AN ABSTRACT OF THE THESIS OF

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Title: An Assessment of Cook-Chill Foodservice Systems

Abstract approved: Ann M. Messersmith

Cook-Chill Foodservice System was a new alternative foodservice system in the 1960s. Food items in Cook-Chill Foodservice Systems are prepared and chilled in advance of service, stored in inventory, and then rethermalized before consumption.

The purpose of this research was to evaluate Cook-Chill Systems from the foodservice manager's view. The objectives of this study were to: (1) identify effects, advantages and disadvantages, and decision making factors for selection Cook-Chill Systems as perceived by managers, and (2) determine if the demographics influence managers' assessment.

A survey questionnaire was used to collect current information of Cook-Chill Systems. One hundred thirty-four surveys were mailed nationwide to foodservice managers with 95(71%) valid responses. Data were analyzed from the 74 respondents who currently used Cook-Chill Systems.

The results indicated that the perceived meal quality, quantity control and personnel satisfaction was equal or better, and labor cost was decreased and equipment cost increased were most often reported by managers in comparing Cook-Chill Systems with prior systems. Managers identified seven advantages: good working conditions, high productivity, labor

savings, consistent quality food, good quantity control, nutrient retention, and safety. One perceived disadvantage was high capital cost of equipment. The five most often cited factors for selection of Cook-Chill Systems were labor savings, good working conditions, consistent quality food, safety, and high productivity. Factors most often cited for not selecting Cook-Chill Systems were the limited menu and types of products produced, complaints of bad food, and high capital cost.

Most Cook-Chill Systems have been installed in the past ten years with previously centralized production flow. Cook-Chill Systems accommodated small to large numbers of meals with both blast chiller and tumbler chiller equipment and many reheating methods. Half of the managers were involved in choosing, designing or implementing Cook-Chill Systems.

Four significant outcomes were: (1) microbiological control was the highest of meal quality contributes; (2) manager satisfaction was higher than customer and employee satisfaction; (3) meal quality and personnel satisfaction differed among reheating methods; and (4) management experience for design or implementation influenced managers' willingness in choosing these systems again.

Four recommendations were drawn from this research. Recommendations were: (1) studies to identify factors contributing to success of reheating methods, (2) standard models for cost recording, (3) approaches to analyze capital cost, create menu items, and find causes of food quality complaints, and (4) a Cook-Chill Information Center to share knowledge and support the further development of Cook-Chill Systems.

An Assessment of Cook-Chill Foodservice Systems

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AN ASSESSMENT OF COOK-CHILL FOODSERVICE SYSTEMS

INTRODUCTION

The Cook-Chill Foodservice System was a new alternative foodservice system in the 1960s(1). Since 1960 alternative foodservice systems have been developed in response to increasing labor costs, shortages of skilled labor, low productivity, and ineffective delivery systems that permitted losses in temperature and quality of food between preparation and service(2,3). According to food product flow, foodservice has been categorized as conventional, commissary, ready-prepared, and assembly/serve (convenience food system)(4). The ready-prepared foodservice system includes Cook-Chill and cook-freeze systems. Cook-Chill and cook-freeze are also used in commissaries or food factories where food is prepared, stored chilled or frozen, and then distributed to several remote areas for rethermalization and service.

The product work flows of the Cook-Chill Systems are food storage of purchases, pre-preparation, preparation/cooking, chilling, cold cooked food storage, distribution, rethermalization and service(5). The techniques of raw materials storage, preparation and cooking of the Cook-Chill Systems are similar to conventional techniques with traditional equipment. After cooking, the food is rapidly chilled, stored in a temperature controlled cold environment, and rethermalized before serving(5,6,7). The process of Cook-Chill Systems provides a distinct separation between the production stages and serving stages of meal.

The Cook-Chill Foodservice System was first installed in Sweden in 1963(1). With the Cook-Chill concept and enhanced technology development, a new way of thinking about the production process was that meals were now cooked to accommodate inventory rather than to meet meal time deadlines(6,8). Therefore, the foodservice manager can actually produce new menu items several days in advance of service. Between the 1960s and 1980s, applications of Cook-Chill technology have been used around the world(9). In the United States, Cook-Chill Systems have been widely applied in school meal production, hospital and nursing home foodservice, county foodservice, industrial foodservice, commercial feeding, food processors, and in-flight kitchens.

Because foodservice managers assume primary responsibility for food safety and quality regardless of the type of system, complex managerial decisions are required to develop and implement appropriate foodservice systems that serve quality food at minimal cost(10). Studies of food quality(11-22) and cost studies(23,24,25) have indicated that the Cook-Chill Foodservice System has acceptability in the foodservice industry. Although individual case studies(26-31) have been reported in regard to the effect of Cook-Chill Foodservice Systems in their operations, no research has been conducted to assess Cook-Chill Foodservice Systems from the management point, and there has been no research to examine what factors influence the decision regarding selection of Cook-Chill Foodservice Systems. Therefore, assessment and decision making information will be collected on the perception of managers of Cook-Chill

Foodservice Systems.

Research Purpose and Hypotheses

The purpose of this research was to evaluate Cook-Chill Foodservice Systems from the perception of managers in the foodservice industry. The qualitative data consisted of the following areas: meal quality, quantity control, customer's opinions, employee's opinions, advantages and disadvantages of Cook-Chill Foodservice Systems; decision making factors; and demographic information. The quantitative data were cost effects. The research objectives were to: (1) identify the effects, advantages and disadvantages, and decision making factors for selection of Cook-Chill Foodservice Systems as perceived by managers, (2) identify demographic characteristics of the facilities and managers of Cook-Chill Foodservice Systems, and (3) determine if demographic characteristics influence the manager's assessment of Cook-Chill Foodservice Systems.

The null hypotheses of this research were:

Ho1: There is no difference in the manager's perception of meal quality of Cook-Chill Foodservice Systems among meal quality attributes (1) serving temperature, (2) sensory evaluation, (3) microbiological control, and (4) nutrient retention.

Ho2: There is no difference in the manager's perception of personnel satisfaction for Cook-Chill Foodservice Systems among customers, employees, and managers.

Ho3: There is no difference in the manager's perception of (1) meal quality and (2) personnel satisfaction of Cook-chill Foodservice Systems among chilling equipment.

Ho4: There is no difference in the manager's perception of (1) meal quality: serving temperature, sensory evaluation, microbiological control and nutrient retention; and (2) personnel satisfaction: satisfaction of customers, employees and managers of Cook-chill Foodservice Systems among reheating methods.

Ho5: There is no difference in the manager's perception of (1) quantity control and (2) personnel satisfaction of Cook-Chill Foodservice Systems between groups serving different numbers of meals per day .

Ho6: There is no difference between Cook-Chill Foodservice Systems and prior systems in cost effects among private, public and combination funding sources.

Ho7: There is no difference in (1) average meal cost per meal, (2) labor cost per meal, (3) food cost per meal of Cook-Chill Foodservice Systems among private, public and combination funding sources.

Ho8: There is no difference in (1) average meal cost per meal, (2) labor cost per meal, and (3) food cost per meal of Cook-Chill Foodservice Systems between commercial and noncommercial feeding groups.

Ho9: There is no difference in willingness to choose Cook-Chill Foodservice Systems again between the groups (1) responsible for decision making for using these systems, (2) responsible for design or implementation these systems, and (3) years of management these systems.

Ho10: There is no correlation between personnel satisfaction and (1) management years, (2) total volume of meals served per day, and (3) hospital size in Cook-Chill Foodservice Systems.

Definition of Terms

Assembly/serve system:

Referred to as convenience food systems or systems using minimal cooking concepts--came about primarily because of the availability of foods that are ready to serve or that require little or no processing in the foodservice operation prior to service(10).

Batch production:

Preparing and cooking the quantity of food required for one meal service time.

Commissary system:

Food procurement and production are completed in a central production facility, with distribution of prepared menu items to several remote areas for final preparation and service(10).

Conventional system:

All production is completed and foods are served on the same or near-by premises.(also known as traditional or cook/serve system)(10).

Cook-freeze system:

Similar to Cook-Chill: cooked foods are brought below the freezing point, kept in frozen storage, drawn from inventory as needed and tempered or slacked to the thaw point under refrigerator(10).

Food product flow:

The alternate paths within foodservice operations which food components and menu items may follow, initiating with receipt of food items and ending with service of food to the client(4).

Hazard Analysis Critical Control Point(HACCP):

HACCP is a preventive system for quality control, designed to inform management of potential dangers so that corrective action can be taken; emphasis on microbiologic control(32). As defined by Bauman (33), hazard analysis is concerned with identifying microbial-sensitive ingredients, critical control points during processing, and human factors that may affect the microbiological safety of the product.

Microbial safety:

The numbers of pathogenic microorganisms or quantity of toxins of microbial origin in foods are sufficiently low to prevent the onset of a foodborne disease outbreak after the food is consumed(4).

Ready-prepared system:

Menu items are produced and held frozen or chilled for service(10).

Rethermalization:

Application of heat to cooked and chilled menu items in a foodservice to achieve the desired level of cooking of the components and /or the appropriate food product internal temperature for service(4).

Sensory evaluation:

A scientific discipline used to evoke, measure, analyze, and interpret human reactions to those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch, and hearing(34).

REVIEW OF LITERATURE

Cook-Chill Foodservice System

The Cook-Chill Foodservice System is defined as a mass feeding method(6,7). This method is based on conventional preparation of food followed by rapid chilling, storing in a temperature controlled environment, and then rethermalizing the food immediately before consumption (6,7). In other words, the Cook-Chill Foodservice System is an approach to meal production and service based on the preparation of forecasted meal demand in advance days of service, storage in inventory, and then rethermalization for service(35).

The primary purpose of using the Cook-Chill System is to achieve economical central production of food and distribution(1). Central production with the Cook-Chill System provides a feasible production by maximizing equipment utilization, improving productivity, controlling labor cost and food cost, and reducing the overall kitchen area(26,36-38).

Other purposes of using a Cook-Chill System were to solve the problems of the growing shortage of skilled foodservice staff and the increasing turnover of personnel employed(36,39). Owing to the chilling method and the cool storage concept of cooked food, production worked to inventory, not to coming meal service in the Cook-Chill Systems(40). Therefore, Cook-Chill separated the food production and service production, where the food production operation requiring skilled staff and the service operation needing largely semiskilled staff who simply reheat complete Cook-Chill meals or individual food items(36). Because of the separation, the Cook-Chill System increased foodservice productivity and economically used skilled staff(35,36). This also allowed for elimination of the crises peaks at meal times to have a smoother work flow and an improvement in working conditions for staff in order to reduce levels of staff turnover(35).

The process of the cooked/chilled production/service operation involves seven stages(7,35):

(1) Preparation takes place on suitable working surfaces and under good conditions of hygiene.

(2) The cooking process is designed to maintain the nutritional value of the foodstuffs, as well as the production of a palatable product for the consumer. The time and temperature of the cooking are sufficient to ensure that heat penetration to the center of the foodstuffs will result in the destruction of non-sporing pathogenic micro-organisms.

(3) Portioning or packaging food in small volume containers help the chilling process. The portioning process is completed within the minimum practicable period of time which can not exceed 30 minutes for any product to prevent the growth of micro-organisms.

(4) The chilling process is carried out as quickly and efficiently as possible in order to preserve the appearance, texture, flavor, nutritional value and safety of the cooked food. The rapid chilling methods reduce the temperature of portioned cooked food from 158°F.(70°C.) to 37°F.(3°C.) or below in a period not exceeding 90 minutes.

(5) Cool storage for the cooked food is in large holding refrigerators or walk-in cold rooms at temperature between 32°F.(0°C.) and 37°F.(3°C.)

(6) Assembly and distribution of chilled food must maintain food temperature below 40°F.(4.5°C.) Chilled food is stored in refrigerated serving tables or containers and low room temperature control throughout the meal assembly process. Distribution of the cooked, chilled food is in either refrigerated transport or insulated containers to maintain temperature between 32°F.(0°C.) and 37°F.(3°C.)

(7) Meal service is either at the site of production or at satellite kitchens. Reheating is carried out, within two hours after removal of the chilled food from refrigerated storage. The reheating process must be adequate for the purposes of both palatability and safety. The chilled food should be reheated and held above 158°F.(70°C.) immediately after removal from chilled storage and eaten within two hours. Reheating methods include convection, infrared, microwave and conduction.

Development of Cook-Chill Foodservice Systems

As early as 1963, Cook-Chill Systems used a heat treatment after the cooked food product was packaged and prior to the chilling process(1,39,41). With the development of food technology, refrigerated food was not subjected to heat treatment, but was chilled to 37°F.(3°C.) and stored at that temperature. Cook-Chill concept with central kitchen production in schools and hospitals was increasing rapidly throughout the United States in the 1970s(42).

Nacka Foodservice System

The Nacka System, a Cook-Chill Foodservice System, was developed in 1963 for the Nacka Hospital in Stockholm, Sweden(1). Food was cooked by frying, boiling, roasting or other conventional methods to a temperature of at least 176°F.(80°C.) in all parts of the food. Hot foods were transferred to plastic bags, five portions per bag, the air was extracted from the bags, and the bags were sealed. The sealed bag was then placed in boiling water (212°F., 100°C.) for three minutes; this step was referred to as the pasteurization process. Next, the sealed bag of cooked food was cooled through a cooling tunnel with running water (at 50°F., 10°C.) and later 37°F.(3°C.) After quick drying, the package was stored in a refrigerated room at a temperature of 37°F.(3°C.) up to three weeks. When food was ready for service, the sealed bags were placed in boiling water for 30 minutes and then the bags were opened and the contents served.

Based on results, the Nacka System produced a satisfactory product from the bacteriological hygienic point of view and taste studies. Fourteen persons prepared, packaged and stored 7500 food portions per day. Production was carried out five days a week and the staff worked 43 hours per week. Although the cost of the kitchen at Nacka Hospital rose from 1 million to 1.2 million kroner(increased 20%), the production of food portions increased from 1,200 to 7,500 per day(increased 525%), and in addition to the hospital at Nacka, the prepared foods were delivered in refrigerated vans to ten hospitals out of Stockholm(1). Extensions and variations of the Nacka System were used in Germany, Holland, and Switzerland(42).

A.G.S. Food System

The first modification of the Nacka System(1) in the United States was reported by McGuckian(39) in 1969. The A.G.S. System in South Carolina was named after the three hospitals-- Anderson, Greenville, and Spartansburg-- that participated in the pilot study(39). Some variations from the Nacka System were developed for the A.G.S. System. Partially cooked or raw ingredients were placed in pouches, vacuum-sealed, and the cooking of food was completed within the pouch in a temperature controlled hot water bath. Prepared products were quick chilled in an ice water tank and then stored in a walk-in freezer at 28° to 32°F.(-2° to 0°C.) for a shelf life at least sixty days. Cool chilled food was distributed to satellite facilities in covered plastic containers which were surrounded by crushed ice. Before the food was served, the sealed pouches were placed in a hot water bath for 20-40 minutes until food reached an internal temperature of 160°F.(71°C.). When the meal was placed on a plate, the portioned food was heated in a microwave oven for 10-20 seconds before serving.

According to McGuckian(39), the A.G.S. System resulted in increased productivity of foodservice employees, lower food and labor costs, improved working conditions, and high patient acceptance of the food. He suggested that, in addition to hospital feeding, the A.G.S. System could also be applicable to other mass feeding media such as schools, colleges, military bases, institutions and hotels and restaurants.

The University of Wisconsin Hospitals

One of the first hospital uses of the Cook-Chill Foodservice Systems was reported in 1972 by Kaud(41). The system of the University of Wisconsin Hospitals implemented the cooked chilled food concept for on-site production of food. The food products were prepared, chilled in bulk, portioned, stored chilled, and then reheated in microwave ovens, as needed, in patient areas.

