INVENTORY MANAGEMENT AND CONTROL AT AN IN-FLIGHT CATERING COMPANY

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Specially dedicated to my beloved husband, Mohd. Faizal bin Abd. Razak and my dearest family

For everlasting love and care.....

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ABSTRACT

This report focused on inventory management and control at an in-flight catering company dry goods raw material store. The objective is to develop an inventory management and control procedure. ABC analysis was carried out to determine the frequency of stock check. Barcode system can improve the inventory control of the dry goods raw material stock. Forecasting technique based on the historical data can help reduce over stock of raw material. The implementation of the inventory control techniques can improve the inventory management and at the company. The techniques proposed have been validated by the expert.

Keywords: Inventory management and control; ABC analysis; forecasting; frequent stock check; barcode; in-flight catering

ABSTRAK

Projek penyelidikan ini menumpukan kepada penggunaan pengurusan dan pengendalian teknik inventori bahan mentah di dalam gudang syarikat katering penerbangan. Objektif pertama penyelidikan ini adalah untuk menyediakan prosedur sistematik pengurusan inventori dan ini telah dicapai dengan melakukan analisis ABC yang mengklasifikasikan inventori bahan mentah kepada kelas 'A', kelas 'B' dan kelas 'C' . Implementasi sistem 'barcode' telah mencapai matlamat tujuan kedua dimana untuk meningkatkan cara pengendalian inventori bahan mentah. Akhirnya, teknik peramalan (forecasting) berdasarkan sejarah data lampau telah membuat tujuan yang ketiga untuk mengurangkan inventori bahan mentah yang telah sampai tarikh luput sebelum digunakan. Pelaksanaan teknik cara yang tepat dapat meningkatkan pengurusan dan pengendalian persediaan pada barang kering gudang di dalam syarikat katering penerbangan. Dengan demikian, setiap organisasi yang menggunakan teknik ini membolehkan mereka untuk membuat pengurusan dan pengendalian inventori di syarikat mereka dengan lancar dan sentiasa terkawal. Teknik ini juga telah mendapat validasi oleh pakar-pakar di industri.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Inventory management is one of the most important business processes during the operation of a manufacturing company as it relates to purchases, sales and logistic activities. It concerned with the control of stocks throughout the whole supply chain. Inventory control sits at the data level where the day-to-day business is organized. Activities here are data driven and are primarily concerned with short-term planning and recording of events. Inventory control is concerned with maintaining the correct level of stock and recording its movement. It deals mainly with historic data.

1.2 Inventory Management

Inventory is generally considered to comprise in three main areas which are raw materials, work in progress and finished goods. Where these are held and in what quantities, and how they are managed will vary significantly from one organization to another. The activities of inventory management involves are identifying inventory requirements, setting targets, providing replenishment techniques and options, monitoring item usages, reconciling the inventory balances, and reporting inventory status.

In order to have clear inventory management, a company should not only focus on logistic management but also on sales and purchase management. Inventory management and control is not only the responsibility of the accounting department and the warehouse, but also the responsibility of the entire organization. Actually, there are many departments involved in the inventory management and control process, such as sales, purchasing, production, logistics and accounting. All these departments must work together in order to achieve effective inventory controls.

In-flight catering company should adopt appropriate inventory management system to ensure the quality of the food supply. Flight catering is unlike any other sector of the catering industry. While the way food is served on trays to airline passengers bears some resemblance to service styles in restaurants or cafeterias, the way food is prepared and cooked increasingly resembles a food manufacturing plant rather than a catering kitchen. The way food and equipment is stored resembles a freight warehouse, and the way meals and equipment are transported and supplied has a close affinity to military-style logistics and distribution systems. Therefore, inventory management is one of the greatest challenges facing by an in-flight caterer (McCool, 1996).

1.3 Background of the Research

This project will investigate problems associated with inventory management and control at the warehouse of in-flight catering company. Inventory control in this company is seen as the management function – forecasting, determining requirements, setting targets and issuing instructions – whereas the monitoring of stocks in the warehouse is seen as a supervisory function that requiring less skill and experience. And yet, if the management and control is overlooked or given less than its due consideration, the feedback information, on which management depends to determine the effect of its instructions, is unreliable and gives no indication as to the quality of the inventory management. This project attempt to provide management with recommendations to improve operations and reduce errors. The need for rapid and accurate management and control of inventory is a vital part of the process of remaining competitive.

1.4 Problem Statement

Flight catering is one of the most complex operational systems in the world with high volume operations. For instance, a large-scale flight catering production unit may employs over 800 staffs to produce as many as 25 000 meals per day during peak periods. A large international airline company may have hundreds of takeoffs and landings every day from just their main hub. Therefore, it is very clear that flight caterers handle a considerable volume of products on a daily basis (Jones, 2004 and McCool, 1995). Below are some of the problems facing by in-flight catering company in their inventory management system.

i. Holding too much stock adds costs to the business and some other problems such as expiry date and material handling will add cost and reduce efficiency.

ii. The record of the inventory does not tally with the actual stock count in the warehouse.

Therefore, effort is needed to address the stated problem. Development of a systematic inventory management and control can reduce or eliminate those problems and consequently would improve the in-flight catering business.

1.5 Methodology

It is important in research strategy to select methods that fit the type of research question being asked. This case study investigates the inventory management and control problems at in-flight catering company. The study has been carried out at one of the in-flight catering company in Penang. Data was collected by interviewing people, observing of the organization practice, studying documents and analyzing numerical data.

There was report that the dry goods raw material warehouse has inventory control problem and academic perspective was adopted to approach the problem. First, the current inventory control at the warehouse was studied. Second, the current inventory practice was analyzed to determine factors contributing to inventory management and control problem. Third, from the main causes of the inventory problem, recommendations for improvements were forwarded. The recommendations mainly cover improvements at the warehouse only which is aimed to be more effective to improve the operation at the in-flight catering company.

1.6 Objectives

The aim of this research is to investigate inventory management problem at the store of in-flight catering company. Three objectives for this project are:

i. To develop a systematic procedure of inventory management and control.
ii. To improve the inventory control of dry goods raw material stock.

1.7 Scope

The scope of the project covers inventory management and control at in-flight catering company. This research only focused on the inventory management and control at the store of dry goods raw material. The processes at the production line are not considered.

1.8 Outline of the Report

Chapter One describes the background of the project problem statement, research objectives and scope of research. It also explains the overview of the chapters in the report. Chapter Two describes literature review in the field of in-flight catering and

inventory management and control of raw material stock. Chapter Three discusses the problem solving steps using certain method to solve the problem identified. Chapter Four presents the data collection from the in-flight catering company data analysis. Chapter Five presents the results of the analysis and proposed solutions for each of the problem identified. All the proposed solutions will be validated by the expert to ensure that the proposed solutions are usable and valid. Chapter Six is the conclusion of the study. The significant of the research will be highlighted and the research implication and contribution are also described. Then, the limitations and the recommendation for future works are explained.

1.9 Summary

The flight catering industry has to constantly cope with both high volume and variety. This project will propose solutions to the problem that have been highlighted on inventory management and control. This research only focuses at the dry goods raw material store.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the literatures on inventory management and control, an organizational perspective and integrated framework on inventory management and control. An overview of the in-flight catering company, inventory management and control at in-flight catering company, purchasing specifications, just-in-time procurement, receipt of goods inwards, storage areas and safe and secure storage will be described. Operational requirements of procument and the automated high rack warehousing system at an in-flight catering company will then be discussed at the end of this chapter.

2.2 Inventory Management and Control Perspective

During the last few decades inventory management and control has been the topic of many publications. There are for example stochastic models to determine order quantities, techniques for forecasting demand and different kinds of ABC analysis. Recently management systems such as manufacturing resource planning (MRP) and enterprise resource planning (ERP) have been added. However, most of these contributions have similar theoretical background: the field of operations management and operations research. This means the concepts and techniques are mainly based on mathematical assumptions and modeling inventory situations. Although this established approach to inventory control has proved to be very valuable in determining inventory parameters and planning resources, its value can be questioned in dealing with practical inventory management and control problems. Plossl and Welch (1979) for instance state that many firms have inventory management and control techniques working but they are not reducing inventories.

On the other hand, some companies are doing a fine job of managing inventory investment even without these tools (Plossl and Welch, 1979, p. 26). In many of the quantitative methods from the field of operations management and operations research are insufficient to cope with today's organizational complexity (e.g. Hayes, 1998; Lovejoy, 1998; Machuca, 1998). These authors favor a broader scope on operations management issues, including qualitative aspects and linkages with other functional areas in an organization. Therefore, there seems to be a need for an extended view on inventory management and control.

2.2.1 Organizational Perspective on Inventory Management and Control

Within the area of operations management and operations research many contributions regarding inventory management and control can be found. Traditionally they focus on three topics that are widely recognized to play an important part in inventory management and control: order quantities, order intervals and inventory control systems (Plossl (1985) and Silver et al. (1998)). The first issue is order quantities or how much to order. In order to determine economic order quantities, several costs associated with inventories play a part, such as ordering costs and inventory carrying costs. The second issue is the order interval or when to order. In this respect demand and lead-time processes are important. Finally, the third issue is on the inventory control system. Common techniques for controlling inventories are ABC classifications and information systems. These three issues represent the traditional characteristics of an inventory system. In addition, they are considered to be starting points for improving inventory control. Over the past two decades, as the field of operations management has developed and matured, several new concepts have been added to the list of relevant inventory control topics. These more management-oriented topics include MRP, just-in-time (JIT) and ERP (Hayes, 1998; Leschke, 1998).

From a practical point of view it seems that the organizational setting of inventories should not be disregarded. Being situated within an organizational context several other factors play a part in inventory management and control. In general these factors lie outside the field of operations management and operations research but should nevertheless be taken into consideration. Most factors regard the organizational incorporation of inventories and the associated information flows. A significant example concerning inventory management is the allocation of responsibilities and authorities. Inventory control problems can easily arise when for instance nobody in the organization is responsible for the inventory or the responsible person has insufficient authorities to carry out the task. Likewise, high inventory values indicating a lack of

control may just be the result of inaccurate inventory records or of a reporting system that does not function well. Thus, the organizational context of inventories also contains several aspects that can affect inventory management and control.

2.2.2 An Integrated Framework of Inventory Management

The employment of the organizational perspective on inventory management and control in practice can be facilitated by means of the framework presented in Figure 2.1. The framework displays a way of approaching practical inventory management and control problems. It is based on a basic control loop to represent the underlying problem-solving process. In general, the starting point for a problem-solving process is an inventory system that performs below pre-set standards. In many cases, these pre-set standards are defined in terms of costs. Some examples of costs associated with the 'performance' of inventory systems are storing costs, stock-out costs, ordering costs and costs due to obsolescence. The performance of an inventory system refers, however, not only to well-defined cost criteria. Actually, the main purpose of inventory management is to facilitate the smoothing between supply and demand. So any symptom indicating a lack of harmony between supply and demand may refer to a poor performance of the inventory system. Examples of some of these symptoms are instabilities in the (production) planning process, the existence of numerous rush orders and inefficient operation of production facilities. In many cases a deviating performance of the inventory system will activate a diagnosis of the inventory situation in which several aspects regarding inventory management and control are investigated. The outcome of this diagnosis then serves as input for the construction of a redesign of the inventory system.

Within this framework, there are a few guidelines for the diagnosis and redesign phase following the application of the organizational perspective on inventory control. To begin with, applying the organizational perspective on inventory control in a problem-solving process partly determines the structuring of the diagnosis phase of the process. The objective of this phase is to achieve a clear insight in the inventory situation under consideration and a thorough understanding of the cause(s) of the inventory control problem. To that end, the inventory system needs to be described and analyzed. With regard to describing an inventory system it is important to obtain a comprehensive description of the inventory system. The end result should contain detailed descriptions of both traditional aspects of inventory control and aspects from the organizational context of the inventory system. This is to ensure a large amount of factors that might play a part in the inventory management and control problem are included in the description.

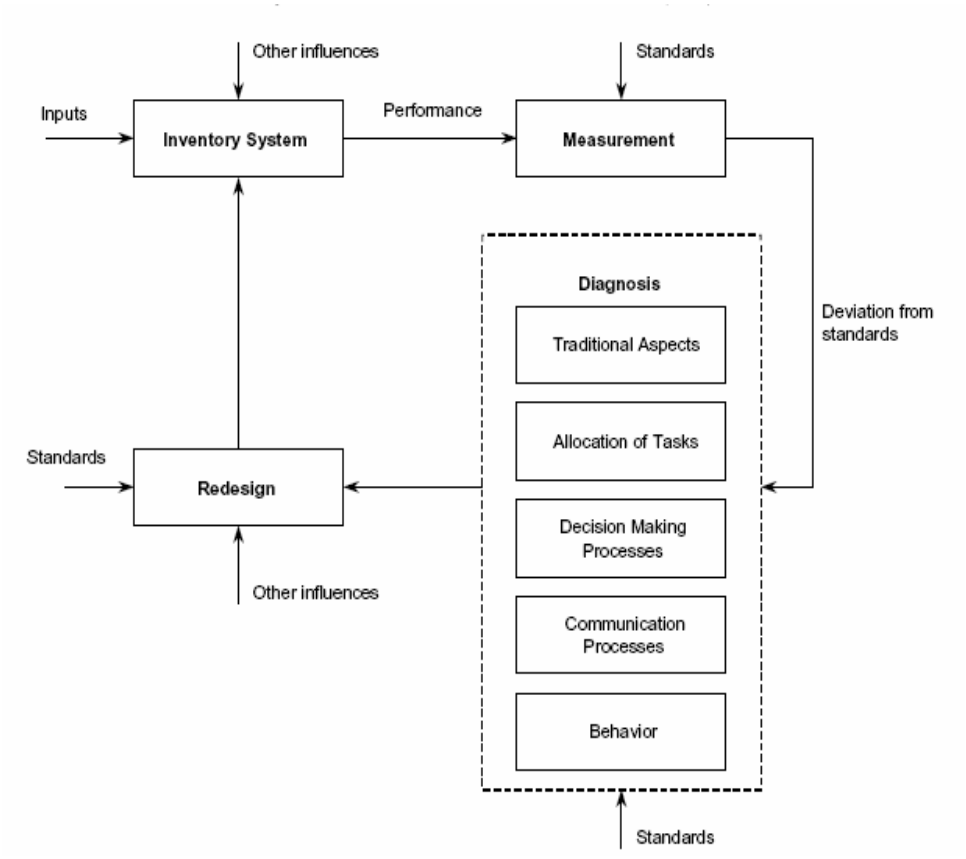

Figure 2.1: Framework for solving inventory management and control problems.

