0	0	0	C
				0	0	0	0	C
				0	0	0	0	C
				0	0	0	0	C
		tl nqn·Vl		0	0	0	0	C
		invadtioila		0	0	0	0	C
				0	0	0	0	C
		und		0	0	0	0	C
		rmu		0	0	0	0	C
				0	0	0	0	C
		1)fin9nstaim	G10			0	0	C
		Total			112,858			

Turnover ratio for B items is 10 to 1. Some items have high volume of quantity (such as chicken, pork, and shell), so their inventory needs to be frequently replenished. And some items (chicken bone and pork bone) are the

main component of food production, so they will be replenished everyday. The turnover ratio of C items is 5 to 1 and same as B items of which some items have to be replenished everyday. It also has some items with a turnover ratio 3 to 1 because there is very low quantity (Item No. 46 — 53).

Table 4.8. Turnover Ratio of the Proposed System (Vegetable & Fruit Items).

Item No	Cnm. of Item	Item Name	Unit	Qt.'''	Amount	Existing Turnover Ratio	Proposed Turnover Ration.	ABC Classification
	1.69%	11°;141')	qn	2670	4,950	19	20	A
	3.39%	1,11q1A111	kg.	44.5	2,982	25	25	A
	5.08%	afifireh	kg.	85	1,685	17	20	A
	6.78%	riwum.puen	kg.	17.2	1,606	18	20	A
5	8.47%	v7111i°,;511	qn	71	1,198	22	20	A
	10.17%		kg.	25	1,070	25	20	A
7	11.86%		kg.	25	830	5	5	A
8	13.56%	11011014	kg.	53	676	11	10	A
	15.25%		kg.	76	626	26	25	A
10	16.95%	fM1,9,fl	kg.	33	621	12	20	A
11	18.64%	41-111DU	kg.	30	621	27	30	A
12	20.34%	fl5t11/1611Mfl	kg.	14	620	7	5	A
13	22.03%	4flfl1M1T3	kg.	52	572	18	15	B
14	23.73%		kg.	11	550	11	15	B
15	25.42%	117111111114,11144	kg.	4	420	4	5	B
16	27.12%	1/13fli1111011	kg.	16	413	13	15	B
17	28.81%	41414'	kg.	17	366	24	25	B
18	30.51%	mulmij	kg.	24	351	12	15	B
19	32.20%	manio	kg.	16	333	16	15	B
20	33.90%	unil0LYIff	kg.	33	321	20	20	B
21	35.59%	aflfl1W11011	kg.	32	294	24	25	B
22	37.29%	61,f15DYI	kg.	6.9	276	4	5	B
23	38.98%		kg.	21.5	265	19	20	B

Table 4.8. Turnover Ratio of the Proposed System (Vegetable & Fruit Items). (Continued)

Item No	Cum. of Item of	Item Name	Unit	Qty.	Amount	Existing Turnover 'Ratio	Proposed Turnover Ration	ABC Classifi-cation
24	40.68%	uni-Nrditra	kg.	21.7	260	17	20	B
25	42.37%	aflia4	kg.	7.5	258	13	15	B
26	44.07%	M12,4111	11	41	254	14	15	B
27	45.76%		kg.	11.5	243	13	15	B
28	47.46%		3: m	36	240	25	25	B
29	49.15%	Ihdau	kg.	9	231	9	15	B
30	50.85%	m,11411.1`d	kg.	28	224	10	15	B
31	52.54%	yaflaql,KM	kg.	5	215	3	5	C
32	54.24%	Nfl14	1:1m	22	202	21	20	C
34	57.63%		kg.	7	154	7	7	C
35	59.32%	oad ra blo	tlJ	15	150	8	7	C
36	61.02%	ranunAl	kg.	3	145	2	3	C
37	62.71%	lAliMI ti andil	kg.	5	140	5	7	C
38	64.41%		kg.	7	140	7	7	C
39	66.10%	fl	kg.	6	111	6	7	C
40	67.80%	coanlvitAoti	kg.	4.7	108	6	7	C
41	69.49%	11'Cm13J N01-.1	kg.	4.2	105	4	7	C
42	71.19%	12;5	kg.	13	101	8	7	C
43	72.88%	Vint1.1111,i		15	99	15	15	C
44	74.58%	,`]f101rfl-1		3.5	96	5	7	C
45	76.27%	ko'.',1,J01,1,f14	kg.	10.5	95	8	7	C
46	77.97%	t152J"1315 1		30	92	22	25	C
47	79.66%	fl5Vir1M1D1	kg.	3	91	3	5	C
48	81.36%	6'1	kg.	8.5	91	8	7	C
49	83.05%	ImnAn	n 1	24	78	19	20	C
50	84.75%			2.5	75	5	7	C
51	86.44%	1N S fl 81411115		1	75	1	1	C
52	88.14%			8.3	67	4	7	C
53	89.83%	11.111tfl p	r) 1	11	66	11	10	C
54	91.53%	1/13f11.118D1	kg.	1.5	56	3	3	C

Table 4.8. Turnover Ratio of the Proposed System (Vegetable & Fruit Items). (Continued)

Item No	Cum. of Item	Item Name	Unit		Amount	Existing Turnover Ratio	Proposed Turnover Ration	ABC Classification
55	93.22%	1419'11		6	53	3	3	
56	94.92%	A &	r11	5	50	1	3	
57	96.61%	fi'A1,11.911		1	37	2	3	
58	98.31%	11.010	4-)	14	36	8	7	
59	100.00%	fl5gAl1f11T1		1	28	1	3	
60		filo		0	0	0	0	
61				0	0	0	0	
62		9511ti		0	0	0	0	
63				0	0	0	0	
64		raniitn		0	0	0	0	
65		1i13fl3Ttrdfl		0	0	0	0	
66		IIng0t1T)		0	0	0	0	
67		ElDfl3J,'1"1511		0			0	
68				0	0			
69				0	0	0	0	
70				0	0	0	0	
71				0	0	0	0	
72		M11958		0	0	0	0	
73		mif10111,11		0	0	0	0	
74		1i13fl66fl1114fl		0	0	0	0	
75		1A13flkall6i1V)		0	0	0	0	
76		1/3flitflA1		0	0	0	0	C
77		ranlmodau		0	0	0	0	
					26,296			
		Total		**3,786**	**52,591**			

Table 4.8 shows specific turnover ratio (monthly) of vegetable and fruit (from Table 4.5).

Turnover ratio of A item is 20 tol, but we can see that item no. 7 (fl5nClE111 bitti) and item no. 12 (nuAnLAn) have turnover ratio of 5 to 1 because these two items have long expiry range. For B items, turnover ratio is 15 to 1 and for C items, turnover ratio is 7 to 1 except for some items that have long expiry range or high volume of quantity (more times replenishment).

Table 4.9. Turnover Ratio of the Proposed System (Non-Perishable Items).