Transition to a chilled food concept has increased productivity and reduced labor requirements at the University of Wisconsin Hospitals. The number of foodservice employees was reduced by 44 full-time equivalent(FTE) positions, while the number of patient meals produced per labor-hour increased from 1.85 in October 1970 to 2.16(16.8%) in January 1972(41).

Trends of Cook-Chill Foodservice Systems

Since Cook-Chill Foodservice Systems were first installed in the 1960s(1), Cook-Chill Systems could be economically feasible for many large-scale operations(6). With enchanced food technology development, Cook-Chill Systems can be a method to decrease operating expense for kitchens. The Cook-Chill Foodservice System has been adapted for school meal production, luncheon clubs, banqueting, conference catering, commercial feeding, hospital foodservice, industrial foodservice, vended meals and the preparation of in-flight meals for aviation foodservice(35).

A survey by Franzese(43) of foodservice directors of 79 general, short-term care hospitals in New York City in 1979 provided data on characteristics of foodservice systems. Results indicated that 19% of the hospitals had centralized, chilled-food assembly systems and the remainder had centralized(75%) or decentralized(6%) conventional foodservice systems.

In a follow-up study to a 1979 survey, Franzese(44) updated the 1977 study by surveying 66 of the New York City hospital foodservice directors in 1983. Results indicated that 14% were Cook-Chill Systems, and 86% were conventional systems. Results indicated that over the four-year period, there had been a decrease in the number of hospital using a centralized and chilled-food assembly system and an increase in the number using centralized, conventional assembly system. The survey results identified that hospitals which changed from the chilled food system back to a conventional hot system did so to increase the quality of patient food, decrease energy consumption, and resolve some of the rethermalization problems.

Greathouse and Gregoire(45) reported a survey of foodservice directors of 807 general, medical-surgical short-term care hospitals with 300 or more total facility beds in 1988 in the continental United States. Results indicated that conventional foodservice systems were found in 81%, Cook-Chill in 10%, cook-freeze in 2%, convenience in 3%, and combination of two or three of above systems in 4%. The data showed that Cook-Chill Systems were first installed in the 1960s(1.5%); their use has continued to increase to 1988(10%)(45).

There has been a rapid rise in interest in cook-chilled foods in the 1980s in England and the number of Cook-Chill Foodservice establishments has also risen quickly and continues to rise(35). Mieh(35) estimated that Cook-Chill was used currently in three hundred different foodservice situations in England in 1987.

Facility Layout and Equipment Selection of Cook-Chill Foodservice Systems

Generally, the kitchen will operate to the highest standards of normal conventional cooking while using a Cook-Chill Foodservice system. The only difference will be in the facility layout between

Cook-Chill Systems and conventional systems. Large batch production units will be used, with the necessary electrical and performance specifications to meet the increased demand placed upon them(36).

In the Cook-Chill Systems, the equipment and design requirements for production, distribution and service units like the conventional system, will vary according to the menu, operation's size, and the specific manufacturer's approach to system installation. In the 1980s in both conventional and Cook-Chill systems the trend is to use multi-purpose equipment for large batch production in order to increase utilization and efficiency, such as forced convection ovens, steam ovens, tilting kettles, boilers, and deep fat fryers(36,46).

Packaging, chilling, storage and rethermalization equipment needed for Cook-Chill systems are different from the conventional production systems. This equipment varies according to menu, service unit and the specific manufacturer's approach to system installization. The following section will describe the equipment of packing, chilling, storage and rethermalization in Cook-Chill Foodservice Systems.

Packaging Equipment

The size, depth, and material of the food containers are governed by the volume of food chilling, storage, transport and rethermalization requirements. There are two types of containers. One, a reusable container is made of heavy gauge stainless steel, aluminium or ceramic material. For appearance, handling or costs concerns, these reusable containers are ideal for banquets, schools, and hospital meals, etc. The other, a disposable container, is made of aluminium foil or paper plastic laminate in which food can be cooked, chilled, stored, transported and reheated. These containers are available in a wide range of sizes, which eliminate ware washing and reduce handling to a minimum(36).

Rapid Chilling Equipment

Two different rapid chill systems have been developed. Blast chillers and tumbler chillers are the options, and both have advantages and limitations(6). Those chillers need skilled maintenance people for periodical maintenance.

Blast chillers look like small walk-in refrigerators with high-tech control panels. Cooked food is portioned, weighed for density to determine the chilling time, loaded onto racks, and then blasted with high speed cold air (carbon dioxide or nitrogen gas) designed to extract heat from the product in less than 90 minutes. A maximum of a two-inch depth of product for proper chilling may be considered a limitation by some operations. Automatic controls are designed to allow the blast chiller to complete the chilling of the last batch of cooked food and then alter the temperature to hold the food at the cold store temperature at 32°F.(0°C.)(6,36).

Tumbler chillers are designed to cool the cooked product in approximately 30 minutes from 190°F.(88°C.) to 40°F.(4.5°C.) using recirculating ice water at 32°F.(0°C.) Tumbler chiller operations are highly automated and designed for a total Cook-Chill System. This system includes steam-jacketed agitator kettles, pump/filler stations, packaging and labeling apparatus, conveyors, and tumbler chiller/cook tanks. These sophisticated systems are extremely labor efficient because there is very little direct handling of the food by people during the process. The tumbler chiller works best with liquid or viscous products such as sauces, soups, stews or pureed or creamed vegetables(6).

Cool Storage Equipment

After chilling, the cold cooked food is loaded in a trolley(portable shelving) which is removed from the blast chiller and transferred straight into the chill storage. The kitchen needs a refrigerated storage room for cooked chilled food inventory, which may be in addition to a conventional system. The temperature of chill storage is 35°F.(2°C.) to 40°F.(4°C.) to accommodate all types of cooked products(36).

Rethermalization Equipment

Basically, there are five methods of rethermalization available; convection, infrared, microwave, contact plate, and integral heat. Some Cook-Chill Systems provide a combination of these methods. Heating in bulk, individual portions or total meal trays certainly influences the decision, in addition to the menu mix, type of meal service and other organizational characteristics unique to the particular operation(10,24,36,47). Description of the five methods of rethermalization is:

(1) Convection ovens: Convection ovens spread heat by the movement of air , steam, or liquid, and may be either natural or forced(10). Convection ovens, although primarily used for prime cooking the

production unit, can also be successfully used for rethermalization(36).

(2) Infrared ovens: The principle of infrared ovens is transfer of infrared to heat energy when infrared enters the food being cooked(10). Infrared cabinets are designed specifically for reheating cooked, chilled meals. Thermal infrared cabinets are mobile and are available in varying sizes for all types of rethermalization(36).

(3) Microwave ovens: Microwave is one type of radiation used in food heating(10). Microwave ovens can reheat individual and small numbers of chilled food portions. These are particularly useful for night shift meal service organization or delayed meals such as hospital or catering(36).

(4) Contact plates: Rethermalization carts or cabinets use contact plates(heating plates) as conductors which transfer heat to food. These heating plates make direct contact with hot food compartments of tray, and heat cooked food. These cabinets are mobile and can be switched to heating after they are delivered to a roll-in refrigerator near the service areas. Both heating and refrigeration apparatus let hot food remain hot and cold food stay cold(47,48).

(5) Integral heat : The basic principle employed is that the resistant coating is applied to the bottom surface of the plate involved that changes electrical energy to heat. Each plate involved is individually thermostatically controlled. Carts of integral heat system can hold chilled cooked food under refrigeration until meal

service time, be plugged into the power supply and reheat the chilled cooked food(49).

Planning and Implementation of a Cook-Chill Foodservice System

The planning process for a new Cook-Chill Foodservice System, like other systems, begins with a menu either in designing new or remodeling systems. The menu is used in determining the design and layout of the kitchen, and its equipment. Recipes are developed, tested and standardized for the product flow of Cook-Chill Foodservice Systems, such as time and temperature of cooking, chilling, storage, assembly and reheating(50).

Job descriptions, work schedules, and production schedules need to be developed. Orientation and training personnel to know the Cook-Chill System and to use specialized equipment continue as personnel are kept informed of the progress made in the planning and construction status. Discussion of the many aspects of the system in small group meetings and on the job training will improve employees acceptance(41,50). Training should include special emphasis on the subject of food hygiene, since hygiene standards need to be the highest order so that the risk of contamination after cooking and during portioning, storage, and assembly is kept to a minimum(35).

In remodeling, the last phase prior to implementation for the new foodservice system, there should be a gradual phasing out of the old production system and phasing into the new. If the Cook-Chill System is relocated in a new area, production should be moved to a new area with some new equipment in the surroundings. Some of the existing production equipment may be transferred; therefore, convenience foods and disposable serviceware can be used during the transfer(41). Other effort is directed toward preparing all foodservice and non-foodservice employees, customers and the general public of the change in the foodservice system. Local newspaper, television coverage, and a slide presentation for explanation of the entire system could help the implementation of the Cook-Chill Foodservice Systems(41,50).

Food Quality Characteristics in Cook-Chill Foodservice Systems

Quality of meals is a primary objective of the foodservice industry(10). Bobeng and David(32) defined quality as an overall characteristic encompassing microbiologic, nutritional, and sensory attributes of food. They(32) noted that for the extended time period between initial preparation of food in Cook-Chill Systems and consumption of final product, the Cook-Chill System must be operated properly in order to prevent potentional microbiological risk and nutrient losses(51). The following are reports of data available relating to food quality from time-temperature relationships and microbiological, nutritional, and sensory studies in Cook-Chill Foodservice Systems.

Time-temperature Relationships

Time-temperature histories are records of time and internal temperature of the menu item in the various phases of product flow. The time-temperature checks begin with receipt of food ingredients and end with the service of food to customers(17). Time-temperature histories have assisted the manager in identifying critical stages of food handling where monitoring techniques should be carried out to assure quality(42). In 1978, Bobeng and David(32) established time-temperature guides for entrees in Hazard Analysis Critical Control Point (HACCP) Models for hospital foodservice systems(See Appendix A, page 87). These internal temperature guides were designed to minimize the time that the entrees were in the zone of growth(40°F. to 140°F.) for microorganisms in food. Nine critical control points identified in entree production in a Cook-Chill Hospital Foodservice System were procurement, preparation, heating, chilling, chilled storage, portioning and assembly, chilled holding and distribution, microwave rethermalization, and service(32).

A time-temperature study made in 1983(52) under Cook-Chill Systems emphasized the need for effective management of all stages of product flow including recognition of potential problems which may occur. The temperature study was made during meal assembly, distribution and service in a Cook-Chill Hospital Foodservice department. The results showed that one menu item (5.6%) of the 18 chilled entrees at meal assembly, eleven(11.8%) of 93 menu items after distribution in unrefrigerated meal delivery carts to patient units, and fifteen(37.5%) of 40 menu items reheated in microwave ovens met the HACCP internal temperature guides(52).

Rollin and Matthews(53) and Cremer and Chipley(17) suggested that special equipment is needed to rapidly chill hot entrees to 37°F.(3°C.) or less without adversely affecting food quality. Rollin and Matthews(53) in 1977 collected temperature data of cooked entrees during the chilling process under actual operating conditions in a school Cook-Chill Foodservice System and in laboratory experiments. The data indicated that it was not possible to chill cooked entrees to 45°F.(7°C.) or below within four hours when entrees were stored in walk-in refrigerators(53). Cremer and Chipley(17) reported average internal temperature of roast beef was 47°F.(8.2°C.), after a 15hr-chilling storage in walk-in refrigerators in a hospital Cook-Chill System. Both temperature study records indicated that reheated foods were in the danger zone.

Bobeng and David(32) suggested 165°F.(74°C.) to 170°F.(77°C.) for microwave reheating in HACCP models in Cook-Chill Systems. Dahl and Matthews(54) showed internal temperatures of beef loaves were an inconsistent temperature after microwave heating. A minimum of 80 seconds allowed a safe temperature(ranged from 140°F. to 207°F.) to be reached. Dahl and Matthews(54) reported that when internal end temperature of food after microwave heating met HACCP recommendations, visual observation indicated that the sensory quality of beef loaf had deteriorated greatly after 80 seconds.

Sawyer et al.(22) in 1983 reported end-point temperatures of beef loaves, peas and potatoes after reheating by conduction, convection and microwave. When only mean values were considered, all products processed in all reheat subsystems met HACCP guidelines for time and temperature(90 seconds, 165°F. to 170°F.) except for potatoes reheated by convection. Although the mean temperature of reheated beef loaf 165°F.(74.5°C.) by conduction met HACCP guidelines(32) and Food and Drug Administration(FDA) guidelines(See Appendix B, page 88)(55), 31% of portions did not achieve HACCP or FDA guidelines, and thus were not in compliance. Ten(53%) of the 19 portions of beef loaf individually reheated by convection did not achieve HACCP or FDA guidelines. Beef loaf reheated by microwave radiation resulted in a product which more closely met HACCP and FDA guidelines for temperature of food at point of service, 4% were below those guidelines in this study.

Microbiological Tests

Supplying safe foods for customers is an objective of a foodservice system. Microbiological tests are used to evaluate the sanitary quality of foods. The extended time period between initial preparation of food in Cook-Chill Systems and consumption of the final food product provides many opportunities for food temperature to fluctuate into the danger zone in which microorganisms have rapid growth(42).

Tuomi et al.(56) simulated the practice of handling precooked chilled beef gravy in school kitchens in Finland to determine if they could contribute to outbreaks of foodborne illness. None of the samples of gravy yielded *Clostridium perfringens* bacteria which can cause foodborne illness. Coagulase-positive *Staphylococcus* bacteria were found in some samples but numbers changed little during holding or heating. The greatest increase in numbers of total aerobic bacteria in gravy occurred during the cooling period rather than the holding period. The importance of rapid cooling of cooked food was emphasized.

Bunch et al.(12) investigated the acceptability and microbiological characteristics of beef-soy loaves in hospital Cook-Chill Foodservice System. Samples removed from loaves after chilled storage for 24, 48, or 72 hours showed that the largest increase in aerobic bacteria occurred during cooling; the greatest increase in numbers of bacteria occurred when holding was 72 hours. Bunch et al.(12) also mentioned the final heating treatment decreased the numbers of aerobic bacteria, but was not sufficient to kill all viable bacteria in the center of any of the portions of beef-soy loaves.

Bobeng and David(16) took the aerobic plate counts of beef loaves produced in three simulated hospital foodservice systems(conventional, cook-chill and cook-freeze) at control points. The result showed the aerobic plate count value of Cook-Chill System was similar to the other two systems and indicated excellent microbiologic quality.

Cremer and Chipley(13,17) conducted a microbiological research of spaghetti and chili in a School Cook-Chill Foodservice System in 1977 and a microbiological assessment of roast beef in a hospital foodservice system in 1980. Results of total aerobic plate counts of the spaghetti, chili and roast beef indicated that the microbial quality of products was good and safe in the whole process of these two systems. After cooking roast beef, the total microbial population was reduced greatly, but increases occurred in following storage, assembly, and before reheating for service after transport and storage of meals in the galleys. These increases are logically explained by the relatively long storage times at temperatures conducive to microbial growth. Following reheating for service, there was reduction again in the microbial population(13,17).

Sawyer et al.(22) showed the aerobic plate counts of beef loaf, peas, and potatoes were in acceptable and safe microbiological range to met Skylab guideline(11) at point of service regardless of whether conduction, convection or microwave reheat subsystems were used. Even though statistical differences were not significant for aerobic plate counts in beef loaf, peas or potatoes reheated by the subsystems, of the three subsytems, conduction heating resulted in the largest numerical decrease in aerobic plate counts while convection reheating resulted in the smallest numerical decrease.