2.3 Inventory Management and Control at In-flight Catering

2.3.1 In-flight Catering: An Overview

The airline industry is a vast international business that is central to world economies. In today's environment, it faces many challenges and a tight operational strategy is vital to survive. In-flight catering is a central part of these strategies at all levels: be they customer satisfaction, marketing, operations or logistics.

Although referred to as ‘flight kitchens’, food production is only one stage in the operation. There are a number of subsequent assembly and delivery stages - dish assembly (assembling hot entrees and other dishes from their components such as meat, fish, rice and assorted vegetables), tray assembly, bar cart assembly, trolley loading and delivery to the aircraft. Flight caterers also have to cope with a high variety of outputs. Most operators contract to supply more than just one airline, as there are few airports where a single airline has enough flights to justify the exclusive use of a kitchen, except for the ‘hub’ airports of major carriers. So within the flight catering business, there is a considerable variety of outputs, deriving from:

i. number of airlines

ii. types of airline - scheduled, charter, low-cost, executive

iii. duration of flight - short haul, long haul

iv. seat class - first, business, economy, and chatter flight.

v. ‘day–part’ - breakfast, midmorning, lunch, mid afternoon, dinner

vi. demand for special meals - 26 different types, such as kosher, ‘halal’, low-fat, low-salt and vegetarian (Jones, 2004)

vii. menu cycles or ‘rotations’ - to ensure that frequent flyers are not always served the same menu (McCool, 1995)

2.3.2 Four Stakeholders of Flight Services

The relationship between these four stakeholders is shown in Figure 2.2. As a result of the fragmentary and international nature of the business, tight interfaces are required between flying passengers and the airlines and the providers (caterers) and suppliers.

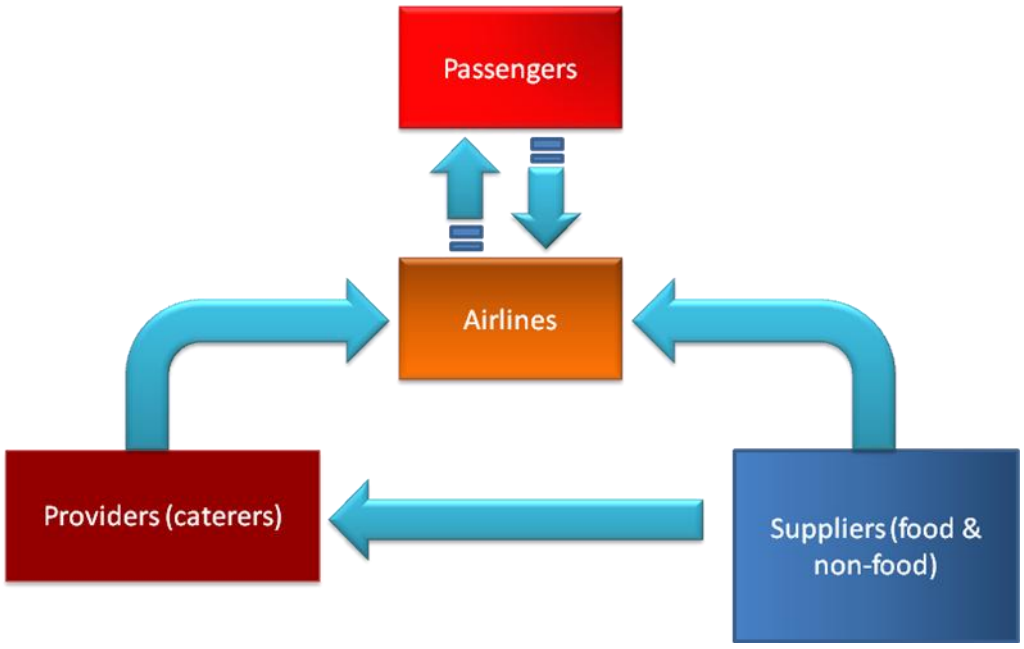

Figure 2.2: The interface between the ‘players’ in-flight catering

2.3.3 Problem Faced by In-flight Catering Company

Once goods have been delivered to the flight kitchen, they need to be stored safely and securely. McCool (1996) suggests that 'inventory management is one of the greatest challenges faced by an in-flight caterer'. There are a number of reasons for this to happen which is:

i. Airlines operate menu cycles; so, ingredients and products are changing regularly.
ii. Caterers are likely to have contracts with several airlines, each of which is likely to have different product specifications.
iii. Product specifications are rigid to ensure airlines have consistent products on all their routes; so, substitution by a similar item is rarely possible.
iv. Meeting products specifications will be part of the airline caterer contract; so, stock outs may lead to penalty payments or even loss of contract.
v. Holding too much stock adds costs to the business and some other problems such as expired food and poor material handling.
vi. Airlines purchase some items directly from the manufacturer and pay the caterer to store them in flight production unit; so, stock has to be held separately to enable stock check.

2.3.4 Purchasing Specifications at In-Flight Catering Company

Purchase specifications determine what is required in relation to purchases. It can vary greatly in relation to the depth of information it contain. This depends on who and where the information is destined to be used. For example, there is little benefit in a back door purchase specification revealing the expected microbiological standard of the

product being supplied, as there is no way of checking it. The level of detail required is dependent on numerous factors, such as the country of origin, the nature of the product, the shelf life, the level of risk associated with the product, how the product will be used, and who is utilizing the information contained in the specification, for example, is it the manufacturer, the wholesaler, supplier, the airline, the caterer, the receiver, or someone dealing with quality assurance.

Purchase specifications come in a number of different forms: food, nonfood, contract, and service. Food purchase specifications may contain information on the quality, ingredients, size, variety, condition, weight, packaging, labeling, shelf life, storage conditions, order lead time of a food product, and include technical specification elements that have the most detail including information on microbiological specification, process standards, HACCP limits, and nutritional information. Supplier specifications outline, for example, what the supplier does, products supplied, locations, contacts, order considerations, lead times, safety inventory, whether the product is delivered frozen, ambient, chilled, or fresh, and the delivery schedule, audit results and vendor rating assessments.

The suppliers must be aware of what is expected of the product. They must also make sure that the flight caterers are aware of any food safety limitations associated with the product. These are usually stated on all labeling. Such statements may simply say 'keep refrigerated' or 'keep frozen'; others might well include a graph or chart of the projected shelf-life at different storage temperatures. Some of the expectations of a product's level of quality or safety may be dictated by airline specifications and these are, generally, found in the catering manual for that airline. The responsibility for meeting those specifications is an important factor in a successful catering operation. Some food items may have no listed specifications but might be covered by a federal or local regulatory mandate.

2.3.5 Just-In-Time Procurement at In-flight Catering Company

In deciding how to control purchases of materials stocks, three standards need to be established: quality standards, quantity standards, and prices. Quality standards derive largely from the decisions made about the concept and service or production standards. The concept determines the basic cost–price relationship, the technology to be used for production purposes, and the customer expectations about quality. The most basic decision that will be made is whether to 'make or buy', i.e. to produce on the premises or buy-in items prepared elsewhere. Once this decision is made, there are still decisions to be made with regards to grades, brands, degree of freshness, sizes, and method of packaging. Each of these factors may be in the standard purchase specifications.

In addition, it is essential to establish the required quantities of items. The ideal stock level for a specific commodity depends on the nature of the business and the characteristics of the commodity; in particular, the level of sales, the stability of demand, the terms of supply, the costs of stock-holding, cash flow limitations, the shelf-life of the commodity, the storage space available, and market trends in price and availability. The characteristics of flight catering industry mean that purchase quantities are established in a way which is different from other catering businesses.

In general, the starting point for planning stock levels would be an analysis of the usage rate. Where items are used infrequently (which is often the case with non-perishable commodities), the periodic order method can be used. On a regular basis, for instance, once a week or once a month, items will be reordered on the basis of the forecast need plus the buffer stock to avoid stock-out less stock in hand. A more sophisticated approach is based around the idea of economic order quantity (EOQ). The total cost associated with a purchase is a combination of the invoice cost, plus the administration cost (postage, clerical time, etc.) plus the storage cost (running the freezer, etc.). These

costs will vary, as shown in Table 2.3. Somewhere between the extremes of one large order and many small orders lies the point where the total cost will be lowest. The EOQs can be calculated using mathematical formulae or by preparing cost tables. Both methods are laborious and time-consuming, and the useful application of EOQs is limited to very large-scale purchasing.

The quantity ordered can also get affected by concerns about cash flow and storage costs, which in turn are affected by the extent to which items are purchased in bulk. The advantages of buying in bulk are that items may be cheaper because of bulk discount; there may be protection against a sudden increase in demand, protection against sudden shortage in supply, and protection against possible inflation. The disadvantages of buying in bulk include the fact that cash flow position can worsen; stock-holding costs increase; deterioration or pilferage may occur; and future demand may decrease. In the case of fresh food the disadvantages obviously outweigh the advantages. With other products the reverse can hold true, for example, wine which can appreciate in value considerably during the storage period.

However, while the flight catering industry is concerned about stock-outs, cash flow, storage costs, and administration costs, caterers now think of inventory as just one part of the total process flow through their production unit. As the system is now being organized on the just-in-time principle, inventory management is also operated in this way. In other words, as far as possible suppliers are asked to supply materials as and when they are needed by the operation. JIT is a ‘pull system’ based on the logic that nothing will be produced until it is needed; which means food production at all stages is firmly linked to a rate determined by the final product assembly schedule, such as the number of trays and choices per flight. JIT production planning for flight caterers equates to ‘producing the necessary units, in the necessary quantities, at the necessary time’. Most successful caterers use this technique, in concept, if not in name. The principles to be adhered to are:

i. keep down stock levels to an optimum (stockless production) level
ii. elimination of waste and unnecessary activities
iii. enforced problem solving
iv. quality at the source
v. clarify process flows
vi. develop supplier network

Materials (food) delivered 'just in time' are required to be absolutely correct. When the allocation for the day is complete, production stops. Inventory is not built up in order to keep the workers busy. Any spare time is spent at the end of the shift to review the day's production and to develop priorities for action. The system itself is simple and its objectives easy to understand. Quality must be inherent both in the product and the process. By its nature JIT procurement means that the stock held is kept to a minimum. It also means that less storage space is required, storage costs are low, and materials are always fresh. There is a danger of stock-out if a supplier fails to deliver, which means that it is essential for the caterer to forecast their requirements and place their orders accurately, as well as select suppliers that can be relied upon.

Table 2.1: Effect of purchase order size on purchase costs

	Invoice cost	Administration costs	Storage costs
Many small orders	High	High	Low
Few large orders	Low	Low	High

2.3.6 Receipt of Goods Inwards

Usually a separate delivery entry is used to unload goods from delivery vehicles. The bay normally has a high-level platform to allow direct delivery from the back of delivery vehicles. This area leads into a goods reception area that allows for the temporary storage, checking and unpacking of all delivered materials before they are allocated either to the appropriate store or directly to a production area.

Universally, the general manager of any flight kitchen is ultimately responsible for assuring that the following responsibilities are carried out:

i. All incoming supplies must be checked for hygienic delivery and condition by a trained person.
ii. All supplies not meeting specified minimum hygiene conditions, temperatures, quality, weight, and grades must be rejected. All other discrepancies must be noted and brought to the vendor's attention.
iii. All deliveries must be checked against the purchase and receiving logs. Vendor shipping documents must be corrected to show any discrepancy in quantity.
iv. Upon delivery, all potentially hazardous food must be refrigerated first.
v. All food items received in cases or in bulk must be stamped so that their receiving dates are known. All supplies must be stored and used with the first in, first out system.
vi. Records must be maintained showing the date of receipt and all other pertinent information such as batch numbers, lot numbers, production dates or use-by dates of items, such as local bakery products, milk products, and other locally prepared foods. These records are important in case of a later problem or recall.

Flight food supplies can be subjected to extremes of temperature, time delays, and zero humidity conditions on board before consumption. Therefore, suppliers of potentially hazardous foods should be able to supply upon request such data as:

i. the maximum refrigerated shelf-life at 7.2°C
ii. the maximum allowable time at 12.7°C
iii. the maximum allowable time at 21°C

These times must be based on the outgrowth of pathogenic organisms that are of significance to their product.

Suppliers of potentially hazardous foods must ensure that any hidden hazards are known to their flight customers. Some examples of hidden hazards are as follows:

i. A pop-out meal that contains partially cooked chicken. The on-board cooking of the chicken to 73°C would not be a readily apparent critical control point.
ii. Frozen vegetables that have been blanched but not completely cooked. Possible temperature abuse by employees who might mistake them for raw vegetables could allow the growth of pathogenic bacteria.
iii. Any product containing raw shell eggs as an ingredient. A cooking temperature of at least 73.8°C would be required.
iv. Any gas-packed or vacuum-packed product that can support anaerobic growth of *clostridium botulinum* if temperature is abused.
v. Any *sous-vide* product. The suggested refrigeration storage temperature of 1°C is not commonly attainable with existing flight equipment.
vi. Any packaged, potentially hazardous product that will support the growth of *pathogenic psychrophilic* bacteria at a refrigeration temperature of 7.2°C or below. The time under refrigeration would be a critical control point. For such items as precooked meats that receive no further cooking, the time under refrigeration prior to delivery could be a critical control point if the storage temperature was above 1°C.

To enable the store person to ensure all of these things, they may be provided with copies of purchase specifications (often in the form of a manual), copies of the original order, price lists, scales (to weigh goods), temperature probes (for checking refrigerated items), a calculator, a jemmy (for opening wooden or cardboard containers), a knife (for cutting into fresh produce such as fruit), and even a bar code reader (if there is a computerized inventory control system). And so that the store person has time to properly inspect goods, supply is often organized so that deliveries are only made during specified hours and staggered to ensure that only one is dealt with at a time.

The paperwork or documentation that accompanies a delivery is typically of two types. In some cases, goods are delivered with an invoice which not only lists the goods but also prices them, in other words it serves not only as a checklist but also as the bill. In the flight catering industry it is more common for the order to be supplied along with a delivery note, which is an unpriced list of goods. In such cases, the supplier issues an invoice separately, sometimes on a weekly or monthly basis, often covering more than one delivery. Whichever system is in use, the store person will be asked to sign a copy for the receipt of the goods. If they are not satisfied, those goods of the correct type or quality have been delivered, they may be rejected. This may mean that the delivery note is adjusted to show goods as returned, or in the case of invoiced delivery, a credit note will be completed by the delivery person to ensure correct invoicing subsequently.

Once the goods have been received and the paperwork completed, it is essential that the goods are moved to their appropriate storage space as soon as possible. Depending on the size of operation, trolleys, carts or conveyor they are placed in a more secure area than the loading bay. In some cases, at this stage, the store person may also have to date the delivered items (to ensure stock rotation), price items, apply tags to meat, or even add bar codes.