Item No	Cum. of Item	Item Name	Unit	Qty	Amount	Existing Turnover Ratio	Proposed Tornover Ration	ABC Classification
	1.69%	14'13.11r1A1/1	iJv	12	4,660	12	10	A
	3.39%		AN	1750	3,381	25	25	A
	5.08%	ct.riLlm		8	1,541	8	7	A
	6.78%	mAilu		8	1,172	4	7	A
	8.47%	Tvin		7	1,113	7	7	A
	10.17%	6371P11.11',1.1/2 1	kg.	5	1,085	5	7	A
	11.86%	1:1,11Ala		18	852	3	7	A
	13.56%	141,1?Sfrl	nizAl	42	702	7	7	A
	15.25%	1,1,`Th`1fl17S'It1		1	685	1		B
10	16.95%	/1D2S1N3r1		24	660	4	4	B
11	18.64%	1111A	kg.	2	560	2	2	B
12	20.34%		1A en	13	552	3	4	B
13	22.03%	69T`YI	'119P1	18	550	3	3	B
14	23.73%	1,1,111°111a111	Vita	24	524	4	4	B
15	25.42%	nnuArinlm		1	450	2	2	B
16	27.12%	um.rkrvin	itnmu	10	442	10	10	B
17	28.81%	IiM1312111911011	kg.	2.5	440	2	4	B
18	30.51%		kg.	20	420	4	4	B
19	32.20%	LIMLF11.1	v10	2	350	2	4	B
20	33.90%	fff31111111(lal		12	336	2	2	B
21	35.59%	1-03,11,111	911	1	300	1	1	B

Table 4.9. Turnover Ratio of the Proposed System (Non-Perishable Items). (Continued)

Item No	Cum. of Item	Item Name	Unit	Qty	Amount	Existing Turnover Ratio	Proposed Turnover Ration	ABC Classification
22	37.29%	lInvnAu	kg.	20	300	10	10	B
23	38.98%				235	1	1	B
24	40.68%	1,1191b1		6	235	1	1	B
25	42.37%			24	224	4	4	B
26	44.07%	1J 1rnDu		3	220	3	3	C
27	45.76%	1,1'11.11,1			200	1	1	C
28	47.46%	1,3.f rnm		6	200	1	1	C
29	49.15%	74n%q	9frl	9	194	2	3	C
30	50.85%	e,NnT:,vd	119	6	192			C
31	52.54%		2112 61	8	178	2	4	C
32	54.24%	3:14P191		1	175		1	C
33	55.93%	2iffSdl]ld		1	165			C
34	57.63%	17(Jun		6	148			C
35	59.32%			3	120	3	3	C
36	61.02%	LTIuwa-ionsnIN		1	120			C
37	62.71%	cilYfau		5	104	3	4	C
38	64.41%			12	99	4	4	C
39	66.10%			12	96	2	2	C
40	67.80%	LA'ralur)		3	87	1	1	C
41	69.49%	.om,annten		2	80	1	1	C
42	71.19%			50	80	1	1	C
43	72.88%			1	78	1	1	C
44	74.58%	qutil	kg.	1	75	2	1	C
45	76.27%			1	75	1	1	C
46	77.97%	7111A Ur)	kg.	0.3	75	1	1	C
47	79.66%	LALIVid		1	72	1	1	C
48	81.36%	vivirmErz		2	70			C
49	83.05%			200	69	2	1	C
50	84.75%	'Init;13.1		20	68	2	2	C
51	86.44%	LnA'alvitl	th	9	63	4	4	C

Table 4.9. Turnover Ratio of the Proposed System (Non-Perishable Items). (Continued)

IteM No	Cum. of Item	Item Name	Unit .	Qty	AMount	Existing Turnover Ratio	PropOsed Turnover Ration	ABC Classification
52	88.14%		kg.	0.5	60	1	1	
53	89.83%	do	6 1 W1	2	58	1	1	
54	91.53%	valEn1		1	44	1	1	
55	93.22%	6961aorn5.-,11a1		3	42	1	1	
56	94.92%	11.11-12T9Nm		1	30	1	1	
57	96.61%	17Erruirrna		1	25	1	1	
58	98.31%			4	24	2	2	
59	100.00%	1r1V1181151M	vit	1	10	1	1	
60		1°1101		0	0	0	0	
61		1,°1111E1q14̃1		0	0	0	0	
62		1719 VD1		0	0	0	0	
63		011)14¯1fl		0	0	0	0	
64		91 m lvl 1J 611 G1		0	0	0	0	
65		⍁Onlvimlu		0	0	0	0	
66				0	0	0	0	
67				0	0	0	0	
68		LKINtyllu		0	0	0	0	
69		lnn6m		0	0	0	0	
70		Lrlz-Sym		0	0	0	0	
71				0	0	0	0	
72		Ngt'IE1		0	0	0	0	
73		1,17111)al.1		0	0	0	0	
74				0	0	0	0	
75		1,94A1 V19		0	0	0	0	
76		W.M1'19 Wal	nsn,ln	0	0	0	0	
77		ivawvan6		0	0	0	0	
78		innyminfrat4		0	0	0	0	
79				0	0	0	0	
				2,409	25,165			

Table 4.9 will show specific turnover ratio (monthly) of non-perishable items (from Table 4.6).

For non-perishable items have long expiry range, their turnover ratio is lower than other groups. Turnover ratio of A items is about 7 to 1 due to high demand. Item no.2 (eggs) has turnover ratio about 25 to 1 because the volume of demand is very high, about 1750/month. For B items, turnover ratio is about 4 to 1, except some items which have low turnover ratio due to less number of quantity purchased per time. Item no. 16 and 22 have turnover ratio about 10 to 1 because these items have short expiry range. Most of the C items have turnover ratio about 1 to 1 due to low of demand.

However, in this project we try to focus on perishable materials for reducing waste and to specify high turnover ratio to A items for reducing waste and increasing freshness of materials. We realize that if turnover ratio is too high, problems may occur in lot size and handling cost. And turnover ratio is too low there is risk to freshness. From our inventory policy, the material group of vegetables and fruits has highest turnover ratio because this material group has more problems in storage. It can not be frozen like meat. C items, material group has long expiry range, so the question is how much stock should be specified inventory investment is not too high.

4.3.2 Average Inventory

After specifying turnover ratio of all items for reducing waste of materials, raw materials are frequently replenished. Next, we have to know estimated inventory levels according to the inventory policy. To estimate inventory the 80-20 rule (detailed in chapter 2 literature reviews) is considered.

From the 80-20 curve with an arbitrary ABC product classification, it can be analyzed mathematically. Although a number of mathematical equations might be used, the following relationship has been suggested:

$$Y = \frac{(1+A)X}{A+X}$$

Where:

$Y =$ Cumulative fraction of sales.

$X =$ Cumulative fraction of items.

$A =$ A constant to be determined.

Constant A can be found by manipulating this equation to give

$$A = \frac{X(1-Y)}{(Y-X)}$$

As shown in figure 4.1a, the relationship is that 24% of the items results in 72% of food costs. Solving the equation yields A = 0.140, and turnover ratio of all items are specified. If the monthly food costs are forecast to be $120,000, how much inventory investment in the stock can be expected?

The stocked items are shown in Table 4.1. items are ranked according to their relative amounts, from highest to lowest. The cumulative item proportion is determined by 1/N for the first item, 2(1/N) for the second, 3(1/N) for the third, and so on. The constant (A) is found from the equation, or A = (0.24(1-0.72) / (0.68-0.24) = 0.140. The cumulative amount proportion is found by applying the equation using A = 0.140. The amount for the first item would be:

$$Y = \frac{(1+0.140)(0.0189)}{(0.140+ 0.0189)}$$

$$= 0.1356$$

Table 4.10. Average Inventory of the Proposed System (Perishable Items).