In another experiment by Bunch et al.(14) *Staphylococcus aureus* bacteria, which produce toxin which can cause foodborne illness, was inoculated into uncooked mixtures of ground beef and soy protein loaves and the survival of the organism was determined during the stages of food handling that would occur in a hospital Cook-Chill Foodservice System. Numbers of *Staphylococcus aureus* in ground beef loaves decreased during holding at 41°F.(5°C.) for 24, 48, and 72 hours. Numbers of *Staphylococcus aureus* in the center of the final product also decreased after loaves were portioned, held chilled at 41°F.(5°C.) for two hours and heated to 176°F.(80°C.) in a microwave oven. Although there were few, if any, *Staphylococcus aureus* present after heating in the microwave oven, preformed toxin, if present, would not be inactivated by any reheating procedure. Hence, products in Cook-Chill Foodservice Systems must be handled with care during all phases of the operation to prevent excessive microbial contamination and to minimize growth of contaminants that might be in the food.

Nutrient Loss Studies

The data available on nutrient loss in Cook-Chill Foodservice Systems are limited. Bobengand and David(16) in 1976 found that the thiamin retention in baked beef loaves cooked conventionally to be 62.5%, for Cook-Chill 62.5% and for cook-freeze 75%. Hence, thiamin losses in Cook-Chill Foodservice Systems compared with other systems appear to be relatively similar. Bognar(18) in a 1980 study concluded that thiamin, riboflavin, retinol, ß-carotene and essential amino acid contents of reheated chilled meals were similar to the comparable cook-freeze system and cooked-and-sterilized meals which had been industrially produced. In the same study Bognar(18) indicated that the ascorbic acid content of chilled vegetable and potato products as compared to freshly prepared dishes was lower by 30-90%, depending on the kind of meal producer and storage days. As compared to deep-frozen and sterilized meals, the differences on an average were negligible. Hunt (57) reviewed literature and reported that Cook-Chill Foodservice Systems, properly operated, do not appear to involve large losses compared with freshly cooked food except for ascorbic acid in cooked meals.

Comparing with conventional systems, the processing phases of chilling, storage and reheating in Cook-Chill Systems may be additional processes to influence the nutrient retention. Bognar(18) indicated that chilling time influenced the vitamin retention. For vitamin retention, the chilling time required for a decrease of the internal temperature from 176°F.(80°C.) down to 59°F.(15°C.) was found to be of primary importance. The ascorbic acid content fell in five model dishes by 1-12% in a chilling time of 0.5 hour, by 2-17% of 2 hours, and by 10-38% when 5 hours were required for chilling. In the chilling range of 59°F.(15°C.) to 35°F.(2°C.), however, losses increased only by 2-6% despite much longer chilling times.

For the storage phase between 32°F.(0°C.) and 41°F.(5°C.), Makings and Cooper(15) showed that after 72 hours, ascorbic acid in white cabbage, cauliflower and peas decreased by 59%, 37% and 25%, respectively, compared with freshly cooked. Nicholanco and Matthews(58) in 1978 reported 63.6% and 72.7% loss of thiamin in the beef stew after cooking and 27 hours' chilled storage. Bognar(18) indicated that according to a simplified regression equation, ascorbic acid loss in chilled meals ranged from 3.3-16% per day of cool storage, depending on the kind of meal. Bognar(18) proposed that if during storage the tolerable loss was a maximum 25% in ascorbic acid and maximum 10% in thiamin and riboflavin, storage times of 3 to 4 days were acceptable from the nutritional point of view.

Reheating food in Cook-Chill Foodservice Systems has been shown to cause loss of thiamin and ascorbic acid. Bobeng and David (16) in 1978, studied the nutrient losses of beef loaf, and reported a 12.5% loss in thiamin due to 90 seconds of microwave reheating. Dahl and

Matthews(54) determined that beef loaf prepared in a simulated Cook-Chill Foodservice System and reheated by microwave 20, 50, 80 or 110 seconds lost 5-10% of its original thiamin content. Bognar(18) in 1980 reported that the ascorbic acid of chilled meals was clearly decreased by reheating. Depending on the kind of food, the loss was 23-49%. Dahl-Sawyer et al.(59) in 1982 studied the retention of ascorbic acid of beef loaf, peas and potatoes in simulated hospital Cook-Chill Foodservice System. There was no significant difference in nutrient retention of experimental products due to conduction, convection and microwave reheating methods.

Sensory Survey and Evaluation

Besides economic, microbiological and nutritional aspects, the sensory quality of food is of essential importance in a foodservice system(10,60). Zacharias(19) determined that after one day's storage at 35.8°F.(2°C.), 60% of chilled meals were of very good to good quality and 38% of satisfactory quality. Cremer and Chipley(17) indicated that sensory evaluations of roast beef were generally good, achieving a score of "7" on a 9-point scale used for evaluation in a Cook-Chill Hospital Foodservice System.

Owing to autoxidation and two heat treatments for Cook-Chill and cook-freeze storage samples, Bobeng and David(16) indicated that scores for overall acceptability of beef loaves in the conventional system were significantly greater than for those of the Cook-Chill and cook-freeze systems in using the HACCP model. On the other hand, Rini et al.(20)

showed that no significant difference in either general acceptability or any other characteristic scores was found between the beef loaf held for one hour without prior chilling and that chilled for 24 hours, heated, and then held in insulated trays for one hour. Rini et al.(20) indicated that chilled holding appeared to have less influence on general acceptability of meat loaf than time for holding heated loaf.

Reheating, one of the quality control points in HACCP models(32), is the last process to determine the quality of serving food in the Cook-Chill Foodservice System. Sawyer(60) studied sensory evaluation of cook-chilled products reheated by conduction, convection and microwave oven in a simulated Cook-Chill Hospital Foodservice System. The study showed that best food temperature control was obtained after microwave reheating, but panelists rated the food prepared in the conduction subsystem highest for sensory quality(60). Sawyer(60) indicated that under full load conditions, conduction reheat was recommended to optimize visual appeal and other sensory qualities of meals served in Cook-Chill Hospital Foodservice Systems.

Cost Effects in the Cook-Chill Foodservice Systems

Besides the quality of food, the cost effects need to be considered in the management of foodservice systems. Herz and Sounder(23) in 1979 reported that Cook-Chill Foodservice Systems were more economical than conventional and convenience systems, but less economical than cook-freeze systems in a cost effect study of 100 to 550-bed army hospital foodservices. The results of this study in 100-bed hospitals showed that the annual cost per meal of Cook-Chill Systems($3.17) was smaller than conventional($3.29) and convenience($3.38) systems, but larger than cook-freeze systems($3.11). The total operating costs of Cook-Chill Systems were less than conventional and convenience systems and more than cook-freeze systems. On the contrast, the total capital costs of Cook-Chill Systems were more than conventional and convenience systems, and less than cook-freeze systems. Herz and Sounder(23) supposed that the capital-intensive cost of Cook-Chill and cook-freeze systems would have the lowest rates of increase because of their dependence on major cost elements-capital costs that were anticipated to be least affected by inflation.

Mieh(35) in 1986 indicated that Cook-Chill Foodservice Systems were more cost effective than conventional foodservice systems. He described the savings that were possible in the following areas: using the skilled staff, better scheduling of staff and equipment of production, bulk buying, and reducing energy consumption.

Pizzuto and Winslow(24) in 1989 indicated that Cook-Chill Systems saved money in terms of total system cost. Capital costs were approximately 15% to 20% higher than a conventional system due to equipment requirements. Operating costs were approximately 10% to 15% lower overall due to large amount of purchase, improved waste controls and decreased labor costs with cook-chill foodservice systems.

Labor and food costs of Cook-Chill System were high in a comparsion of conventional, Cook-Chill, and cook-freeze foodservice systems reported by Greathouse et al.(25) The results indicated that the Cook-Chill System had the highest, though not statistically significant, expenditure for salaries and total cost. They also reported that the Cook-Chill system had significant higher food costs, but this finding was somewhat puzzling.

Advantages in the Use of Cook-Chill Foodservice Systems

There are several advantages in the use of Cook-Chill Foodservice Systems application. The greatest advantages are productivity improvements and cost reduction in the following studies(6,23,35,50). Other advantages are more debatable and depend on what previous system the Cook-Chill System was compared with(35). The following paragraphs will describe those advantages of Cook-Chill Foodservice Systems.

High productivity is due to better utilization of equipment and labor in Cook-Chill production(6). All meals are prepared in advance of requirements and production can be scheduled for the best use of equipment, space, and staff. Production staff can concentrate on specific tasks with little or no peak mealtime tension(6,35). Similar products can be prepared together and the work load is evenly distributed through the day(3). Kaud(41) reported that the productivity of University of Wisconsin Hospitals increased in using Cook-Chill Foodservice Systems. The number of patient meals produced per labor-hour increased 16.8% during sixteen months.

Labor cost can be reduced significantly(23,24). Less skilled labor was needed for rethermalization and service. The requirement for skilled personnel was reduced. Lake Hospital System(31) in northeastern Ohio has been able to pare the staff down from six cooks to two by selecting a Cook-Chill System. Many Cook-Chill operations converted to a five-day with no weekend production schedule, where labor savings of 40% were possible(6). Pizzuto and Winslow(24) indicated that the overall labor costs with the Cook-Chill Systems can be 10% to 15% lower than cook-serve.

Food costs were lower which were based on bulk buying through central purchasing(6,35). Reduction of kitchen waste through centralized control over preparation and storage conditions was also a benefit of Cook-Chill Systems(6). For example, per-meal food cost, which was $1.10 in 1983, was $0.97 in 1987 in Essex County Hospital Center, New Jersey(29).

Mieh(35) indicated that it was possible to make savings by reducing energy consumption by careful design and planning. Reduced energy consumption through more efficient use of production equipment and storage refrigeration is common with conversion to Cook-Chill. If Cook-Chill were compared with cook-freeze, the absence of the need to thaw food prior to reheating could further save energy and time(6,23,26,35). Batch production during a five-day, 40-hour week production schedule means that energy intensive equipment was turned off two days a week(6). Thomas and Brown(61) did research on electricity usage in Cook-Chill/freeze production system in a 500-bed hospital in 1983 and showed that the amount of electricity needed for processes specific to the Cook-Chill/freeze system was minimal. Chilling, freezing, holding under refrigeration, and reheating food used a mean of 860.3 kwh of electricity per day, or 0.74 kwh of electricity per tray delivered to the service galleys. At $0.05 per kwh in 1983, the cost was $43.01 per day or $0.037 per tray(61).

Other advantages of Cook-Chill Foodservice Systems were reported(3,4,6,24,35,57). Cook-Chill Foodservice Systems allow for a smooth work flow, no crisis peaks at meal times and improvement in working conditions for employees compared with conventional foodservice systems. Those results that more individuals may be attracted to the foodservice industry(3,35). Foods can be served at their proper temperature more easily than in conventional foodservice systems and hot foods maintained hot and cold foods cold(3,24). Foods are produced in uniformly controlled batches, therefore, the quality was more consistent(6,24). Nutritional value can be potentially better than food produced conventionally and held hot for long periods of time prior to service(57). The Cook-Chill Foodservice System itself was also flexible. Short-term staff shortages due to holidays or illness do not precipitate immediate crises. Also because the system employs many conventional cooking methods up to the chill operation, staff mobility from the conventional kitchen was not affected(35).

Disadvantages in the Use of Cook-Chill Foodservice Systems

There are some disadvantages in the use of a Cook-Chill Foodservice System. The capital cost of equipment and alterations to buildings is high and a major disadvantage of the system(35). Installing a Cook-Chill System demands additional effort in management and supervisory staff, such as menu design, food quality control, food safety and staff training.

Menu planning must take account of the quality of different prepared foods. For example, eggs, toast, some thickening agents and fried foods are not suitable for Cook-Chill Systems, because the quality does not hold up well in the process of cooking, chilling and rethermalization(31,35). Foods with a high fat content may oxidize quickly with a resulting change in sensory quality with off-flavor during chill storage(35,51). Due to twice heating and a period of storage, cooked foods are not served as fresh as those of fresh cooked, and quality and safety controls that include time-temperature and microbiological audits must be very precise(3,17,47,52). Because of large losses of ascorbic acid, menu design to supplement a Cook-Chill meal with fruit juice, raw vegetable and/or use fortified fruit or vegetable products such as mashed potato might be considered(57) .

Foodservice staff who have been used to working in conventional kitchens may at first show reluctance to adapt to new production systems(35,50). Additional training was required to prepare staff to use the new equipment and introduce the new concepts involved in operating the Cook-Chill Systems. In some organizations, there may be labor union opposition to a scheme which cuts staffing cost by reducing the working hours or changing the working position of some employees(35).

METHODOLOGY

A survey research design was selected and a survey instrument mailed nationwide to collect current information regarding the foodservice manager's perception of the facility's Cook-Chill Foodservice Systems. The questionnaire was designed to provide qualitative data such as perceived meal quality, quantity control, personnel satisfaction, cost effects, advantages, disadvantages, and decision making factors. A Likert 5-point scale(62,63) was used to assess Cook-Chill Foodservice Systems. The quantitative data included meal, food and labor costs. Demographic characteristics were used to create a profile of facilities of Cook-Chill Foodservice Systems and a profile of managers.

Research Design

Survey Questionnaire

A survey questionnaire(Appendix C, page 89) which was used to collect perceptive information of Cook-Chill Foodservice Systems was developed based on Dillman's(64) survey methodology. The questionnaire consisted of two parts (1) to identify the manager's perceived evaluation of Cook-Chill Foodservice Systems and (2) to obtain demographic data about the facility of Cook-Chill Foodservice Systems and respondents. The majority of the questions were close-ended with established response. However, one or two questions were open-ended to allow managers to contribute the factors of decision making in the selection of Cook-Chill

Foodservice Systems.

Survey questions were developed based on professional knowledge and experience of three experts in the areas of food system management. Questions in the first part addressed the following perceived information and quantitative data of Cook-Chill Foodservice Systems:

1. Prior system---identified as conventional, cook-freeze, convenience food or combination of two or three of above foodservice systems
2. Meal quality---included serving temperature, sensory evaluation, microbiological control, and nutrient retention
3. Quantity control---production quantity control
4. Cost effects---included food cost, labor cost, energy cost, equipment cost, annual meal cost, and the number of full-time equivalents(FTEs)
5. Personnel satisfaction---includes manager, employee, and customer satisfaction
6. Advantages and disadvantages of Cook-Chill Foodservice Systems
7. Decision making factors

Questions in the second part were demographic questions regarding the facilities of Cook-Chill Foodservice Systems and professional profiles of the respondents:

1. Installation year of Cook-Chill Foodservice Systems
2. Types of establishment(commercial or noncommercial feeding)
3. Funding sources of organization

4. Type of building construction(new or remodeling) for the Cook-Chill Foodservice Systems
5. Type of production flow
6. Meal times per day
7. Total volume of meals per day
8. Type of chilling equipment of Cook-Chill Foodservice Systems
9. Reheating method of menu items
10. Numbers of years of manager's management experience in Cook-Chill Foodservice Systems
11. Manager's responsibility for decision making for using Cook-Chill Foodservice Systems
12. Manager's responsibility for design or implementation Cook-Chill Foodservice Systems

In addition to the survey, cover letters and postcard follow-up communication(Appendix D, page 93 to 96) utilizing the survey construction methods of Dillman(64) were included to briefly describe the purpose of the research, directions for completing the questionnaire and importance of the study. The questionnaires were coded for follow-up purposes only and participants were assured confidentiality.

Pilot Study

A pilot study was conducted to test the survey questionnaire for accuracy, ease of completing and format and content clarity. The survey questionnaire, Appendix C, page 89, was sent to four food management professionals. Participants was asked to evaluate the survey questionnaire and give suggestions on format and content. The pilot study participants were not included of the actual study.