It is important to remove as much outer packaging as possible outside the kitchen area as the packaging can bring soil, bacteria, and insects into the kitchen. Items such as fruit and vegetables are decanted from crates and boxes, and placed in plastic containers. Glass containers are emptied or replaced with plastic containers before storing in the unit to prevent breakage during the cooking process. For frozen items, it is vital; both for reasons of quality and hygiene, those products are thawed in a temperature-controlled environment. Thawing items in a warm room will encourage the growth of pathogens and cause the structure of the items to break down reducing texture and quality. A skilled stores operative should check to see that:

i. the quality of goods, such as fresh fruit, is as good in all the layers of a box, and not rely on inspecting just the top layer
ii. tins and packages are undamaged or ‘blown’
iii. product weights have not been increased by adding excess water, packaging, ice, or some other impurity (such as stones in bags of fresh potatoes)
iv. the delivery person does not illicitly remove items from the loading bay or stores area, especially when goods or packaging (such as empty crates or boxes) are being returned

2.3.7 Storage Areas

Specialized storage areas are required for a wide range of food and non-food materials. Some require a separate temperature-controlled storage area in either a freezer or fridge. Bonded items like alcohol and duty-free goods require a specific area with extra security. Food materials generally include:

i. fresh fruit and vegetables
ii. frozen fruit and vegetables
iii. fresh fish/seafood
iv. frozen fish/seafood
v. raw meats
vi. cooked meats
vii. dairy products
viii. dry goods

All storage areas should be cooled and well ventilated, screened against insects, and fitted with easily cleaned shelves and bins. The storage of non-consumables is relatively straightforward, as they typically may be stored under normal conditions, at ambient temperature. Some cleaning agents must be stored in well-ventilated areas to avoid the buildup of toxic fumes and kept separate from each other to avoid the possibility of a chemical reaction.

Consumables, on the other hand, may require a variety of different storage conditions depending on their perishability or ‘shelf-life’, i.e. the length of time they may be stored safely without deterioration. Dry goods, such as canned foods, packet items, and jars are stored like non-consumables, under ambient or cool, well-ventilated conditions. Perishable items such as dairy products, fresh meat and fish, and fruit and vegetables need to be refrigerated. Chilling reduces enzyme action and bacterial growth, which either cause the food to deteriorate or allow pathogens or poisons to grow on the food, or both. Frozen products obviously have to be kept in a freezer.

2.3.7.1 Dry Stores

There are three main ways in which dry goods, either consumables or not consumables, may be stored: shelved, binned, or palletized.

Shelving is used for items that are individually packed in some way, such as packets, jars or cans. There are three types of shelving. Fixed shelving is permanently fixed to the wall or floor; static shelving is self-standing on legs; and mobile shelving is self-standing but on wheels or casters. All types of shelving are made either from wood or metal, sometimes covered with plastic. It is important that these materials are easily cleaned.

Bins are used to store items that may be delivered in paper or cardboard containers but need to be protected from infestation either by insects or rodents. Typically flour and rice are stored in this way. The bin comprises a large metal container, often on castors, with a firmly fitting lid.

Palletized storage occurs in very large-scale operations. A pallet is a wooden platform that can easily be moved by a forklift truck on which goods are stored in bulk, usually in boxes or cases.

2.3.7.2 Refrigerated Storage

Chillers are designed to hold stored materials at a temperature of between 1°C and 3°C, whereas freezers hold frozen goods at a temperature of –20°C. There are two main types of chiller or freezer unit used for storage self-standing cabinets or walk-in. Cabinet chillers or freezers have a front opening door with interior shelving. They are versatile since they can be located anywhere in the storage area (of the food production unit) and are relatively low cost to buy and maintain.

Walk-in chillers or freezers are usually made from urethane foam 10 cm thick sandwiched between two sheets of metal, such as unpainted or painted aluminium, steel or stainless steel. Units are either prefabricated from panels of standard sizes or built in situ. Prefabricated units are less costly to install than purpose-built chillers, but the latter can have a longer working life. The refrigeration system, which comprises a condenser, evaporator and expansion valve, may be mounted on top of the unit, if the ceiling height permits; or on the side of the unit; or remotely, in some other area of the building or the exterior. Remote refrigeration systems are less efficient but have the advantage that the heat and noise of the system is moved away from the working area.

The net capacity of a walk-in unit is considerably less, roughly 50 per cent, than its total cubic capacity, as space has to be left for a person to access stored items. This usually means that items are stored on either side of the chiller, with an aisle down the middle running from the door to the back of the unit. Further space may also be unusable due to fans, evaporators, lights, and so on. Despite this, large walk-in chillers are considerably cheaper to operate than several cabinet chillers.

The efficiency of operating and maintaining refrigerated storage is affected by many factors:

i. Amount of insulation - over time door seals and rubber 'grommets' may wear and lead to tiny but continuous leaks

ii. Efficiency of air flow - fans assist airflow to ensure a consistent temperature throughout the unit

iii. Items stored in the unit - any item placed in the unit that is above the temperature of the refrigerated space will raise the overall temperature in the unit

iv. Number of doors and frequency of opening - normal usage is assumed to be six to eight openings per 8-hour shift. Heavy usage (12 openings or more) increases the heat load by 50 per cent (Borsenik and Stutts, 1997). If units are subject to heavy usage, plastic strip doors may reduce heat gain by up to one-third.

v. Surrounding environment - refrigeration should not be placed near sources of heat, including direct sunlight. Energy savings can be achieved if walk-in chillers and/or freezers are located adjacent to each other (by 6 per cent according to Borsenik and Stutts, 1997) or if access to the freezer is through the chiller (by nearly 19 per cent).

vi. Efficiency of the evaporator - as this is cold; air moisture will freeze on it making it less efficient. Most units have an automatic defrost of this component every 12 hours, either using a hot gas defrost system or electric resistance wires.

2.3.8 Safe and Secure Storage

The basic aim of the storage system is to ensure no loss of value in goods purchased. Such losses may be of two types, spoilage or theft. Spoilage can be prevented by adherence to some basic principles, as follows.

i. Stock rotation - goods are used in sequence, the older items first, to ensure that they are consumed while still in prime condition.
ii. Stock separation - goods that might contaminate each other, even if just by odour (such as fish tainting dairy products), must be stored separately, if not in their own fridge, at least in sealed containers on separate shelves.
iii. Sanitation - to avoid cross-contamination, both the store areas must be kept clean and stores operatives must comply with good hygiene practices.
iv. Temperature monitoring - the temperature in each main type of storage area- ambient, chilled, and frozen - must be monitored to ensure it is maintained correctly, and if a fault is detected it must be repaired immediately.
v. Safe handling- items must be handled and transported safely to avoid breakages.
vi. Prevention of infestation - insects and rodents must be prevented from entering storage areas through the maintenance of floors, walls, and ceilings, the closures and screens on windows and doors, and specific equipment such as ultra-violet fly killers.

In the flight catering industry a Hazard Analysis and Critical Control Point (HACCP) system is often adopted to ensure food safety. The security of goods can be threatened by anyone who gains access to the stores. The best way to ensure good security is to design the physical storage area to be totally secure. In most cases, further control systems are put in place in order to deter, prevent or detect dishonest practice. Security systems include:

i. Bar codes - the computerization of inventory control through the use of bar codes has made it possible to have a ‘perpetual inventory’.

ii. Stock-taking - This is the physical alternative to perpetual inventory, i.e. maintaining a physical count of all stock items on a regular basis. The main purpose of this is to calculate the cost of raw materials (and identify any wastage or loss of materials). It also provides information about what needs to be ordered and enables a crosscheck against records and budgets. Physically taking stock can be time consuming and labor intensive. It typically involve, one person counting the stock and a second person recording the information on a standard stock record form. Hence, operators have to choose between their need for timely and accurate stock information and the cost of collecting the data. It is typically done at least once a month, and more frequently in high-volume operations or for high-value stock items. In flight production units, stock may be counted by employees of the caterer or sent in by the airline to check on the stock held in storage for them.

iii. Locks and keys - Another obvious security measure is to ensure that goods are stored in a space that is locked when not in use. In many cases, goods are only issued from stores at limited times of the day. This is so that they can be kept secure for the rest of the time. Only authorized individuals should be issued with keys and locks should be replaced if keys go missing. For a higher level of security, it is now possible to install computerized locks that record who used the lock.

iv. Rubbish compactors-Storage areas produce a large amount of paper waste in the form of cardboard boxes and packaging materials. In order to prevent the 'scam' of stealing items, secreting them in waste bins, and then retrieving once the bins have been placed outside the premises, a waste compactor may be used. They also facilitate waste handling and recycling.

v. Employee entrance security-All flight catering operations should have a single entrance for use by employees. This entrance will typically be staffed by a member of the security team, whose role is to ensure only authorized personnel

are allowed access to the building, as well as monitor what is being brought into or taken out of the premises. This is to ensure security for aircraft in flight as well as in the production unit itself.

vi. Premises surveillance-While access to storage area should always be limited and controlled, a further deterrent is provided by the use of closed circuit television (CCTV). This provides a 24-hour record of all personnel movements.

2.3.8.1 Stock Valuation and Stocktaking

Just-in-time inventory management greatly assists in stock control and stock-taking is simplified by the fact that stock levels are kept to a minimum. Stocktaking therefore tends to be applied in this system only to items that are stored in bulk or for relatively long periods. Once the stock has been counted, it also has to be valued, in order to reconcile it with the value of goods purchased and sold. The choice of valuation method, particularly in times of rapid inflation, can have significant implications for profit and asset reporting. There are four methods of stock valuation, which can be summarized as:

i. FIFO (first-in, first-out) - which tends to give the highest value to stocks and to inflate profits
ii. LIFO (last-in, first out) - which tends to undervalue stocks, with a more realistic profit valuation
iii. AVERAGE - which tends to overvalue stocks and consequently overstates profit; it has the advantage of being administratively convenient
iv. STANDARD - which is a sophisticated technique forming the basis for a comprehensive cost control system.

These stock valuation methods can all be used for the valuation of issues from stores. The use of any one of these methods facilitates the preparation of a stores reconciliation which will accurately identify any loss (possibly through pilferage) from the stores. Computer-based stock control systems can utilize one or another of these methods.

There is an alternative method of stock valuation which is administratively far simpler and which is commonly used in many food service businesses. This is to value stock using the most recent price paid for a commodity-also known as the current price. There is a significant disadvantage associated with the of this current stock valuation method, namely that it does not permit an accurate stores reconciliation to be prepared. Managers can choose a more complex method of stock valuation which permits accurate measurement of stores losses or a simpler (and cheaper) method of valuation and forfeit an accurate control over the stores.

2.3.8.2 Investigating Stock Control Problems

Stock-taking serves a number of purposes. First, it establishes the value of stock according to one of the methods described above. Second, stock-taking compares the actual value of the stock held with the value of the stock calculated from the stock record system. This enables the actual food cost or profit percentage to be established for comparison with the target, if necessary. If there is a discrepancy between the target food cost and the actual food cost, but no physical stock discrepancy, this is likely to be a policy variance or a production control problem. The manager needs to carry out a systematic investigation into the causes of the problem.

If there is a difference between stock records and actual stock, this is a stock variance. Stock shortages may be due to 'ghost' supplies, poor stock rotation, breakages or usage, unauthorized consumption on the premises, or theft. The so-called 'ghost' supplies refer to goods for which the operator is charged but which are never received. This can occur in a number of ways-the supplier can supply the correct stock but overcharge, the supplier can charge the correct price but undersupply, the delivery person can deliver less than the full order, or substitute inferior goods for those specified. Poor stock rotation leads to wastage, as perishable items may deteriorate before they are used, and tins or jars may be held onto beyond their 'use-by date'. New deliveries should always be stored behind existing stocks to ensure the older items are used first. Breakages also create losses. Management should ensure that the staffs are trained in the safe handling of materials and that proper equipment is provided for transporting items. Obviously, if goods are stolen, there will be a stock discrepancy. Theft may be carried out by trespassers on the premises who do not have the authorization to be there, or by dishonest employees. Employees, in particular, can engage in one specific form of theft, namely unauthorized consumption, i.e. eating or drinking items that have not been provided to them.

2.3.9 Operational Requirements of Procurement

The selection of the comprehensive system (two separate warehousing and ordering systems) was determined by the operational requirements. These consisted of short term airline orders combined with long-term information of the catering ordering system. Taking into consideration the airline timetables which determine a production plan for availability of materials, production ordering for the individual operational

divisions are set up. This includes material requirements for the supply of shift as well as daytime operations; material requirements for the supply of air-traffic dependent and immediate operations; and permanent material requirements for serial production.

This resulted in the following sequence for the technical information and materials flow:

i. optimal planning incorporating the differential material demand and dissolution in procurement withdrawals on the basis of specific demand;
ii. demand specific availability of materials for procurement;
iii. ordering guided and supported by technical information;
iv. availability of material in the production sector.

2.3.10 The Automated High Rack Warehousing System

All non-perishable foodstuffs as well as commercial and consumer goods are stored and kept constantly ready for delivery. Readiness for delivery is ensured by having goods on two levels which are connected to the high rack warehousing by means of conveyor belt technology. The orders are executed systematically. Apart from tracing the automated transport of the pallets to the predetermined spaces for delivery, the employee can monitor the order including the quantities of each dispatch on a computer terminal and later obtain a receipt for the quantities dispatched.

Figure 2.3: A view into the automatic high rack warehouse

2.4 Conclusion

This chapter has described literature review in the field of in-flight catering and inventory management and control of raw material. The methodology of this project will be discussed in Chapter 3.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The purpose of this chapter is to discuss the research methods employed in the project. The research methodology incorporated a number of stages, each designed to provide insight into flight catering inventory management and control. The stages is shown in Figure 3.1.

This chapter is divided into two sections. The first part is on justification for selecting the methodology. The next part is on research methodology employed in this study. It describes data sources, data collection and analysis, method used for developing proposed solutions and validation of the result by expert.

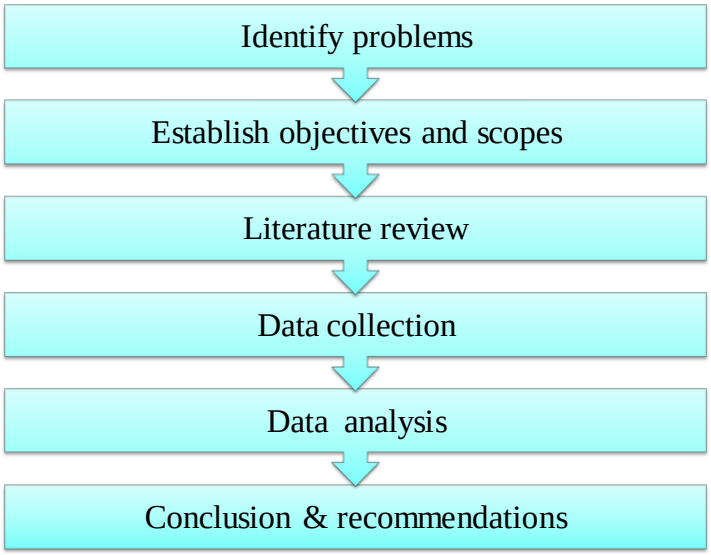

Figure 3.1: Research methodology flowcharts

3.2 Justification for the Methodology

The project focuses on inventory management and control. The case study was done in one in-flight catering company in Penang. This case study use quantitative and qualitative analysis. The study was carried out in a period of 4 months at the company. Data was collected by interviewing people, studying documents and analyzing numerical data. The interview is on the current state of inventory system and problems faced. Dry goods store has the most problem in inventory control.