Itc,M No	Cum. % of Item (X)	Item Name	Cuinulative of Amount	Cnmula-tive Food Cost (Y)	Projected Item Sales	Proposed Tni'nover Ration	Average Inventory	ABC CIassifi cation
1	1.89%	rj1K911,inj	16.64%	16,247	16,247	15	1,083	A
2	3.77%	1.1n-riauLAn	24.30%	29,045	12,798	15	853	A
3	5.66%		30.91%	39,386	10,341	15	689	A
4	7.55%		37.30%	47,916	8,530	15	569	A
5	9.43%		42.85%	55,072	7,157	15	477	A
6	11.32%		47.74%	61,162	6,090	15	406	A
7	13.21%	VIMILLRS1	51.89%	66,408	5,245	30	175	A
8	15.09%	LInnntrilLfin	55.17%	70,973	4,565	15	304	
					70,973		4,557	
9	16.98%	Ietffij	58.37%	74,982	4,009	10	401	
10	18.87%	vaa~u~aseJ~ia Zuni	61.31%	78,530	3,549	20	177	
11	20.75%	iJanv~a n1	63.74%	81,694	3,163	10	316	
12	22.64%	tmsvadlil	66.05%	84,531	2,838	30	95	
13	24.53%	LL_ill	68.09%	87,091	2,560	30	85	
14	26.42%		70.07%	89,412	2,321	10	232	
15	28.30%		72.04%	91,525	2,114	10	211	
16	30.19%	Atawan	73.97%	93,459	1,933	10	193	
17	32.08%		75.84%	95,233	1,775	10	177	
18	33.96%	01191E1	77.68%	96,869	1,635	10	164	
19	35.85%	WatY0151,617tgn	79.45%	98,380	1,511	20	76	
20	37.74%	Aaria	81.16%	99,781	1,401	10	140	
21	39.62%	TP711.1111_1	82.84%	101,084	1,303	30	43	
22	41.51%	vnAu	84.48%	102,298	1,214	20	61	
23	43.40%	LilpnntA"	85.99%	103,432	1,134	10	113	
24	45.28%	LWaliMnrIti	87.42%	104,494	1,062	15	71	
25	47.17%	MfffIIV711.4	88.77%	105,490	996	10	100	
26	49.06%		89.99%	106,427	937	30	31	
27	50.94%	tutAialla	90.96%	107,310	882	10	88	
28	52.83%	ปูอัด	91.94%	108,142	833	10	83	
					37,170		2,859	
29	54.72%	ปลาเก๋า	92.88%	108,929	787	5	157	
30	56.60%	ชี่โครงหมูแหนม	93.73%	109,674	745	5	149	
31	58.49%	เนื้อติดมัน	94.51%	110,380	706	10	71	
32	60.38%	กะทิ	95.05%	111,050	670	30	22	
33	62.26%	ตับหมู	95.59%	111,687	637	5	127	
34	64.15%	เอ็นไก่	96.02%	112,294	606	5	121	
35	66.04%	หมู3ชั้น	96.43%	112,871	578	5	116	
36	67.92%	กบ	96.83%	113,422	551	5	110	
37	69.81%	ไส้ตัน	97.17%	113,949	526	5	105	
38	71.70%	คอหมู	97.48%	114,452	503	5	101	
39	73.58%	เส้นใหญ่	97.79%	114,933	481	30	16	
40	75.47%	เนื้อแดดเดียว	98.10%	115,394	461	5	92	

Table 4.10. Average Inventory of the Proposed System (Perishable Items). (Continued)

Item No	Cum. % of Item (X)	Item Name	Cumulative of Amount	Cumulative Food Cost (Y)	Projected Item Sales	Proposed Turnover Ration	Average nventory	ABC Classifi-cation
41	77.36%	1,01-*Awam	98.38%	115,836	442	10	44	C
42	79.25%	lAnsan	98.65%	116,261	424	5	85	C
43	81.13%	nsnri-.;	98.90%	116,668	407	5	81	C
44	83.02%	iitm\v6au	99.08%	117,060	392	5	78	C
45	84.91%	umuNvia	99.26%	117,436	377	5	75	C
46	86.79%	Dual	99.43%	117,799	362	3	121	C
47	88.68%	vniun	99.54%	118,148	349	3	116	C
48	90.57%	.Tut,v111	99.65%	118,484	337	5	67	
49	92.45%	un	99.76%	118,809	325	3	108	C
50	94.34%	141,1111	99.84%	119,122	313	3	104	C
51	96.23%	majarlywriu	99.92%	119,425	303	3	101	C
52	98.11%		99.99%	119,717	292	3	97	C
53	100.00%	81:11YITIel	100.00%	120,000	283		94	C
54		1.1£11"1	100.00%	0	0		0	C
55			100.00%	0	0		0	C
56		tot"saa'lulri	100.00%	0	0		0	C
57		L1amlri	100.00%	0	0		0	C
58			100.00%	0	0		0	C
59		iJfinolny.i	100.00%	0	0		0	C
60		IrmajtioAN	100.00%	0	0		0	C
61		wilmAk!	100.00%	0	0		0	C
62		unm..1	100.00%	0	0		0	C
63			100.00%	0	0		0	C
64			100.00%	0	0		0	C
65			100.00%		0		0	
					1-1,858		•2,362	
		total	100.00%		120,000		9,777	

Table 4.11. Average Inventory of the Proposed System (Vegetable & Fruit Items).

Item No	Om. % of Item (X)	item:: Name	Cumulative Food Cost (Y)	Projected Item Sales	Proposed Turnover Ration	Average Inventory.	ABC Classification
1	1.69%	3.1`:, LVI9	3,719	3,719	20	186	A
2	3.39%	SWAN	6,713	2,994	25	120	A
3	5.08%	eTnn.q.i'l	9,176	2,462	20	123	A
4	6.78%	1131'1i1VI41'1i1n	11,237	2,061	20	103	A
5	8.47%	gli1I.,101	12,986	1,750	20	87	A
6	10.17%	66V141.1	14,491	1,504	20	75	A

Table 4.11. Average Inventory of the Proposed System (Vegetable & Fruit Items). (Continued)

Item No	Cum. % of Item (X)	Item Name	Cumulative Food Cost (Y)	Projected Item Sales	Proposed Turnover Ration	Average Inventory	ABC • Classifi-cation
7	11.86%		15,798	1,307	5	261	A
8	13.56%	V1'a3.166M	16,945	1,146	10	115	
9	15.25%	a 1	17,958	1,014	25	41	A
10	16.95%	rr.5itm	18,861	903	20	45	A
11	18.64%	PLA1,1`61.1	19,670	809	30	27	A
12	20.34%	n2r,SimAn	20,399	729	5	146	A
				20.399		1,.32()	
13	22.03%	e:Inn-imn9	21,059	660	15	44	
14	23.73%	ti91fln	21,660	601	15	40	
15	25.42%	varmv,011	22,210	549	5	110	
16	27.12%	minrimp,m1	22,714	504	15	34	
17	28.81%		23,178	464	25	19	
18	30.51%	vm1.11,1Anj	23,607	429	15	29	
19	32.20%		24,004	397	15	26	
20	33.90%	1,1:;411`DLYIri	24,374	369	20	18	
21	35.59%	1TnmPIIM1.1	24,718	344	25	14	
22	37.29%	66(P1TaV1	25,039	321	5	64	
23	38.98%		25,340	301	20	15	
24	40.68%	1,lnjrN	25,622	282	20	14	
25	42.37%		25,887	265	15	18	
26	44.07%	tyamm,iii4	26,137	250	15	17	
27	45.76%	1A13snr*I66m4	26,372	235	15	16	
28	47.46%		26,595	223	25	9	
29	49.15%	M U14	26,805	211	15	14	
30	50.85%	fll:Virniso	27,005	200	15	13	
				6,606		513	
31	52.54%	ctA3neT2Lelm	27,194	189	5	38	
32	54.24%	r,Tn q	27,374	180	20	9	
33	55.93%	ii" ntinq	27,545	171	15	11	
34	57.63%	mia1,14eslfi	27,708	163	7	23	

Table 4.11. Average Inventory of the Proposed System (Vegetable & Fruit Items). (Continued)

