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Order Number 9105213

Staffing and scheduling flexibility: A study of hospital nursing units

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The Ohio State University, 1990

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STAFFING AND SCHEDULING FLEXIBILITY: A STUDY OF HOSPITAL NURSING UNITS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree of Doctor of Philosophy in the Graduate
School of The Ohio State University

By

Sue Perrott Siferd, B. S., M. B. A., M. A.

* * * * *

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To Michael and Jeffery

ACKNOWLEDGMENTS

I wish to thank Professor Larry P. Ritzman for his direction, guidance, and encouragement throughout this research. Professor W. C. Benton and Professor Glenn Milligan have also provided a great deal of assistance and support for which I am extremely grateful. I also would like to express my appreciation for the support of Professor Cheryl Gaimon, now of the Georgia Institute of Technology, who carefully mentored me through the course work and general exam stages of my Ph. D. study. Professors Ritzman, Benton, Milligan, and Gaimon have been most responsible for shaping my thought processes throughout my graduate study at the Ohio State University. These four professors have taught me the value of carefully planned, well executed, and thoughtfully analyzed scholarly research. They also have contributed greatly to my current state of knowledge about the field of operations management and to my philosophy about the role of research in advancing that state of knowledge. I thank them all for their combined wisdom!

I also would like to thank all of the nursing executives and hospital research board members who gave permission for my research study to be conducted in their hospitals. I always will be grateful to the 348 nurse managers who completed and returned my survey instrument. Without the information they so graciously shared with me, there would have been no study.

I would like to gratefully acknowledge the financial support for this research received from the Graduate Student Alumni Research Award, and from the Faculty of Management Sciences Fellowship.

I would like to thank my good friend, Dorothy L. Fiorino, Director of the Ohio Board of Nurses, for her continuous support and unwavering encouragement throughout this research. Ms. Fiorino is responsible for stimulating my interest in the hospital nurse staffing and scheduling problem, and for providing me with much background material. I have benefitted greatly from her knowledge and intuition gained from experience at every level of the nursing hierarchy.

I also wish to thank Carla Evans, Teresa Luterbach, and Tammy Schwerman for their most able technical assistance at various stages of this research.

Lastly, I especially would like to thank my sons, Michael and Jeffery, my sister Mary Carol Perrott, my daughter-in-law Colleen, and my good friend Frank Canda for their love and support during the past six years.

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FIELDS OF STUDY

Major Field: Business Administration

Studies in Operations Management and Logistics

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1.1 INTRODUCTION

In the service sector, the selection and utilization of the work force are the keys to successful operations. The importance of the work force to a service sector organization cannot be understated. Much of the product or service must be prepared and presented in the presence of the customer. When customer demand occurs, the availability or lack of appropriate workers greatly impacts a service organization's ability to achieve its objectives. This research explores relationships between work force staffing and scheduling and several other influences in the service sector work environment.

The focus of this study is on the role of flexibility in service sector staffing and scheduling. Figure 1.1 illustrates staffing and scheduling flexibility as it is viewed in this research. For the purposes of this research, an extremely flexible work force is considered to be a work force that can perform, at their employer's request, any job, at any time, in any place, for any volume of demand, and who are willing to accept frequent reassignments. The counterpart of an extremely flexible work force is an extremely flexible organization. Such an organization is one in which the work force may perform tasks of their choosing, at any time, in any place, in any volume of supply, and may select new tasks at intervals of

Characteristics of Staffing and Scheduling Flexibility

DIMENSION

DEGREE	Organization	Work Force
Highly Flexible	Employees may chose from a wide variety of work assignments.	Each employee is able to perform a wide variety of work assignments.
	Employees may choose the time of task or job performance.	Employees are able to work at any time.
	Employees may choose the place at which work is performed.	Employees are able to work at many places.
	Any number of employees may be working at any time.	Any number of employees are available as needed.
	There are frequent opportunities for employees to reselect work assignments.	Employees are willing to make very frequent changes in work assignments.
Highly Inflexible	Employees have no choice in work assignments.	Each employee is able to perform a narrow range of tasks.
	Employees have set start times, shift lengths and days off, rigidly adhered to.	Each employee is only available within a limited time frame.
	Employees have one assigned work station.	Each employee is only able to work at a single machine, location or work station.
	The size of the work force is always the same.	It is difficult to change the number of employees available.
	Changes in assignments are very rare.	Employees are very unwilling to accept work assignment changes.

Figure 1.1

Characteristics of Staffing and Scheduling Flexibility the employees' choosing, in accordance with overall objectives of the organization.

Few, if any, completely flexible work forces and organizations exist. However, the underlying premise of this research is that staffing and scheduling flexibility is the primary buffer against uncertainty in service sector operations. If a service sector organization has a limited operation or a very predictable demand, there is little need for staffing and scheduling flexibility. However, the need for staffing and scheduling flexibility becomes greater as an organization makes more services available to its customers, at more times, in more places. The wider the range of service offerings, and the more unpredictable the demand, the greater the need for the buffers provided by staffing and scheduling flexibility. Figure 1.2 gives some examples of organizations and work forces that fall along the continuum from high to low flexibility. This research represents an initial effort to develop a way to measure service sector work forces and organizations with respect to their staffing and scheduling flexibility. These flexibility measures are related to several characteristics that shape the operations management environment in an organization.

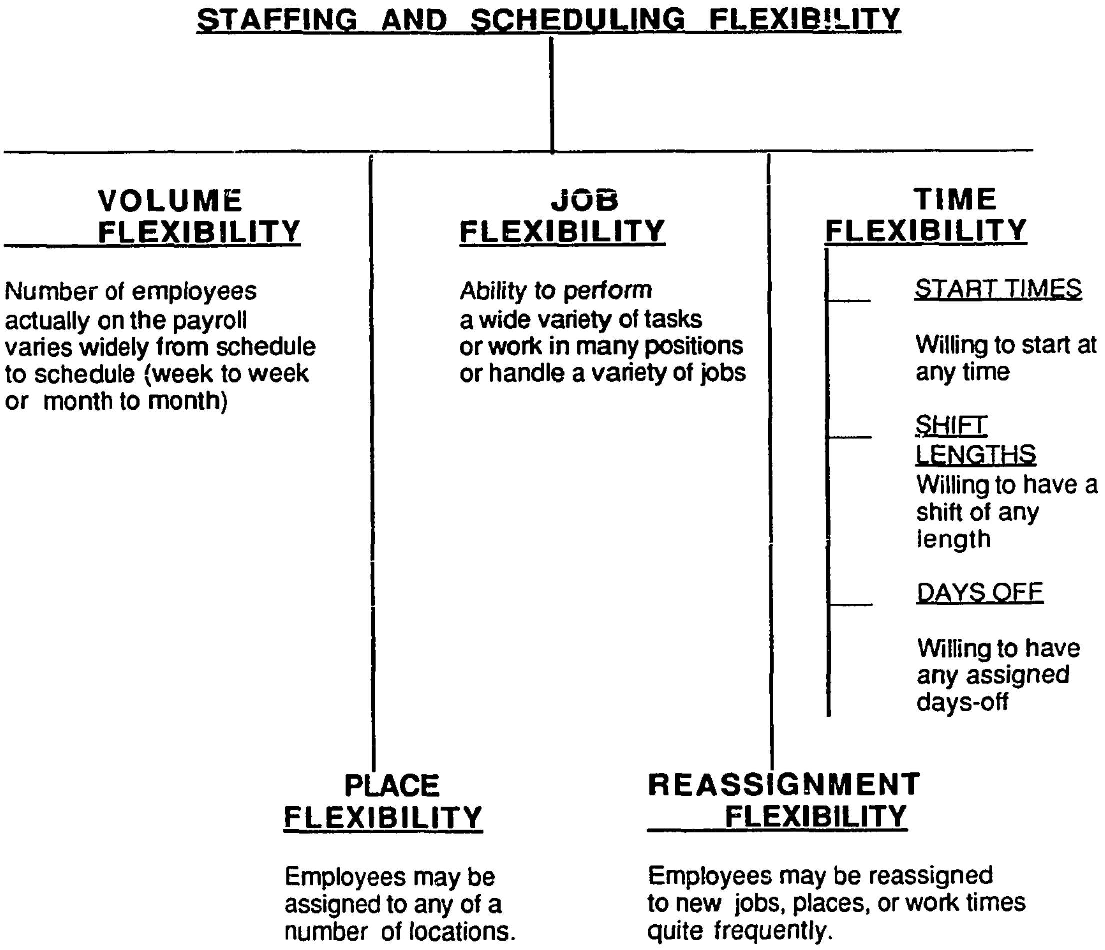
Staffing and scheduling flexibility is a many faceted characteristic. An organization or work force may have job flexibility, time flexibility, place flexibility, volume flexibility and reassignment flexibility. These facets are defined in Figure 1.3. This research is concerned with these five facets and their relationships to several characteristics of operations. Operations characteristics of interest are the size of the operating unit, and the degrees of technology, capital intensity, and variability in demand in the immediate work place. The role of the first -line manager in the determination, implementation,

A Spectrum of Staffing and Scheduling Flexibility in the Service Sector

	Organizations	Work Forces
Highly Flexible	Universities with respect to the research function	Temporary Services Employee Outside Salespeople Registered Nurses in an Agency Pool Substitute Teachers Loaders of overnight packages Managerial Consultants Home Nursing Service Employees Registered Nurses in a Hospital
Medium Flexibility	Law firms Accounting firms Consulting firms Universities with respect to the teaching function Public Utility Repair Services	Lawyers Certified Public Accountants Bank Check Encoders Elementary School Teachers Food service workers Utility Line Workers Police forces Computer Programmers Skilled Repair Technicians University Professors Clerical Workers
Low Flexibility	Most Hospital Nursing Units Many Corporations with respect to their office support functions Public School Systems Government Welfare Agencies	Unionized Auto Workers Secondary School Teachers Unionized Electricians Civil Servants

Figure 1.2

Examples of Staffing and Scheduling Flexibility in Selected Organizations



STAFFING AND SCHEDULING FLEXIBILITY

VOLUME FLEXIBILITY

Number of employees actually on the payroll varies widely from schedule to schedule (week to week or month to month)

JOB FLEXIBILITY

Ability to perform a wide variety of tasks or work in many positions or handle a variety of jobs

TIME FLEXIBILITY

START TIMES

Willing to start at any time

SHIFT LENGTHS

Willing to have a shift of any length

DAYS OFF

Willing to have any assigned days-off

PLACE FLEXIBILITY

Employees may be assigned to any of a number of locations.