3.3 Research Methodologies Used

3.3.1 Data Sources

Data collection was obtained from both secondary and primary sources. Primary data sources included interviews with employees and managers. Secondary data sources include technical document on historical data and annual reports of the company. Secondary data are from different sources and provide an essential preparation for the interviews. Secondary data helped to cross-check official information, learn about major events, technical details, historical decisions and main organizational players and roles. They also supported the exploring of particular responses during interviews.

An extensive literature review was conducted including the analysis of industry related data in inventory management and control at in-flight catering company (from books and trade publications).

3.3.2 Data Collection and Analysis

Data from the in-flight catering company obtained during the case study was analysed and ranked. The process begins by understanding the problem the company is facing in inventory management and control at the dry goods store. The root cause of the problem will be identified.

The information and data obtained in this study was from semi-structured interviews, observation and secondary source. Personal interviews constitute the most important and valuable sources of information. From the site visit and observation, current practices in inventory management and control are observed. Inventory data from production and store such as total usage of material in certain menu and total number of items disposed due to expiry date are collected. The data are analyzed by using appropriate techniques so that suitable and effective solutions can be proposed.

3.3.3 Develop Appropriate Solutions

After the data was collected and analyze, the solutions for the problem will be developed and proposed. The main problems at the store were identified and the solutions are proposed. The solutions to the problem include technology, technique and procedure.

The barcode scanning system is a technology to track and manage inventory. Forecasting techniques using moving average is proposed in the purchasing policy to maintain sufficient inventory all the times. Finally the procedure for frequent stock check is introduced so that the balance physical quantity and number of quantity in the system is synchronized all the time. The expiry date of the raw material can be controlled by using first in first out (FIFO) withdrawal concept.

3.3.4 Validation of the Method Used

For validation purposes, the pilot questionnaire was sent to the expert. In the initial survey, the questionnaire was tested with five respondents. After the questions were answered, the respondents were asked for any suggestions or any necessary corrections to improve and validate of the technique used. The content of the questions is reviewed to determine the reliability of the technique used. Irrelevant questions were excluded and sentence restructured to make it easy to understand. The five respondents who were initially in the pilot survey were excluded.

3.4 SUMMARY

In this chapter, the research was conducted in stages. In the research design, data was collected from questionnaire and interview. During the data collection, the data was collated and summarized. The data was then analyzed to determine the cause of the problem and recommendations were developed.

CHAPTER 4

DATA COLLECTION AND ANALYSIS

4.1 Introduction

This chapter discusses data collection and data analysis of the in-flight catering company. Background of the company where this case study was carried out is explained. Data collection and analysis was discussed.

4.2 Data Collection

4.2.1 Case Study Background

The problems of dry goods raw material inventory control at in-flight catering company were determined and appropriate methodology was used to solve the problem. A case study approach is chosen to have a real problem with a realistic data. An in-flight catering company located in Penang is was chosen as a case study. In-flight service remains the company core business and the type of service provided by this company include catering of in-flight meals, equipment washing and handling, dry stores and amenities uplifts, rental storage facilities and laundry services, Ad-hoc catering include uplift for non-schedule flights and private functions such as VVIP, charters, Hajj, event, private jet, etc, and catering at airport lounge.

The in-flight kitchen produces hot meals, cold meals and dessert. Preparing food the Islamic way is the principle behind this company “halal” kitchen concept. Not only are raw ingredients “halal”, with meats and poultry slaughtered in the prescribed Islamic manner, all other produced are free from pork and pork products such as gelatin and lard.

In order to maintain the quality of their products and services, strict standards of hygiene are maintained. All staffs follow the strict hygiene guidelines and standards covering food handling, preparation, sanitation etc. Hazard Analysis and Critical Control Points (HACCP) procedures are implemented and followed by this company. To ensure safety in the apron areas, this company has also implemented and follows strict ramp safety procedures.

The production capacity of this company is 4000 meals per day and the current meal production averaged 1200 meals per day with 650 flights per month. It operates 24 hours per day with 3 rotating shifts. Inventory control of the dry goods raw material in this company is managed by the store/procument department: one junior executive, 3 officers, 1 storekeeper and 1 store helper.

4.2.2 Plant Layout of In-flight Catering Company

The in-flight production unit was the amalgamation of three existing operations which, while not providing any additional capacity, had the benefits of improve process flows and logistics, consolidating warehouse and office operations. The total land area of this company is 56,144 square feet and the storage area is 2,280 square feet. The 3 units of freezers and the 8 unit of chillers have a capacity of 4438 square feet and 1438 square feet respectively which include 1 unit garbage chiller. This company has 2 inbound docks and 4 outbound docks.

Goods are received and dispatched from the dock area and from goods in, food follows a path through dry stores holding to cold room storage (see Figure 4.1). Food then follows the flow to preparation, hot kitchens, blast chilling, tray assembly and chiller. Great attention has been paid to prevent back tracking and cross-contamination from areas; for example, the hot kitchen preparation area has one door in from the food storage area and a second door out to the kitchen.

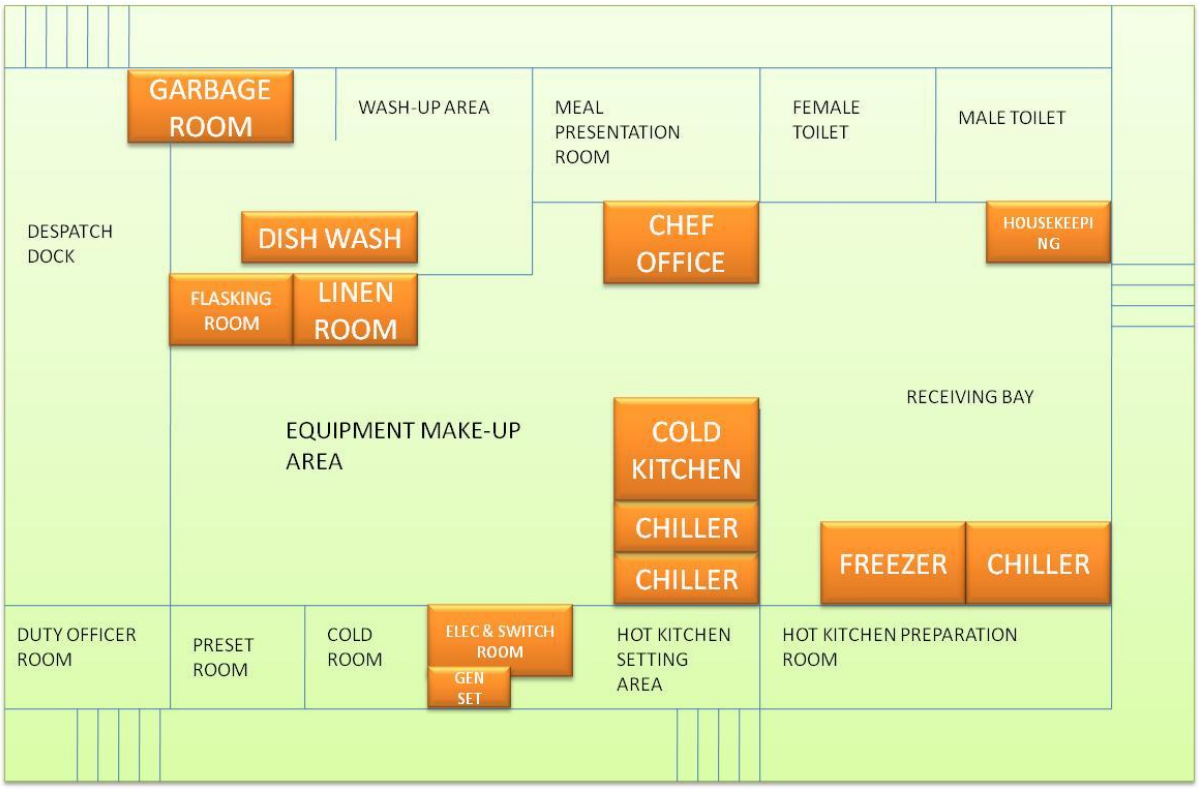

Figure 4.1: Plant layout of in-flight catering company

4.2.3 Process Flow Chart of In-flight Catering Company

Food preparation is planned to allow a ‘workflow’, whereby the food is processed through the flight kitchen from the point of delivery to the point of assembly on the tray ready for distribution to the aircraft with the minimum of obstruction. Various processes are separated as little as possible. Staff time is costly and a design that reduces wasteful journeys is both efficient and cost effective. Figure 4.2 illustrates a schematic workflow at the in-flight catering company.

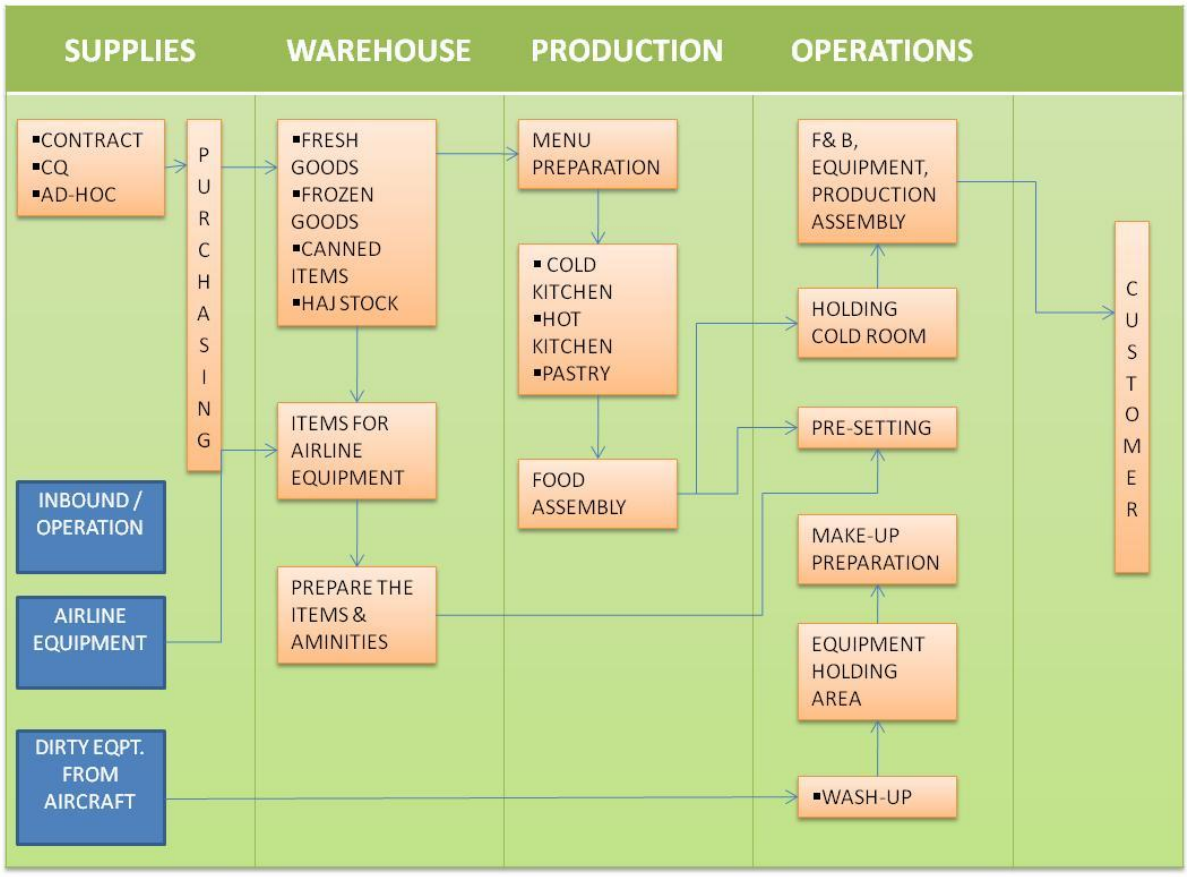

Figure 4.2: Process flow chart of in-flight catering company

4.2.4 Summary of Flight and Meal Production

Table 4.1 shows the total number of meal produced by this company from January 2008 to March 2009. The flight that obtained service from this company is Malaysia Airlines (MH) (both domestic and international flight), Federal Office of Civil Aviation (FOCA) (domestic and international flight) and adhoc flight. From table 4.1, high production output was from October 2008 until December 2008. The production

was increased during the months because of Hajj. The total number of flights and meals from January 2008 to March 2009 is 9 948 flight and 350 342 meals.

Table 4.1: Number of flight and meal produced from January 2008 until March 2009

MONTH & YEAR	MH DOMESTIC		MH INTERNATIONAL		FIREFLY		FOCA DOMESTIC		FOCA INTERNATIONAL		AD-HOC		TOTAL	
	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL
Jan-08	271	2000	78	11075	132	-	95	12899	163	881	1	28	740	26,883
Feb-08	225	1637	45	2527	110	-	108	17285	162	1043	3	12	653	22,504
Mar-08	258	1820	55	2817	88	-	111	16874	194	1128	1	0	707	22,639
Apr-08	255	1766	134	1939	0	-	113	18338	196	1272	7	56	705	23,371
May-08	267	1796	134	1798	0	-	118	20079	192	1198	1	0	712	24,871
Jun-08	277	1674	124	1956	0	-	107	15404	189	1179	3	143	697	20,356
Jul-08	271	1663	127	2376	0	-	90	15070	198	1332	3	101	689	20,542
Aug-08	251	1663	102	2311	0	-	84	15843	184	1220	5	198	626	21,205
Sep-08	249	1281	113	2120	0	-	92	15645	187	1280	0	0	641	20,326
Oct-08	256	1488	140	3015	0	-	116	16706	192	1225	8	271	712	22,705
Nov-08	239	1441	128	8731	0	-	103	17991	190	1213	9	791	669	30,167
Dec-08	254	1423	132	7684	0	-	106	20211	191	1164	5	1664	688	32,146
											GRAND TOTAL		8,239	287,715

MONTH & YEAR	MH DOMESTIC		MH INTERNATIONAL		FIREFLY		FOCA DOMESTIC		FOCA INTERNATIONAL		AD-HOC		TOTAL	
	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL	NO. OF FLIGHT	MEAL
Jan-09	216	1138	122	6689	0	-	107	14093	174	976	4	942	623	23,838
Feb-09	191	1066	90	1859	0	-	92	13807	164	1001	2	936	539	18,669
Mar-09	180	986	98	2542	0	-	99	14433	163	1073	7	1086	547	20,120
											GRAND TOTAL		1,709	62,627

4.2.5 Amount of Dry Goods Raw Material Disposed

Table 4.2 shows the list of dry goods raw material which has been disposed due expired, damage or dented. This data was from April 2008 to May 2009.The total financial loss is MYR 2 238.44.