Item No	Cum. % of Item (X)	Item Name	Cumulative Food Cost	Projected Item Sales	Proposed Turnover Ration	Average Inventory	ABC Classification
35	59.32%	Ei'D MITAIA101	27,864	156	7	22	C
36	61.02%	Alin1,111111`1	28,013	149	3	50	C
37	62.71%	srromnelil	28,155	142	7	20	C
38	64.41%	11;19	28,291	136	7	19	C
39	66.10%	mnn:-viAn	28,421	130	7	19	
40	67.80%	1A131111/1TAMA	28,545	125	7	18	C
41	69.49%	1411 1 11?)"ald	28,665	120	7	17	C
42	71.19%	1.1:1:1:,'	28,780	115	7	16	C
43	72.88%	211;To:61,1)11,1	28,890	110	15	7	C
44	74.58%	TIT.1,11 1T.1 LA1,1	28,997	106	7	15	C
45	76.27%	1.1:51,q1E unl	29,099	102	7	15	C
46	77.97%	n T.L,'LIN rl	29,197	98	25	4	C
47	79.66%	r,-.11?1E13.1MD1	29,292	95	5	19	C
48	81.36%	091!\),	29,384	92	7	13	C
49	83.05%	MI,W1	29,472	88	20	4	C
50	84.75%	1d'aEI	29,557	85	7	12	C
51	86.44%	orilnimqj ail	29,640	82	1	82	C
52	88.14%	1_11.1:5113AVLI	29,719	80	7	11	C
53	89.83%	inznao	29,796	77	10	8	C
54	0.915254	1A13111,141	29,871	75	3	25	C
55	93.22%	411,14'1	29,943	72	3	24	C
56	94.91%	P141	30,013	70	3	23	C
57	96.61%	67A1.116l1	30,081	68	3	23	C
58	98.30%	19J WM	30,147	66	7	9	C
59	100%	f11:51Y1E19;f9	30,211	64	3	21	C
60		X3,IT	0	0		0	C
61		e,l""	0	0		0	C
62		A	0	0		0	C
63		1.1:-'2.1Q1	0	0		0	C
64		`AnAU')	0	0		0	C

Table 4.11. Average Inventory of the Proposed System (Vegetable & Fruit Items). (Continued)

Item No	Cunt. % of Item (X)	Item Name	Cumulative Food Cost (Y)	Projected Item Sales	Proposed Turnover Ration	Average Inventory	ABC Classifi-cation
65		พริกหยวก	0	0		0	C
66		มะเขือยาว	0	0		0	C
67		ยอดมะพร้าว	0	0		0	C
68		หัวปลี	0	0		0	C
69		ข่า	0	0		0	C
70		มะละกอดิบ	0	0		0	C
71		ขิงดอง	0	0		0	C
72		อบเชย	0	0		0	C
73		พริกแพนง	0	0		0	C
74		พริกแกงเผ็ด	0	0		0	C
75		พริกแกงเขียว	0	0		0	C
76		พริกแกงส้ม	0	0		0	C
77		พริกไทยอ่อน	0	0		0	C
				]:(1()			
				30,211		2,422	

Table 4.12. Average Inventory of the Proposed System (Non-Perishable Items).

Item No	Cum. % of Item ...(X)	Item Name	Cumulative Food Cost (1	Projected Item Sales	Proposed Turnover Ration	Average Inventory	ABC ClassifiCatio
	1.69% 1111:11411		3,693	3,693	10	369	A
2	3.39% °Ad		6,667	2,973	25	119	A
3	5.08%		9,112	2,445	7	349	A
4	6.78% LVI'111.4		11,158	2,046	7	292	A
5	8.47% 'ATI LN`I		12,896	1,738	7	248	A
6	10.17% 1,11P11,111,194		14,390	1,494	7	213	A
7	11.86% 11.,ILX1,1		15,688	1,298	7	185	A
8	13.56% 1.4.1701		16,827	1,138	7	163	A
				16,827		1,940	

Table 4.12. Average Inventory of the Proposed System (non-perishable items). (Continued)

Item No	CUM. % of Item (X)	Item Name	Cumulative Food Cost	Projected Item Sales	Proposed Turnover Ration	Average Inventory	ABC Classification
9	15.25%	น้ำตาลทราย	17,833	1,007	1	1,007	B
10	16.95%	ซอสพริก	18,729	896	4	224	B
11	18.64%	กุ้งแห้ง	19,533	803	2	402	B
12	20.34%	โกยซี่หมี่	20,257	724	4	181	B
13	22.03%	ซีอิ๊วขาว	20,913	656	3	219	B
14	23.73%	แป้งขนมปัง	21,509	597	4	149	B
15	25.42%	กระเพาะปลา	22,055	546	2	273	B
16	27.12%	น้ำมันหอย	22,556	501	10	50	B
17	28.81%	ปลาหมึกวงแห้ง	23,017	461	4	115	B
18	30.51%	มะขามเปียก	23,442	426	4	106	B
19	32.20%	ปลาเค็ม	23,837	395	4	99	B
20	33.90%	ซอสภูเขาทอง	24,204	367	2	183	B
21	35.59%	น้ำมันงา	24,545	342	1	342	B
22	37.29%	น้ำตาลปี๊บ	24,865	319	10	32	B
23	38.98%	เนย	25,163	299	1	299	B
24	40.68%	น้ำจิ้มไก่	25,443	280		280	B
25	42.37%	แป้งโกกิ	25,707	263	4	66	B
				8,880		4,026	
26	44.07%	Llmns'au	25,954	248	3	83	C
27	45.76%	14'11.1142SfIM	26,188	234		234	C
28	47.46%	1.111TIO	26,409	221	1	221	C
29	49.15%	จิ๊nIV)	26,618	209	3	70	C
30	50.85%	ran2ros	26,817	198		198	C
31	52.54%	149 61M11,1.11M-1	27,005	188	4	47	C
32	54.24%	1:14vinn	27,183	179		179	C
33	55.93%	vazinfitta	27,353	170		170	C
34	57.63%	บ๊วยกอ	27,515	162		162	C
35	59.32%	ถั่วลิสงดิบ	27,670	155	3	52	C
36	61.02%	เกี๋ยมฉายกระป๋อง	27,817	148	1	148	C
37	62.71%	ถุงร้อน	27,958	141	4	35	C

Table 4.12. Average Inventory of the Proposed System (Non-Perishable Items). (Continued)

Item No	Cum. 'Yo Of Item (X)	Item Name	Cumulative Food Cost (Y)	Projected Item Sales	Proposed Turnover Ration	Average Inventory	ABC Classifi-cation
38	64.41%	L1,9113.714	28,093	135	4	34	
39	66.10%	Inn nun	28,223	129	2	65	
40	67.80%	WI'l 69 El')	28,346	124	1	124	
41	69.49%	1.1`11:1941AlinI,N1	28,465	119		119	
42	71.19%	TIA13.111;Itlj	28,579	114		114	
43	72.88%	t),419	28,689	110	1	110	
44	74.58%	quiiiEl	28,794	105	1	105	
45	76.27%	fltil	28,896	101	1	101	
46	77.97%	I AM	28,994	98	1	98	
47	79.66%	Lavvvi	29,088	94	1	94	
48	81.36%	PI inti:;	29,179	91	1	91	
49	83.05%	1A13,16gfl	29,267	88	1	88	
50	84.75%	111/11.1	29,351	85	2	42	
51	86.44%	Ln'fl'IVIE1	29,433	82	4	20	
52	88.14%	qnuin	29,512	79	1	79	
53	89.83%	M All V1S1	29,589	77	1	77	
54	91.53%	1'11E111	29,663	74	1	74	
55	93.22%	6961.101111S:',11D1	29,734	72	1	72	
56	94.92%	61,1114i1 'AIN P1	29,804	69	1	69	
57	96.61%	IIIIIITIATILI	29,871	67	1	67	
58	98.31%	Lflg`aal	29,937	65	2	33	
59	100.00%	'1 MIMS') P1	30,000	63		63	
60		111,1M	0	0		0	
61		1106.1q1211	0	0		0	
62		1119 tlPD1	0	0		0	
63		?ITV T'It1	0	0		0	
64		1ARni,viudim	0	0		0	
65		vanlyitiilla	0	0		0	
66		9, 9,24	0	0		0	
67							

Table 4.12. Average Inventory of the Proposed System (Non-Perishable Items). (Continued)

Item No	Cum. % of Item (X)	Item Name	CuMulative Food Cost (Y)	Projected Item Sales	Proposed Turnover Ration	Average inventory	ABC Classification
68		NE`1114,	0	0		0	C
69		LT1 I&	0	0		0	C
70		L,COL'r19U	0	0		0	C
71		1.1'11 LI	0	0		0	C
72		PI1VIE	0	0		0	C
73		117109A1.1	0	0		0	C
74		ni	0	0		0	C
75		LIAA1M`19	0	0		0	C
76		34:14'190M	0	0		0	C
77		LI, nna4	0	0		0	C
78		nT:,-frnyv-lnol	0	0		0	C
79		C111.1 ==	0	0		0	C
						3,337	
				30,000		9,302	

V. SYSTEM EVALUATION

5.1 Product Availability

A primary objective of inventory management is to assure that product is available at the right time and in the quantities desired. This is commonly judged on the basis of the probability of being able to fill a request for a product from current stock. This probability, or item fill rate, is referred to as the service level, and, for a single item, can be defined as

$$\text{Service level} = 1 - \frac{\text{Expected Number of Units Out of Stock Annually}}{\text{Total Annual Demand}}$$

Service level is expressed as a value between 0 and 1. Because a target service level is typically specified, our task is to control the expected number of units out of stock.