REASSIGNMENT FLEXIBILITY

Employees may be reassigned to new jobs, places, or work times quite frequently.

Figure 1.3

Five Facets of Staffing and Scheduling Flexibility

and control of policies relating to work force staffing and scheduling, and the relationship between staffing and scheduling flexibility and an organization's objectives also are studied.

Staffing and scheduling are closely connected with productivity issues, particularly in labor intensive operations, such as those found in hospitals, universities, restaurants, banks and many other service sector organizations. Staffing and scheduling practices in the service sector also influence the selection and timing of service offerings, the quality of service, costs, customer satisfaction and employee satisfaction.

Hospital nurse staffing and scheduling operations have been chosen as the vehicle through which staffing and scheduling flexibility is investigated in this research. The study centers on the staffing and scheduling practices of hospital nursing units because most hospital nursing units represent a variety of operating characteristics often ascribed to pure services. Explored in this study are the relationships between those practices and characteristics of the environments in which nursing units operate. Insights gained from this exploration are reported.

Traditional operations management approaches to staffing and scheduling have concentrated on the development of algorithms to solve scheduling problems in individual organizations. This algorithmic research, much of which has been directed to specific situations, has been, and continues to be, valuable at the tactical level of decision making. However, it has become clear that the focus must be broadened if the nagging productivity problems being experienced throughout the U.S. economy are to be addressed. In order to make headway on policy issues, relationships between policy variables must first be hypothesized and tested. This research breaks from traditional OM research in investigating relationships between an organization's operating environment and its staffing and scheduling decisions. A large scale empirical study has been conducted in thirty-one hospitals with 348 nursing unit managers. Data collected from these hospital nursing units have been analyzed in an attempt to establish baseline measures for staffing and scheduling flexibility, and to determine the relationship of staffing and scheduling flexibility to other environmental and managerial influences on operations.

1.2 RESEARCH OVERVIEW

One purpose of this research is to begin the development of measures for staffing and scheduling flexibility from an operations management point of view. In order to develop such measures, relationships are explored between variables representing characteristics of staffing and scheduling strategies and practices, the operating environment, and management objectives. In Section 1.5 and in Chapter II a series of simple hypotheses related to work force flexibility are presented. The hypotheses given in Chapter II are developed from the operations management scheduling and staffing literature. These hypotheses are tested and further discussed in Chapter V.

Another objective is to describe the current state of hospital nurse staffing and scheduling practice with respect to staffing and scheduling flexibility, technology, capital intensity, variability in the work environment, and management's objectives for the operating unit. In this exploratory research study, relationships are examined between some of these elements of the operating environment and staffing and scheduling strategies. These results are presented in Chapter III. This first chapter presents an overview of the research problem, the research methodology, and expected contributions. Section 1.3 discusses characteristics of staffing and scheduling in the service sector, and the strategic issues inherent in staffing and scheduling decisions. Section 1.4 contains the motivation for the research. Section 1.5 is a methodological overview, including descriptions of the research instrument, data collection techniques, a priori hypotheses, and statistical analyses. Section 1.6 reviews the contributions of the research.

In the second chapter, a review of the literature relevant to the service sector and to staffing and scheduling decisions in operations management is presented. Characteristics of service sector operations, and the importance of conducting service sector research, are reviewed. Previous research into operations strategy and its linkage to more tactical decisions are briefly discussed. Operations management literature about work force staffing and scheduling research in specific service sector industries, including hospitals, also is reviewed. Relationships between past research and the current research are developed, and motivation for the current research is discussed.

Chapter III contains an extensive discussion of the summary statistics for all questions in the research instrument, as well as comparisons of the summary statistics for different types of nursing units. Chapter IV discusses staffing and scheduling flexibility, and develops some measures for different dimensions of work force flexibility. Chapter V reports the tests of hypotheses presented in Chapter I and II. Chapter VI discusses linkages among the results presented in

Chapters III, IV, and V. Results are synthesized, and specific and general conclusions stated. Opportunities for future research are discussed.

1.3 STAFFING AND SCHEDULING IN THE SERVICE SECTOR

The service sector has become increasingly important in our economy as 80% of all workers are now employed in service sector organizations. Health care is a significant segment of the service economy, and hospitals are a major subset of health care. There is growing pressure to contain costs and increase productivity in the health care area. A renewed look at staffing and scheduling practices is one response to that pressure. Health care decision makers are in search of new ways to match employee supply with customer demand, as are other service sector managers. While this research has chosen to concentrate on one area of the service sector, parallels to other service industries may be drawn, and results may have implications beyond the health care sector.

1.3.1 Importance of Staffing and Scheduling in the Service Sector

In most service sector operations, the customer must be present before the exact nature of the required service is known. This dependency upon customer presence means that output usually cannot be inventoried or prepared in advance. On the other hand, if a desired service is not provided in a timely fashion, the customer's demand may expire and the opportunity to provide a particular service may be lost forever. In a service sector organization, for any given time period, the kinds of employees hired and on duty directly impact the selection and timing of services offered during that time period.

Throughout the U.S. economy, pressure exists for productivity increases. Fewer inputs are expected to produce greater output. The service sector is hard hit by this pressure because service sector operations tend to be more labor intensive. Traditional responses to productivity pressure, such as increased automation, are being used where feasible. Technological advances continually increase the range of feasibility for such automation, but the human worker remains the backbone of many service sector operations. Employees may be trained in better work methods, so that customers may be served more quickly, or employees can be trained to provide a wider range of services, thus increasing their flexibility. However, in the service sector, productivity increases often come down to the ability of the organization to match employee availability with customer demands. To paraphrase the "rights" statement in material management [Coyle, Bardi, & Langley, 1988], "Having the right number of the right employees in the right place at the right time" is a major determinant of productivity in the service sector.

In a service organization, capacity may be thought of as "physically limited" or "server limited." Physical capacity limitations are determined by hardware. Items such as the number of square feet of floor space, the number of tables in a restaurant, the number of seats in a theater, the number of checkout stands in a supermarket, or the number of beds in a hospital unit are examples of physical limitations to capacity. Server limitations to capacity are determined by the number of customers that can be served by the available employees. Effective capacity of the facility, then, at any given time, is the lesser of the two. If enough employees are available that service could be provided in excess of the physical limits of the facility, the result will be idle time on the part of the employees. In a cost-conscious organization, this situation is unlikely to occur. Therefore, in a cost-conscious, productivity-pressured service organization, the effective capacity is very likely to be limited by the number of available employees. Filling the physical capacity with customers, in excess of the server capacity merely increases the queue. Service to some or all customers will be delayed, because there are not enough employees to go around.

It is not difficult to see that quality of service and customer satisfaction are affected as well. If too few employees are available at a very busy time, the customers may be served but, in addition to the occurrence of long waiting times, mistakes may be made, sloppy service may result, and some services may be omitted. If too many employees are available, costs may be higher than necessary, although customer satisfaction may improve. One of the challenges to service sector managers is to balance the trade-offs between high productivity and high quality. Certainly, staffing and scheduling decisions play a key role in achieving a desired balance.

Staffing and scheduling decisions are not only a determinant of customer satisfaction, but employee satisfaction as well. Employee morale, turnover, attitude toward customers, and willingness to accept the goals of the organization as their own can all be affected by the staff composition and size and the schedules assigned. The choice and use of human resources in service sector organizations become critically important, if operating objectives are to be achieved.

1.3.2 A Staffing and Scheduling Decision Hierarchy

Employees available to be scheduled at any given time are the result of a series of management decisions, strategic as well as tactical. Service sector organizations make many decisions related to the scheduling of their human resources. Four such decisions are the design of the flow of work through the organization, the design of the work force, the design of the work-force scheduling system, and the assignment of employees to specific responsibilities and tasks. Tables 1.1 and 1.2 show the kinds of decisions likely to be found in each category.

The first three of these decision categories are primarily strategic in nature. These three sets of decisions, for the purpose of this research study, will constitute a work-force staffing and scheduling strategy. The fourth set of decisions, concerned with the actual short-term scheduling of workers, cannot be made unless the other sets of decisions have been executed, either explicitly or implicitly. Work-force staffing and scheduling strategy design decisions constrain the choices available for the actual scheduling assignment decisions. One premise of this researcher is that the need for staffing and scheduling flexibility should be considered when design decisions are made.

Table 1.1

Strategic Decisions in a Work-Force Staffing and Scheduling System

Strategic decisions related to the scheduling of human resources in service sector organizations may include the following choices:

1. The basic design of the operating system, including:
    a. Services each unit will provide;
    b. Days and hours each unit will operate;
    c. The number of operating units;
    d. The type of operating units;
    e. The interrelationships to exist between the various operating units.

2. The basic design of the work force, including:
    a. Skills and abilities needed in each unit;
    b. Number of managers and supervisory personnel needed in each unit;
    c. Management reporting hierarchy;
    d. Purpose, method, timing, and location of employee training;
    e. Number of employees of each type to be assigned to each unit under various demand scenarios;
    f. Circumstances or decision rules to be used to determine the number of each type of employee on duty at any given time;
    g. Policies or decision rules to determine when to hire, fire, train, promote and reassign employees;
    h. Policies or decision rules to be used to assign available employees to specific operating units over the long term ;
    i. Types of employment commitments such as full-time, part-time, temporary, or seasonal, to be used;
    j. Sources to be used for supplying employees; and
    k. Frequency with which each of the sources is to be used.