Population Description

The sample population to receive the survey were the managers of the Cook-Chill Foodservice Systems in the foodservice industry. There is no identified listing of facilities with Cook-Chill Foodservice Systems in the United States. Therefore, the facilities were very difficult to identify. Five foodservice equipment companies and two foodservice consultants provided the names of foodservice facilities using Cook-Chill Systems. Consultation with Oregon State University statistical staff determined that the population included all Cook-Chill facilities that were identified, N=134. This was considered to be nonprobability sampling(65). Foodservice facilities across the nation were included. The population included foodservice managers of hospitals, nursing homes, schools, universities, correctional centers, county programs, in-flight kitchens, contractors, restaurants, and retail food markets .

Instrument Administration

Four separate mailings were conducted in an effort to achieve the greatest possible return rate. The mailings and follow-up techniques were as follows:

Mailing	Number	Date
1. Original cover letter and questionnaire (Appendix D, page 93 and Appendix C, page 89)	134	March 13, 1990
2. Postcard follow-up (Appendix D, page 94)	134	March 20, 1990
3. Second cover letter and questionnaire (nonrespondents only) (Appendix D, page 95)	82	April 5, 1990
4. Third cover letter and questionnaire (nonrespondents only) (Appendix D, page 96)	50	April 19, 1990

The first mailing consisted of the questionnaire and original cover letter to all participants. One week after the first mailing, a reminder postcard was sent to all participants. Revised cover letter and the original questionnaire were mailed to all non-respondents the fourth and sixth week following to achieve the highest possible return rate(64).

Statistical Analysis

Several comparisons were made. The statistical staff of Oregon State University suggested that descriptive statistics which included the frequencies, percentages, and means of Likert 5-point scale(62,63) be used to describe the data. The computer software program, Statistical analysis System(SAS)(66), was used in the analysis of data. Chi square, student's t, F and correlation tests were done on various responses related to the perceived assessment of Cook-Chill Foodservice System and demographic data for significance at the level of $P \leq .05$. The responses were organized tabulated and included in Appendix E, page 97.

RESULTS AND DISCUSSION

The purpose of this study was to assess Cook-Chill Foodservice Systems from the perception of foodservice managers. A questionnaire (Appendix B, page 96) was mailed nationwide asking for an evaluation of the quality, cost, personnel satisfaction, and advantages and disadvantages of Cook-Chill Foodservice Systems. Recipients included the foodservice managers of hospitals, nursing homes, schools, universities, jails, county programs, contractors, restaurants, and retail food markets.

One hundred thirty-four surveys were mailed to foodservice managers identified as using Cook-Chill Foodservice Systems with 95(71%) valid responses. However, 74(78%) returned surveys were from respondents using Cook-Chill Foodservice Systems and 21(22%) from persons who were not currently using Cook-Chill Foodservice Systems. These seventy-four reponses using Cook-Chill Foodservice Systems were categorized according to foodservice history. Nine(12%) respondents indicated the Cook-Chill Foodservice System was the first foodservice system in their facilities. Sixty-five(88%) had prior systems including conventional system, cook-freeze system, and combinations of conventional, cook-freeze, or convenience food systems before Cook-Chill Foodservice Systems. Data were tabulated and analyzed from the 74 respondents who were currently using Cook-Chill Foodservice Systems. Of 21 not currently using Cook-Chill Foodservice Systems, respondents had used Cook-Chill Systems in the past or used some Cook-Chill

Foodservice Systems equipment, but did not use the whole system.

Manager's Perception of Meal Quality, Quantity Control, and Personnel Satisfaction of Cook-Chill Foodservice Systems

One goal of the survey was to learn how the managers assessed Cook-Chill Foodservice Systems in meal quality, quantity control and personnel satisfaction. Managers' responses were rated on a Likert 5-point scale(62) as very poor-1, poor-2, fair-3, good-4,or excellent-5. The meal quality attributes were serving temperatures, sensory evaluation, microbiological control, and nutrient retention. Personnel satisfaction attributes included customer, employee, and manager satisfaction.

Meal Quality

Serving temperature of cook-chill meals was rated as excellent by 23(35%) respondents and as good by 32(49%), and the mean of Likert 5-point scale was good (4.1)(Table 1, page44); sensory evaluation, 20 percent excellent, 66 percent good, and the mean was good(4.0); microbiological control, 52 percent excellent, 38 percent good , and the mean was good(4.4); and nutrient retention, 25 percent excellent, 64 percent good, and the mean was good(4.1). These overall quality results were reported as good to excellent for the Cook-Chill Foodservice Systems.

Meal quality had a significant difference($P \leq .05$) of comparing the perceptive attributes of the managers in an Analysis of Variance (ANOVA)(67)(Table 2, page 44). Microbiological control had the highest mean(4.4)(good) of the four attributes of meal quality in the result of ANOVA multiple comparison Fisher's Least Significant Difference(LSD) test(67).

Quantity Control

Quantity control was at good to excellent level; 37(52%) managers rated it as good and 22(31%) as excellent. The mean of response was good(4.1)(Table 1, page 44).

Personnel Satisfaction

Customer satisfaction was rated as good by 47(67%) managers and as excellent by 10(14%). The response mean was fair(3.9)(Table 1). Employee satisfaction responses as perceived by managers were 53 percent good, 26 percent excellent, and the mean as good(4.0). In manager satisfaction, 49 percent said good, 36 percent excellent, and the mean was good(4.1). Over 78 percent of the 70 managers reported personnel satisfaction as good to excellent.

Personnel satisfaction differed significantly($P \leq .05$) in comparing the perceptive attributes in an ANOVA analysis(Table 2, page 44). Manager satisfaction was significantly better than the managers' perception of customer and employee satisfaction (ANOVA multiple comparison, Fisher's LSD test).

Table 1. Manager's Perception of Meal Quality, Quantity Control and Personnel Satisfaction for Cook-Chill Foodservice Systems; Percentages and Means of Likert 5-point Scale.

Variables	N	very poor (1) %	poor (2) %	fair (3) %	good (4) %	excel-lent (5) %	Mean± SD of Likert 5-point Scale
		Responses					
Meal quality							
Serving temperature	66	1	4	11	49	35	4.1 ± 0.9
Sensory evaluation	70	1	2	11	66	20	4.0 ± 0.7
Microbiological control	68	0	3	7	38	52	4.4 ± 0.8
Nutrient retention	65	0	0	11	64	25	4.1 ± 0.6
Quantity control	71	1	0	16	52	31	4.1 ± 0.8
Personnel satisfaction							
Customers	70	1	6	12	67	14	3.9 ± 0.8
Employees	70	1	3	17	53	26	4.0 ± 0.8
Managers	70	1	3	11	49	36	4.1 ± 0.8

Table 2. Manager's Perception of Meal Quality and Personnel Satisfaction of Cook-Chill Foodservice Systems; ANOVA Analyses of the Response Means of Likert 5-point Scale.

Meal Quality & Personnel Satisfaction Variable	N	Likert 5-point scale mean	SD	F value	df	significant level
Meal Quality				6.63	71	0.0001*
Serving temperature	66	4.1	0.9	7.74	3	0.0001*
Sensory evaluation	70	4.0	0.7			
Microbiological control	68	4.4	0.8			
Nutrient retention	65	4.1	0.8			
Personnel Satisfaction				10.84	69	0.0001*
Customers	70	3.9	0.8	8.38	2	0.0004*
Employees	70	4.0	0.8			
Managers	70	4.1	0.8			

* Significant at $P \leq .05$

Manager's Perception of Meal Quality, Quantity Control and Personnel Satisfaction in Comparing Cook-Chill Foodservice Systems with Prior Systems

Managers compared Cook-Chill Foodservice Systems with prior foodservice systems. Facilities with prior foodservice systems before Cook-Chill Foodservice Systems(88%) were a majority of the 74 respondents using Cook-Chill Foodservice systems. The meal quality was defined as serving temperature, sensory evaluation, microbiological control and nutrient retention. Personnel satisfaction attributes included customer, employee and manager satisfaction from the manager's perception. Managers rated these attributes as better, equal, worse or don't know(Table 3, page 46).

Meal Quality

In comparing Cook-Chill Foodservice Systems meal quality with prior systems, most respondents rated meal quality as better or equal(Table 3). For example, serving temperature, 32(51%) respondents rated as better, 24(38%) as equal, only 4(6%) as worse. Sensory evaluation, 25(39%) rated as better, 29(5%) as equal, and 9(14%) as worse. Microbiological control and nutrient retention attributes had similar results.

Quantity Control

Quantity control was rated in Cook-Chill Foodservice better than prior systems(Table 3, page 46). Forty-seven(73%) of respondents rated the production quantity control as better and 10(16%) of respondents rated it as equal. Only 5(8%) respondents rated quantity control as worse and 2(3%) as don't know.

Personnel Satisfaction

Customer satisfaction with Cook-Chill Foodservice Systems was reported as better than and equal to prior systems(Table 3). Twenty-three(36%) and 29(45%) managers rated the customer satisfaction as better and equal, and 7(11%) as worse. Twenty-six(41%) and 27(42%) managers rated the employee satisfaction as better and equal, and 6(9%) as worse. Most (78%) managers reported that the Cook-Chill Foodservice System was better than the prior system. Seven(11%) managers rated it as equal, and 6(9%) as worse. Overall, the perceived personnel satisfaction in comparing Cook-Chill with prior systems was between better and equal.

Table 3. Manager's Perception of Meal Quality, Quantity Control and Personnel Satisfaction in Comparing Cook-Chill Foodservice Systems with prior systems; Frequencies and Percentages.

		System Comparing Responses							
Variables	N	better		equal		worse		don't know	
		(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)
Meal quality									
Serving temperature	63	32	51	24	38	4	6	3	5
Sensory evaluation	64	25	39	29	45	9	14	1	2
Microbiological control	64	38	60	13	20	2	3	11	17
Nutrient retention	63	29	46	18	29	1	1	15	24
Quantity control	64	47	73	10	16	5	8	2	3
Personnel satisfaction									
Customers	64	23	36	29	45	7	11	5	8
Employees	64	26	41	27	42	6	9	5	8
Managers	64	50	78	7	11	6	9	1	2

Cost Effects in the Cook-Chill Foodservice Systems

Managers' perception of costs in comparing Cook-Chill Foodservice Systems with prior foodservice systems and current costs were collected. Cost attributes included food, labor, energy, equipment, construction, total cost, as well as annual cost per meal, and the number of full-time equivalents(FTEs). Respondents rated these attributes as decreasing, the same, increasing, or don't know, and cost percentages as decreasing or increasing. The current cost information was the cost of meal, labor, and food.

Comparing Cook-Chill Foodservice System with Prior Systems

The managers' perception of costs in comparing Cook-Chill with prior system is presented in Table 4(page 48). Labor cost(59%) was the category most often seen as decreasing followed by numbers of FTEs(49%) and food cost(40%). Equipment cost(41%) was the category most often seen as increasing followed by construction cost(30%). There were " don't know" responses in each category; energy cost had the highest percentage(57%). Some participants did not answer the cost comparison question, therefore, the size of population varied.

Managers were asked to evaluate costs of Cook-Chill Foodservice systems versus prior systems. Results are given in Table 5(page 48). Few managers(n=1 to 17) shared any cost percentage information. The percentage range was very large; the minimum decreasing labor cost percentage was 3%, the maximum was 50%, the mean was 18% and standard deviation was 11%. The minimum increasing construction cost percentage was 5%, the maximum was 50%, the mean was 32%, and standard deviation was 21%.

Table 4. Manager's Perception of Cost Effects and Cost Change in Comparing Cook-Chill Foodservice Systems with Prior Systems; Percentages.

Cost effect Items	N	Responses(%) Decrease	The same	Increase	Don't know
Labor cost	49	59	25	2	14
FTEs	45	49	16	4	31
Food cost	47	40	28	17	15
Energy cost	49	10	19	14	57
Equipment cost	48	8	19	42	31
Construction cost	47	6	26	30	38
Total cost	46	28	15	17	39
Annual cost per meal	48	31	23	15	31

Table 5. Manager's Perception of Cost Effects in Comparing Cook-Chill Foodservice Systems with Prior Systems; Summary Cost Percentage Decreasing or Increasing

Cost Effect Items	Comparing System Responses(%) Decreasing					Increasing				
	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD
Labor cost	17	3.0	50.0	18.1	11.2	0	-	-	-	-
Food cost	13	4.0	32.8	13.4	7.8	3	3.0	19.0	9.0	8.7
FTEs	11	1.3	60.0	19.2	18.8	0	-	-	-	-
Energy cost	1	5.0	5.0	5.0	0	0	-	-	-	-
Equipment cost	1	20.0	20.0	20.0	0	5	2.0	25.0	13.0	11.4
Construction cost	1	20.0	20.0	20.0	0	4	5.0	50.0	32.5	21.8
Total cost	6	5.0	28.0	14.9	8.3	2	10.0	50.0	30.0	28.3
Annual cost per meal	7	4.0	16.0	12.4	4.6	3	2.0	60.0	32.3	29.1

Current Cost

The current average costs of meal, labor and food per meal is present in Table 6. Because the manager's facilities included many varieties of facility types, such as hospital, schools, correctional centers and restaurants, the ranges of current costs were very large. The average meal cost per meal was from \$1.14 to \$10.70, the mean of those was \$3.86, and standard deviation was \$3.56; the labor cost per meal was from \$0.10 to \$8.40, mean was \$2.42, and standard deviation was \$2.05; and the food cost per meal ranged from \$0.43 to \$ 4.53, mean was \$1.71, and standard deviation was \$1.12. The mean percentage of labor cost by average meal cost was 50%, the standard deviation was 19% and the mean percentage of food cost by average meal cost was 40%, and standard deviation was 13%.

Table 6. Average Meal Cost, Labor Cost, and Food Cost Per Meal in Using Cook-Chill Foodservice Systems.

Cost Items	N	Cost Responses Minimum (\$)	Maximum (\$)	Mean (\$)	SD (\$)
Average meal cost per meal	40	1.14	10.70	3.86	3.56
Labor cost per meal	33	0.10	8.40	2.42	2.05
Food cost per meal	36	0.43	4.53	1.71	1.12

Manager's Perception of Advantages and Disadvantages of Cook-Chill Foodservice Systems

Foodservice managers evaluated ten identified advantage attributes and eight identified disadvantage attributes(Table 7, page 50, and Table 8, page 51). The open-ended question of "other" was used to allow respondents to specify advantages and disadvantages. Response was recorded in yes or no categories.

Perceived advantage, defined as having a response percentage over 75 percent, are presented in Table 7. There were seven perceived advantages of Cook-Chill Foodservice Systems: good working conditions(90%), high productivity(89%), consistent quality food (87%), good quantity control(87%), nutrient retention(86%), labor savings(83%), and safety(76%). Responses which were less frequently perceived were reduced food cost(66%), increased palatability of food(60%), and energy savings(55%). Other advantages mentioned by respondents included good control of ingredient, revenue generation, easier life, less stress, improved contingency planning, employee satisfaction due to scheduling, low maintenance of equipment, and safety of food during long travel and transportation.

Table 7. Advantage Variables of Cook-Chill Foodservice Systems from Respondent's Perception; Frequencies and Percentages.

Advantage Variables	N	Responses			
		Yes		No	
		#	%	#	%
Good working conditions	69	62	90+	7	10
High productivity	71	63	89+	8	11
Consistent quality food	70	61	87+	9	13
Good quantity control	69	60	87+	9	13
Nutrient retention	66	57	86+	9	14
Labor savings	70	58	83+	12	17
Safety	70	53	76+	17	24
Reduced food cost	70	46	66	24	34
Increased palatability of food	68	41	60	27	40
Energy saving	76	36	55	30	45
Others	8	8			

+ meets advantage criterion.