We will see that controlling the service level for single item is computationally convenient. However, customers frequently request more than one item at a time. Therefore, the probability of filling the customer order completely can be of greater concern than single-item service levels. For example, suppose that five items are requested on an order where each item has a service level of 0.95, that is, only a 5 percent chance of not being in stock. Filling the entire order without any item being out of stock would be the probability of filling the order completely which is somewhat less than the individual item probabilities as follows:

$$0.95 * 0.95 * 0.95 * 0.95 * 0.95 = 0.77$$

Number of orders from many customers will show that a mixture of items can appear on any one order. The service level is then more properly expressed as a weighted average fill rage (WAFR). The WAFR is found by multiplying the frequency

with which each combination of items appears on the order by the probability of filling the order completely, given the number of items on the order. If a target WAFR is specified, then the service levels for each item must be adjusted so as to achieve this desired WAFR.

Table 5.1. Computation of the Weight Average Fill Rate.

Item Combination On Order	**Frequency Of order**	**Probability of Filling Complete Order**	**(^{3}) = (^{1}) *(^{2}) Marginal value**
A	0.2	(0.95) = 0.95	0.19
B	0.1	(0.90) = 0.90	0.09
C	0.2	(0.80) = 0.80	0.160
A B	0.1	(0.95) *(0.90) =0.855	0.0855
A C	0.2	(0.95) * (0.80) = 0.760	0.0152
B C	0.1	(0.90) * (0.80) = 0.720	0.072
A B C	0.1	(0.95) * (0.90) * (0.80) = 0.684	0.0684
	1.0	WAFR =	0.6811

This table shows product availability of ABC items (from ABC analysis) that are ordered by customers in various combinations. From a sampling of orders over a period of time, the items appear on orders in seven different combinations with frequencies as noted in Table 5.1. Also from the restaurant's historical records, the probability of having each item in stock is service level, *SL, =0.95; SLb* =090; and *SL,* = 0.80. The calculations in Table 5.1 shows that WAFR is 0.681. There will be about one order in five where our restaurant cannot supply all items at the time of the customer's request.

However, from Table 5.1, WAFR = 0.681 is shows that our restaurant can fill all items about 68 percent of issuing items for the service level ($SL_{,}$ =0.95; $SL_{,,}$ =090; and $SL_{,}$ = 0.80) after classifying all into three groups: A, B, and C,

5.2 Relevant Cost

Three general classes are important to determining inventory policy: procurement cost, carrying cost, and out-of-stock costs. These costs are in conflict, or in trade off, with each other. For determining the order quantity to replenish an item in inventory, these relevant costs trade off as shown in Figure 5.2.

Procurement Costs

Costs associated with the acquisition of goods for the replenishment of inventories are often a significant economic force that determines the reorder quantities. When a stock replenishment order is placed, a number of costs are incurred that are related to the processing, setup, transmitting, handling, and purchase of the order. More specifically, procurement costs may include the price, or manufacturing cost, of the product for various order sizes; the cost for setting up the production process; the cost of processing an order through the accounting and purchasing departments; the cost of transmitting the order to the supply point, usually by mail or electronic means; the cost of transporting the order when transportation charges are not included in the price of the purchased goods; and the cost of any material handling or processing of the goods at the receiving point. When the firm is self-supplied, as in the case of a factory production setup costs. Transportation costs may not be relevant if a delivered pricing policy is in effect.

Some of these procurement costs are fixed per order and do not vary with the order size. Others, such as transportation, manufacturing, and material-handling costs, vary to a degree with order size. Each requires slightly different analytical treatment.

Carrying Cost

Inventory carrying costs result from storing, or holding goods for a period of time and are roughly proportional to the average quantity of goods on hand. These costs can be collected into four classes: space costs, capital costs, inventory service costs, and inventory risk costs.

(a) Space Cost: Space costs are charges made for the use of the cubic footage inside the storage building. When the space is rented, storage rates are typically charged by weight for a period of time, for example, $/cwt./month. If the space is privately owned or contracted, space costs are light, as well as fixed costs, such as building and storage equipment cost, on a volume-stored basis. Space costs are irrelevant when calculating carrying costs for in-transit inventories.

(b) Capital Costs: Capital costs refer to the cost of the money tied up in inventory. This cost may represent more than 80 percent of total inventory cost (see Table 5.2), yet it is the most intangible and subjective of all the carrying cost elements. There are two reasons for this. First, inventory represents a mixture of short-term and long-term assets, as some stocks may serve seasonal needs and others are held to meet longer-term demand patterns. Second, the cost of capital may vary from the prime rate of return on the most lucrative investments forgone by the firm.

(c) Inventory Service Costs: Insurance and taxes are also a part of inventory carrying costs because their level roughly depends on the amount of inventory on hand. Insurance coverage is carried as a protection against losses from fire, storm, or theft. Inventory taxes are levied on the inventory levels found on the day of assessment. Although the inventory at the point in

time of the tax assessment only crudely reflects the average inventory level experienced throughout the year, taxes typically represent only a small portion of total carrying cost. Tax rates are readily available from accounting or public e cost.

Table 5.2. Relative Percentages of the Cost Elements in Inventory Carrying Costs.

	Existing system	**Proposed system**
Interest and opportunity costs	79	88
Obsolescence and physic depreciation	20%	10%
Storage and handling	1%	2%
Total	100%	100%

(d) Inventory Risk Costs: Costs associated with deterioration, shrinkage (theft), damage, or obsolescence makes up the final category of carrying costs. In the course of maintaining inventories, a certain portion of the stock will become contaminated, damaged, spoiled, pilfered, or otherwise unfit or unavailable for sale. The costs associated with such stock may be estimated as the direct loss of product value, as the cost of reworking the product, or as the cost of supplying it from a secondary location.

Out-of-Stock Costs

Out-of-stock costs are incurred when an order is placed but cannot be filled from the inventory to which the order is normally assigned. It presupposes certain actions on the part of the customer, and, because of their intangible nature, they are difficult to measure accurately.

A lost sales cost occurs when the customer, faced with an out-of-stock situation, chooses to withdraw his or her request for the product. The cost is the profit that would have been made on this particular sale and may also include an additional cost for the negative effect that the stockout may have on future sales. Products for which the customer is very willing to substitute competing brands, such as bread, gasoline, or soft drinks, are those that are most likely to incur lost sales.

5.3 Inventory Level

In Chapter 4, we made inventory system for the proposed system, and in this chapter it will be compared with the existing system.