3. The basic design of the work-force scheduling system, including:
    a. The determination of specific start times and shift lengths;
    b. The determination of the total number of hours in a given time period that employees in different classes (full-time, part-time, temporary) will be expected to work in a given time period;
    c. A policy for days off, vacations, and sick leave;
    d. A policy for weekend work assignments;
    e. A policy for overtime work assignments; and
    f. A policy for work breaks during the daily work period.

Table 1.2

Tactical Decisions in a Work-Force Scheduling System

Tactical decisions related to the scheduling of human resources in service sector organizations may include the following choices:

> The actual assignment of specific employees to specific operating units and duties, including:
>
> a. Long term work assignments for permanent employees;
> b. Short term scheduling or the assignment of work tours (actual days on and off and hours to be worked over a limited time horizon) to individual employees within each operating unit;
> c. Even shorter term reassignments or reallocation of work force among tours or between operating units, as need shifts;
> d. Determination of actual use of overtime by specific employees;
> e. Determination of the need for temporary employees and their actual procurement;
> f. Short term assignment of specific duties and responsibilities to individual members of the work force.

1.4 MOTIVATION FOR THE RESEARCH

1.4.1 The Health Care Industry

In the past decade many changes have taken place in the health care industry. There is no reason to believe that the next decade will be calmer. Today, pressures to lower costs of health care come from the government, insurance companies, communities, individual consumers of health-care services, and others. At the same time, many of the same groups are demanding an ever high quality of care and an ever wider variety of services. Exacerbating the problem are consumer demands that the latest in health-care technology be available to all. Thus, the health care industry operates amid conflicting pressures, and is likely to do so for some time.

One major catalyst for changes in health care operations occurred at the beginning of the 1980s. In the early 1980s the Federal government began a switch in its reimbursement policies for patients treated in hospitals under the Medicare system. Before 1981, hospitals were reimbursed for patient care on a "cost-of-service" basis, whereby the government paid the hospital whatever the hospital determined to be the cost. Such a system did little to inspire cost efficiency. In 1981, the Medicare system began the first phase of a prospective payment system which was fully in place by 1985.

Under a prospective payment system, known as a PPS, all hospital patients were classified into one of 471 categories, known as Diagnostic Related Groups, or DRGs [Curtin and Zurlage, 1984; Spiegel and Kavaler, 1986]. Hospitals are reimbursed based on average costs for caring for a patient with a particular DRG, regardless of the cost of caring for the individual patient. If a given hospital's cost of care is lower than the average cost, the hospital profits. If a hospital's cost is higher than average, the hospital loses. Although Medicare accounts for less than 40% of hospital patients overall, other third-party payers, such as States' Medicaid programs and major insurance companies, also have adopted prospective payment systems. These actions have further increased cost reduction pressures on hospitals. Much has been written about DRGs, pro and con, but one point of agreement is that hospitals have been forced to show greater concern with costs during the 1980s than in earlier decades.

Prospective payment systems have forced hospitals to reexamine many of their operations. In the 1980s, hospitals have tended to increase outpatient services, and decrease inpatient services. Inpatient hospital services are those services received by patients who have actually been admitted to the hospital. To receive outpatient services, hospital admission is not required. Cost pressures as well as technological advances have allowed the shifting of many medical treatments and surgical procedures from an inpatient basis to an outpatient basis. Many hospitals have been renamed as Health Centers or as Medical Centers, in order to reflect the image of providing broad-based health services, and not just hospital services. Over the past decade, inpatient hospital services increasingly have tended to be reserved for patients in need of a great deal of nursing care.

1.4.2 Reasons for Studying Nursing Services

This research concentrates on hospital nursing services for a number of reasons. First, hospital nursing services exhibit almost all characteristics of "pure" services. These services, for the most part, must be continuously available, 24 hours a day, 7 days a week, with no breaks for weekends or holidays. Output is non-inventoriable, demand is highly time-dependent, and there is a great deal of customer contact.

Second, provision of nursing services is the primary reason for hospitals to continue to exist, in today's cost-conscious environment. Patients in need of a daily check by a physician are no longer kept in a hospital, unless nursing care also is needed. Patients in need of a reduced level of nursing care are dismissed and assigned a home health worker to stop by their homes every day or so for a few days or weeks after dismissal from the hospital. Patients in a hospital today are in need of highly skilled nursing care. The very cost pressures that have created the need for a higher level of nursing care *in the hospital* also make the staffing and scheduling decisions even more difficult. The need for the right employees in the right place at the right time becomes even more critical when services being provided have life and death overtones. This study investigates the links between strategic and tactical staffing and scheduling decisions, and the environments in which nursing services are provided.

At the time this dissertation is being written, a serious nursing shortage faces the nation. Not all hospitals and all nursing units are equally affected by the shortage. However, the nursing shortage is a contributing factor in the continuing search by nursing executives and first line nursing managers for better solutions to their staffing and scheduling problems.

1.5 OVERVIEW OF RESEARCH METHODOLOGY

1.5.1 Research Instrument

The research tool, a closed form questionnaire, was developed by this researcher. It was designed to test several hypotheses linking nurse staffing and scheduling practices in hospitals to the environment in which nursing units operate, and to operating goals. A copy of the questionnaire is shown in Appendix A. Summary responses to the questions, including percentage frequencies and means, are given in Appendix C. First line nursing managers, in charge of day-to-day management of nursing units, were the target respondents. These nurse managers carried a variety of titles such as Head Nurse, Unit Manager, Unit Director, Unit Coordinator, Nurse Manager, Assistant Head Nurse, Assistant Nurse Manager, Director, and Assistant Director. (See Appendix C, Question #1.) The unit of analysis is the individual nursing unit. Respondents in charge of more than one unit, were asked to respond for the unit consuming most of their time.

Respondents were asked questions about characteristics of their units, their nursing staff, the scheduling options and procedures they use, their patients and their hospital. Other questions dealt with their management responsibilities and the frequency with which certain types of decisions are made. One set of questions relates to the degree of control the respondents have over various aspects of nursing services on their units. Another set of questions deals with the variability of certain characteristics of operations on their units. In addition nurse managers were asked about their own and top management's goals for the operation of their units. Respondents were asked to rate their own performance on these goals. The front page of the questionnaire served as a cover letter, provided a brief project description, and informed respondents that their hospital had granted permission for them to complete the questionnaire. The cover letter stated that their informed consent was implied when they returned the survey instrument. Complete confidentiality was promised to respondents. In addition, many hospitals who granted permission to their nurse managers to respond to the survey instrument requested anonymity. Therefore, a list of participating hospitals is not included with this document.

A pilot study was conducted in 12 nursing units in three different hospitals, to test the survey instrument design and to determine the time it took to complete the questionnaire. The best estimate of the completion time was 40 minutes. Several revisions to the survey research instrument were made as a result of the pilot study.

The proposed study, and specifically the research instrument, received approval of the Ohio State University Human Subject Review Committee, on April 15, 1988, and was assigned Protocol Number 88B0059.

1.5.2 Sample Selection and Data Collection

Forty-two hospitals were selected from a directory of hospitals in the United States [American Hospital Association Guide to the Health Care Field, 1987]. Hospitals participating in the study were located in three states. The majority of the hospitals were in southwestern, central, and northeastern Ohio, and central Arizona. An initial contact was made with the senior nursing executive or with the secretarial staff of the senior nursing executive at each hospital in order to determine the procedures necessary to obtain permission to distribute questionnaires to *all* nursing unit managers in the chosen hospital. Whatever procedures were described were then followed by the researcher in order to receive permission to do the study in each selected hospital.

Thirty-one hospitals participated in this research. Of the 42 hospitals contacted about the study, 36 gave consent to their nursing unit managers to complete the research instrument. Three hospitals declined the opportunity to participate in the study. In three others, after the initial contacts and written requests, repeated phone calls did not result in closure. As far as it is known, the project is still "under review" at these three hospitals, and, should they agree to participate, data can be included in extensions of this study. Between June and September 1988, questionnaires were received from nurse managers at 31 of the 36 hospitals who granted permission to their nurse managers to complete the research instrument. In five hospitals, after originally agreeing to allow nurse managers to participate, permission was withdrawn. Reasons varied from visits to the hospital by accreditation teams, installation of new computer systems, participation in other internal studies, and other hospital priorities.

Questionnaires were distributed to nursing managers in participating hospitals in two ways. For hospitals located within a 75-mile radius of Columbus, Ohio, the researcher offered to attend a nursing management meeting, briefly explain the research project, and distribute the questionnaires. The researcher attended fifteen nursing management meetings to distribute questionnaires to those present. For nursing unit managers not present at the meetings (due to vacations, or work emergencies), questionnaires were left to be placed in their mailboxes or otherwise given to them. For hospitals beyond a 75-mile radius, and for those hospitals for whom it was not mutually convenient for the researcher to attend a nursing management meeting, questionnaires were sent to a contact person designated by the hospital for distribution to the appropriate nursing managers.

Originally, it was planned to choose a completely random sample of hospitals in Ohio and surrounding states, and then contact those hospitals for permission to conduct the survey among their nursing unit managers. Initially, the researcher was naive about the procedures necessary to gain permission to perform research in hospitals, and the time those procedures might consume.

One of the early learning experiences in the data collection phase of this research eliminated that naiveté as two things became apparent. One was that each hospital's individual requirements for approving research projects would have to be addressed if this project was to be carried to its conclusion. The second was that hospitals in which any research proposal must first be approved by a committee, the researcher's time-frame became secondary to the research committee's time-frame. While this did not preclude a random sample, a few hospitals were contacted which were suggested to this researcher by nursing executives and nurse researchers at other hospitals. As a consequence, a claim that the sample of hospitals was strictly random would have to be rejected.

A second influence on sample selection was the offer by the researcher to attend nearby nursing management meetings to explain the research project and solicit the cooperation of the appropriate nurse managers in completing the survey instrument. It was the hypothesis of the researcher, her dissertation committee, and many of the nursing executives and nurse researchers from whom permission to do the study was obtained, that a better response rate would result from direct personal contact with potential respondents. Thus several hospitals were chosen for their proximity to Columbus, Ohio. The response rates per hospital did not bear out the "higher response rate with personal contact" hypothesis. There was such a high level of interest in the project from the nursing community that an excellent response rate of over 45% resulted. However, there was no discernable difference between the rate of response from nurse managers in those hospitals visited by the researcher, and those not visited. The visits did provide invaluable experience to this researcher in obtaining a sense of the overall climate in hospitals today, as well as a sense of the depth of concern about nurse staffing and scheduling.