Perceived disadvantages of Cook-Chill Foodservice Systems, defined as having a response percentage over 75 percent, are given in Table 8. High capital cost of equipment(77%) was the only disadvantage meeting this criterion. Responses not meeting the criterion were additional effort for menu, 47%; additional effort for staff training, 40%; high energy cost, 35%; poor food flavor and texture, 19%; increased hazard of food poisoning, 13%; increased food cost, 13%; and nutrient loss, 10%. Other disadvantages mentioned by respondents were increased packaging cost, increased garbage, intensive paper trail system needed, stifled creativity of staff, difficulty in finding qualified service equipment when starting up, limited menu items, cost of disposable supplies and difficult and expensive equipment repair and maintenance.

Table 8. Disadvantage Variables of Cook-Chill Foodservice Systems from Respondent's Perception; Frequencies and Percentages.

Disadvantage Variables	N	Responses			
		Yes		No	
		#	%	#	%
High capital cost of equipment	69	53	77+	16	23
Additional effort for menu design	71	33	47	38	53
Additional effort for staff training	68	27	40	41	60
High energy cost	66	23	35	43	65
Poor food flavor & texture	68	13	19	55	81
Increased food cost	70	9	13	61	87
Increased hazard of food poisoning	69	9	13	60	87
Nutrient loss	67	7	10	60	90
Others	8	8			

+ meets disadvantage criterion.

Manager's Decision Making Factors for the Selection of Cook-Chill Foodservice Systems

Decision making factors to select or not to select the Cook-Chill Foodservice Systems were reported by respondents from the open-ended question. Sixty-two(86%) of the 72 respondents using Cook-Chill Foodservice Systems were willing to choose Cook-Chill Foodservice Systems again and ten(14%) would not.

Factors in favor of selecting Cook-Chill Foodservice Systems had 175 frequencies and 20 factors, presented in Table 9(page 53). The five most common factors cited were labor efficiency and labor savings, 15%; good working conditions, 14%; consistent quality food with good quality control, 13%; safety with better handling of food for storage and transportation to satellite services, 13%; and high productivity with better production planning and control, 11%. Other factors are also presented in Table 9.

Factors against selecting Cook-Chill Foodservice Systems were reported in twenty-five frequencies and fourteen categories(Table 10, page 54). The three most common factors cited were limitation on menu and types of product that can be produced, 24%; bad food, 16%; and high capital cost, 12%. Other negative factors are also presented in Table 10.

Table 9. Manager's Decision Making Factors for Selection of Cook-Chill Foodservice Systems; Frequencies and Percentages.

Decision Making Factors	Responses #	%
Labor saving, labor efficiency	26	15
Good working conditions: Cook to inventory, volume of product produceed at one time, relief and flexibility offered in scheduling of production and assembly,time factor not as crucial in preparation, less crisis peaktime and valley, less stress.	24	14
Consistent quality food: Good standardization of products	22	13
Safety: Increased microbiological control, better handling of food, better storage and transportation for satellite service,assurance of food quality.	22	13
High productivity: Better production planning and control, production five days a week.	19	11
Reduced food cost	12	7
Good quantity control, excellent portion control.	10	6
More palatable food	8	5
Energy saving	7	4
Nutrient retention	7	4
Food served at appropriate temperature, no cold food complaints, improved customer satisfaction.	6	3
Cost effective to meet ever increasing demands	3	2
Doing a variety of homemade items with minimum labor	2	1
Very limited space in production area	1	1
Less opportunity for pilferage	1	1
Simplified maintenance of equipment	1	1
Mass buying power	1	1
Ease of use	1	1
More manageable food production program	1	1
It is a good system	1	1
Total	175	100

Table 10. Manager's Decision Making Factor for not Selecting Cook-Chill Foodservice Systems; Frequencies and Percentages.

Decision Making Factors	Responses #	%
Limitation on menu and types of product	6	24
Bad food, some food do not look as appetizing	4	16
High capital cost of equipment	4	16
Equipment repair and maintenance difficult and expensive	2	8
It is difficult to make any change in production, managing production for needs is difficult.	2	8
High labor cost, additional labor required for ingredient control	2	8
High training cost	1	4
Increased food cost	1	4
High cost of supplies such as paper, aluminum and plastic	1	4
Problems of quality and temperature on service	1	4
Limited package size	1	4
Increased paper work and system development	1	4
Decentralization of service requires too much management time	1	4
The facility is not large enough to take advantage of virtues of this system	1	4
Total	25	100

Manager Comments

Responses to the open ended comment section of the questionnaire were both positive and negative on various aspects of Cook-Chill Foodservice Systems. The following statements reflect many of the general comments made by respondents:

* Cook-Chill Foodservice System is a good system.

* Cook-Chill is a good idea for centralized production and satellite

services.

* Menu is a big issue in Cook-Chill Foodservice Systems, especially for serving different facilities at a centralized kitchen.
* Acquire equipment services from contract company, because repairs and replacement parts are extremely important in Cook-Chill Foodservice Systems.
* Poor rethermalization system can negate a good production system.
* Some foods are of poor quality in Cook-Chill Foodservice System.
* Some of the food and equipment costs are hard to compare due to different time periods and the change in personnel responsible for various aspects of the cost controls and implementation.

Demographics

Cook-Chill Foodservice System Facility

One objective of the survey was to gather information on the demographic characteristics of Cook-Chill Foodservice System facilities and managers. The demographic characteristics of facilities included installation year, type of establishment, funding sources, building construction, production flow, meal times per day, volume of meals per day, chilling equipment, and reheating methods. The managers' characteristics were the numbers of year of management experience, responsibility for decision making and for design or implementation

Cook-Chill Foodservice Systems.

The installation year of Cook-Chill Foodservice System facilities from those respondents reporting is presented in Table 11. Of the respondents, 59 percent installed between 1986 and 1990, 33 percent installed between 1980 and 1985, and 8 percent installed between 1970 and 1979. This suggests that Cook-Chill Foodservice Systems facilities have increased 51% in the past ten years.

Table 11. Year; Cook-Chill Foodservice Systems Were Installed at Respondent's Facility; Frequencies and Percentages(N=72).

Installed Year	#	%
Prior to 1960	0	
1960 to 1969	0	
1970 to 1979	6	8
1980 to 1985	24	33
1986 to 1990	42	59
Total	72	100

The facility type was identified. Most facilities were noncommercial(90%), such as hospitals, nursing homes, schools, correctional centers, county programs, and plant feedings. Commercial feeding was only 10 percent representing restaurants, food contractors, and food processing companies. Hospitals(66%) were the majority of the facilities(Table 12, page 57). Cook-Chill Foodservice Systems were found in all sizes of hospitals, with the majority being installed in hospitals with more than 450 beds. Hospitals of more than 750 beds had the highest percentage(31%)(Table 12, page 57).

Table 12. Hospital Facility, Non-hospital Facility, and Numbers of Hospital Beds; Frequencies and Percentages.

Variables	#	%
Hospital facility	48	66
Non-hospital facility	24	33
Both	1	1
Total	72	100
Hospital beds(N=48)		
Less than 300	6	12
300 to 449	12	25
450 to 599	8	16
600 to 749	8	16
More than 750	15	31
Total	48	100

Funding sources for foodservice system facilities were classified as private(37%), public(33%) and combination of private and public(30%). There were three types of building construction, existing, new and both existing and new buildings. Cook-Chill facilities were more frequently installed when existing kitchens were remodeled(Table 13, page 58). Cook-Chill Foodservice Systems installed in existing kitchens(69%) was higher than in new buildings(23%) and both existing and new buildings(8%).

Food production is centralized in the majority of Cook-Chill Foodservice System kitchens. Sixty-one(85%) of the 72 respondents' facilities had centralized food production flow and 9(12%) had decentralized food production flow. Some respondents(3%) reported that their facilities had centralized food production flow for hot food items and decentralized food production for cold food items.

Table 13. Facility Funding Sources and Building Types of Cook-Chill Foodservice System of Respondents; Frequencies and Percentages.

Variables	N	#	%
Funding Sources	73		
Private		27	37
Public		24	33
Combination		22	30
Building Types	73		
Existing building		50	69
New building		17	23
Both existing and new		6	8

Most(82%) managers indicated that their foodservice facilities served three meals per day(Table 14, page 59). Seven(10%) facilities supplied two meals per day; and six(8%) facilities supplied one meal per day. The volume of meals per day of respondents' facilities are given in Table 14. Of the volume of meals per day, 67 percent reported more than 2,000 meals a day. The largest percentage, 42 percent of respondents' facilities, served more than 4,000 meals a day, which numbers ranged between 4,001 and 38,000 among the reported facilities. These results indicated that the Cook-Chill Foodservice Systems can accommodate small to large numbers of meals.

Table 14. Meal Times Per Day and Volume of Meals of Cook-Chill Foodservice Systems of Respondents; Frequencies and Percentages.

Variables	N	#	%
Meal Times Per Day	71		
One meal a day		6	8
Two meals a day		7	10
Three meals a day		58	82
Volume of Meals Per Day	69		
Less than 1000		7	10
1000 to 1999		17	23
2000 to 2999		8	11
3000 to 4000		10	14
More than 4000		30	42

Chilling and reheating are important production processes in Cook-Chill Foodservice Systems. Chilling equipment, both blast chiller(38%) and tumbler chiller(38%), or combination of those two(19%) were more frequently used in Cook-Chill Foodservice Systems. Other chilling methods and equipment such as cook tank, ice water bath and traditional refrigeration were used in 4% the facilities in this study.

Types of reheating equipment used in Cook-Chill Foodservice Systems are presented in Table 15(page 60). There were many varieties of reheating equipment used: microwave ovens, 6%; convection ovens, 27%; infrared regeneration ovens, 10%; heating plates, 14%; and integral heat system, 6%. Other methods of reheating specified by respondents were 21 percent which included conveyor ovens, water bath, steamers, steam kettles, conduction ovens and braising pans. Combinations of those two or three methods were used by 17 percent of the total 71 Cook-Chill

Foodservice System respondents. The combination varieties were convection ovens with steam kettles and steamers, convection ovens with heating plates, convection ovens with microwave ovens and range top ovens, and hot water bath with range-top ovens.

Table 15. Reheating Methods of Cook-Chill Foodservice Systems; Frequencies and Percentages(N=71).

Reheating Method	#	%*
Convection ovens	19	27
Others	15	21
Combination	12	17
Heating plates	10	14
Infra-red regeneration ovens	7	10
Microwave ovens	4	6
Integral heat system	4	6

* Does not equal 100 percent due to rounding effect.

Manager's Experience with Cook-Chill Foodservice Systems

Demographic information also was collected on managers' experience with Cook-Chill Foodservice Systems to determine the manager's characteristics. Years of management experience in the Cook-Chill Foodservice Systems is presented in Table16(page 61). Forty-two(59%) reported two to five years experience with Cook-Chill Foodservice Systems, and 14(20%) reported six to nine years. This resulted in a total 79% of the Cook-Chill Foodservice Systems respondents having two to nine years of management experience of the Cook-Chill Foodservice Systems.

Table 16. Years of Management of Cook-Chill Foodservice Systems of Respondents; Frequencies and Percentages(N=71).

Years	#	%
1 or less	12	17
2 to 5	42	59
6 to 9	14	20
10 and beyond	3	4

Of the 72 Cook-Chill Foodservice System respondents, thirty-four(47%) had been a part of the decision making for the selection of these systems for their facilities. Forty-two(59%) reported that they had experience in the design or implementation of these systems. Most managers who had been involved in selection also reported they had been involved in the design or implementation of these systems. Only one had the experience of decision making for selection but not in the design or implementation of Cook-Chill Foodservice Systems.

Effects of Demographic Data on the Manager's Perception of Meal Quality, Quantity Control and Personnel Satisfaction Variables

Determining the demographic characteristics influencing the manager's assessment of Cook-Chill Foodservice Systems was one objective of this study. These demographic characteristics were chilling equipment, reheating methods and total volume of meals per day. The assessed effects were meal quality: serving temperature, sensory evaluation, microbiological control, and nutrient retention; quantity control; and personnel satisfaction: customer, employee, and manager satisfaction. ANOVA analyses were done to determine whether the distribution of manager's perception of meal quality, quantity control, and personnel satisfaction responses were independent of demographic characteristics(Table 17, page 63). Results indicated that reheating methods by the meal quality of sensory evaluation and microbiological control and customer satisfaction were significant.

Sensory Evaluation

The respondent's perception of sensory evaluation differed significantly($P \leq .05$) among the reheating methods of Likert 5-point scale. The sensory evaluation mean and standard deviation for each reheating method are presented in Table 18(page 64). The results of ANOVA multiple comparison Fisher's LSD test indicated that the sensory evaluation mean of heating plates method(3.6) was significantly lower than those means of microwave ovens(4.5), integral heat system(4.5) and combination reheating method(4.4), also the sensory evaluation mean of combination reheating methods(4.4) was significantly higher than the mean of other reheating method(3.8).

Microbiological Control

The respondent's perception of microbiological control had a significant difference among reheating methods in the mean of Likert 5-point scale(Table 17, page 63). The microbiological control means for each reheating method are given in Table 18(page 64). There were three significant results in an ANOVA multiple comparison Fisher's LSD test. Microbiological control with integral heat system(5.0) was perceived to be better than heating plates method(3.8). Combination method(4.8) was higher than microwave ovens(4.0), convection ovens(4.2), and heating plates(3.8). Other method(4.7) was higher than convection ovens (4.2) and heating plates(3.8).

Table 17. Manager's Perception of the Meal Quality, Quantity Control and Personnel Satisfaction Variables and Demographic Characteristics; One Way ANOVA Analyses of the Means of Likert 5-point Scale .

Demographic Characteristics and Meal Quality, Quantity Control & Personnel Satisfaction	Significant Level
Chilling equipment by	
serving temperature	0.97
sensory evaluation	0.66
microbiological control	0.65
nutrition retention	0.54
customer satisfaction	0.74
employee satisfaction	0.84
manager satisfaction	0.78
Reheating methods by	
serving temperature	0.33
sensory evaluation	0.05 *
microbiological control	0.01 *
nutrient retention	0.28
customer satisfaction	0.05 *
employee satisfaction	0.21
manager satisfaction	0.89
Total volume of meals per day by	
quantity control	0.96
customer satisfaction	0.97
employee satisfaction	0.99
manager satisfaction	0.93

* Significant level at $P \leq .05$

Table 18. Manager's Perception of Sensory Evaluation, Microbiological Control and Customer Satisfaction among Reheating Methods with the Means of Likert 5-point Scale.

Perceptive Variables & Reheating Methods	N	Likert 5-point Scale Means	SD
Sensory evaluation			
Microwave ovens	4	4.5	0.6
Integral heat system	4	4.5	0.6
Combination	10	4.4	0.5
Convection ovens	18	4.1	0.5
Infrared ovens	7	3.9	0.4
Others	15	3.8	0.7
Heating plates	10	3.6	1.2
Microbiological Control			
Integral heat system	3	5.0	
Combination	10	4.8	0.4
Others	14	4.7	0.6
Infrared ovens	7	4.4	0.5
Convection ovens	18	4.2	0.7
Microwave ovens	4	4.0	
Heating plates	10	3.8	1.0
Customer Satisfaction			
Microwave ovens	4	4.8	0.5
Combination	10	4.3	0.5
Integral heat system	4	4.0	
Infrared ovens	7	3.9	0.4
Convection ovens	18	3.8	0.6
Others	15	3.7	0.7
Heating plates	10	3.4	1.3

Customer's Satisfaction

In the perception of customer satisfaction, a significant difference($P \leq .05$) existed among reheating methods in the means of Likert 5-point scale of manager perception of customer satisfaction(Table 17, page 63). The results of ANOVA multiple comparison Fisher's LSD test indicated that the customer satisfaction for microwave ovens(4.8) was perceived to be better than those for convection ovens(3.8), heating plates(3.4), and other reheating method(3.7). Also, customer satisfaction for combination reheating method(4.3) was better than those using heating plates(3.4).