Table 5.3. Comparison of Average Inventory between the Two Systems.
(Perishable Items)

Item No	Cum-% of Rein (X)	item.. N ame	Amount	Existing "Turnover Ratio	Existing Average Inventory	Cum. % of AmOunt •	Cumulative Food Cost (Y)	Projected item Sales	Proposed Turnover Ratio	Avm-age Inventory
1	1.89%	6:191"Ambi	18,780	15	1,252	16.64%	16,247	16,247	15	1,083
2	3.77%	lialiouth	8,646	19	455	24.30%	29,045	12,798	15	853
3	5.66%	IA	7,455	9	828	30.91%	39,386	10,341	15	689
4	7.55%	ilaimin 1101J	7,210	11	655	37.30%	47,916	8,530	15	569

Table 5.3. Comparison of Average Inventory between the Two Systems (Perishable Items). (Continued)

Item No	Cum. % of Item (X)	Item Naine	Amount	Existing Eurnoyer Rado	Existing :Average Inventory	Cunt % of Amount	Cumulative Food Cot (Y)	Projected Item Sales	Proposed Turnover Ratio	Average Inventory
5	9.43%		6,273	10	627	42.85%	55,072	7,157	15	477
6	11.32%	64(1'191M'13J	5,520	9	613	47.74%	61,162	6,090	15	406
7	13.21%	waLUATI	4,680	26	180	51.89%	66,408	5,245	30	175
8	15.09%		3,701	11	336	55.17%	70,973	4,565	15	304
	16.98%	lua1j	3,610	2	1,805	58.37%	74,982	4,009	10	401
10	18.87%	wannIndio	3,315	16	207	61.31%	78,530	3,549	20	177
11	20.75%		2,750	5	550	63.74%	81,694	3,163	10	316
12	22.64%	mmAkrlil	2,600	26	100	66.05%	84,531	2,838	30	95
13	24.53%	.1161	2,310	25	92	68.09%	87,091	2,560	30	85
14	26.42%	L.lfl'Inthl	2,230	13	172	70.07%	89,412	2,321	10	232
15	28.30%		2,219	8	277	72.04%	91,525	2,114	10	211
16	30.19%	v1kifli4an	2,187	13	168	73.97%	93,459	1,933	10	193
17	32.08%		2,110	5	422	75.84%	95,233	1,775	10	177
18	33.96%		2,072	2	1,036	77.68%	96,869	1,635	10	164
19	35.85%	In£11,111714K9iAn	2,000	20	100	79.45%	98,380	1,511	20	76
20	37.74%	Ubfll	1,930	12	161	81.16%	99,781	1,401	10	140
21	39.62%		1,890	27	70	82.84%	101,084	1,303	30	43
22	41.51%	911jXII	1,858	21	88	84.48%	102,298	1,214	20	61
23	43.40%	lOvwvla	1,700	1	1,700	85.99%	103,432	1,134	10	113
24	45.28%	A LualmnrmA	1,620	12	135	87.42%	104,494	1,062	15	71
25	47.17%	UflErIATIU	1,520	5	304	88.77%	105,490	996	10	100
26	49.06%	Wafil61,1Mfi	1,375	26	53	89.99%	106,427	937	30	31
27	50.94%	A TAA'tau	1,100	10	110	90.96%	107,310	882	10	88
28	52.83%		1,100	4	275	91.94%	108,142	833	10	83
29	54.72%		1,056	5	211	92.88%	108,929	787	5	157
30	56.60%	ifTAS4IAIJLLIA1.4.1	960	4	240	93.73%	109,674	745	5	149
31	58.49%	A le0161144	880	8	110	94.51%	110,380	706	10	71
32	60.38%		616	26	24	95.05%	111,050	670	30	22
33	62.26%	Kum	610	6	102	95.59%	111,687	637	5	127
34	64.15%	[:N1ri	480	5	96	96.02%	112,294	606	5	121
35	66.04%	nkpina	462	2	231	96.43%	112,871	578	5	116
36	67.92%	nu	456	4	114	96.83%	113,422	551	5	110
37	69.81%		384	2	192	97.17%	113,949	526	5	105
38	71.70%	AU111,1	352	2	176	97.48%	114,452	503	5	101
39	73.58%		351	27	13	97.79%	114,933	481	30	16
40	75.47%	adflUMMtME19	350	3	117	98.10%	115,394	461	5	92
41	77.36%	13111111 M	315	7	45	98.38%	115,836	442	10	44
42	79.25%	rlAnsm	300	4	75	98.65%	116,261	424	5	85

Table 5.3. Comparison of Average Inventory between the Two Systems (Perishable Items). (Continued)

Item No	Cum. % of **Item**	Item Name	Amount	Ex1Sting Turnover Ratio	Existing Average Inventory	Cum. % of Amount	**Cumulative** Food Cost (Y)	Projected Item Sales	**Proposed Turnover** Ratio	Average Inventory
43	81.13%	nstkrinz-,	286	3	95	98.90%	116,668	407	5	81
44	83.02%	iftmwdau	205	3	68	99.08%	117,060	392	5	78
45	84.91%	l6l1111,11J9ka	200	2	100	99.26%	117,436	377	5	75
46	86.79%	Ul111,1	190	1	190	99.43%	117,799	362	3	121
47	88.68%	Injun	130	2	65	99.54%	118,148	349	3	116
48	90.57%	9%11911	120	4	30	99.65%	118,484	337	5	67
49	92.45%		120	1	120	99.76%	118,809	325	3	108
50	94.34%	alth	90	1	90	99.84%	119,122	313	3	104
51	96.23%	kluduV19114	90	1	90	99.92%	119,425	303	3	101
52	98.11%	'DtPalfl	83	2	42	99.99%	119,717	292	3	97
53	100.00%	az.rellor	11	1	11	100.00%	120,000	283	3	94
54		Likmi	0	0	0	100.00%	0	0	0	0
55		riuo	0	0	0	100.00%	0	0	0	0
56		LA'Dluiri	0	0	0	100.00%	0	0	0	0
57		lkoAri	0	0	0	100.00%	0	0	0	0
58		mll'aullAnj	0	0	0	100.00%	0	0	0	0
59		tlwInIti	0	0	0	100.00%	0	0	0	0
60		lmjeffra	0	0	0	100.00%	0	0	0	0
61		1.111,1	0	0	0	100.00%	0	0	0	0
62		vevsar	0	0	0	100.00%	0	0	0	0
63		(1D11	0	0	0	100.00%	0	0	0	0
64		6:11.1.11	0	0	0	100.00%	0	0	0	0
65		llaggisnalm	0	0	0	100.00%	0	0	0	0
		Total	**112,858**		**15,420**	100.00%		**120,000**		**9,777**

The average inventory of perishable items of the proposed system is 9,777 from projected food cost of 120,000 or is about 8.15% of food cost. While the average inventory system of the existing system is 15,420 from food cost of 163,638 or is about 9.42. It is meant that we reduce the inventory investment about 5% of food cost. And there will be more add of replenishment of the items.

Table 5.4. Comparison of Average Inventory between the Two Systems.
(Vegetable & Fruit Items).

item :. No.	Cum. % of item (X)	Item Na me	A111011nt	Existiri Turnover Ratio....	I xistiag erage Ln c'11t1S1CY	Cum. of Amount	Cumulativ Food ost	rojeeted item Sales	Proposed Turnover Ratio
	1.69%	3,1:1,1d`19	4,950	19	261	3,719	3,719	20	186
	3.39%	Lhrphl	2,982	25	119	6,713	2,994	25	120
	5.08%	an Pl °Al	1,685	17	99	9,176	2,462	20	123
	6.78%		1,606	18	89	11,237	2,061	20	103
	8.47%		1,198	22	54	12,986	1,750	20	87
	10.17%	upilt1.1	1,070	25	43	14,491	1,504	20	75
	11.86%	nmchn.illAnj	830	5	166	15,798	1,307	5	261
	13.56%	v1E1.11011	676	11	61	16,945	1,146	10	115
	15.25%	101111.1	626	26	24	17,958	1,014	25	41
	16.95%	m:vam	621	12	52	18,861	903	20	45
	18 .64%	AVIA'a3	621	27	23	19,670	809	30	27
	20.34%		620	7	89	20,399	729	5	146
	22.03%	eTr1MMI'Ir)	572	18	32	21,059	660	15	44
	23.73%	nql'Dn	550	11	50	21,660	601	15	40
	25.42%	–	420	4	105	22,210	549	5	110
	27.12%	1AIIrlihAV,LLM	413	13	32	22,714	504	15	34
	28.81%	Aaa	366	24	15	23,178	464	25	19
	30.51%	4E1.11,vicli	351	12	29	23,607	429	15	29
			333	16	21	24,004	397	15	26
	33.90%	wAa6Tm	321	20	16	24,374	369	20	18
	35.59%	eTnnlmviE34	294	24	12	24,718	344	25	14
	37.29%	LIA	276	4	69	25,039	321	5	64
	38.98%	aflii	265	19	14	25,340	301	20	15
	40.68%	I.InAl111Sg1`d	260	17	15	25,622	282	20	14
	42.37%	awl	258	13	20	25,887	265	15	18
	44.07%	?..MMT1,15r11,1	254	14	18	26,137	250	15	17
	45.76%	11311011a1	243	13	19	26,372	235	15	16
	47.46%	2	240	25	10	26,595	223	25	9
	49.15%	IhM4	231	9	26	26,805	211	15	14