1.5.3 Data Analysis

1.5.3.1 Development of Hypotheses

Measures for staffing and scheduling flexibility will be developed in order to explore relationships between variables representing characteristics of staffing and scheduling policies, the operating environment, and management objectives. Table 1.3 lists staffing and scheduling hypotheses developed by this researcher prior to the data collection and analyses. One source of inspiration for these hypotheses was the operations management literature in staffing and scheduling. Table 2.5 in Chapter II gives a summary of some specific hypotheses on staffing and scheduling flexibility that have been developed from this source. Articles in the business press (for example, the Wall Street Journal, Fortune, Forbes, and Business Week) also served as a source of inspiration for hypotheses to be tested, as did this researcher's own long-time observation of many service sector organizations at work. The exploratory nature of this research leads to a wide range of hypotheses covering many of the strategic and tactical decision areas in work force staffing and scheduling that have been listed in Tables 1.1 and 1.2. In general the hypotheses take one of these forms:

H_0: The level of {a specific type of flexibility} is not related to {specific environmental conditions or operating policies} that exist.

or

H_0: The presence of {specific operating environment conditions, or management objectives} makes no difference in the use of {a specific staffing and scheduling condition or policy}.

or, as corollaries to the above formats, some hypotheses have the form

H_0: The use of {a specific staffing and scheduling condition or policy} under a {given environmental or operating condition} makes no difference in the performance of {a specific management objective}.

The hypotheses are stated in this format so that they will be testable. In general, the objective of this research is to accumulate evidence that will allow these hypotheses to be rejected. The belief of this researcher, based on managerial observation and the operations management literature, is that various scheduling strategies and policies will be used under different operating conditions, and that the choice of staffing and scheduling policies does make a difference in the accomplishment of objectives. The hypotheses shown in Table 1.3 have been generated in the spirit of Campbell and Stanley [1963] who said

> We may assume an ecology for our science in which the number of potential positive hypotheses very greatly exceeds the number of hypotheses that will in the long run prove to be compatible with our observations. *The task of theory-testing data collection is therefore predominantly one of rejecting inadequate hypotheses.* In executing this task, any arrangements of observations for which certain outcomes would disconfirm theory will be useful, including quasi-experimental designs of less efficiency than true experiments. ... experimental results never "confirm" or "prove" a theory — rather, the successful theory is tested and escapes being disconfirmed. [p.35]

In this spirit, the hypotheses this researcher hopes will "escape disconfirming" are the alternatives to the hypotheses stated in Tables 1.3 and 2.5.

1.5.3.2 Analyzing the Data and Testing The Hypotheses

As in any exploratory study, the first step was to look at very basic statistics about each variable [Hartwig and Dearing, 1979; Reynolds, 1984; Hildebrand, Laing and Rosenthal, 1977]. Means, standard deviations, modes, medians, quartiles, and simple frequency tables were analyzed based on all 348 responses for all variables in the survey. All variables collected in the research instrument are listed in Appendix B. Also in Appendix B, each variable is classified as to whether it is nominal scale, ordinal scale, or interval scale [Cohen and Cohen, 1983; Forthofer and Lehnen, 1981]. In some cases, two scale classifications are shown. In those cases, there is some support for placing the variable in the stronger category. Because this researcher thinks that one of the goals of an exploratory study is to find indications as well as strong relationships, some "poetic license", with respect to scale classifications, is taken in certain analyses with the hope that some additional insights will result. Whenever one of these slight misclassifications is used, it is so noted in the discussion accompanying the particular analysis. Few variables that could be considered ratio scale were collected in this study, although for many questions, the response categories represent underlying continuous variables. Means and frequency tables for each variable, based on all 348 respondents, are shown in Appendix C.

After examining the data at a very elementary level, the respondents were split into two groups of equal size (174, in each group). The procedure and rational for splitting the respondents is discussed in the following section. After the split, all exploratory analyses, including tests of the hypotheses in Tables 1.3 and 2.5, were performed on the first group of respondents. The second group was used for verifying (or not verifying, as the case may be,) affirmative results, significant correlations, measures, and indications found in the first group.

In the exploratory spirit of this research, all pairs of variables were examined for significant correlations using the relevant correlation coefficient for the scale of the two variables being correlated. Correlation coefficients used were the Pearson product moment correlation coefficient for two continuous variables, along with two special cases of the Pearson correlation coefficient; the point biserial correlation coefficient for a dichotomous variable with a continuous variable, and the Phi coefficient for two dichotomous variables. Also used were the Spearman rank-order correlation coefficient and Kendall's tau for two ordinal variables. All of these correlation coefficients are defined in Allen and Yen [1979]. Table 1.4 summarizes the type of correlations used under various circumstances. Biserial and tetrachoric correlations have not been used in the analyses in this research. These two correlations are estimates of the correlations that would be derived if the dichotomous variables in the point biserial correlation and the Phi coefficient were replaced by the continuous variables which theoretically underlie the dichotomous variables. The biserial and tetrachoric correlations serve to expand the truncated range of values of the point biserial and the Phi correlations. The range of values that a correlation coefficient usually assumes is [+1, -1]. However, when dealing with dichotomous variables, the range is limited by the proportion of responses falling into each category of the dichotomous variable. The farther from 50% that proportion is, the greater the truncation of the range of values the the point biserial or Phi coefficient can actually assume [Allen and Yen, 1979; Cohen and Cohen, 1983]. This researcher's interest in using correlations is to find strong indications of relationships, and to be forewarned of multicollinearity, so the Phi coefficient and the point biserial correlation coefficient are adequate.

Many of the variables included in analyses in this research are nominal or ordinal in nature. The nominal variables are descriptive in nature such as "open 24 hours a day or not," or "does or does not offer custodial care". Responses to these kinds of questions are represented by 0 for not having the characteristic, and 1 for having the characteristic in question. However, 17 and 194 could just as easily have been chosen, as the number coded for the response bears no meaning to the characteristic. The advantage of using 0 and 1, besides convention, is that the "mean response" then represents the proportion of respondents having the characteristic in question.

The responses to many of the questions are categories which are not well represented by a single number, although there may be an underlying continuous distribution such as number of beds on the unit, number of daily admissions, or number of times a decision is made annually. In other cases, the best that can be hoped for is to rank the responses in a certain order, such as "very important" comes before "somewhat important," which in turn comes before "unimportant". To assign values to such responses, for example, 1, 2 and 3, respectively, and compute a "mean response" has no intuitive numerical meaning, but does allow comparisons between questions with the same response set. Therefore a brief discussion of some the techniques available for the analysis of categorical data is included here because these techniques are used in Chapters III through V. Table 1.5, adapted from Forthofer and Lehnen [1981], shows the major data analysis techniques available for continuous

Table 1.3

Staffing and Scheduling Hypotheses

Related to the design of the operating system:

1.1 H_0: The level of **job flexibility** present in the work force (ability to perform a variety of tasks) is not related to the variety of services an operating unit provides.

1.2 H_0: The level of **time flexibility** present in the work force (ability to work a variety of times) is not related to the number of hours per day, and the number of days per week that a unit operates.

1.3 H_0: The level of **place flexibility** present in the work force (the ability to perform jobs in a variety of places) is not related to presence or absence of centralized scheduling of the work force.

Related to the design of the work force:

1.4 H_0: Demand uncertainty is not related to the levels of **time and volume flexibility** found in the work force. (The proportion of the work force composed of temporary and part time workers does not vary with demand uncertainty.)

1.5 H_0: The level of **reassignment flexibility** in the work force is not related to demand uncertainty . (The frequency of schedule generation is unrelated to demand uncertainty .)

1.6 H_0: The level of **job flexibility** (ability to perform a variety of tasks) is unrelated to demand uncertainty.

1.7 H_0: The presence or absence of one or more types of **staffing and scheduling flexibility** is unrelated to an organizational goal of providing quick service.

Related to the design of the work force scheduling system:

1.8 H_0: The number of shift lengths used (**time flexibility**) are unrelated to the skill of the work force.

1.9 H_0: The number of start times used (**time flexibility**) are unrelated to the skill of the work force.

1.10 H_0: The scarcity of the work force is unrelated to the number of shift lengths, and start times used (**time flexibility**).

1.11 H_0: The use of computers in the scheduling process is unrelated to the degree of centralization of the scheduling process.

Table 1.3 (Continued)

Staffing and Scheduling Hypotheses

1.12 H_0: The use of computers in the scheduling process is unrelated to the number of scheduling options (**time flexibility**) available.

1.13 H_0: The frequency with which schedules are generated (**reassignment flexibility**) is unrelated to the number of scheduling options (**time flexibility**).

1.14 H_0: The size of the work force being scheduled is unrelated to the computerization of the scheduling process.

1.15 H_0: The proportion of workers with permanent work assignments and permanent work shifts is unrelated to the computerization of the scheduling process

Related to environmental operating conditions

1.16 H_0: Demand uncertainty is unrelated to the computerization of the scheduling process.

1.17 H_0: The frequency of last minutes adjustments to the schedule is unrelated to demand uncertainty.

1.18 H_0: The degree of control over the scheduling process held by first-line managers is unrelated to the centralization of the scheduling process.

1.19 H_0: The degree of orientation to the work place required for employees is unrelated to the level of technology in the work place.

1.20 H_0: The degree of orientation to the work place required for employees is unrelated to the level of capital intensity.

Related to goals of the operating unit.

1.21 H_0: The presence of **time and volume flexibility** in the work force is unrelated to a goal of cost containment.

1.22 H_0: The presence of **job and place flexibility** in the work force is unrelated to a goal of high quality operations.