Effects of Demographic Data on Cost Variables

Effects of demographic cost characteristics in comparing Cook-Chill Foodservice Systems with prior systems were identified by chi square analyses. Cost characteristics were private, public, and combination funding sources. The cost variables were cost of food, labor, energy, equipment, and construction, the numbers of FTEs, total cost, and annual cost per meal. Results showed that there were no significant differences among private, public and combination funding sources for any of the eight cost variables in comparing Cook-Chill Foodservice Systems and prior systems.

Other cost information(meal, labor, food cost per meal) were also analyzed with demographic characteristics with ANOVA and student's t tests to determine the influence effects. The demographic characteristics included funding sources: private, public, and combination funding sources; and facility types: commercial and noncommercial feeding groups. There were no significant differences for the response of cost per meal among funding sources, but also no significant differences between commercial and noncommercial feeding groups.

Effects of Demographic Data on the Manager's Willingness to Choose Cook-Chill Foodservice Systems

The manager's willingness to choose Cook-Chill Foodservice Systems was analyzed with the demographic characteristics by chi square analyses to determine the influence effects(Table 19, page 67). The demographic characteristics were manager's responsibility for decision making, responsibility for design or implementation, and management years of Cook-Chill Foodservice Systems. The effect of having been responsible for design or implementation on willingness to choose this system was the only one of the three demographic characteristics analyzed that was significant. A significant difference($P \leq .05$) existed between having been responsible for design or implementation and the manager's willingness to choose Cook-Chill Foodservice systems again. Of the 60 respondents, 39(56%) managers who had experience in design or implementation were willing to choose Cook-Chill Foodservice Systems again. Twenty-one(30%) managers who had no experience in design or implementation were willing to choose this system(Table 19). The results indicated that willingness to choose Cook-Chill Foodservice Systems was greater among managers with design or implementation experience than it was among managers who had no experience of design or implementation of Cook-Chill Foodservice Systems.

Table 19. Management Characteristics and Willingness to Choose Cook-Chill Foodservice Systems Again ; Chi Square Analyses, Frequencies and Percentages.

Management Characteristics	Willing Response Yes(%)	No(%)	Chi square value	df	Sig. level
Decision making	44	4	1.49	1	0.22
Nondecision making	42	10			
Design or implementation	56	4	4.38	1	0.04 *
Nondesign or non-implementation	30	10			
Management years					
Less than 1	14	3	1.22	3	0.77
2 to 5	50	9			
6 to 9	19	1			
10 and beyond	4	0			

* significant level at $P \leq .05$

Correlation Between Management Characteristics and Personnel Satisfaction

The correlation between management characteristics and personnel satisfaction was analyzed to determine the effects of various influences. The personnel satisfaction variables were customer, employee and manager satisfaction. The management characteristics included management years of Cook-Chill, volume of meals served per day, and number of hospital beds. Correlation analyses were completed to determine whether there was correlation between management characteristics and personnel satisfaction. The results indicated there were no significant correlations between management characteristics and personnel satisfaction.

Study Outcome: Null Hypotheses

Hypothesis(Ho1): There is no difference in the manager's perception of meal quality of Cook-Chill Foodservice Systems among meal quality attributes (1) serving temperature, (2) sensory evaluation, (3) microbiological control, and (4) nutrient retention.

Cook-Chill Foodservice Systems respondents reported that microbiological control had the highest mean of the four attributes of meal quality. There was a significant difference in the manager's perception of meal quality of Cook-Chill Foodservice Systems among meal quality attributes: serving temperature, sensory evaluation, microbiological control, and nutrient retention; therefore, the null hypothesis was rejected.

Hypothesis (Ho2): There is no difference in the manager's perception of personnel satisfaction for Cook-Chill Foodservice Systems among customers, employees, and managers.

Cook-Chill Foodservice Systems respondents rated manager satisfaction better than customer and employee satisfaction. There was a significant difference in the manager's perception of personnel satisfaction among customers, employees, and managers, therefore, the null hypothesis was rejected.

Hypothesis (Ho3): There is no difference in the manager's perception of (1) meal quality and (2) personnel satisfaction of Cook-Chill Foodservice Systems among chilling equipment.

There was no significant difference in the manager's perception of (1)meal quality and (2) personnel satisfaction of Cook-Chill Foodservice Systems among chilling equipment in the means of Likert 5-point scale; therefore, the null hypothesis was accepted. Data are given in Table 18(Page 64). Since there was no significant difference, there was no discussion.

Hypothesis (Ho4): There is no difference in the manager's perception of (1) meal quality: serving temperature, sensory evaluation, microbiological control, and nutrient retention, and (2) personnel satisfaction: satisfaction of customer, employees, and managers of Cook-Chill Foodservice Systems among reheating methods.

In meal quality after heating, Cook-Chill Foodservice Systems respondents rated the heating plates method lower than integral heat system, microwave ovens, and combination method in sensory quality. Integral heat system and combination method were rated higher than microwave ovens, convection ovens, and heating plates in microbiological control. There was a significant difference in meal quality: both sensory evaluation and microbiological control among reheating methods, therefore, the null hypothesis was rejected. There was no significant difference in meal quality with regard to serving temperature and nutrient retention among reheating methods; therefore, these parts of the null hypothesis was accepted. In personnel satisfaction, Cook-Chill Foodservice Systems respondents rated the microwave ovens higher than convection ovens, heating plates and other method in customer satisfaction. There was a significant difference in customer satisfaction in response to different reheating methods; therefore, the null hypothesis was rejected. Thewas no significant difference in employee and managers satisfaction in response to different reheating methods; therefore, those parts of the null hypothesis were accepted.

Hypothesis (Ho5): There is no difference in the manager's perception of (1) quantity control and (2) personnel satisfaction between groups serving different numbers of meals per day.

There was no significant difference in the manager's perception of (1) quantity control and (2) personnel satisfaction between groups serving different numbers of meals per day; therefore, the null hypothesis was accepted. Data are given in Table 18(page 64).

Hypothesis (Ho6): There is no difference between Cook-Chill Foodservice Systems and prior systems in costs among private, public and combination funding sources.

There was no difference with funding sources the facilities had in how the respondents rated the cost effects in comparing Cook-Chill Foodservice Systems with prior systems. There were no significant differences in comparing Cook-Chill Foodservice Systems with prior systems in cost effects among private, public and combination funding sources; therefore, the null hypothesis was accepted.

Hypothesis (Ho7): There is no difference in the (1) average cost per meal, (2) labor cost per meal, (3) food cost per meal of Cook-Chill Foodservice Systems among private, public and combination funding sources.

There was no significant difference in the (1) average cost per meal, (2) labor cost per meal, and (3) food cost per meal of Cook-Chill Foodservice Systems among private, public and combination funding sources; therefore, the null hypothesis was accepted.

Hypothesis (Ho8): There is no difference in (1) average cost per meal, (2) labor cost per meal, (3) food cost per meal of Cook-Chill Foodservice Systems between commercial and noncommercial feeding groups.

There was no significant difference in (1) average cost per meal, (2) labor cost per meal, (3) food cost per meal of Cook-Chill Foodservice Systems between commercial and noncommercial feeding groups; therefore, the null hypothesis was accepted.

Hypothesis (Ho9): There is no difference in willingness to choose Cook-Chill foodservice Systems again between the groups (1) responsible for choosing these systems, (2) responsible for design or implementation these systems, and (3) years of management of these systems.

Cook-Chill Foodservice Systems managers with experience in design or implementation had higher willingness to choose Cook-Chill Foodservice Systems again than managers with no experience for design or implementation. There was a significant difference between these groups; therefore, the null hypothesis was rejected. There was no significant difference in choosing Cook-Chill Foodservice Systems again between these groups responsible for decision making, and persons with various years of management; therefore, these parts of the null hypothesis were accepted.

Hypothesis (Ho10): There is no significant correlation between personnel satisfaction and (1) management years, (2) total volume of meals served per day, and (3) hospital size in Cook-Chill Foodservice systems.

There is no significant correlation between personnel satisfaction and (1) management years, (2) total volume of meals served per day, and (3) hospital size in Cook-Chill Foodservice systems; therefore, the null hypothesis was accepted.

Four significant outcomes of this study resulted from the analyses of managers' responses. These outcomes were: in the manager's perception of (1) meal quality of Cook-Chill foodservice Systems among meal quality attributes: serving temperature, sensory evaluation, microbiological control, and nutrient retention; (2) personnel satisfaction among customers, employees, and managers; (3) meal quality (sensory evaluation and microbiological control) and personnel satisfaction(customer satisfaction) response to different reheating methods; and (4) willingness to choose Cook-Chill Foodservice Systems again between the groups with responsibility for design or implementation of these systems.

Study Outcomes and Implications

The majority of Cook-Chill Foodservice Systems managers reported that the perceived meal quality of Cook-Chill Foodservice Systems was good to excellent. In comparing Cook-Chill Foodservice Systems with prior systems, most managers rated the meal quality as better or equal. Of the four attributes of meal quality: serving temperature, sensory evaluation, microbiological control and nutrient retention, microbiological control was considered to be significantly better. This could be the result of one or a combination of the following reasons: (1) time and temperature control points might be considered to be important in the operation of Cook-Chill Foodservice Systems, (2) when starting a new system, there are many opportunities to set control points and improve meal quality, (3) enhancement of appropriate menu items that were created or adjusted from traditional menu for Cook-Chill Foodservice Systems.

Quantity control was reported as good to excellent in Cook-Chill Foodservice Systems, and as better or equal compared with prior systems by managers. More manageable food production program may be due to in advance production, or reduction of food waste through centralized control over preparation and storage.

Cook-Chill Foodservice Systems managers reported that their perception of personnel satisfaction was good to excellent. Factors could be : (1) customers are satisfied with appropriate food serving temperatures with no food temperature complaint, (2) employees are satisfied with the good working conditions(no peak meal time), (3) managers are satisfied with successful management function in labor savings, good quantity control, and customer and employee satisfactions.

In the cost effects of Cook-Chill Foodservice Systems, managers had the opportunity to rate costs as decreasing or increasing, only labor cost was identified as decreasing(59%). It could be that the requirement for skilled personnel in production was reduced due to better scheduling and the use of less skilled labor for rethermalization and service in the Cook-Chill Foodservice Systems.

Managers reported that good working conditions, high productivity, reduced labor, consistent quality food, and high food safety encouraged selection of Cook-Chill Foodservice Systems. Contributing factors were: (1) all meals are prepared in advance of requirements and production can be scheduled for the best use of equipment, space and staff; (2) production staff can concentrate on specific tasks with little or no peak mealtime tension; (3) five-day with no weekend production scheduling of skilled personnel results in labor saving; (4) foods are produced in uniformly controlled batch sizes with standardized recipes, so the quality is more consistent; (5) improved food safety may be due to the better temperature control in handling of food for storage and transportation to satellite services.

High capital cost of equipment, limited menu and complaints of bad food were reported as disadvantages and factors for not selecting Cook-Chill Foodservice Systems. High capital cost could be a result of Cook-Chill Foodservice Systems equipment often being imported from other countries or just additional added equipment. Limited menu and complaints of bad food could be due to inappropriate preparation and reheating.

RECOMMENDATIONS

This study indicates that managers of Cook-Chill Foodservice System facilities either lack complete records or unwilling to report cost information or have little information available on comparative cost of changing from one system to another system to share. A standard model of cost recording for Cook-Chill Foodservice Systems is recommended for further research.

A variety of reheating methods were reported by managers in the study. There was a significant difference in perception of sensory evaluation, microbiological control, and customer satisfaction with Cook-Chill Foodservice Systems in response to different reheating methods. Factors contributing to the rating difference should be examined in a further study.

High capital cost, limited menu and types of products and some food quality complaints are the flaws of Cook-Chill Foodservice Systems and affected the managers' decision not to use Cook-Chill Foodservice Systems. There are three recommendations: (1) analyze the capital cost and develop methods to reduce the capital cost for Cook-Chill Foodservice Systems, (2) create appropriate menu items and ways to adjust menu from traditional menu to improve limitation of menu and types of products, and (3) find the causes of food quality complaints and find appropriate preparation and reheating methods to improve the food quality.

In addition, it is recommended that a Cook-Chill Information Center be developed to support the development of Cook-Chill Foodservice Systems in the foodservice industry. This Cook-Chill Information Center would be a method to share knowledge of Cook-Chill Foodservice Systems. The Cook-Chill Information Center possibly formed by foodservice industry would collect information on data bases of Cook-Chill facilities, menu, chilling and reheating methods, facility layout and equipment, cost information, implementation principles, management and control, operational data, decision making information, and research reports.

SUMMARY AND CONCLUSIONS

The Cook-Chill Foodservice System is a ready-prepared foodservice system substituting for the traditional foodservice production system. A review of literature indicated that the number of Cook-Chill Foodservice systems has increased since its inception about thirty years ago. Laboratory studies of food quality, cost studies, and individual case studies have reported the effects of Cook-Chill Foodservice Systems operations.

In an effort to provide management information for the development of Cook-Chill Foodservice Systems in the foodservice industry, a nationwide survey was conducted of management personnel working in organizations that have Cook-Chill Foodservice Systems. The purpose of this research was to evaluate Cook-Chill Foodservice Systems from the perception of managers in the foodservice industry. The objectives of this study were to: (1) identify the effects, advantages and disadvantages, and decision making factors for selection of Cook-Chill Foodservice Systems as perceived by managers, (2) identify demographic characteristics of the facilities and managers of Cook-Chill Foodservice Systems, and (3) determine if demographic characteristics influence managers' assessment of Cook-Chill Foodservice Systems.

One hundred thirty-four surveys were mailed nationwide to foodservice managers with 95(71%) valid responses. This survey collected current information on managers' view of Cook-Chill Foodservice Systems. Data were tabulated and analyzed from the 74 respondents who were currently used Cook-Chill Foodservice Systems.

Managers rated the perception of meal quality, quantity control and personnel satisfaction of the Cook-Chill Foodservice Systems in Likert 5-point scale as very poor, poor, fair, good, or excellent. Most managers rated meal quality, quantity control and personnel satisfaction as good to excellent. In perception of meal quality, microbiological control was significantly($P \leq .05$) higher than serving temperature, sensory evaluation, and nutrient retention. In addition, manager satisfaction was significantly better than customer and employee satisfaction when comparing the perceptive attributes of personnel satisfaction.

Foodservice managers rated the perception of meal quality, quantity control and personal satisfaction as better, equal, worse, or don't know in comparing Cook-Chill Foodservice Systems with prior systems. The perception was equal or better in this comparison.

Cost information is important in the management of a foodservice system, but only 60% to 66% managers offered cost information of their facilities. Managers rated the perception of cost effects in comparing Cook-Chill Foodservice Systems with prior systems as decreasing, the same, increasing and don't know. These cost attributes included food cost, labor cost, number of FTEs, energy cost, equipment cost, construction cost, total cost and annual cost per meal. The most often reported as decreasing was labor cost, 59% and the most often reported as increasing was equipment cost, 42%. Many(14% to 57%) respondents rated cost comparison as don't know, especially in energy cost(57%). The percentage range of decreasing or increasing cost in comparing

Cook-Chill Foodservice Systems with prior systems was very wide. In addition, the current average meal cost $3.86, labor cost $2.42, and food cost $1.71 per meal for Cook-Chill Foodservice Systems were reported by managers. The mean percentage of labor cost by average meal cost was 50 percent and the mean percentage of food cost by average meal cost was 40 percent.

Managers identified seven advantages and one disadvantage in the Cook-Chill Foodservice Systems. The seven perceived advantages of Cook-Chill Foodservice Systems were (1) good working conditions, (2) high productivity, (3) labor savings, (4) consistent quality food, (5) good quantity control, (6) nutrient retention, and (7) safety. The only one perceived disadvantage of Cook-Chill Foodservice Systems was high capital cost of equipment.