Table 4.2: List of disposed dry goods raw material

Date	Product	Quantity	Non-Conformance	Reason for Non-Conformance	Corrective Action	PRICE (RM)
2/4/2009	LIMA BEAN	2 PKT	EXP : AUGUST 2008	SLOW MOVING ITEM	Dispose	32.40
2/4/2009	BLACK BEAN PASTE	10 EA	EXP : 20/11/08	SLOW MOVING ITEM	Dispose	47.00
2/4/2009	GROWNED PEANUT	4 PKT	Spoiled	SLOW MOVING ITEM	Dispose	31.20
2/5/2009	CAULIS DE TOMATO	1 CAN	EXP : 8/10/2010	SLOW MOVING ITEM	Dispose	29.45
2/5/2009	COOKING OIL	1 CAN	EXP : 7/12/2010	DAMAGE/DANTED	Dispose	54.42
24/2/2009	STRAW MUSHROOM	6 CAN	EXP : 10/3/2011	DAMAGE/DANTED	Dispose	12.30
24/2/2009	YOUNG CORN	2 CAN	EXP : 29/01/2011	DAMAGE/DANTED	Dispose	3.50
24/3/2009	PEACHES IN SYRUP	2 CAN	EXP : 10/7/2009	DAMAGE/DANTED	Dispose	9.00
24/04/2009	SALT & PEPPER	14 PKT	EXP : 9/1/2008	SLOW MOVING ITEM	Dispose	76.80
14/10/2008	KUAH AYAM MADU	19 PKT	EXP: 8/5/08	CHANGE MENU	Dispose	115.50
14/10/2008	PES KARI AYAM	11 PKT	EXP: 11/7/08	CHANGE MENU	Dispose	115.50
10/11/2008	KNOR TOMYAM PASTE	4 PKT	EXP: 22/09/08	CHANGE MENU	Dispose	71.72
14/10/2008	REFRESHMENT BAG	1 CTN	EXP: 5/9/08	SLOW MOVING ITEM	Dispose	54.05
21/11/2008	PENNE DE GATE	1 CAN	EXP: 25/09/08	SLOW MOVING ITEM	Dispose	76.80
30/11/2008	1000 ISLAND	3 TUBE	EXP: 30/11/08	SLOW MOVING ITEM	Dispose	58.20
11/10/2008	LEMON SQUEEZE	29 TUBE	EXP: 3/11/08	SLOW MOVING ITEM	Dispose	59.45
26/11/2008	NASI TOMATO PASTE	16 PKT	EXP: 25/11/08	SLOW MOVING ITEM	Dispose	184.00
30/11/2008	ELICALL	31 PKT	EXP: NOV 2008	SLOW MOVING ITEM	Dispose	191.89
5/1/2008	NESCAFE GOLD BLEND	3 CTN	EXP: 04/2008	SLOW MOVING ITEM	Dispose	194.00
8/1/2008	COFFEE CREAMER	1 CTN	EXP: 04/08/08	SLOW MOVING ITEM	Dispose	50.00
10/6/2008	CREAMER NON-LOGO	1 CTN	EXP: 02/10/08	SLOW MOVING ITEM	Dispose	38.84
10/6/2008	MILO SACHECT	2 CTN	EXP: 01/10/08	SLOW MOVING ITEM	Dispose	56.00
21/1/2008	BLOODY MADVY	12 CTN	EXP: 01/10/08	SLOW MOVING ITEM	Dispose	662.40
4/9/2008	HONEYSTAR	111 PKT	EXP: 8/4/09	SLOW MOVING ITEM	Dispose	113.22
					TOTAL LOSS	2 238.44

4.2.6 Weekly Stock Counting

This company conducted weekly stock counting of raw material inventory at their store by the storekeeper or store helper to determine the physical inventory in their stock. Table 4.3 shows the list of physical stock in the dry goods raw material store in which the physical quantity is not tally with the number in the system (SAP system).

Table 4.3: List of physical stock not tally with the record

No	Code No	Description	UNIT	SAP Stock Balance	Stock Counting
1	PDRY0044	White Sugar	KG	50	36
2	PDRY0091	Sarina Cornflour 400gm	PKT	83	82
3	PDRY0159	Mayonnaise 3 Lits	EA	35	35
4	PDRY0169	Coconut Cream 1 Lit	PKT	97	85
5	PDR0171	Beras Siam Wangi Mongkut 10 kg	KG	160	190
6	PDRY0176	Tuna Fish (Rex) 1.33 kgs	CAN	51	51
7	PDRY0239	Salted Peanut20gm	SAC	400	0
8	PDRY1016	S & W Whole Dills Pickles	JAR	12	12
9	PDRY2012A	COCA-COLA 325 ml X24 CANS	CTN	8	7
10	PDRY3009	Dutch Lady Fresh Milk 1 Lit	PKT	92	90
11	PDRY4000	Jacob Hi Calsium Crackers 180 gm	BOX	214	228
12	PDRY4007	Maggi H/Cup Chix 56 gm	CUP	131	120
13	PDRY4008	Maggi H/Cup Veg. 56 gm	CUP	152	139
14	PDRY7000	SAJI Cooking Oil 17 kg	CAN	37	38
15	PPER0018	Tomato	KG	13	8
16	PPER0053	Celery	KG	4.5	4.5
17	PPER2002	Frozen Peeled Prawn 31-40 nos/kg	KG	10	6
18	PPER4002	Anchor Unsalted Minidish Butter 10	EA	7,200	6400
19	PPER4011	Nestle Yoghurt Fruits 100 Gm	CUP	1,506	1440
20	PPER8000	Chicken Eggs	NOS	1,650	1380

4.2.7 Weekly Consumption and Quantity to Re-order

The sample of weekly consumption and the quantity to re-order of the dry goods raw material in the warehouse is shown in the table 4.4. From the list, we can see beras wangi mongkut has the highest consumption due to it is normally a main menu of the meal.

In order to have proper inventory management to prevent shortage / under stock of the raw material, the company has come out with weekly consumption and quantity to re-order so that the purchasing officer can generate the purchase order for the necessary items. The formula for weekly re-order quantity was created by the company and the formula that they used is:

$$\text{Quantity to Re-order} = \frac{\text{Weekly consumption} - \text{Balance Stock in the system}}{\text{Safety Stock}}$$

From interview with the purchasing officer, the recommended acceptable range by this company to re-order raw material is between -25% to +25%. Table 4.4 shows that many of the raw materials are over this range. This means that the level of raw material inventory is above the safety stock and this will lead to overstock.

Table 4.4: Weekly Consumption and Re-order Quantity of Dry Goods Raw material

		Formula				
		A	**B**	**C**	**(A-B)+C**	**(B-C)/C**
No	Item Description	Weekly consumption	Balance Stock	Safety Stock From … to…	Qty to Re-order	Deviation
1	Beras Wangi Mongkut 10 kgs	170	120	100	150	20%
2	Cooking Oil 17 kgs	20	32	12	0	167%
3	Button Mushrooms 425 gm	86	134	48	0	179%
4	Young Corn 425 gm	73	103	30	0	243%
5	Sliced button mushrooms 425 gm	46	70	24	0	192%
6	Straw mushrooms 425 gm	49	69	20	0	245%
7	Oyster Sauce 3.3 kg	24	34	10	0	240%
8	Whole kernal corn 432 gm	48	66	18	0	267%
9	Chili Sauce 3.3 kg	22	34	10	0	240%
10	Caulis tomato 3 kg	35	47	12	0	292%
11	Tomato ketchup 3.3 kg	20	30	10	0	200%
12	Paste Zara penne rigate 500 gm	10	60	20	0	200%
13	Claypot yee mee 600 gm	45	65	20	0	225%
14	Tomato Puree 3.0 kgs	9	16	7	0	129%
15	Longivity noodle 600 gm	30	50	20	0	150%
16	Wantan noodle 454 gm	28	38	10	0	280%
17	Curry powder 500 gm meat	10	15	5	0	200%
18	Curry powder 500 gm fish	9	14	5	0	180%
19	Black mushroom	4	6	2	0	200%
20	Chili powder 500 gm	7	10	3	0	233%
21	White pepper powder 500 gm	8	12	4	0	200%
22	Jintan manis powder 500 gm	5	8	3	0	167%
23	Jintan putih powder 500 gm	5	8	3	0	167%
24	Kunyit powder 1 kg	3	5	2	0	150%
25	Shitake mushroom	3	1	1	3	0%

4.2.8 Store Process Flow Chart

Figure 4.3 shows the process flow at the store. The processes start with ordering by the purchasing executive after receiving the quantity to re-order from the purchasing officer. It then followed by receiving and storage of the material issuing and recording. For ordering process, the purchaser will generate the purchase order and fax to the supplier. The supplier who received the order will deliver the material to the warehouse.

At the receiving stage, the store person will verify the quantity and amount received from the suppliers against the quantity and amount ordered by purchasing. The information on the order of the raw material can be checked through system (SAP). The condition of raw material will be inspected upon receiving the order to avoid defective items such as dented can, corroded can, etc. Once verification process has been done and the quantity is correct, the received items will be transferred into the store according to the type of raw material, brand, size and weight. The system update will be performed on the day by manual key-in of the receiving items into the system. Then the purchasing executive will get the received goods report from store person for payment processing to the supplier.

For the issuance process, the production personnel will fill up the requisition form for the list of raw material and passed to the store person. The information state the items and quantity required. The store person will verify the order and issue the raw material according to the form or list. In this stage, the store person will prepare the material with the right quantity and the expiry dates of the raw material are checked at the same time. Finally, the raw material will be delivered to the respective production section based on issuing time. The chef signature will be taken as a record that the raw materials already delivered to production floor. Then the system will be updated again by manual key-in by store person to charge out the quantity in the system so that the physical quantity left in the warehouse are tally with the system (SAP).

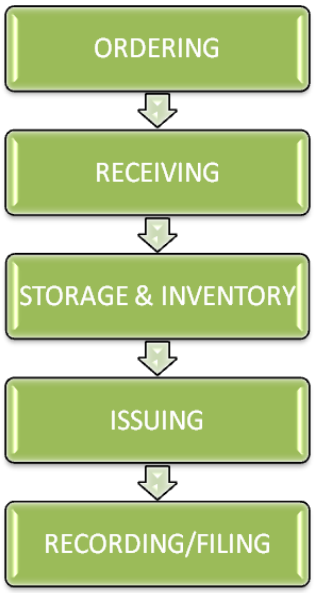

Figure 4.3: Store process flow chart

4.3 Data Analysis

4.3.1 Reason of the Disposed Dry Goods Raw Material

The percentage of disposed raw material is shown in the pie chart in Figure 4.4. From the pie chart, slow moving item has the highest percentage which is 70% then followed by damaged or dented item which is 17% and the lowest is changed menu which is 13%. The reason this raw material reach the expiry date is because of slow moving or low demand by production. This happened due to customer request to change menu and the inventory which is always above a safety stock. This company did not practice forecasting for every raw material using historical data. The store person also did not follow the first in and first out (FIFO) method in the arrangement and issuing of raw material to the production floor.

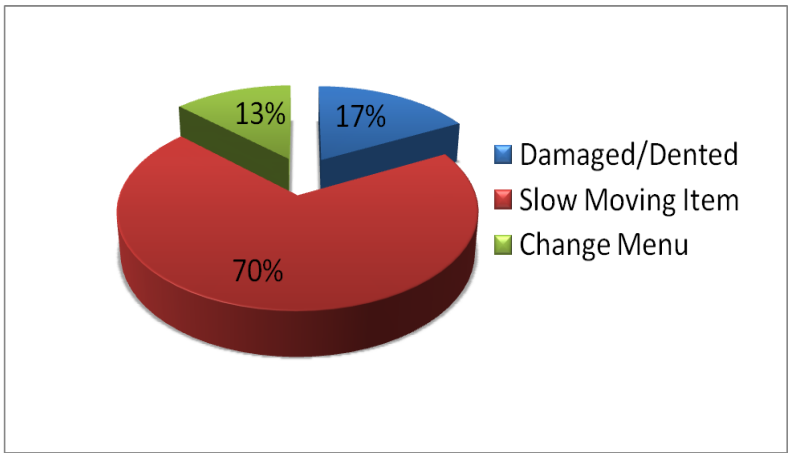

Figure 4.4: Percentage of disposal product

4.3.2 Physical Stock Not Tally With Record

Another problem facing dry goods raw material store is the physical stock does not tally with the number in the system. In table 4.5, the negative value shows the difference where inventory balance was higher or more than SAP value while the positive number shows physical stock is less than in the SAP system.

From the interview and observation, the main reason why physical stock does not tally with the SAP system are that the store person failed to record the issuance of raw material in the SAP system after the raw material is issued to production. This is because the warehouse of this company can be easily accessed by other staffs. Pilferage can occur in this situation.

From Table 4.5, anchor unsalted minidish butter has the highest difference followed by salted peanut. The possible cause why these 2 items has the highest difference is that this is small item which can easily be taken out or wrongly counted by store personnel. Only 3 items (yellow row) have the correct value.

Table 4.5: Difference between balance inventory in the system and stock counting

No	Description	UNIT	SAP Stock Balanc	Stock Counting	Difference
1	White sugar	kg	50	36	14
2	Sarina cornflour 400 gm	pkt	83	82	1
3	Mayonnaise 3 liters	ea	35	35	0
4	Coconut cream 1 liter	pkt	97	85	12
5	Beras siam wangi mongkut 10 kg	kg	160	190	-30
6	Tuna fish (rex) 1.33 kgs	can	51	51	0
7	Salted peanut 20 gm	sac	400	0	400
8	S & W whole dills pickles	jar	12	12	0
9	COCA-COLA 325ml X24 cans	ctn	8	7	1
10	Dutch Lady Fresh Milk 1 lit	pkt	92	90	2
11	Jacob Hi Calsium crackers 180gm	box	214	228	-14
12	Maggi H/Cup Chix 56gm	cup	131	120	11
13	Maggi H/Cup Veg. 56gm	cup	152	139	13
14	SAJI Cooking Oil 17 kg	can	37	38	-1
15	Tomato	kg	13	8	5
16	Celery	kg	4.5	4.5	0
17	Frozen Peeled prawn 31-40nos/kg	kg	10	6	4
18	Anchor unsalted minidish butter 10	ea	7,200	6400	800
19	Nestle Yoghurt Fruits 100 gm	cup	1,506	1440	66
20	Chicken Eggs	nos	1,650	1380	270

4.3.3 ABC Analysis

In managing the inventory, the operation manager needs to perform some analysis so that the inventory items can be classified for better record and control. In order to perform this task, ABC analysis is proposed. The ABC analysis classify on-hand inventory into three classifications based on dollar value. ABC analysis used the Pareto principle. The Pareto principle states that there are 'critical few and trivial many'. The purpose is to establish inventory policies that focus resources on the few critical inventory item and not the trivial many. It is not realistic to monitor inexpensive items with the same intensity as expensive items.