Table 1.4

Types of Correlations Used Under Various Conditions

	Multistep or Continuous variable is measured at interval or ratio level		**Multi-step variable is a rank order**
	Correlation of Observed Scores	Estimated Correlation replacing Dichotomous variables with Normal variables	
Both variables dichotomous	**Phi**	**Tetrachoric**	
One variable dichotomous, other is multi-step or continuous	**Point biserial**	**Biserial**	
Both variables are multistep or continuous	**Pearson coefficient**		**Spearman coefficient or Kendall's Tau**

Source: Adapted from Allen and Yen, [1979], p. 41.

(interval and ratio scale) data and categorical (nominal and ordinal scale) data, both as independent and as dependent variables.

Traditional parametric techniques work well for analyses involving continuous dependent variables, and there is a well developed body of knowledge surrounding such techniques as analysis of variance (ANOVA), regression analysis, and analysis of covariance. Analysis of variance is used to test many of the hypotheses in which the dependent variable is continuous and the independent variable is a category such as "offers intensive care," or "does not offer intensive care." Dummy variable regression is used in some cases

Table 1.5

Data Analysis Techniques for Categorical and Continuous Variables

	Dependent or Response Variables:	
Independent Variables:	**All Categorical**	**All Continuous**
All Categorical	(A) Categorical data analysis	(D) Analysis of Variance (Dummy variable Regression)
All Continuous	(B Logistic Regression*	(E) Regression
Both Categorical and Continuous	(C) Logistic Covariance*	(F) Analysis of Covariance

Source: Adapted from Forthofer and Lehnen [1981], p. 9.

* At present no ideal generalized method exists for analyzing data in these categories.

where a continuous response measure is desired for a particular category or categories of the independent variables.

For analyses in which the independent and dependent variables are both categorical, a traditional approach is to identify a relationship in a table format, where each category of the independent variable is crosstabulated with each category of the independent variable. Percentages are calculated within categories of the independent variable, and compared with percentages across categories of the independent variable. If the percentages differ by a significant amount, using the chi-square test for independence, a relationship is said to exist [Knoke and Burke, 1980]. In such models, the proportion in a given cell is determined by dividing the cell frequency by the category total.

Much categorical data collected by researchers in the social sciences lends itself to multiway crosstabulations. During the 1970s and 1980s, hierarchical log-linear models were developed for dealing with multiway crosstabulations of categorical data. Log-linear models bear many similarities to ordinary regression. Consider the cases in which the dependent variable is a dichotomy, coded 0 or 1. An ordinary regression, using dummy predictor variables, can be interpreted as showing how the *probability* of a favorable response is affected [Knoke and Burke, 1980]. Log-linear models, instead of dealing with a proportion, deal with the *odds* of being in a particular category. An odds is the ratio between the frequency of being in one category, and the frequency of not being in that category. For example, suppose that of 200 nursing units, critical care nursing services were offered in 80 of them. The *proportion* of critical care units is .4 or 40%. However, the *odds* of being a critical care unit are 80 to 120 or 2/3:1 or 2/3. The odds illustrated here would be considered a *marginal odds,* which applies to the total frequencies in one margin of a crosstabulation without regard to the effects of any other variable. Conditional odds can also be calculated within the body of the table, corresponding to the traditional percentages. According to Knoke and Burke [1980], conditional odds are the chances of being in one particular category of the dependent variable, given a certain category of the independent variable. They further state

> In a traditional percentage table, two variables are unrelated if the percentages are identical or very close across all levels of the independent variable. Similarly, in an odds table, the variables are not associated if all the conditional odds are equal or close to each other,

> and hence equal to the marginal odds as well. ... To compare directly two conditional odds, a single summary statistic can be formed by dividing the first conditional odds by the second, forming an *odds ratio.* The odds ratio is the workhorse of log-linear models. ... Odds ratios take only positive values, have no upper limit, and are 1.00 when no relationship exists (i.e., the two conditional odds are equal). Odds ratios larger than 1.00 indicate direct covariation between variables, while odds ratios smaller than 1.00 indicate an inverse relationship. Of course, "direction" of covariation is arbitrary when the variables are measured only at the nominal level since category order can be changed....
>
> There are two major approaches to log-linear modeling of contingency table data. (1) The *general log-linear model* does not distinguish between independent and dependent variables. All variables are treated alike as "response variables" whose mutual associations are explored. Under the general log-linear model the criteria to be analyzed are the expected cell frequencies, **F_{ij}'s**, as a function of all the variables in a model. ... This approach provides a basis for the second. (2) In the *logit model* one variable is chosen as the dependent variable. The criterion to be analyzed is the expected odds, **Ω_{ij}'s**, as a function of the other independent variables. The logit model is closely analogous to ordinary regression. By extension it is possible to choose two variables as dependent and to analyze the relationship between them as a function of other variables. [Knoke and Burke, 1980, pp. 10-12.]

Forthofer and Lehnen [1981] caution users of the log of the probability p of x that analyses performed with the log of the probability (1 - p) of "not x" will yield different results. Thus they suggest the use of the logit transformation of the probability p. This transformation is given by logit (p) = the natural logarithm of {p/(1-p)}. Note that {p/(1-p)} is an odds ratio. In addition, according to Forthofer and Lehnen [1981], models based on this transformation have the technical advantage of always yielding estimates in the range of 0.0 to 1.0. Models using a sample proportion, particularly if based on a small sample, may produce estimated proportions beyond the 0.0 to 1.0 range. In analyses and development of measures where traditional regression is not appropriate due to limitation of the data, dummy variable regression, and logit regression may be used.

1.5.3.3 Splitting the Sample

This study was exploratory with a goal of establishing measures for the facets of staffing and scheduling flexibility. To that end, the decision was made to split the respondents into two groups. One group was used for specifying and estimating measures, and the other group was used to confirm (or fail to confirm) the measures developed in the first group. This approach is suggested by Harvey [1981], so as to "get past the charge of data mining." Theil [1971] recommends splitting data into three groups. One group would be used to specify the form of the variable relationships (x, x^2, log x, or other form), and the second group would be used to determine the value of the coefficients in each relationship or model. The third group would be used for conditional prediction. Models developed by using the first two groups are tested on the third group. Theil's approach may provide a stronger set of measures as the end result; however, some of the techniques used in data analysis require larger cell sizes than would result if this data set were to be split into thirds. Thus, the decision to use two groups was based on the practical issue of needing a sample size large enough to develop measures with some degree of reliability, and the desire to have a holdout sample on which to test the newly developed measures.

The split was accomplished as follows. As questionnaires were received they were coded with an identification number reflecting the respondent's hospital and the order in which the questionnaire was received. The number assigned to each hospital was purely arbitrary, and was used for purposes of keeping track of response rate per hospital, and overall. Within each hospital, the research instrument was distributed at approximately the same time. During the data collection period more than one questionnaire was received in return mail on most days. Therefore, the second part of the identification number also was arbitrary, and the order in which the questionnaires were received from any one participating hospital was random. The questionnaires were batched by hospital as they were entered onto the computer file. Thus, the coded responses are in "order" by hospital on the computer file.

A program from the SAS Guide to Applications [1985A] was modified to select a random sample from the entire data set. The program "guarantees" the number will be selected that the user specifies, because the probability of choosing any given respondent is a function of the ratio of the number yet to be selected and the number remaining from which selection is to be made. The data set in this research has 348 members, and the desired size of Sample Number One to be chosen from the data set was exactly half, or 174. Thus, the first member had a 174/348 chance of being chosen for Sample Number One. If the first member is selected, the second member has a 173/347 chance of being chosen. If the first member is not selected, the second member's chance of being chosen is 174/347, or slightly higher than .5. In this manner, the probability of any particular respondent being selected is adjusted for the number already chosen for Sample Number One.

This approach was chosen by the researcher, rather than splitting the sample by hospital, because the operating unit is the item of interest and not the hospital. Influences attributable to individual hospitals will be investigated at a future time. Also this method creates two groups of the same size, and splitting by hospital would not guarantee two groups of equal size. For the purposes of keeping track of the two samples, one was designated "Sample Number One" (SN1), and the residual respondents were placed in a file referred to as "Sample Number Two" (SN2). Strictly speaking, each group is as "random" as the other. After SN1 was chosen, a SAS program also was used to form SN2 from the residual members of the master data set.

1.5.3.4 Data Coding and Missing Data

For each respondent, 340 variables were collected and coded into the computer. Three hundred forty eight nurse managers returned the survey instrument, and all 348 questionnaires were deemed useable. All 348 respondents did not answer all 340 queries, because, in some cases, the questions did not apply to their units. For example, questions dealing with Licensed Practical Nurses (LPNs) did not apply to units who employed no LPNs. In a few cases the respondent failed to respond to one or more questions for no obvious reason. Such missing responses had no apparent pattern, and will be treated as missing data. Nonresponse was coded differently from responses in which the nurse manager noted that the question was not applicable to her or his unit, although in most analyses, missing data and nonapplicable responses were treated the same way. Cases in which a particular variable was missing, or not applicable, were simply dropped from analyses involving that variable. Cohen and Cohen [1983] suggest one acceptable method for dealing with missing data is listwise deletion. Listwise deletion means dropping the cases with missing data, and is acceptable, as long as the number of cases remaining for analysis is still at least 90% to 95% of the original number of cases, and the total number of cases is reasonably large. Cohen and Cohen caution that the decision to consider the missing variables as random should not be made lightly. This researcher was also chief data encoder, and has some insight as to whether the missing data were random or not. Two subjects omitted two entire sets of questions, (numbers 35 and 36, on control and variability), and these omissions were clearly not random. However, this researcher decided to include in the data base the other 320 variables from these two subjects rather than lose the other information that might be gained from these subjects.

Cohen and Cohen [1983] also suggest missing data may be handled by dropping the variables for which a substantial portion of the cases lack data. This alternative was used with the last three questions in the survey on hospital demographics. These questions had very poor response rates, and were dropped from the analyses. These questions, numbers 42, 43 and 44, also had a poor response rate in the preliminary test. Respondents were directed to omit these demographic questions if they did not know the answers, and, apparently, many of the respondents did not know the answers, or were suffering from questionnaire fatigue at this point in the questionnaire.