Managers' willingness to choose Cook-Chill Foodservice Systems again and decision making factors were reported by respondents. Eighty-six percent of the 72 respondents using Cook-Chill Foodservice Systems were willing to choose Cook-Chill Foodservice Systems again and 14 percent were not. The five most often cited factors for selection of Cook-Chill Foodservice Systems were labor efficiency and labor savings, good working conditions, consistent quality food, safety with better handling of food for storage and transportation to satellite services, and high productivity with better production planning and control. On the other hand, the three most often cited reasons for not selecting Cook-Chill Foodservice Systems were the limited menu and types of products that can be produced, complaints of bad food and high capital cost.

Demographic data were collected regarding Cook-Chill Foodservice Systems facility and manager's experience in Cook-Chill Foodservice Systems. The largest percentage of respondents' facilities have installed the Cook-Chill Foodservice Systems in the past ten years. Systems were installed facility having in private, public or combination funding sources. Cook-Chill facilities were installed most frequently when existing kitchens were remodeled. Most respondents reported that their facilities had centralized food production flow rather than decentralized production flow. Three meals per day were more commonly served. In addition, 67% of the respondents indicating the volume of meals per day frequently accommodated more than 2,000 meals a day. Both blast chiller and tumbler chiller were most common in Cook-Chill Foodservice Systems. There were many varieties of reheating methods in use, such as microwave ovens, convection ovens, infra-red regeneration ovens, heating plates, integral heat system, steamer, steam kettles, and hot water bath.

Most respondents had two to nine years of management experience with the Cook-Chill Foodservice Systems. Half had been involved in choosing, designing or implementing the Cook-Chill Foodservice Systems.

Demographic characteristics influencing managers' assessment of Cook-Chill Foodservice Systems were evaluated. In reheating methods, there was a significant difference in the perception of sensory evaluation(at $P \leq .05$), microbiological control($P \leq .05$), and customer satisfaction($P \leq .05$) among reheating methods. Microwave ovens, integral heat system and combination reheating methods were better than other methods in sensory evaluation attribute, integral heat systems and combination reheating methods were better than others in microbiological control, and microwave ovens were better than other reheating methods in customer satisfaction. A significant difference($P \leq .05$) existed between experience in design or implementation and the manager's willingness to choose Cook-Chill Foodservice Systems again. The managers who had design or implementation experience were more likely willing to choose Cook-Chill Foodservice Systems again than managers who did not.

REFERENCES

1. Bjorkman, A.: Sweden's Nacka hospital food system centralizes preparation and distribution. Cornell Hotel & Restaur Admin. Q 7(3):84,1966.

2. Willete, R.: Hospital food service systems. Cornell Hotel Restaur Admin Q 10(1):100, 1969.

3. Rinke, W.J.: Three major systems reviewed and evaluated. Hospitals 50(4):73, 1976.

4. Unklesbay, N., Maxcy, R., Knickrehm, M., Stevenson, K., Cremer, M., & Matthews, M.: Foodservice systems: Product flow and microbial quality and safety of foods. Research Bulletin 1018. Columbia: University of Missouri-Columbia Agricultural Experiment Station, March 1977.

5. Glew, G.: The contribution of large-scale feeding operations to nutrition. Wld Rev Nutr Diet 34:1, 1980.

6. Stilwell, J.R.L.: Cook-chill systems. Restaurant Business 86(1):136, 1987.

7. Department of Health and Social Security: Guidelines on pre-cooked chilled foods. London, Her Majesty's Stationary Office, 1980.

8. O'Sullivan, L. & Chaney, E.: Cook/chill & cook/freeze " of meals & microbes". The Consultant 18(1):23, 1985.

9. Hall, J.: Cook-chill/freeze around the world. The Consultant 18(1):19, 1985.

10. Spears, M.C. & Vaden, A.G.: Foodservice Organizations. John Wiley & Sons, Inc. 1985.

11. Heidelbaugh, N.D., Rowley, D.B., Powers, E.M., Bourland, C.T. & McQuinn, J.L.: Microbiological testing of Skylab foods. Appl. Microbiol 25(1):55, 1973.

12. Bunch, W.L., Matthews, M.E. & Marth, E.H. : Hospital cook-chill foodservice systems: Acceptability and microbiological characteristics of beef-soy loaves when processed according to system procedures. J of Food Science 41(6):1273, 1976.

13. Cremer, M.L., & Chipley, J.R.: Satellite foodservice system assessment in terms of time and temperature conditions and microbiological and sensory quality of spaghetti and chili. J of Food Science 42(1):225, 1977.

14. Bunch, W.L., Matthews, M.E. & Marth, E.H.: Fate of staphylococcus aureus in beef-soy loaves subjected to procedures used in hospital chill foodservice systems. J of Food Science 42(2):565, 1977.

15. Makings, S.M. & Cooper, H.M.: Ascorbic acid retention in chilled food. Catering Research Unit Report 98, Leeds:University of Leeds, 1977.

16. Bobeng, B.J. & David, B.D.; HACCP models for quality control of entree production in hospital foodservice systems. II. Quality assessment of beef loaves utilizing HACCP models. J Am Diet Assoc 73(5):530, 1978.

17. Cremer, M.L. & Chipley, J.R.: Time and temperature, microbiological and sensory assessment of roast beef in a hospital foodservice system. J of Food Science 45(6):1472, 1980.

18. Bognar, A.: Nutritive value of chilled meals. Advances In Catering Technology, Ed. G. Glew, London: Applied Science, p.387, 1980.

19. Zacharias, R.: Chilled meals: sensory quality. Advances In Catering Technology, Ed. G. Glew, London: Applied Science, p.409, 1980.

20. Rini, M.J., Cremer, M.L., & Chipley, J.R.: Sensory and microbiological qualities of beef in four commissary foodservice treatments. J Am Diet Assoc 78(5):483, 1981.

21. Turner, M. & Brown, J.: The determination of ascorbic acid in food samples collected at a school meals cook-chill production unit. Catering Research Unit Report 140, Polytechnic, Huddersfield. 1981.

22. Sawyer, C.A., Naidu, Y.M. & Thompson, S.: Cook-chill Foodservice systems: Microbiological quality and end-point temperature of beef loaf, peas and potatoes after reheating by conduction, convection and microwave radiation. J of Food Protection 46(12):1036, 1983.

23. Herz, M.L. & Sounder Jr.J.J.: Preparation systems have significant effect on costs. Hospitals 53(1):89, 1979.

24. Pizzuto, R. & Winslow, E.: Why cook-chill systems do not work--when they really should. The Consultant 22(1):32, 1989.

25. Greathouse, K.R., Gregoire, M.B., Spears, M.C., Richards, V.,& Nassar, R.F.: Comparison of conventional, cook-chill, and cook-freeze foodservice systems. J Am Diet Assoc 89(11):1606, 1989.

26. New central kitchen pays off big for Portland, Ore., Schools. Restaurant & Institutions 89(6):131, 1981.

27. Cook-chill serves up savings and quality. Modern Healthcare 13(9):202, 1983.

28. King, P.: On site systems: central production at MCC/New York. Food Management 22(5):76, 1987.

29. King, P.: On site systems: a phased approach. Food Management 23(3):54, 1988.

30. King, P.: On site systems: food production on a grand scale. Food Management 23(4):60,1988.

31. King, P.: On site systems: meeting elderly patients' needs with cook-chill. Food Management 24(6):80, 1989.

32. Bobeng, B.J. & David, B.D.: HACCP models for quality control of entree production in hospital foodservice systems. I. Development of Hazard Analysis Critical Control Point models. J Am Diet Assoc 73(5):524, 1978.

33. Bauman, H.E.: The HACCP concept and microbiological hazard categories. Food Technol 28:30, 1974.

34. Institute of Food Technologists, Sensory Evaluation Division: Sensory evaluation guide for testing food and beverage products. Food Technology 35(11):50, 1981.

35. Mieh, R.A.: Cook-chill catering. Environmental Health 94(10):253,1986.

36. Electricity Councils' Project Planning Unit(Catering): Planning for cook-chill. Electric Catering Centre. 45th Martin's Lane, London WC2N 4EJ 2nd Edition, Feb. 1980.

37. King, P.: On site systems: applying cook-chill in schools. Food Management 22(4):71, 1987.

38. Morrow, T.A.: Centralizing does the trick. School Foodservice Journal 39(5):152, 1984.

39. McGuckian, C.A.T.: The A.G.S. Food System-- chilled pasteurized food . Cornell Hotel Restaur Admin Q 10(1):87, 1969.

40. Beaudin, R.: The other side of the cook-chill coin. Food Management 24(8):50,1989.

41. Kaud, F.A.: Implementing the chilled food concept. Hospitals 46(15):97, 1972.

42. Matthews, M.E.: Quality of food in cook-chill foodservice systems: a review. School Food Service Research Review 1(1):15, 1977.

43. Franzese, R.: Food service systems of 79 hospital studied. Hospitals 55(3):64, 1981.

44. Franzese, R. : Food service survey shows delivery shift. Hospitals 58(16):61, 1984.

45. Greathouse, K.R. & Gregoire, M.B.: Variables related to selection of conventional, cook-chill, and cook-freeze systems. J Am Diet Assoc 88(4):476, 1988.

46. Bamett, L.: Simplifying operations: Using cook-chill. School Foodservice Research Journal 41(3):78, 1987.

47. Little, J.H. & Norman, N.: Cook-chill: How to put banquet problems in the cooler. Canadian Hotel & Restaurant 64(5):35, 1986.

48. Paszek, M.M.: Analysis of ALADDIN rethermalization meal delivery system. Aladdin Synergetic, Inc. 1986.

49. Bell, A.G.: Decentralized rethermalization systems. The Consultant 18(1):38, 1985.

50. Carroll, G.H.: A bulk pack chilled/frozen food production system for a 500-bed hospital. J of Foodservice systems 1(1):51, 1980.

51. Hunt, C.: Preparing foods to meet nutritive and eating quality requirements. International Journal of Hospitality Management 1(1):19, 1982.

52. Ridely, S.J. & Matthews, M.E.: Temperature histories of menu items during meal assembly, distribution, and service in a hospital foodservice. J of Food Protection 46(2):100, 1983.

53. Rollin, J. & Matthews, M.E.: Cook/chill foodservice systems: Temperature histories of a cooked ground beef product during the chilling process. J of Food Protection 40(11):782, 1977.

54. Dahl, C.A. & Matthews, M.E.: Effect of microwave heating in cook/chill foodservice systems. J Am Diet Assoc 77(3):289, 1980.

55. U.S. Department of Health, Education, and Welfare: Food service sanitation manual. Public Health Service, FDA, DHEW Pub. No. (FDA) 78-2081, Division of Retail Food Protection, Washington, DC. 76pp, 1978.

56. Tumoi, S., Matthews, M.E. & Marth, E.H.: Temperature and microbial flora of refrigerated ground beef gravy subjected to holding and heating as might occur in a school foodservice operation. J. Milk & Food Technol 37(9):457, 1974.

57. Hunt, C.: Nutrient losses in cook-freeze and cook-chill catering. Human Nutrition: Applied Nutrition 38A:50, 1984.

58. Nicholanco, S. & Matthews, M.E.: Quality of beef stew in a hospital chill foodservice system. J Am Diet Assoc 72(1):31, 1978.

59. Dahl-Sawyer, C.A., Jen,J.J. & Huang, P.O.: Cook-chill foodservice systems with conduction, convection, and microwave reheat systems. Nutrient retention in beef loaf, potatoes, and peas. J of Food Science 47(4):1089, 1982.

60. Sawyer, C.A.: Sensory evaluation of cook-chilled products reheated by conduction, convection, and microwave radiation. J of Foodservice Systems 3(2):89, 1984.

61. Thomas, C.J. & Brown, N.E.: Use and cost of electricity for selected process specific to a hospital cook-chill/freeze food production system. J of Foodservice Systems 4(3):159, 1987.

62. Likert, R.: A Technique for the Measurement of Attitudes. Archives of Psychology No:140, New York, 1932.

63. Warwick, D.P. & Lininger, C.A.: The Sample Survey Theory and Practice. New York: McGraw-Hill, Inc., 1975.

64. Dillman, D.A.; Mail and Telephone Surveys: The total design method. New York: John Wiley and Sons, Inc., 1978.

65. Cochran, W.G.: Sampling Techniques, 3rd Ed. New York: John Wiley and Sons, Inc., 1977.

66. SAS / STAT User's Guide, Release 6.03 edition, SAS Institute Inc., Cary, NC, 1988.

67. Devore, J. & Peck, R.: Statistics: The Exploration and Analysis of Data. St. Paul, MN: West Publish Company, 1986.

APPENDICES

APPENDIX A:

Time-temperature Critical Control Points during Entree Production in Conventional, Cook-Chill, and Cook-freeze Hospital Foodservice Systems@

control point	conventional		cook-chill		cook-freeze	
	time	temperature~	time	temperature~	time	temperature~
preparation	min#	45°-140°F.	min#	45°-140°F.	min#	45°-140°F.
heating	---^	≥ 140°F.+	---^	≥ 140°F.+	---^	≥ 140°F.+
hot holding	---^	≥ 140°F.	N.A.*	N.A.	N.A.	N.A.
chilling	N.A.	N.A.	≤ 4 hr.!	≤ 45°F.	N.A.	N.A.
chilled storage	N.A.	N.A.	≤ 20 hr.!	≤ 45°F.	N.A.	N.A.
freezing	N.A.	N.A.	N.A.	N.A.	≤1.5 hr.	≤ -4°F.
frozen	N.A.	N.A.	N.A.	N.A.	≤ 8 wks.	≤ 0°F.
thawing	N.A.	N.A.	N.A.	N.A.	min#	≤ 45°F.
portioning, assembly,& distribution	min#	≥ 140°F.	N.A.	N.A.	N.A.	N.A.
portioning & assembly	N.A.	N.A.	min#	≤ 45°F.	min#	≤ 45°F.
cold holding & distribution	N.A.	N.A.	---^	≤ 45°F.	---^	≤ 45°F.
microwave heating	N.A.	N.A.	---^	165°-170°F.	---^	165°-170°F.
service	min#	≥ 140°F.	min#	≥ 140°F.	min#	≥ 140°F.

@From Bebeng and David 1978.
~Internal temperature at completion of control point activity.
#Minimal.
^Time will vary with entree, equipment, and/or system.
+Minimum temperature; will vary with entree.
*Control point not applicable for system.
!Combined time of chilling and chilled storage should be ≤ 24 hr.

APPENDIX B:

Time-temperature Guidelines in FDA Food Service Sanitation Manual@

process item	time	temperature
heating		≥ 140°F.!
poultry & stuffed meats		≥ 165°F.!
pork		≥ 150°F.!
rare roast beef		≥ 130°F.!
hot storage		≥ 140°F.*
chilling	≤ 4hr.	≤ 45°F.*
refrigerated storage		≤ 45°F.*
frozen storage		≤ 0°F.*
thawing		≤ 45°F.*
hot transportation		≥ 140°F.*
chilled transportation		≤ 45°F.*
reheating	rapidly	≥ 165°F.!
display & service		≤ 45°F.* or ≥ 140°F.*

@Adapted from USDHEW: FDA Food Service Sanitation Manual, 1978.
!Temperature at all parts of the food.
*Internal temperature of the food.

APPENDIX C: Survey Questionnaire

AN ASSESSMENT OF COOK-CHILL FOODSERVICE SYSTEM

Definition of Cook-Chill Foodservice System:
Cook-Chill Foodservice system is defined as a mass feeding method. This method is based on conventional preparation of food followed by rapid chilling, storage in a temperature controlled environment, and then rethermalizing the food immediately at time of service.

1. Does your facility use a Cook-Chill Foodservice System? (Circle one number)

   1 YES
   2 NO (If your facility is not using the Cook-Chill Foodservice System, please do not answer the following questions and return the questionnaire to us.)