Table 5.4. Comparison of Average Inventory between the Two Systems (Vegetable & Fruit Items). (Continued)

Item No.	CUm. of item (X)	Item Name	Amount	Existing Turnover	Existing Average Inventory	Cum. % of Amount	Cumulative Food Cost 041	Projected Item Sales	Proposed Turnover Ratio
30	50.85%		224	10	22	27,005	200	15	13
31	52.54%	lA n am L el	215	3	72	27,194	189	5	38
32	54.24%	e:fr	202	21	10	27,374	180	20	9
33	55.93%	c19iif1trI'1	185	16	12	27,545	171	15	11
34	57.63%	inie,3,ir	154	7	22	27,708	163	7	23
35	59.32%	tiE vin9T1Nm	150	8	19	27,864	156	7	22
36	61.02%	rib un1111	145	2	73	28,013	149	3	50
37	62.71%	1A13nviEnn al	140	5	28	28,155	142	7	20
38	%	4 W	140	7	20	28,291	136	7	19
39	66.10%	MnnnAA1	111	6	19	28,421	130	7	19
40	67.80%	1A8n'ImAm.,1	108	6	18	28,545	125	7	18
41	69.49%	vrtd[aflu	105	4	26	28,665	120	7	17
42	71.19%	1,in:5	101	8	13	28,780	115	7	16
43	72.88%	01:52.°566111.	99	15	7	28,890	110	15	7
44	74.58%	tisnirm Lau	96	5	19	28,997	106	7	15
45	76.27%	3.IL'Ll'a am	95	8	12	29,099	102	7	15
46	77.97%	nS:561AITI	92	22	4	29,197	98	25	4
47	79.66%	nnLfitn.ifil	91	3	30	29,292	95	5	19
48	81.36%	6911	91	8	11	29,384	92	7	13
49	83.05%		78	19	4	29,472	88	20	4
50	84.75%	?lN dan	75	5	15	29,557	85	7	12
51	86.44%	lAanlvicij dfl	75		75	29,640	82	1	82
52	88.14%	1J14511'12-1'ald	67	4	17	29,719	80	7	11
53	89.83%	1_114°;,Tqm	66	11	6	29,796	77	10	8
54		3f161'1 4 '1	56	3	19	29,871	75	3	25
55		41114'1	53	3	18	29,943	72	3	24
56		Al&	50	1	50	30,013	70	3	23
57		rindi.,Iwn	37	2	19	30,081	68	3	23
58		iv Lfriu	36	8	5	30,147	66	7	9
59	1	m:,ntrCh	28		28	30,211	64	3	21

Table 5.4. Comparison of Average Inventory between the Two Systems (Vegetable & Fruit Items). (Continued)

Item No.	Cum. % of item (X)	Item Name	Afflotto I	Fur Hover Ratio	xistit2, erage Inventor	Cuni. % of Amon t	Cumulative Food Cost (V)	Projected Item Sales	Proposed Turnover Ratio
60		ส้มโอ	0	0	0	0	0		0
61		ฝรั่ง	0	0	0	0	0		0
62		ชมพู่	0	0	0	0	0		0
63		มะม่วง	0	0	0	0	0		0
64		พริกเขียว	0	0	0	0	0		0
65		พริกหยวก	0	0	0	0	0		0
66		มะเขือยาว	0	0	0	0	0		0
67		T!011,1:14"19	0	0	0	0	0		0
68		หัวปลี	0	0	0	0	0		0
69		ข่า	0	0	0	0	0		0
70		มะละกอดิบ	0	0	0	0	0		0
71		ขิIAN	0	0	0	0	0		0
72		อบเชย	0	0	0	0	0		0
73		พริกแพนง	0	0	0	0	0		0
74		พริกแกงเผ็ด	0	0	0	0	0		0
75		พริกแกงเขียว	0	0	0	0	0		0
76		พริกแกงส้ม	0	0	0	0	0		0
77		พริกไทยอ่อน	0	0	0	0	0		0
			26,296		667		3,206		580
					2,272		30,211		2,422

The average inventory of vegetable &fruit of the proposed system is 2,422 from projected food cost of 120,000 or is about 2.02% of food cost. While the average inventory system of the existing system is 2,272 from food cost of 163,638 or is about 1.40%. It is meant that we increase the inventory investment about 0.60% of food cost for increasing the freshness of raw materials. And there will be more add of replenishment of the items.

Table 5.5. Comparison of Average Inventory between the Two Systems.
(Non-Perishable Items).

Item No	cum. % of Item (x)	Item N:nne	* 1114,iiill	F, isting Turnover Ratio	Existing Average Inventory	Cumula tive Food Cost (Y),	Projected Item sales	Proposed Turnover Ratio	Avii*ge Tin entoiy
1	1.69%	1:113:fUil`11	4,660	12	388	3,693	3,693	10	369
2			3,381	25	135	6,667	2,973	25	119
3	5.08%	น้ำปลา	1,541	8	193	9,112	2,445	7	349
4	6.78%	เหล้าจีน	1,172	4	293	11,158	2,046	7	292
5	8.47%	พริกเผา	1,113	7	159	12,896	1,738	7	248
6	10.17%	เม็ดมะม่วง	1,085	5	217	14,390	1,494	7	213
7	11.86%	กุ้นเส้น	852	3	284	15,688	1,298	7	185
8	13.56%	นมสด	702	7	100	16,827	1,138	7	163
9	15.25%	น้ำตาลทราย	685	1	685	17,833	1,007	1	1,007
10	16.95%	ซอสพริก	660	4	165	18,729	896	4	224
11	18.64%	กุ้งแห้ง	560	2	280	19,533	803	2	402
12	20.34%	โกยซี่หมี่	552	3	184	20,257	724	4	181
13	22.03%	ซีอิ๊วขาว	550	3	183	20,913	656	3	219
14	23.73%	แป้งขนมปัง	524	4	131	21,509	597	4	149
15	25.42%	กระเพาะปลา	450	2	225	22,055	546	2	273
16	27.12%	น้ำมันหอย	442	10	44	22,556	501	10	50
17	28.81%	ปลาหมึกวงแห้ง	440	2	220	23,017	461	4	115
18	30.51%	มะขามเปียก	420	4	105	23,442	426	4	106
19	32.20%	ปลาเค็ม	350	2	175	23,837	395	4	99
20	33.90%	ซอสภูเขาทอง	336	2	168	24,204	367	2	183
21	35.59%	น้ำมันงา	300	1	300	24,545	342	1	342
22	37.29%	น้ำตาลปี๊บ	300	10	30	24,865	319	10	32
23	38.98%	เนย	235	1	235	25,163	299	1	299
24	40.68%	น้ำจิ้มไก่	235	1	235	25,443	280	1	280
25	42.37%	LollInfi	224	4	56	25,707	263	4	66
26	44.07%	Ll mrbau	220	3	73	25,954	248	3	83
27	45.76%	IVIPLIOM	200	1	200	26,188	234	1	234
28	47.46%	ไม้กวาด	200	1	200	26,409	221	1	221
29	49.15%	จิ๊กโฉ่ว	194	2	97	26,618	209	3	70