One other set of questions, those responses solicited in number 39, were answered by only two-thirds of the respondents. This set of questions dealt with selecting, from a list of 21 management objectives, the five objectives that most governed the day-to-day management of the nursing unit. This question was physically placed in an awkward position on the research instrument (see Appendix A), and may have been overlooked by some. However, it is equally likely that many nurse managers simply chose not to answer this set of questions, as they may have been viewed as dealing with particularly sensitive issues. These cases were coded so that it is possible to analyze separately those who answered number 39 and those who did not. Number 39 will be dropped from the analysis entirely, as results from those who did answer the question confirm results obtained in question 38. Question 38 is discussed in Chapter III. Other individual exceptions to the treatment of missing data as random are discussed in the chapter in which the relevant question is analyzed.

1.6 CONTRIBUTIONS AND FUTURE RESEARCH

1.6.1 Expected Contributions to Operations Management Theory

The major contributions of this research study are to define staffing and scheduling flexibility from an operations management point of view (see Figures 1.1 and 1.3), and to develop an initial set of measures for this multifaceted concept. An additional contribution is to characterize the set of decisions leading to the design and implementation of staffing and scheduling policies on the strategic and tactical levels. Tables 1.1 and 1.2 list these sets of decisions. This study confirms insights into staffing and scheduling relationships already held by successful service sector managers. By taking a broad view of staffing and scheduling policy issues, this research investigates relationships between process design decisions, staffing choices, scheduling practices, positioning strategies, and performance measures in service sector organizations. This investigation is guided by the hypotheses listed in Tables 1.3 and 2.5. These hypotheses have been tested by a variety of statistical techniques applied to data collected from 348 nurse managers in 31 hospitals. This study is apparently the first nonproprietary study to use empirical data gathered from a large number of sources to address policy concerns in the area of staffing and scheduling from an operations management viewpoint. Scheduling has been viewed as a tactical area in operations, yet strategic goals of service sector organizations cannot be accomplished without proper staffing and scheduling. The results of this study may enhance understanding of the linkages between strategic and tactical issues in the staffing and scheduling process.

Another contribution of the study is to make available a non-proprietary statistical description of current hospital nurse staffing and scheduling practices. Such a set of baseline statistics offers insights into ways nursing executives are coping with the difficult problem of providing nursing services in various environments, often under quite trying circumstances. These results are expected to be of particular interest to those involved in hospital and nursing management.

1.6.2 Future Research Opportunities

Refining the measurement of staffing and scheduling flexibility in the service sector is the next step in this research process. The research instrument developed for this study will be used in part, or in whole, in future studies with the same or other hospitals to continue confirmatory studies of relationships between operating environment variables and staffing and scheduling policies. If permission can be obtained from previous participants, a longitudinal study may be conducted to investigate changes in relationships over time. Another possible extension to this research is the development of a diagnostic instrument with which hospitals may assess the state of their current environment, and their staffing strategies and scheduling practices. From such a diagnosis, a logical step is the prescription of staffing strategies and scheduling practices that will let the hospital move toward the kind of environment it is seeking. The database collected for this research, representing responses from 348 nurse managers, also can provide the basis for continuing investigations of differences between specific types of nursing units. Costing of nursing services, the use of in-house nursing pools, and the contracting for outside nursing services are specific areas which this researcher would like to investigate. These projects will be discussed further in Chapter VI Additionally, extensions of this research to non-hospital based nursing services, to other areas of health care, and to other service sector industries, are planned.

CHAPTER II

LITERATURE REVIEW: STAFFING AND SCHEDULING IN THE SERVICE SECTOR AND RESOURCE FLEXIBILITY ISSUES

2.1 INTRODUCTION

The purpose of this chapter is to provide a framework to support the new research reported in this document. Previous research concerned with operations management issues in the service sector is reviewed and discussed. The major focus of research reviewed here is staffing, scheduling, work force flexibility, and other resource flexibilities used by service sector organizations to implement competitive priorities and achieve organizational goals.

The chapter is divided into six sections. The first section reviews literature which defines service sector characteristics and contrasts such characteristics with manufacturing. The first section also contains a discussion of productivity and capacity issues in the service sector, and concludes with a discussion of some strategies for management of service sector operations. The second section discusses the importance of conducting research into service sector operations. The third section briefly reviews previous research in operations strategy, and discusses linkages of operations strategy to more tactical decisions. The fourth section looks at previous research in work-force staffing and scheduling concerned with the development of algorithms that produce optimal or near optimal solutions to selected scheduling or staffing problems. The fifth section considers staffing and scheduling research by operations management researchers in specific service sector industries outside of health care. The sixth section reviews operations management research that is health care specific, and primarily focuses on hospital nurse staffing and scheduling. In each section, relationships between the past research and the current research are developed.

2.2 SERVICE SECTOR CHARACTERISTICS

Over the past forty five years, since the end of World War II, jobs in the service sector have increased from just under 50% of the total jobs in the U.S. economy, to almost 80% of the total jobs in the United States [Wessel, 1989]. However, only in the last thirty years have researchers and writers in the field of operations management noted the differences and similarities between characteristics of operations in the service sector and in manufacturing. Some of the generally-agreed-upon characteristics are shown in Table 2.1. Table 2.1 gives the extreme characteristics, most often associated with "pure" services or "pure" manufacturing. Most of the characteristics of manufacturing and service operations fall along continuums between the two extremes. A complicating factor is that individual operations of any service or goods producing organization may fall on entirely different parts of the continuum from other operations in the same organization. This complication applies to hospital nursing units as much as it does to other service organizations.

Table 2.1

Service Sector Characteristics Versus Manufacturing Characteristics*

Focal Point	Service Sector Characteristic	Manufacturing Characteristic	Discussion Sources
Operations	Humanistic	Technocratic	Levitt, 1972
Operations	Volatile, uncertain	Stable, predictable	Levitt, 1972 Sasser, 1976 Chase, 1978, 1981
Operations	Labor intensive	Capital intensive	Krajewski & Ritzman, 1987 Schmenner, 1986
Operations	Decentralized	Centralized	Thomas, 1978
Operations	System malfunction directly affects the customer	System malfunction affects the customer only indirectly if at all	Chase, 1981
Operations	Difficult to balance resources available with demand	Easy to balance resources available with demand	Chase, 1978,1981 Sasser, 1976
Operations	Customer is part of the process	Customer is isolated from the process	Fitzsimmons, 1985 Chase, 1978, '81, '85 Schmenner, 1986 Collier, 1987
Product or Service	Simultaneous production and consumption	May be produced ahead	Sasser, 1976 Chase, 1981
Product or Service	Performed on an individual basis, customized	Mass-Produced, standardized	Levitt, 1972 Chase, 1981 Schmenner, 1986
Product or Service	Intangible, perishable. Demand is time dependent In general, no backorders	Physical, durable. Can have backorders	Sasser, 1976 Krajewski & Ritzman,1987 Thomas, 1978 Collier, 1987
Product or Service	Cannot be inventoried	Can be inventoried	Sasser, 1976 Krajewski & Ritzman, 1987 Chase, 1978, 1981 Collier, 1987

* Most of the characteristics of manufacturing and service operations fall along continuums between the two extremes. Individual operations of any service or goods producing organization may fall on entirely different parts of a continuum from other operations in the same organization.

Table 2.1 (Continued)

Service Sector Characteristics Versus Manufacturing Characteristics*

Focal Point	Service Sector Characteristic	Manufacturing Characteristic	Discussion Sources
Product or Service	Cannot be transported	Can be transported	Sasser, 1976
Employees	Loosely supervised	Closely supervised	Levitt, 1972
Employees	Must be able to interact with public	Need technical skills only	Chase, 1978, 1981
Employees	High contact with customers	Low or no contact with customers	Sasser, 1976 Krajewski & Ritzman, 1987 Chase, 1978, 1981
Employees	Wages may be based on hours worked	Wages may be based on output	Chase, 1981
Response time	Short	Long	Krajewski & Ritzman, 1987
Location	In local markets	National or international markets	Krajewski & Ritzman, 1987
Location	Near customer	Near supply, labor or transportation	Chase, 1978, 1981 Collier, 1987
Facilities	Small facilities	Large facilities	Krajewski & Ritzman, 1987
Quality	Difficult to measure Very Subjective	Easier to measure More quantifiable	Sasser, 1976 Krajewski & Ritzman, 1987 Chase, 1978, 1981
Capacity	Difficult to measure	More easily quantified	Sasser, 1976 Collier, 1987
Capacity	Highly variable output rate	Repetitive, fixed output	Levitt, 1972 Sasser, 1976 Chase, 1978,1981

* Most of the characteristics of manufacturing and service operations fall along continuums between the two extremes. Individual operations of any service or goods producing organization may fall on entirely different parts of a continuum from other operations in the same organization.

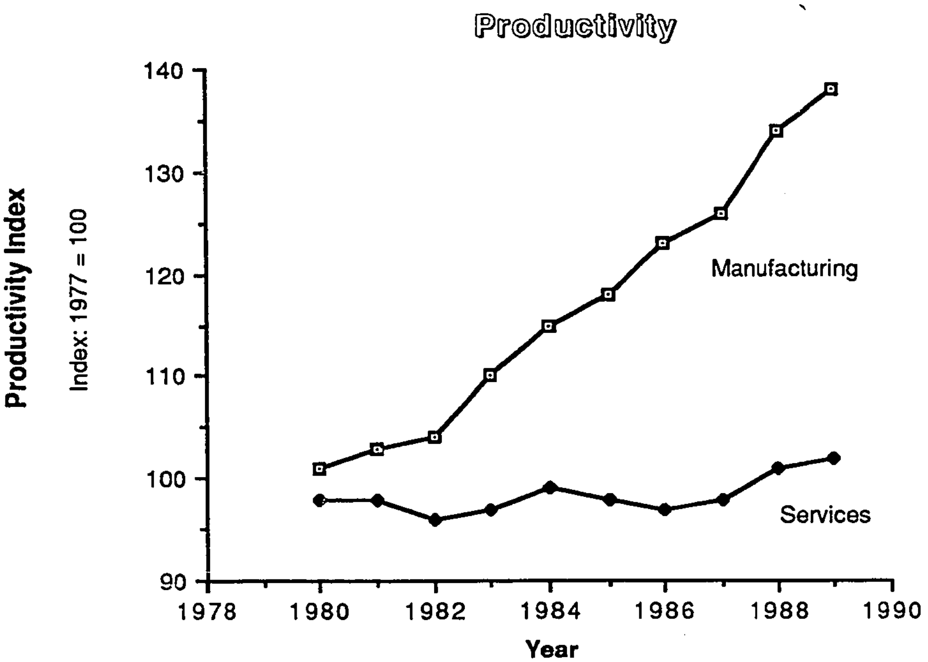
2.2.1 Productivity in the Service Sector

One purpose of this research is to gain insight into productivity issues in the service sector. One area of the service sector is examined in detail: the staffing and scheduling strategies and practices of hospital nursing units. Staffing and scheduling are closely connected with productivity issues, particularly in labor intensive operations, such as those found in hospitals and many other service sector organizations.