2. Is the Cook-Chill Foodservice System the first foodservice system in your facility? (Circle one number)

   1 YES (New established facility) (Skip to Question 3, Page 2)
   2 NO

2a. Which system did your facility use prior to Cook-Chill Foodservice System?

   1 CONVENTIONAL (Cooking close to serving)
   2 COOK-FREEZE (Cooking to frozen inventory and reheating before serving)
   3 CONVENIENCE FOOD (Buying ready-prepared food and reheating before serving)
   4 COMBINATION (Combine two or three above systems)

2b. For each of the attributes listed below, please rate your Cook-Chill Foodservice System compared to your prior system in question 3 as better, equal, or worse. (Circle one number for each)

	BETTER	EQUAL	WORSE	DON'T KNOW
a. Serving temperature	1	2	3	4
b. Sensory (Flavor, texture, appearance)	1	2	3	4
c. Microbiological condition (number of bacteria, safety of the food)	1	2	3	4
d. Nutrient retention	1	2	3	4
e. Production quantity control	1	2	3	4
f. Customers' satisfaction	1	2	3	4
g. Employees' satisfaction	1	2	3	4
h. Your satisfaction	1	2	3	4

2c. In the following list of cost items compare Cook-Chill Foodservice System with prior foodservice system. Please indicate whether costs are decreasing, staying the same, or increasing in your hospital. If costs are changing, also give the percentage of the decrease or increase. (Circle one number for each and write down the percentage)

	DECREASE	%	THE SAME	INCREASE	%	DON'T KNOW
a. Food cost (per meal)	1	____	2	3	____	4
b. Labor cost (per meal)	1	____	2	3	____	4
c. FTEs (specify number of FTEs decreased or increased ________).	1	____	2	3	____	4
d. Energy cost (per meal)	1	____	2	3	____	4
e. Equipment cost	1	____	2	3	____	4
f. Construction cost	1	____	2	3	____	4
g. Total cost	1	____	2	3	____	4
h. Annual cost/per meal	1	____	2	3	____	4

(PLEASE TURN THE PAGE)

3. For each attribute listed below, please rate your Cook-Chill Foodservice System as very poor, poor, fair, good, or excellent. (Circle one number for each)

	VERY POOR	POOR	FAIR	GOOD	EXCELLENT
a. Serving temperature	1	2	3	4	5
b. Sensory (flavor, texture, appearance)	1	2	3	4	5
c. Microbiological condition (number of bacteria, safety of the food)	1	2	3	4	5
d. Nutrient retention	1	2	3	4	5
e. Production quantity control	1	2	3	4	5
f. Customers' satisfaction	1	2	3	4	5
g. Employees' satisfaction	1	2	3	4	5
h. Your satisfaction	1	2	3	4	5

4. In the table below are some possible advantages of Cook-Chill Foodservice System. Please indicate whether or not you feel each is an advantage of the system. (Circle one number for each)

	YES	NO
a. High productivity	1	2
b. Labor saving	1	2
c. Energy saving	1	2
d. Consistent quality food..............................	1	2
e. Nutrient retention.................................	1	2
f. Good quantity control	1	2
g. Reducing food cost	1	2
h. Safety	1	2
i. Increasing the palatability of food......................	1	2
j. Good working condition (no crisis peaks at meal time)	1	2
k. Others (Specify_______________________)	1	2

5. Now, listed below are some possible disadvantages of Cook-Chill Foodservice System. Please indicate whether or not you feel each is a disadvantage of the system.(Circle one number for each)

	YES	NO
a. High capital cost of equipment	1	2
b. High energy cost	1	2
c. Increasing food cost	1	2
d. Poor food flavor and texture	1	2
e. Nutrient loss	1	2
f. Increasing hazard of food poisoning	1	2
g. Additional efforts for staff training	1	2
h. Additional efforts for menu design	1	2
i. Others (Specify_______________________)	1	2

6. Please write down the following current costs in your facility.

a. Average meal cost = $__________________

b. Labor cost/meal = $__________________

c. Food cost/meal = $__________________

7. If you had a chance to decide what system to use for your facility, would you choose a Cook-Chill Foodservice System again? (Circle one number)

1 YES, WOULD (Go to Question 7a)

2 NO, WOULD NOT (Skip to Question 7b)

(PLEASE GO TO THE NEXT PAGE)

7a. What are the reasons you would choose a Cook-Chill Foodservice System?

(SKIP NOW TO QUESTION 8)

7b. What are the reasons you would not choose a Cook-Chill Foodservice System?

8. What type of foodservice does your facility have? (Circle one number)

    1 COMMERCIAL FEEDING (Such as restaurant, food contractor, and hotel/motel)
    2 NON-COMMERCIAL FEEDING (Such as school, hospital , nursing home , community center, military feeding, prison, transportation (airline, cruise ship))

9. Is your facility's funding private, public or a combination? (Circle one number)

    1 PRIVATE
    2 PUBLIC
    3 COMBINATION

10. In what year was your Cook-Chill Foodservice System installed in your facility? (Circle one number)

    1 PRIOR TO 1960
    2 1960 - 1969
    3 1970 - 1979
    4 1980 - 1985
    5 1986 - 1990

11. What type of production flow does your facility have? (Circle one number)

    1 CENTRALIZED FOOD PRODUCTION
    2 DECENTRALIZED FOOD PRODUCTION

12. Is your Cook-Chill Foodservice System housed in an existing building, a new building or both? (Circle one number)

    1 EXISTING BUILDING
    2 NEW BUILDING
    3 BOTH NEW AND EXISTING

13. Does your facility serve one meal a day, two meals or three meals? (Circle one number)

    1 ONE MEAL/DAY
    2 TWO MEALS/DAY
    3 THREE MEALS/DAY

(PLEASE TURN THE PAGE)

14. Approximately, how many meals does your facility accommodate per day? (Circle one number)

1 LESS THAN 1000
2 1000-1999
3 2000-2999
4 3000-4000
5 MORE THAN 4000 (Specify_______________)

15. What type of main chilling equipment is your facility using? (Circle one number)

1 BLAST CHILLER
2 TUMBLER CHILLER
3 OTHER_______________

16. What is the primary reheating method used by your facility? (Circle one number)

1 MICROWAVE OVENS
2 CONVECTION OVENS
3 INFRA-RED REGENERATION OVENS
4 HEATING PLATES
5 INTEGRAL HEAT SYSTEM
6 OTHER_______________

17. Is your facility a hospital? (Circle one number)

1 YES (Go to Question 17a)
2 NO (Skip to Question 18)

17a. How many beds does your hospital have? (Circle one number)

1 LESS THAN 300
2 300 - 449
3 450 - 599
4 600 - 749
5 MORE THAN 750

18. For each attribute listed below, please indicate whether or not you have been responsible for Cook-Chill Foodservice System in your facility. (Circle one number for each)

	YES	NO
a. Decision making for selection the Cook-Chill System	1	2
b. Design or implementation the Cook-Chill System	1	2

19. How many years have you managed a Cook-Chill Foodservice System ?

__________ YEARS

20. We may not have covered all of the issues involved in your foodservice management. Is there anything would like to tell us? Use this space or attach an additional page for other comments.

(THANK YOU FOR YOUR COOPERATION)

APPENDIX D: Cover Letter, Initial Mailing

DEPARTMENT OF
NUTRITION AND FOOD
MANAGEMENT

OREGON
STATE
UNIVERSITY

Milam Hall 108
Corvallis, Oregon
97331-5103

March 13, 1990

Dear Manager:

We are conducting a study to determine the operational effects and to identify the factors of decision making in the selection of Cook-Chill Foodservice System. This system has been installed in the United States for about 30 years. We are interested in the manager's opinion to assess this method of food production.

Your response will be used to evaluate the Cook-Chill Foodservice System in foodservice industry. Facilities with Cook-Chill Foodservice System are relatively small in number, therefore your contribution will be extremely valuable. It is important that each questionnaire be completed and returned in the enclosed postage paid envelope. You may be assured of complete confidentiality. Questionnaires are number coded only for the purpose of mailing administration and responses will not be linked to your name or organization.

We appreciate your time in completing this questionnaire. Results are expected to be reported through The Journal of American Dietetic Association. If you have any question or comment, please call the Department of Nutrition and Food Management at (503) 737-0959. We look forward to your response.

Sincerely,

Mei-Fang Yang

Ann Messersmith

Mei-Fang Yang	Ann Messersmith, Ph.D., R.D.
Project Director	Associate Professor
Dept. of Nutrition	Dept. of Nutrition
and Food Management	and Food Management

Telephone
503-737-3561

APPENDIX D: Post Card

March 20, 1990

Last week a questionnaire was mailed to you for information about your assessment of Cook-Chill Foodservice System. If you have already completed and returned it to us, please accept our sincere thanks. If not, please do so today. Because it has been sent to only a small number of Cook-Chill Foodservice System users, it is important that yours be included in the study if the results are to accurately represent the user group.

If by some condition, you did not receive the questionnaire, or it got mislead, please call (503) 737-0959 and another questionnaire will be sent to you.

Sincerely

Mei-Fang Yang
Project Director

APPENDIX D: Cover Letter, Second Mailing

DEPARTMENT OF
NUTRITION AND FOOD
MANAGEMENT

OREGON
STATE
UNIVERSITY

Milam Hall 108
Corvallis, Oregon
97331-5103

Telephone
[illegible]

April 5, 1990

Dear Manager:

About three weeks ago, we wrote to you seeking your assessment of the Cook-Chill Foodservice System. As of today, we have not yet received your completed questionnaire. In the event that your questionnaire has been misplaced, a replacement is enclosed. We would appreciate your reply as soon as possible. If you have any questions, please call (503) 737-0959.

We are contacting you again because each questionnaire is of great significance to be the usefulness of this study. Only a small number of users are being asked to complete this questionnaire. In order for the results of this study to be useful, we need your response. It is important that each person return his or her questionnaire. As mentioned in our last letter, you may be assured of complete confidentiality.

Sincerely,

Mei-Fang Yang	Ann Messersmith, Ph.D., R.D.
Project Director	Associate Professor
Dept. of Nutrition	Dept. of Nutrition
and Food Management	and Food Management

APPENDIX D: Cover Letter, Third Mailing

DEPARTMENT OF
NUTRITION AND FOOD
MANAGEMENT

OREGON
STATE
UNIVERSITY

Milam Hall 108
Corvallis, Oregon
97331-5103

Telephone
[illegible]

April 19, 1990

Dear Manager:

We are writing to you again for our study of assessment the cook-chill foodservice systems. We have not yet received your completed questionnaire. We would deeply appreciate your response and have enclosed a replacement questionnaire for you.

The number of questionnaires returned is very encouraging. But, your response will be able to help us to accurately determine what the effects of
Cook-Chill Foodservice Systems in the foodservice industry.

We encourage you to complete and return the questionnaire as quickly as possible. Your response is critical to this study and would be greatly appreciated.

Sincerely,

Mei-Fang Yang	Ann Messersmith, Ph.D., R.D.
Project Director	Associate Professor
Dept. of Nutrition	Dept. of Nutrition
and Food Management	and Food Management

APPENDIX E: Methodology Supplements

The response data were organized and tabulated in the following manner:

1. Frequencies and percentages of response of perception of meal quality, quantity control and personnel satisfaction in comparing Cook-Chill Foodservice Systems with prior system:
   A. Serving temperature
   B. Sensory evaluation
   C. Microbiological control
   D. Production quantity control
   E. Customer satisfaction
   F. Employee satisfaction
   G. Manager satisfaction
2. Frequencies and percentages of response and the changed percentages of perception of cost effects in comparing Cook-Chill Foodservice Systems with prior system:
   A. Food cost
   B. Labor cost
   C. Numbers of full-time equivalents(FTEs)
   D. Energy cost
   E. Equipment cost
   F. Construction cost
   G. Total cost
   H. Annual cost/per meal
3. Frequencies, percentages and means of Likert 5-point(very poor,

poor, fair, good, and excellent) scale of response perception of meal quality, quantity control and personnel satisfaction of Cook-Chill Foodservice Systems:

A. Serving temperature
B. Sensory evaluation
C. Microbiological control
D. Nutrient retention
E. Production quantity control
F. Customer satisfaction
G. Employee satisfaction
H. Manager satisfaction

4. Ranges(the highest and lowest) and means of current meal cost, food cost per meal and labor cost per meal.
5. Frequencies and percentages of the response perception of the advantage variables of Cook-Chill Foodservice Systems:

A. High productivity
B. Labor savings
C. Energy savings
D. Consistent quality food
E. Nutrient retention
F. Quantity control
G. Reducing food cost
H. Safety
I. Increasing the palatability of food
J. Good working conditions(no crisis peaks at meal time)

K. Others

6. Frequencies and percentages of the response perception of the disadvantage variables of Cook-Chill Foodservice Systems:
    A. High capital cost of equipment
    B. High energy cost
    C. Poor food flavor and texture
    D. Nutrient loss
    E. Increasing hazard of food poisoning
    F. Additional effort for staff training
    G. Additional effort for menu design
    H. Others
7. Ranking the major reasons of choosing Cook-Chill Foodservice Systems.
8. Ranking the major reasons of not choosing Cook-Chill Foodservice Systems.
9. Frequencies and percentages of demographic data of response's facility of Cook-Chill Foodservice Systems:
    A. Prior system
    B. Installation year of Cook-Chill Foodservice Systems
    C. Type of establishment
    D. Funding sources of organization
    E. Type of building construction
    F. Type of production flow
    G. Meal times per day
    H. Volume of meals per day

I. Type of chilling equipment

J. Reheating method of menu items

10. Frequencies and percentages of professional profile of the respondents:

    A. Numbers of years of manager management Cook-Chill Foodservice Systems

    B. Manager responsibility for decision making for using Cook-Chill Foodservice Systems

    C. Manager responsibility for design and implementation of Cook-Chill Foodservice Systems

11. F test analysis of means of Likert 5-point scale response in the perception of meal quality of Cook-Chill Foodservice Systems among meal quality attributes (1) serving temperature, (2) sensory evaluation, (3) microbiological control, and (4) nutrient retention.

12. F test analysis of means of Likert 5-point scale response in the perception of personnel satisfaction for Cook-Chill Foodservice Systems among customers, employees and managers.

13. F test analysis of mean of Likert 5-point scale response among chilling equipment of Cook-Chill Foodservice Systems in the perception of:

    A. Meal quality

    B. Personnel satisfaction

14. F test analysis of mean of Likert 5-point scale response among reheating methods of Cook-Chill Foodservice Systems in the perception of:

A. Meal quality

B. Personnel satisfaction

15. F test analysis of mean of Likert 5-point scale response between groups serving different numbers of meals per day of Cook-Chill Foodservice Systems in the perception of personnel satisfaction.
16. Chi square analysis of response in comparing Cook-Chill Foodservice Systems and prior system in cost among private, public and combination funding sources.
17. F test analysis of the means of average meal cost, labor cost and food cost per meal of Cook-Chill Foodservice Systems among private, public and combination funding sources.
18. Student's t test analysis of the means of average meal cost, labor cost and food cost per meal of Cook-Chill Foodservice Systems between commercial and noncommercial feeding groups.
19. Chi square analysis in manager's willingness to choosing Cook-Chill Foodservice Systems again between the groups:

    A. Responsible for decision making for using Cook-Chill Foodservice Systems

    B. Responsible for design or implementation Cook-Chill Foodservice Systems

    C. Years of management Cook-Chill Foodservice Systems
20. Correlation analysis of means of Likert 5-point scale response of Cook-Chill Foodservice Systems between:

    A. Manager satisfaction and management years of Cook-Chill Foodservice System

B. Manager satisfaction and total volume of meals served per day

C. Manager satisfaction and hospital size

D. Employee satisfaction and total volume of meals served per day

E. Employee satisfaction and hospital size

F. Customer satisfaction and total volume of meals served per day

G. Customer satisfaction and hospital size