Table 5.5. Comparison of Average Inventory between the Two Systems (Non-Perishable Items). (Continued)

Item No	Cum. O/ of Item (:\	Item ame L:1	Amount	Existing Furnover Ratio	I outing 'o, (Tays	Cumulative Food Cast (17)	Projected Item sales	Proposed Turnover Ratio	Average Inventnry
30	50.85%	wnsnn	192		192	26,817	198		198
31	52.54%	W9 L'1 PY1	178	2	89	27,005	188	4	47
32	54.24%	117S	175	1	175	27,183	179	1	179
33	55.93%	ff'd119.4	165	1	165	27,353	170	1	170
34	57.63%	T_ITTa	148	1	148	27,515	162	1	162
35	59.32%	[TriA MPLI	120	3	40	27,670	155	3	52
36	61.02%	LIEn.itnti mnID1	120	1	120	27,817	148	1	148
37	62.71%		104	3	35	27,958	141	4	35
38	64.41%	Lo111:114	99	4	25	28,093	135	4	34
39	66.10%	1,nAlva	96	2	48	28,223	129	2	65
40	67.80%	6P111,9?...n	87	1	87	28,346	124	1	124
41	69.49%	1141annirsin	80	1	80	28,465	119	1	119
42	71.19%		80	1	80	28,579	114		114
43	72.88%	qlvn	78	1	78	28,689	110		110
44	74.58%		75	2	38	28,794	105	1	105
45	76.27%		75	1	75	28,896	101		101
46	77.97%	l,Z4tio	75	1	75	28,994	98		98
47	79.66%	dv	72	1	72	29,088	94		94
48	81.36%		70	1	70	29,179	91		91
49	83.05%	lAhILAn	69	2	35	29,267	88		88
50	84.75%		68	2	34	29,351	85	2	42
51	86.44%		63	4	16	29,433	82	4	20
52	88.14%	qnLnfrl	60	1	60	29,512	79	1	79
53	89.83%	do T1	58	1	58	29,589	77	1	77
54	91.53%	111E1'11	44	1	44	29,663	74	1	74
55	93.22%	64,11,V1 nrAl	42	1	42	29,734	72	1	72
56	94.92%		30	1	30	29,804	69	1	69
57	96.61%	1°111119 mTu	25	1	25	29,871	67	1	67

Table 5.5. Comparison of Average Inventory between the Two Systems. (Non-Perishable Items). (Continued)

Item No	Cunt. % of Item (X)	Item Name	Amount	Existing Turnover Ratio	Existing, Average Inven	Ford ost)	Projected Item salt.;	Proposed Turnover Ratio	Average Inventory;
58	98.31%	Lng e•ffl	24	2	12	29,937	65	2	33
59	100.00%	14`1G1nffn9m	10	1	10	30,000	63	1	63
60			0	0	0	0	0	0	0
61			0	0	0	0	0	0	0
62			0	0	0	0	0	0	0
63			0	0	0	0	0	0	0
64		1/434v1tio1m	0	0	0	0	0	0	0
65		vilnlinutha	0	0	0	0	0	0	0
66		9, O'11y1	0	0	0	0	0	0	0
67		11.6n	0	0	0	0	0	0	0
68		iRiNunlu	0	0	0	0	0	0	0
69		Ln-i6v1	0	0	0	0	0	0	0
70		tin,im	0	0	0	0	0	0	0
71		isnIlLgtru	0	0	0	0	0	0	0
72		t_ ViltlE1	0	0	0	0	0	0	0
73		1,17iMVI3.1	0	0	0	0	0	0	0
74		,, SA	0	0	0	0	0	0	0
75		LIAX1 V19	0	0	0	0	0	0	0
76		3.1:1419 M1	0	0	0	0	0	0	0
77			0	0	0	0	0	0	0
78		nJ—;;m-	0	0	0	0	0	0	0
79		1'11U1',	0	0	0	0	0	0	0
		Total	46,934		7.818		30,000		

The average inventory of vegetable &fruit of the proposed system is 9,302 from projected food cost of 120,000 or is about 7.75% of food cost. While the average inventory system of the existing system is 7,818 from food cost of 163,638 or is about

4.78%. It is meant that we reduce the inventory investment about 3.0% of food cost. And there will be more replenishments of the items.

VI. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This project is based on the problem of how to reduce the food cost from reducing waste of raw materials. So we try to analyze the existing inventory system in each process: purchasing, receiving, storing, issuing, and production. From monitoring, we see that most functions of each process have no principle. For instance, if an item is sold out it will be replenished for preparing the next sales. But this action will increase waste material because this is not supplying the demand of customer. Since a suitable system for good flow of raw materials is necessary this project has been implemented for improving the inventory system.

First, the project is started with data collection process for knowing how many items should be stocked, how much should be replenished, and how much should be the amount of inventory investment. We collect the data monthly because most business activities of our restaurant will be evaluated monthly. In data collection process, we divide the items into three groups according to their nature.

(1) Perishable items: most items of this group will be main items of food production of each menu, so they will be expensive. The characteristics of these items are they have shot expiry range, need more freshness of material, and need storage by freezing, such as meat.

(2) Vegetable and fruit: this item group is the component of menu and most of them are non-expensive. The problem of this item group is, it is difficult to keep them always fresh. This group will have the highest volume of waste materials.

(3) Non-perishable item: most items of this group will have long expiry range. The problem of this group is "how many stocked items is not too high inventory investment."

When data collection is finished, the items, which have high volume of demand, is classified by "ABC Classification". The database is computed in worksheet, cumulative % of amount and cumulative % of items. The 80-20 curve is plotted from these two data and then fit in the curve with three lines, and classified into 3 groups: A, B, and C items.

When we got ABC items are obtained, we try to set inventory policy is set by using the 80-20 curve to find out Turnover Ratio and Average Inventory. By having specified Turnover Ratio, the relation between inventory level and demand of customer is improved.

However, after using ABC analysis some items have lower stocked volume that causes out-of-stock cost. But **weight average filled rate** (WAFR) = 0.681 show that there will be only 32% of loss opportunity.

6.2 Recommendations

In management of inventory control of most medium-sized restaurant, the managers will not any principle to help in management. He will use his experience to mange everything. So this project may use him to find a way to improve the inventory control system.

From data collection, using the amount (unit price x quantities) to be variable for ranking, it is seen that the items, which have high volume of amount, will have more importance than the items which have low volume of amount. Some items have more quantities because they are the main components in many menus but they are cheap, so they are classified into B item such as item no. 21 (IffilIti9s11). Most items of vegetable

and fruit will have more waste because they are non-expensive so most people will not pay attention to them. But this item group has a volume of 15% of total amount (30,000/month). In the real situation, average inventory may be adjusted by purchaser since unit price is not constant everyday, so the purchaser has to set the plan for product availability.

Food production is another process, which is very important to reduce percent of food cost. It is very difficult to use the exactly quantities of raw materials to produce a menu. Because controlling the food production process with high efficiency is very difficult for a medium-sized restaurant because the production process has to reset. In one menu, there are more than 8 component items, so it is hard to have 100% of raw materials for use in food production process. It will have high cost for development process when compared to the income of the restaurant.

However, to reduce percentage of food cost is not only to develop the inventory system, but also sales and marketing need to be developed. Setting sales promotion improves the relationship between sales demand and inventory. It is used as a factor for setting the stock policy. For instance, the menus with items B may be discounted in order to increase the demand in this group for more circulation all of items. Menus with items C will be coupled with menus with items A.

Eventually, people will still be the cause of most problems that occur in our restaurant, although we try to set the new system. We have to develop human resource for manipulating the new process efficiently. Because in the existing system the biggest problem is comes from people, so when there is a new problem the user should understand and accept it. In this project our chef participated in data collection process, because we know that if our subordinates do not participate it will cause problems in implementation.

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