To determine monthly dollar volume in ABC analysis, data of the monthly demand of each dry goods raw material and the cost per unit is obtained. Class 'A' items are those in which the monthly dollar volume is high. Although such items may represent only about 15% of the total number of inventory items, they represent 60% to 70% of the total dollar usage. Class 'B' are those inventory items of medium monthly dollar usage. These items may represent about 30% of inventory items and 15% to 25% of the total value. Those with low monthly dollar volume are class C, which may represent only 5% of the monthly dollar volume but about 55% of the total inventory items. Table 4.6 shows ABC analysis that has been done on the dry goods raw material in the store and has been categorized into class A, B and C.

Table 4.6 : ABC analysis for dry good items in warehouse

Volume Rank	Item Description	Volume	Unit Cost	MYR Volume	Percent of MYR Volume	Cum Percent of MYR Volume	Category
1	BERAS WANGI MONGKUT 10KG	MYR 30.00	MYR 680.00	MYR 20,400.00	48.56%	48.56%	A
2	COOKING OIL 17kgs	MYR 54.42	MYR 80.00	MYR 4,353.60	10.36%	58.92%	A
3	COULIS TOMATO 3KG	MYR 29.45	MYR 140.00	MYR 4,123.00	09.81%	68.73%	A
4	OYSTER SAUCE3.3 KG	MYR 23.00	MYR 96.00	MYR 2,208.00	05.26%	73.99%	B
5	BUTTON MUSHROOM 425GM	MYR 4.50	MYR 344.00	MYR 1,548.00	03.68%	77.67%	B
6	WHOLE KERNEL CORN 432GM	MYR 6.90	MYR 192.00	MYR 1,324.80	03.15%	80.83%	B
7	CHILI SAUCE 3.3 KG	MYR 15.00	MYR 88.00	MYR 1,320.00	03.14%	83.97%	B
8	TOMATO KECTHUP 3.3 KG	MYR 15.00	MYR 80.00	MYR 1,200.00	02.86%	86.83%	B
9	SLICED BUTTON MUSHROOM 4	MYR 5.20	MYR 184.00	MYR 956.80	02.28%	89.10%	B
10	PASTA ZARA PENNE RIGATE 50	MYR 5.60	MYR 160.00	MYR 896.00	02.13%	91.24%	B
11	YOUNG CORN 425GM	MYR 1.75	MYR 292.00	MYR 511.00	01.22%	92.45%	B
12	CLAYPOT EE MEE 600GM	MYR 2.80	MYR 180.00	MYR 504.00	01.20%	93.65%	B
13	STRAWMUSHROOM 425GM	MYR 2.05	MYR 196.00	MYR 401.80	00.96%	94.61%	C
14	CHILIPOWDER 500GM	MYR 4.30	MYR 88.00	MYR 378.40	00.90%	95.51%	C
15	TOMATO PUREE 3.0KGS	MYR 10.00	MYR 36.00	MYR 360.00	00.86%	96.37%	C
16	WANTAN NOODLE 454GM	MYR 3.00	MYR 112.00	MYR 336.00	00.80%	97.17%	C
17	LONGIVITY NOODLE 600GM	MYR 2.50	MYR 120.00	MYR 300.00	00.71%	97.88%	C
18	CURRY POWDER 500GM MEAT	MYR 5.00	MYR 40.00	MYR 200.00	00.48%	98.36%	C
19	CURRYPOWDER 500GM FISH	MYR 5.00	MYR 36.00	MYR 180.00	00.43%	98.78%	C
20	BLACK MUSHROOM	MYR 8.00	MYR 16.00	MYR 128.00	00.30%	99.09%	C
21	WHITE PEPPER POWDER 500GM	MYR 3.30	MYR 32.00	MYR 105.60	00.25%	99.34%	C
22	SHITAKE MUSHROOM	MYR 7.80	MYR 12.00	MYR 93.60	00.22%	99.56%	C
23	JINTAN MANIS POWDER 100GM	MYR 3.30	MYR 20.00	MYR 66.00	00.16%	99.72%	C
24	JINTAN PUTIHPOWDER 500GM	MYR 3.30	MYR 20.00	MYR 66.00	00.16%	99.88%	C
25	KUNYIT POWDER 1KG	MYR 4.30	MYR 12.00	MYR 51.60	00.12%	100.00%	C
				MYR 42,012.20	**100.00%**		

Based on the list, *Beras Wangi Mongkut* 10 kg, cooking oil and caulis tomato are takes place in A category which means these 3 items are the most expensive item because of high usage with monthly total dollar usage of about 68.73%. The ‘B’ items represent 19.66% of the total value and ‘C’ items represent 6.35 % of the total value.

4.4 Problem Identification

After data collection and analysis, it was found that the store of in-flight catering company faced two main problems.

i. The quantity of dry raw material inventory in the store does not tally (physical quantity and number in the system (SAP))

ii. Poor inventory control which cause expired food still in storage due to improper tracking.

4.5 Summary

From data collection and analysis, the store is facing problem in managing inventory. There is no system to track the balance stock quantity to ensure the physical inventory tally with the system. This problem is partly due to the human error in updating from the system during issuance of the raw material. The issuance also did not follow first in first out (FIFO) criteria causing the raw material expired before used.

CHAPTER 5

PROPOSED SOLUTIONS

5.1 Introduction

This chapter discussed the proposed solution to solve the current inventory problem at dry goods raw material store.

5.2 Proposed Solutions

To ensure the problem identified can be solve and to meet the project objective, a few solutions have been proposed. Below are the proposed solutions for the each of the problem.

i. Stock not tally
    a. Implement barcode system for receiving and issuing material from warehouse and computerized inventory control system.
    b. Frequent stock check – based on ABC analysis

ii. Expired food – the main cause to this problem is the store person did not really follow FIFO procedure during issuing of material to production area and wrong forecast which cause over stock.

a) From the stock check data, it is proposed to separate the inventory using the zones system. These zones will represent the expected time raw material will expire. For example: zone 1 will indicate the expired date is 1 month from stock check date and zone 2 will indicate the expired date is 3 month from stock check date and so on.

b) Implement purchasing policy using forecasting method to buy material. This forecasting data can be taken from number of meal/flight per day or month.

5.2.1 Proposed Solutions for Physical Stock Does Not Tally with SAP

5.2.1.1 Barcode and Computerized Inventory Control

Barcode system and computerized inventory control can be introduced to the store operation to solve the physical stock does not tally with record.. Bar codes provide a simple and inexpensive method of encoding text information that is easily read by electronic readers. Bar coding also allows data to be collected rapidly and with extreme accuracy. A bar code consists of a series of parallel, adjacent bars and spaces. Predefined bar and space patterns or "symbologies" are used to encode small strings of character data into a printed symbol. Bar codes can be thought of as a printed type of the Morse code with narrow bars (and spaces) representing dots, and wide bars representing dashes. A bar code reader decodes a bar code by scanning a light source across the bar code and measuring the intensity of light reflected by the white spaces. The pattern of reflected light is detected with a photodiode which produces an electronic signal that exactly matches the printed bar code pattern. This

signal is then decoded back to the original data by electronic circuits. Due to the design of most bar code symbologies, it does not make any difference if a bar code is scanned from right to left or from left to right.

The basic structure of a bar code consists of a leading and trailing quiet zone, a start pattern, one or more data characters, optionally one or two check characters and a stop pattern as shown in Figure 5.1.

Figure 5.1: Barcode structure

There are different types of bar code encoding schemes or "symbologies", each of which were originally developed to fulfill a specific need in a specific industry. Several of these symbologies have matured into de-facto standards that are used universally throughout most industries. The symbologies supported by B-Coder, the TALtech Bar Code ActiveX control and the TALtech Bar Code DLLs are the most commonly used across all industries.

The different symbologies have different capabilities for encoding data. For example the UPC symbology used to identify retail products always contains 12 numeric digits whereas the general purpose Code 39 or Code 128 bar code symbologies can encode variable length alphanumeric data up to about 30 characters. These types of bar codes are called "linear symbologies" because they are made up of a series of lines of different widths. Most commercially available bar code scanners are able to read all of the different linear bar code symbologies and there is no need for different readers for different types of bar codes.

New "2-Dimensional" bar code symbologies like PDF417, Aztec Code and Data Matrix can encode several thousand bytes of data in a single bar code symbol including text or binary data. The newer 2D bar code symbologies typically require special bar code readers that are designed specifically for reading them.

The primary purpose of a bar code is to identify something by labeling the item with a bar code containing a unique number or character string. Bar codes are typically used with a database application where the data encoded in the bar codes is used as an index to a record in the database that contains more detailed information about the item that is being scanned. For example, when a checkout clerk scans a bar code on a product in a grocery store, the bar code data is fed to a computer that looks up the information in a central database and returns more detailed information about the item that was scanned including possibly a description of the item and a price. By using bar codes, the grocery store does not need to put a price tag on each item in the store and they can also change the price for a particular item by modifying a single entry in the central database. They can also track how much of a product is currently in stock so that they know when to re-order more of each item as the number of items in stock falls.

Bar codes also provide a quick and error free means for inputting the data into an application running on a computer. By using bar codes, the potential for errors from manual data input is eliminated. Another typical application for bar codes is therefore for inputting data without having to type. For example you could encode name or address data in a bar code on an ID badge and then scan the ID badges to input a persons name into a computer program instead of typing the information.

The linear barcode is proposed to the store to scan the original barcode from the manufacturer to identify the item description and record the in and out quantity to

the database server. The data are auto-update by the barcode software once the barcode was scan in or scan out from the store.

The company needs to invest in this system to have better traceability of raw material. The investment is on the hardware and software. The hardware is computer or database server, barcode reader or scanner to scan in and out the raw material from store to production or vice verse. The software of this barcode system is provided by barcode system supplier. The information to store in the computer can be customized, such as date in and out of the store, date of purchase, product name and quantity and etc.

The function of the scanner is to scan the barcode label on the product. The data from the barcode will be transferred to the database server. The server will update the product in and out from the store. Information such as item description, quantity, price and etc will be auto update in server using the software. Other hardware investment is 3 units of client computer. The 3 client computer can be used to access the database server to get the detail real-time information about stock balance, safety stock, location of the stock, value of the stock, etc.

These 3 client computer can be used by:

i. Purchasing

ii. Store person

iii. Operation manager

Data on inventory control is confidential and only these 3 people are granted the access inventory information in store. Purchasing department can get data from the system to check the balance stock in the store and place order if necessary. The store person will handle the receiving transaction using barcode scanner to scan in all

material during receiving and scan out the material during issuing. Another task of the store person, is to ensure all physical raw material quantity left in store tally with the quantity in the system. They need to perform self inventory audit from time to time. The working of this how this barcode is shown in Figure 5.2.

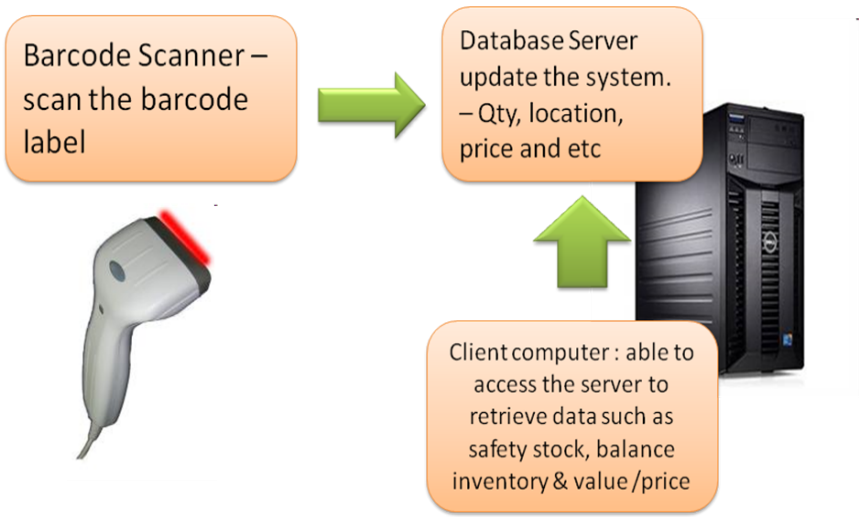

Figure 5.2: Barcode process flow

Once the barcode is installed in the store, the procedure for receiving and issuing using barcode scanner should be created. This procedure is to ensure inventory balance in store tally with the system all the time.

At the start, purchasing will generate purchase order to the supplier for necessary item after safety stock check in the system and physical check in the store. This order is generated to stock necessary item and prevents overstock which may lead to waste if the material not used. The purchaser also needs to forecast the quantity needed by referring to the weekly consumption data or meal order from customer.

The supplier has to deliver the order to the store on time so that shortage of material will not happen. Normally, suppliers need to deliver the raw material from 1 to 3 days from the order date. All material should already have barcode label by the

manufacturer. The system can store the data by using the same barcode. The stores personnel need to check the total quantity delivered and scan all the material entering the store so that the receiving item and quantity is updated in the system to ensure the quantity in store continuously tally (between physical in store and number in the system).