There is good reason to be concerned about productivity in the service sector. Recent figures comparing a U.S. service sector productivity index with a manufacturing productivity index show the service sector index has been nearly flat, hovering around 100 since 1977 (the base year). The manufacturing index has increased from 100 in 1977 to approximately 135 at the end of 1989, and is projected to go as high as 140 through the end of 1990 [Allyn, 1988; May 1990]. These figures are shown graphically in Figure 2.1.

2.2.1.1 The Technocratic Approach to Productivity

One author who thinks the key to productivity in the service sector is to focus on the similarities between manufacturing and services is Levitt. Levitt [1972] discusses the need to think about services in technocratic terms instead of humanistic terms, if productivity in the service sector is to be improved. He points out that most manufacturing organizations have a large element of service in the sales, delivery, installation, repair, maintenance, and warranty operations. On the other hand, most large "service" organizations have at least some operations that are divorced from the customer and could be treated as "manufacturing-like" functions.



Source: Fortune, 6-8-87, 8-1-88, 1-25-90

Figure 2.1

Productivity Indices for Manufacturing and Services

Levitt says that the presumptions of service being performed on a one-to-one basis, by loosely supervised personnel, under highly variable and volatile conditions, cloud our thinking about ways to make service operations more efficient. He goes on to cite high-volume, repetitive operations in the service sector that have been successful in applying manufacturing principles. Levitt thinks that in order to improve services, one must get beyond ways to make the individual server do the job better, and start to look at entirely new ways to perform the service. Levitt concludes that as long as service is "viewed as something residual to the ultimate reality," and as long as service is "treated as purely a human task ... performed by a single individual working alone", we will fail to give service the kind of attention it deserves. Services will continue to be "left for residual performers," and not be subject to rigorous technocratic thinking that would allow for the vast improvement of services.

Levitt [1976] continues this theme by warning that if advanced industrial nations are to maintain their edge in productivity they must not continue to view servitude in preindustrial terms. He discusses the paradox that as nations advance and have a higher standard of living, their demand shifts to services that are "little susceptible to the employment of mass-production efficiencies." Levitt does hold out hope for the United States, "where much improvement has already occurred, (though it has gone) vastly unnoticed." He goes on to give many examples of service productivity and inventiveness, while citing areas that remain for improvement. He divides the opportunities for service sector improvement into three categories. In the first category, hard technologies, machinery or tools substitute for human efforts. Examples are electrocardiograms and airport X-ray baggage checks. In category two, soft technologies, are found. These include organized preplanned systems in which "special hardware or routines are specifically designed to produce the desired results." Often, in this category, human effort has not been replaced, but shifted from the employee to the customer. An example of a soft technology improvement is self-service in a restaurant salad bar, and income-tax preparation services such as those offered by H. & R. Block. Levitt's third category for industrializing services is hybrid technology in which hard equipment is combined with carefully planned systems "to bring efficiency, order, and speed to the service process." Limited service, fast, low-priced repair facilities such as muffler and transmission shops are examples of hybrid technologies. Levitt concludes

> The concept of industrialization of service, once it enters our minds - though we have unknowingly lived with it since the beginning of mortal time - can transform how we behave, what we do, and where we go. It can generate liberating new solutions to intractable old problems. It can bring to the increasingly service-dominated economies of the future the same kinds of vaulting advances in productivity and living standards as the newly created goods-producing factory economies brought to the world in the past. [Levitt, 1976]

2.2.1.2 Productivity and Customer Contact

Other authors do not think all services lend themselves to such technocratic approaches to productivity. Chase [1978, 1981] divides service operations into "pure" services, mixed services, quasi-manufacturing, and "pure" manufacturing, based on the extent of customer contact, or the duration of the physical presence of the customer in the system during the creation of the service. He lists several characteristics of service operations (see Table 2.1), which he calls propositions. For example, in high contact systems there is greater uncertainty, supply only matches demand by happenstance, and the employee's attitude can really affect the customer's view of the service. Furthermore, the system is at the mercy of time: the customer may be offended by even a slight delay in the start of service, if the reason for the delay is not readily apparent to the customer. Violations of the "law of the queue," first-come, first-served, also may upset the customer when the service system is highly visible to the customer. Chase writes of the ability to achieve greater productivity if the "technical core" of operations can be separated from the customer's presence. Chase [1981] gives several specific strategies for reducing contact (with the customer), for improving contact, and for improving low contact. He suggests a description scheme for service systems using a "taxonomical approach such as: High (low) contact/ Standardized (customized) service/ Tangible (intangible) product dominant/ Automated (nonautomated) technology." Further, he suggests this taxonomy could be used to test his propositions and strategies for isolating the technical core , and to develop a general theory of service operations.

Chase [1985] lists "Ten Commandments of Service System Management," dealing with the facility, the customer, and the server. He concludes with an admonishment that, in order to gain productivity, rethink the design of the "psychological subtleties of the customer-service system at the interface, ... , appreciate the significance of the customer being in the system," and seek "the right balance between services desired by the customer and (the firm's) material and human-resource capaçity."

Fitzsimmons [1985] suggests using the customer as a productive resource, and details several strategies for doing so. These strategies are direct substitution of customer labor for provider labor; smoothing service demand by getting the customer to adjust the timing of demand to match the availability of service; substituting technology for personal attention; and requiring customers to wait for service. He notes the last technique is used extensively in the health care field. Some of these strategies may require the consumer to learn new skills, to assume a diagnostic role, and to provide quality control checks.

2.2.1.3 The Current Status of Service Sector Productivity

Currently, labor shortages are forcing service firms, especially hotels, hospitals, and banks, to place new emphasis on productivity [Wessel, 1989]. Many productivity gains are being achieved by following the strategies proposed by operations management researchers and authors over the past decade [Levitt, 1972; Levitt, 1976; Chase, 1978; Chase, 1981; Fitzsimmons, 1985]. One such strategy is to redesign jobs in combination with new and more expensive technology, and with intensive training of employees. Other gains come from the use of computers to track past demands, employee turnover, and employee schedules, and to forecast upcoming demand matched with the needed number of employees, by the half-hour or shorter time periods. In addition, gains come from automation, a traditional source, and from nurturing current employees to cut down on turnover and training requirements.

The fact that automation in medical technology seems to create a need for more workers, rather than fewer, is well documented in the popular press [Wessel, 1989; Hubbell, 1989; Otten, 1989]. New medical technology seems to mitigate productivity gains and contribute to increasing medical costs. This researcher hypothesizes that the reason for new medical technology failing to increase worker productivity is because that is not its purpose. Much new medical technology has to do with improving present services and providing more services to the individual patient. As a consequence, more highly trained medical, nursing and other technical personnel are required to install, administer, operate, monitor and interpret such technology. This hypothesis, while not specifically addressed by this research, is supported by a cursory review of medical technological advances in the past decade, particularly in care of premature infants, cancer patients, heart attack and stroke victims, trauma care, and intensive care applications. Such technological developments provide one underlying reason for the shortage of nursing personnel in many hospitals today, and for the high level of interest in ways to address the hospital nurse staffing and scheduling problem [Hubbell, 1989; Otten, 1989].

2.2.1.4 Productivity Measures

It should be noted that the issue of no growth in service sector productivity is a controversial one [Berger and others,1989]. Recently, three researchers at the Wharton Fishman-Davidson Center for Study of the Service Sector, Faulhaber, Allen, and MacKinlay, have concluded that service sector productivity is poorly measured by traditional means of quantifying output [Burck, 1989]. These researchers have sought a new measure that tracks the results of output: through increased value of service firms in the market place. Their conclusions, based on studies of 25 years of (financial) performance, are that service firms actually may have outperformed manufacturing in productivity gains. If substantiated, such claims would be good news indeed. Their measurement techniques unfortunately would not apply to the thousands of service sector organizations such as governments, and other non-profit organizations that compose part of the service sector, but do not enter the capital markets directly.

Other researchers, such as Adam, Hershauer, and Ruch [1986], have worked to developed measures combining productivity and quality. Their working definition of productivity includes measurement of good quality output. They define a process productivity-quality ratio which measures good units produced per dollar spent to produce and correct, if necessary. For services, this ratio reflects that user's concern for quality characteristics in services versus an operational concern for cost. A second measure, called a prevention quality-productivity ratio, measured the percentage of services satisfactorily performed per dollar spent to prevent unsatisfactory service. They give a step-by-step process for developing organization specific ratios, but caution that the process is very complex.

Methodology for measurement of productivity in the service sector is likely to remain a controversial topic. Chapter IV presents an initial attempt to establish measures with which to characterize staffing and scheduling strategies by use of factor analytic techniques. In Chapter IV relationships between these initial measures and productivity objectives and performance measures are examined.

2.2.2 Capacity in the Service Sector

One of the determinants of productivity is capacity. One of the determinants of capacity in the service sector is the number of employees on hand or available to work. The number of employees available and working at any given time is a direct result of the staffing and scheduling strategies and practices of the organization. Many operations management writers have discussed the capacity issue in the service sector [Starr, 1964; Sasser, 1976; Fitzsimmons and Sullivan, 1982; Smith-Daniels, Schweikhart, and Smith-Daniels, 1989].