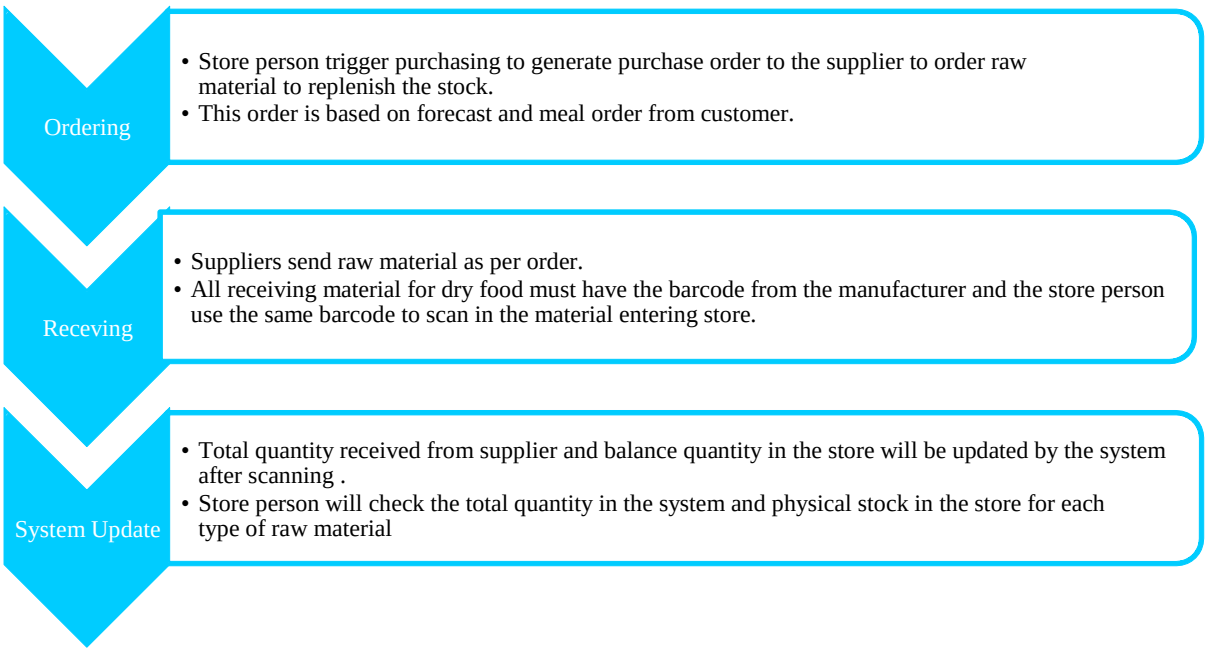

Figure 5.3 : Receiving procedure using barcode system

All material issuance must go through the barcode scanner to scan out the material so that the quantity in warehouse can be charged out and the quantity in the system is deducted and shows actual balance quantity in store. For issuance, the chef or production staff will provide the list of material needed or issuance form to the store person. Then the store person will prepare the material as per request and scan out all the material to charge out to production. The scan out activity will deduct the quantity issued to the production. Figure 5.4 shows the process flow chart for material issuance using barcode system.

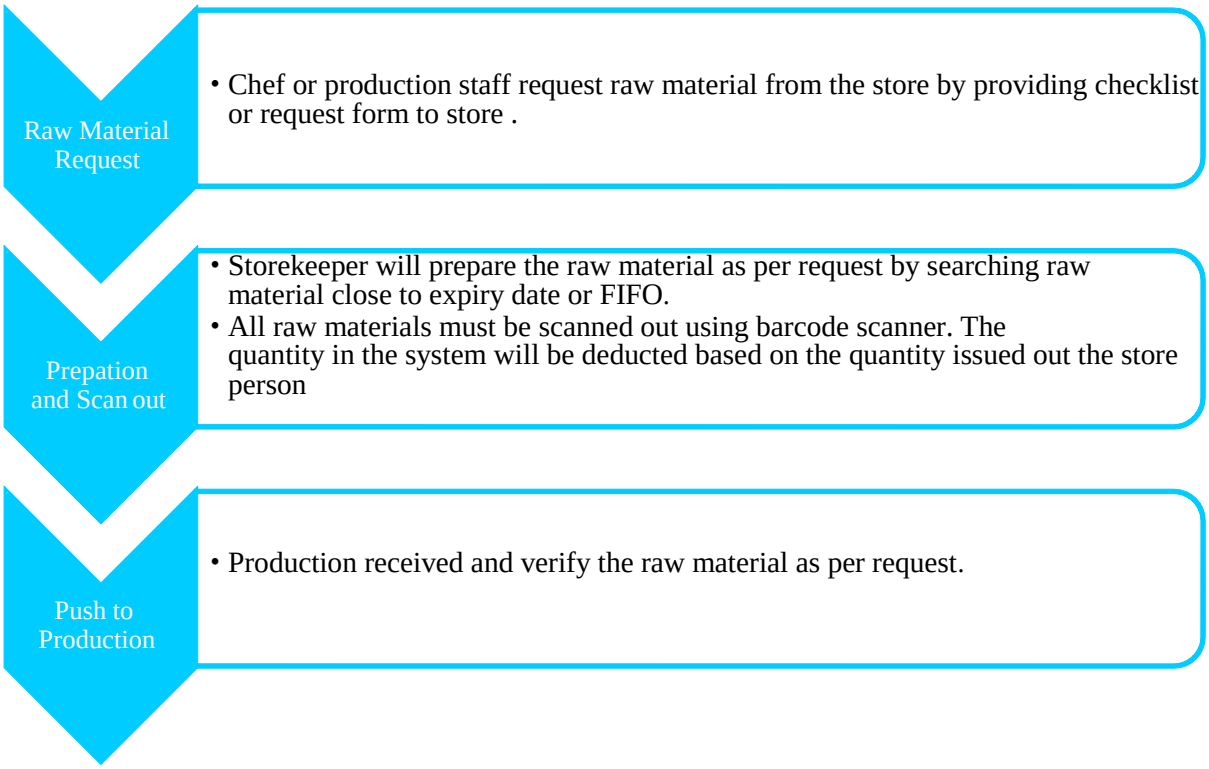

Figure 5.4: Material issuing procedure after using barcode system

5.2.1.2 Benefit Using Barcode System

In inventory control, the use of barcodes can provide very detailed up-to-date information on key aspects of the business, enabling decisions to be made much more quickly and with more confidence. For example:

i. Fast- issuance can be identified quickly and automatically recorded to meet the production demand.
ii. The most issued items can be identified quickly with details of usage. This information will help the company to forecast the purchasing quantity.
iii. Slow-issuance items can be identified, preventing a build-up of unwanted stock.

iv. The effects of repositioning a given product within a store can be monitored, allowing fast-moving more profitable items to occupy the best space.
v. Historical data can be used to predict seasonal fluctuations very accurately.

Besides inventory tracking, barcodes are very useful in shipping/receiving/tracking.

i. When a manufacturer packs a box with any given item, a Unique Identifying Number (UID) can be assigned to the box.
ii. A relational database can be created to relate the UID to relevant information about the box; such as order number, items packed, quantity packed, final destination, etc.
iii. The information can be transmitted through a communication system such as Electronic Data Interchange (EDI) so the retailer has the information about a shipment before it arrives.
iv. Tracking results when shipments are sent to a distribution centre (DC) before being forwarded to the final destination.
v. When the shipment gets to the final destination, the UID gets scanned, and the store knows where the order came from, what's inside the box, and how much to pay the manufacturer.

The reason barcodes are business-friendly is that the scanners are relatively low cost and extremely accurate compared to key-entry data manually.

5.2.1.3 Cost Implementation

The estimated cost for installing the barcodes is described below.

Scanner = RM 650 X 2 units		= RM 1300.00
Database server		= RM 4000.00
Client computer	=RM 2000X3	= RM6000.00
Barcode inventory software		= RM 1000.00
Installation & training package		= RM 2000.00
Total cost		= **RM 14,300.00**

The new system to be installed is requiring budget allocation. The implementation benefits far outweigh the initial investment cost.

5.2.1.4 Return of Investment (ROI)

Every single investment in any field of business must have the return of investment (ROI). The simple method for the ROI calculation of the barcode system consider the total implementation cost and divided with the total losses of the raw material over certain period times.

The total losses of raw material disposed after reaching expiry date from 4 September 2008 until 1 April 2009 is MYR 2 238.44. The value of losses is rounded to MYR 2238.00. The company loss MYR 2 238 every 6 month if the barcode is not implemented. Therefore the ROI in term of time period is follow:

1 year losses = (MYR 2 238/6 month) * 12 month = MYR 4 476.00

The total cost of implementation as shown above is MYR 14 300.00

Therefore the ROI of this system is MYR 14 300.00 / MYR 4476 = 3.2 years. The store will get back the total cost of implementation in 3.2 years after implementation assuming there are no more losses after installing this system.

5.2.2 Frequent Stock Check / Cycle Counting

Even though the warehouse can be installed with barcode or computerized inventory system, the record in the system and the physical quantity must be manually verified through continuous audit. This audit is called frequent stock check or cycle counting. This practice often meant shutting down the facility and having in-experience people count parts or material in the store. All inventory record in system should be verified via cycle counting. This method can use the inventory classifications using results from ABC analysis.

With cycle counting procedures, all items or dry raw materials are counted, records are verified, and inaccuracies documented. The cause of inaccuracies is then traced and appropriate remedial action taken to ensure the integrity of inventory system is in place at all times. Based on ABC analysis, all category of item will counted as follows:

i. ‘A’ items will be counted frequently - once a week

ii. ‘B’ items will be counted less frequently - once every 2 weeks

iii. ‘C’ items will be counted - once a month

The other information collected during these stock counting is the expiry date for all items. This data will be used during segregation the item near to expiry date. The procedure of cycle counting is shown Figure 5.5.

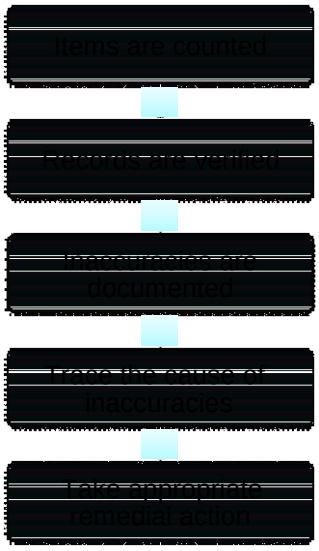

Figure 5.5: Procedures for cycle counting

5.2.2.1 Advantages of Cycle Counting and Frequent Stock Check

i. Eliminates the shutdown and interruption of production.

ii. Maintains accurate inventory records.

iii. Allow the cause of the errors to be identified and remedial action to be taken.

iv. Train personnel in audit the accuracy of inventory.

v. Eliminates annual inventory adjustment.

5.2.3 Raw Material Reaching Expiry Date Before Used

5.2.3.1 Practice FIFO and Segregate in Zone Area

During stock check and audit at the store, the expiry date of every item of dry raw material should be recorded. From the expiry date data, the dry raw material can be segregated into 3 groups. The first group consist of dry raw material which will reach expiry date within 1 month from the stock audit date. The second group is for raw material reach expiry date within 3 months from the stock audit date and the third group is for dry raw material reach expiry date more than 3 months.

These three groups of raw material will be segregated and placed at different locations or different racks. The first group is the first priority for the store person to issue to production when there is request from production. All raw materials in this group will be pasted with the orange sticker to show that this lot need to be issued first. All raw materials in the first group must be located near to issuance area in the

store so that it is easily visible. The second group of raw material can be pasted with blue sticker to represent the second priority after the first group of material has all been issued. The location or rack of the 2 groups should also be labelled for ease of identification. The third group will have no sticker but the location or rack need to be labelled.

If this technique is practiced, the problem disposing of raw material after reaching expiry date can be minimized. In order to maintain this practice, frequent audit is needed to continuously re-classify the raw material from the third group to second group and from the second group to the first group. The sticker should also be change from blue to orange if the raw materials in second group reach the expiry date within one month from the audit date.

5.2.4 Purchasing Policy

The current practice of purchasing the raw material is based on weekly consumption. The purchaser did not obtain the actual stock balance in store and some raw material is over stocked. This practice can cause the dry raw material in to be disposed after reaching expiry date.

In order to overcome this problem, forecasting method in purchasing raw material can be is introduced. Forecasting is the process of estimation in unknown situations. Prediction is a similar, but more general term. Both can refer to estimation of time series, cross-sectional or longitudinal data. Usage can differ between areas of application. Risk and uncertainty are central to forecasting and prediction. Forecasting is used in the practice of customer demand planning in everyday business forecasting for manufacturing companies. The discipline of demand

planning, also sometimes referred to as supply chain forecasting, embraces both statistical forecasting and a consensus process.

Forecasting methods can be divided into two broad categories: qualitative and quantitative. Many forecasting techniques use past or historical data in the form of time series. A time series is simply a set of observations measured at successive points in time or over successive periods of time. Forecasts essentially provide future values of the time series on a specific variable such as sales volume. Division of forecasting methods into qualitative and quantitative categories is based on the availability of historical time series data.

Based on the data collected and the suitability of the problem, quantitative forecasting method will be used. Quantitative forecasting methods are used when historical data on variables of interest are available - these methods are based on an analysis of historical data concerning the time series of the specific variable of interest and possibly other related time series. There are two major categories of quantitative forecasting methods. The first type uses the past trend of a particular variable to base the future forecast of the variable. As this category of forecasting methods simply uses time series on past data of the variable that is being forecasted, these techniques are called time series methods.

The second category of quantitative forecasting techniques also uses historical data. But in forecasting future values of a variable, the forecaster examines the cause-and-effect relationships of the variable with other relevant variables such as the level of consumer confidence, changes in consumers' disposable incomes, the interest rate at which consumers can finance their spending through borrowing, and the state of the economy represented by such variables as the unemployment rate. Thus, this category of forecasting techniques uses past time series on many relevant variables to produce the forecast for the variable of interest. Forecasting techniques falling under this category are called causal methods, as the basis of such forecasting

is the cause-and-effect relationship between the variable forecasted and other time series selected to help in generating the forecasts.

Based on theoretical description above, the quantitative method is suitable in forecasting the purchasing raw material. In times series forecasting, there are 3 techniques or approaches can be used, that is naive approach, moving average, and exponential smoothing.

The moving average forecasting technique is chosen because this technique is the simplest technique to apply because the demand is quite stable. A moving average forecast method use historical data to generate forecast. Moving average is useful if we can assume that market demands will stay fairly steady over time. 4 periods after the 3 period forecasting values are found by simply summing the demand during the past 3 months and dividing by 3. With each passing month, the most recent month's data are added to the sum of the previous 3 month data, and the earliest month is dropped. This practice tends to smooth out short-term irregularities in the data series.

Mathematically, the simple moving average (which serves as an estimate of the next period's demand is expressed as

$$\text{Moving Average} = \frac{\sum \text{Demand in previous n periods}}{N}$$

where n = number of periods in moving average – for example 4, 5 or 6 months, respectively, for 4- ,5- , or 6- period moving average.

Three examples of moving average forecast for the raw material in class 'A' group is used to show how the forecast can be done. Since *beras wangi*, cooking oil

and button mushroom are represent the highest monetary value in ABC analysis and fall into 'A' group, more attention should be given to avoid overstock and shortage. Figure 5.6, 5.7 and 5.8 show 3-month moving average forecast for *beras mongkut*, cooking oil and button mushroom.

Period	Demand
January	807
February	675
March	680
April	701
May	747
June	608
July	617
August	637
September	610
October	681
November	906
December	966
Next period	851

Forecasts and Error Analysis				
Forecast	Error	Absolute	Squared	Abs Pct Err
720.67	-19.67	19.67	386.78	02.81%
685.33	61.67	61.67	3802.78	08.26%
709.33	-101.33	101.33	10268.44	16.67%
685.33	-68.33	68.33	4669.44	11.08%
657.33	-20.33	20.33	413.44	03.19%
620.67	-10.67	10.67	113.78	01.75%
621.33	59.67	59.67	3560.11	08.76%
642.67	263.33	263.33	69344.44	29.07%
732.33	233.67	233.67	54600.11	24.19%
Total	398.00	838.67	147159.33	105.76%
Average	**44.22**	**93.19**	**16351.04**	**11.75%**
	Bias	**MAD**	**MSE**	**MAPE**
		SE	**144.99**	

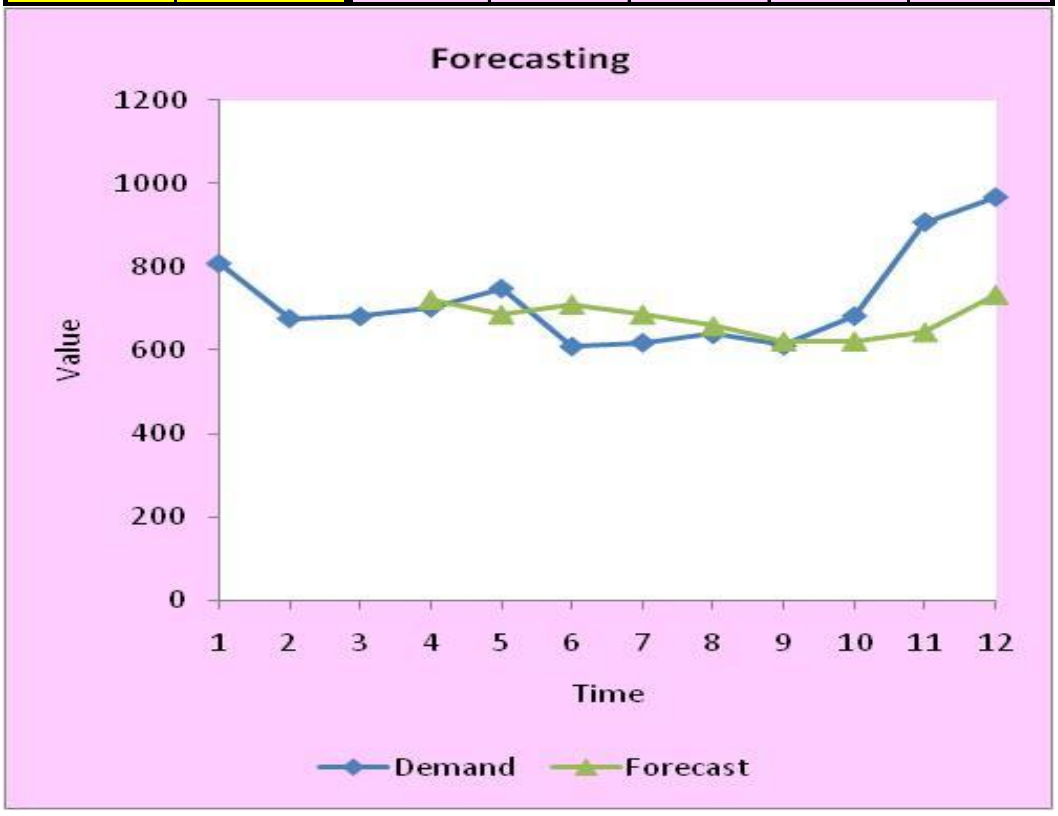

Figure 5.6: 3-month moving average forecast for *beras wangi mongkut* 10 kgs

Period	Demand
January	94
February	79
March	80
April	79
May	88
June	72
July	72
August	75
September	72
October	80
November	106
December	113
Next period	**99.66666667**

Forecasts and Error Analysis				
Forecast	**Error**	**Absolute**	**Squared**	**Abs Pct Err**
84.33	-5.33	5.33	28.44	06.75%
79.33	8.67	8.67	75.11	09.85%
82.33	-10.33	10.33	106.78	14.35%
79.67	-7.67	7.67	58.78	10.65%
77.33	-2.33	2.33	5.44	03.11%
73.00	-1.00	1.00	1.00	01.39%
73.00	7.00	7.00	49.00	08.75%
75.67	30.33	30.33	920.11	28.62%
86.00	27.00	27.00	729.00	23.89%
Total	46.33	99.67	1973.67	107.36%
Average	**5.15**	**11.07**	**219.30**	**11.93%**
	Bias	**MAD**	**MSE**	**MAPE**
		SE	**16.79**	

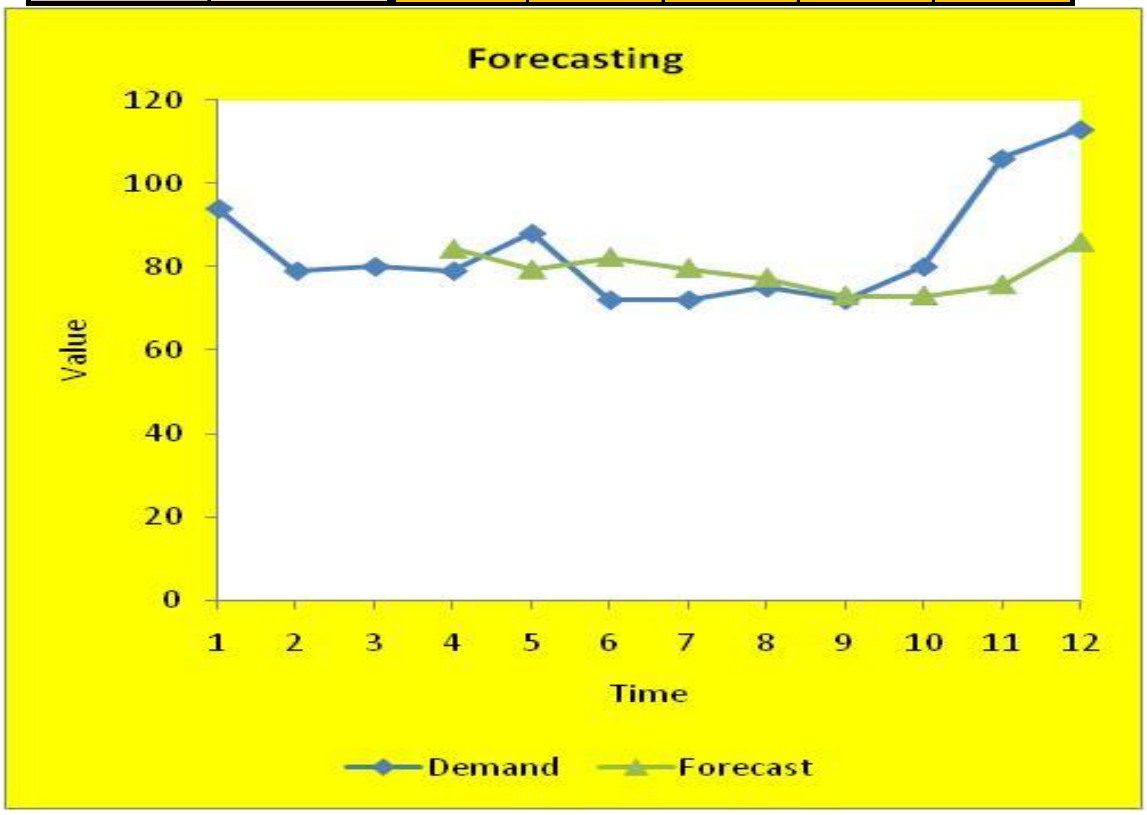

Figure 5.7: 3-month moving average forecast for cooking oil 17 kgs

Period	Demand
January	413
February	346
March	344
April	354
May	376
June	308
July	307
August	321
September	307
October	344
November	457
December	487
Next period	**429.3333333**

Forecasts and Error Analysis				
Forecast	Error	Absolute	Squared	Abs Pct Err
367.67	-13.67	13.67	186.78	03.86%
348.00	28.00	28.00	784.00	07.45%
358.00	-50.00	50.00	2500.00	16.23%
346.00	-39.00	39.00	1521.00	12.70%
330.33	-9.33	9.33	87.11	02.91%
312.00	-5.00	5.00	25.00	01.63%
311.67	32.33	32.33	1045.44	09.40%
324.00	133.00	133.00	17689.00	29.10%
369.33	117.67	117.67	13845.44	24.16%
Total	194.00	428.00	37683.78	107.44%
Average	**21.56**	**47.56**	**4187.09**	**11.94%**
	Bias	**MAD**	**MSE**	**MAPE**
		SE	**73.37**	

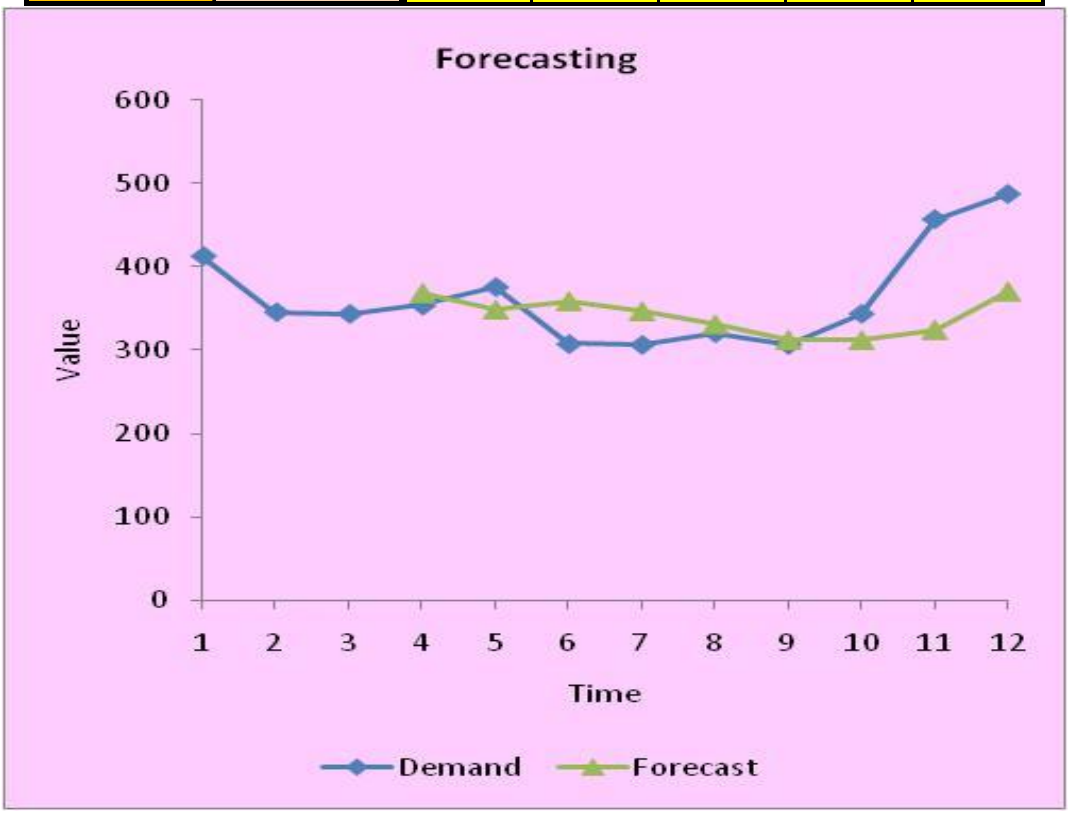

Figure 5.8: 3-months moving average forecast for button mushroom 425 gm

5.3 Validation

In order to validate the proposed solutions to determine whether the techniques are practicable or not, questionnaires was send to the expert such as production planner, production manager and people who are managing the production.

According to the result of the questionnaires, 82% of the respondents agree the propose solutions can help the store of the company to reduce problem in inventory management and control. Majority of the respondents agree that by applying this approach, the cost of the operating and handling dry raw material inventory in the store can be saved and the time in managing warehouse transaction will be reduced compared to current system.

5.4 Summary

This chapter discussed the solutions to achieve the target objective. The implementation of barcode system, ABC analysis, frequent stock check and forecasting can improve the inventory management and control at an in-flight catering company.

CHAPTER 6

CONCLUSIONS AND FUTURE WORKS

6.1 Introduction

This chapter discusses conclusions of this project. The first part summarize the project the second part explained the research implications and contributions. Limitations of the research and recommendation of the future works are also described.

6.2 Conclusions

This project proposed developing methods that can be used to solve problem in inventory management at dry goods raw materials store at in-flight catering company. This project started with review on the literature about in-flight catering company and methods to be used to solve the problem.

The first objective is to develop a procedure of inventory management and control; this can be achieved by ABC analysis that which determine the frequency of stock check. Barcode system can improve the inventory control of dry goods raw

material stock. Forecasting technique based on historical data is able to reduce raw material loss.

The implementation of the correct technique can improve inventory management and control at dry goods raw materials store at an in-flight catering company. The proposed techniques have been validated by the expert.

6.3 Limitations of the Research

This project has some limitations. The case study was carried out at one in-flight catering company in Penang and there is no benchmarking that can be done because of there is no competitor for this company in Penang. Some of the data are confidential.

6.4 Recommendations for Future Works

In this project, the focus is on the use of techniques to solve problem in inventory management at an in-flight catering company. The future works should be directed on other improvement strategies in order to be more efficient. The following are three recommendations for future works:

i. Development of a fully computerized inventory management and control.
ii. Use the Just-in-Time approach in purchasing of raw material.
iii. Conduct benchmarking in order to make comparisons with the best practice.

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APPENDIX A

UNIVERSITI TEKNOLOGI MALAYSIA
QUESTIONNAIRE FOR VALIDATION OF THE PROJECT

Thesis title: INVENTORY MANAGEMENT AND CONTROL AT AN IN-FLIGHTCATERING COMPANY

1. Is this an enhancement to an existing method?
   ☐ Yes ☐ No

2. If you are enhancing an existing application, will you wish to use this approach of the inventory management and control?
   ☐ Yes ☐ No

3. Why has your company decided to use this approach now? What or who is driving this project?

   ☐ Cost savings
   ☐ Time/staffing savings
   Other: _____

   _____

4. What are some of the anticipated benefits to your company from this research?
   ☐ Cost savings
   ☐ Time/staffing savings
   Other: _____
   _____

5. Is there other benefit to company by implement this approach? ☐ Yes ☐ No
   ☐ Reduced expired raw material
   ☐
   ☐
   ☐
   Other: _____

6. Have you seen a similar approach implement by other industry?

☐ Yes ☐ No ☐ Not Sure

If yes, by whom? Please provide the name of the company, if available.

_____

7. Which other department this approach can also be use? *(Please check all that apply)*

☐ Production Planning
☐ Meal Forecasting
☐ Other _____