2.2.2.1 Queuing Systems and Capacity Management

In an early production management text, Starr [1964] deals very briefly with service operations. He notes that "production management encompasses both goods and services, " and that the "queueing (sic) or service models raise the question as to whether the production of goods is anything more than a special case of providing services." Starr devotes a chapter to the use of simple queuing models as a way to describe operations in the service sector. The relevancy of queuing models to services operations is detailed by Fitzsimmons and Sullivan [1982], who devote three chapters to queuing systems in their text on service operations management. Queuing theory (and common sense) indicate that in the long run the capacity to serve must exceed the demand for service. Fitzsimmons and Sullivan discuss several techniques for adjusting and smoothing capacity in the service sector. These include demand management techniques such as price incentives for off-peak usage, partitioning demand from nonhomogeneous sources, promotion of off-peak periods, reservations and appointments, and the development of complementary services. These techniques also are found in Sasser [1976]. Sasser also suggests increasing consumer participation, sharing capacity, and investing in "the expansion ante" (providing for expansion before the demand occurs). All of these techniques have been used to manage capacity in the hospital industry.

Fitzsimmons and Sullivan also discuss the negative consequences of failure to develop enough capacity to meet demand: customers may leave the system before being served; customers may fail to enter the system, if the wait is long; and servers may speed up, omit essential services, or become frustrated with the customer, all to the detriment of the quality of the service.

2.2.2.2 Limitations to Capacity in the Service Sector

The importance to service sector managers of understanding queuing phenomena is not disputed. However, it is equally important for service sector managers to understand the myriad of other characteristics that mitigate complete reliance on queuing models as a guide to understanding capacity issues. In a service organization, capacity may be thought of as "physically limited" or "server limited." Physical capacity limitations are determined by hardware. The number of beds in a hospital unit or the number of operating rooms in a hospital are examples of physical limitations to capacity. Server limitations to capacity are determined by the number of customers that can be served by the available employees. Effective capacity of a facility, then, at any given time, is the lesser of the two. If enough employees are available that service could be provided in excess of the physical limits of the facility, the result will be idle time on the part of the employees. In a cost-conscious organization, this situation is unlikely to occur. Therefore, in a cost-conscious, productivity-pressured service organization, the effective capacity is very likely to be limited by the number of available employees. Filling the physical capacity with customers, in excess of the server capacity, merely increases the queuing time for customers. Service to some or all customers will be delayed, because there are not enough employees to go around.

It is not difficult to see that quality of service and customer satisfaction are affected as well. If too few employees are available at a very busy time, the customers may be served but, in addition to the occurrence of long waiting times, mistakes may be made, sloppy service may result, and some services may be omitted. If too many employees are available, costs may be higher than necessary, although customer satisfaction may improve. One of the challenges to service sector managers is to balance the trade-offs among capacity, high productivity and high quality. Certainly, staffing and scheduling decisions play a key role in achieving a desired balance.

2.2.2.3 Capacity Management Strategies

Sasser [1976] notes several characteristics which make the management of capacity in the service sector different from the management of capacity in manufacturing. The characteristics he mentions are: non-inventoriable services, a high degree of customer interaction, the intangibility of services, the non-transportability of services, and the simultaneous production and consumption of a service. He gives examples of what happens for four different errors in capacity management. A firm may increase the wrong kind of capacity, or increase part of capacity, but not all-round capacity. Additionally, a firm may ignore the competitive reaction; or may undercut one's own services by providing some services at a lower price, just to fill capacity, only to have these services become more popular, but be a drain on profits.

Sasser also discusses the two extreme strategies for dealing with capacity: chasing demand, and having level capacity. He contrasts the differences between these two strategies. The chase strategy is characterized by low labor skill levels, low job discretion, low compensation rates, low training required per employee, low per employee costs to hire and fire, a high error-rate, and a high amount of supervision required. In general, the opposite is true of the level strategy. Service sector managers must decide how much of peak demand their systems are going to handle. Sasser gives several ways that employees could be utilized to attack the peak capacity constraint. Some of these are cross-training of employees, and performing only essential tasks during peak periods, while using slack periods for supporting tasks. In addition he suggests a careful examination of skill levels and the facility layout needed at peak times.

2.2.2.4 Capacity Research in the Health Care Industry

Smith-Daniels, Schweikhart, and Smith-Daniels [1988] review health care capacity issues. They discuss past and potential future research related to the location, sizing, acquisition, and allocation of health care facilities, and the work force and equipment therein. They point out the complexities of these types of decisions stemming from the interaction between the demand for services and the demographic characteristics of the population surrounding the facility. The interested reader is referred to their thorough review of research concerning decisions in health care facility location and aggregate capacity size, inpatient unit size, ambulatory care unit size, inpatient admissions scheduling, surgical-suite scheduling, and ambulatory care scheduling. Some of the research they review on work force acquisition and allocation is also discussed in section six of this chapter. Smith-Daniels, Schweikhart, and Smith-Daniels report that future research directions in health-care capacity are likely to focus on vertical integration, multi-hospital systems, hospital downsizing, subcontracting services, freestanding ambulatory care clinics, health maintenance organizations, and diagnostic related groups. They state

> A major challenge for researchers is to incorporate organizational goals in capacity decisions in order to evaluate alternative strategic plans and their impact on performance. This requires the development of measures of customer service, resource flexibility, cost, and market share, and the quantification of their interrelationships with capacity decisions.

This research addresses the issue of measures for resource flexibility in Chapter IV. Data collected on nurse managers' objectives for their units is discussed in Chapter III. Linkages between some of these objectives, and the resource flexibility measures are discussed in Chapter IV.

2.2.3 Other Service Sector Operations Management Strategies

Several authors have proposed strategies for growth [Thomas, 1978], for survival and prosperity [Schmenner, 1986], and for the lessening of competition in the service sector [Heskett, 1986, 1987]. Most of these strategies are based on various dichotomies of service operations characteristics. The theory supporting these sets of strategies has been empirically grounded, in that the strategies have been observed to "work," in a managerial sense. The success of these strategies is reported in a number of case studies, involving one or more firms for each strategy. To the best of this researcher's knowledge, none of the strategies have been tested empirically on a large scale. Some of the strategies discussed in the next sections have direct implications for staffing and scheduling, and many have found application in the health care industry. Some of these strategies, presented below, also will be discussed in Chapters IV and V, as evidence from this research supports or fails to support their validity.

2.2.3.1 Growth Strategies

Thomas [1978] discusses growth strategies for service operations and how these strategies are different from those for manufacturing operations. He bases his discussion on a classification scheme that separates services into equipment-based versus people-based. Thomas' spectrum of types of service businesses is given in Table 2.2. Thomas notes that as businesses evolve they may move along a spectrum from one extreme to the other, and that many companies are in more than one type of business. Nursing services today tend to be both people-based and equipment-based. Individual nursing units within any given hospital could be classified at several different points along Thomas' spectrum. One objective of this research is to provide measures that would describe that element of the environment in which nursing services are provided.

Thomas [1978] discusses several ways for service firms to grow and to diminish competition. One strategy typically employed by manufacturing firms as they grow is to take advantage of economies of scale. Other authors would say this strategy is to move toward a production environment with more repetitiveness [Krajewski and Ritzman, 1987]. Thomas tells how service firms can overcome intangible products, decentralized operations, and the inherent need to have small facilities in order to achieve economies of scale in their operations. He suggests multiple (identical or similar) locations, or achieving economies of scale by putting several different but related operations under one roof or in one location in order to save on energy costs or maintenance. Similarly, services may gain economies of scale from regional or national advertising clout; from proprietary technology, programs and services; and from developing a brand name identification. All of these strategies act as barriers to entry for others wishing to enter the same business. Other ways for service organizations to grow are through development of new services and through acquisition. Thomas says that the development of new services is more difficult than the development of new products, because of the difficulty in test marketing a concept. Thus many service organizations are known more for their imitativeness than inventiveness. Thomas also comments that growth through acquisition is trickier in people-based services than in equipment-based services, because the major asset being acquired is the people, who may leave and take their skills with them. Many of these growth strategies are being employed by health care service organizations today, as traditional hospitals offering inpatient care become health care centers offering a wider range of services. Currently, there is much change and turmoil in the health care industry. In Chapter VI, this research reports on some possible implications of these changes on nursing services.

2.2.3.2 Strategies for Managing Change in the Service Sector

Schmenner [1986] classifies services by two elements, one of which is labor intensity. Labor intensity is measured relative to capital investment in plant and equipment per employee. The second element is a joint measure of customer interaction with the service process, and the degree of customization of the service. He proposes a "Service Process Matrix" as shown in Figure 2.2. He calls services with a low labor intensity and a low degree of customer interaction and customization "Services Factories." "Service Shops" are those

Table 2.2

A Spectrum of Types of Service Organizations

Service Basis	Dominant Labor Force	Examples
Equipment	Automation	Vending Machine Automatic Car Wash
	Relatively Unskilled Operators	Motion Picture Theaters Dry Cleaners
	Skilled Operators	Airlines Excavation
People	Unskilled Labor	Lawn Care
	Skilled Labor	Appliance Repair Catering
	Professionals	Lawyers Accountants

Source: Thomas, 1978

service organizations with low labor intensity, but more interaction and customization. "Mass Services" have a high degree of labor intensity but low interaction and customization. "Professional Services" are highly labor intensive and have a high degree of customer interaction and customization. Schmenner classifies hospitals as service shops, based on the low ratio of dollars spent on labor to dollars invested in facilities and equipment, and the

The Service Process Matrix

Degree of Interaction and Customization

		Low	High
Degree of Labor Intensity	Low	Service Factory Airlines Trucking Hotels	Service Shop Hospitals Auto Repair Other Repair Services
	High	Mass Service Retailing Wholesaling Schools	Professional Service Doctors Lawyers Accountants

Source: Schmenner, 1986

Figure 2.2

A Classification Scheme for Service Sector Organizations

high degree of interaction and customization between the patient and the service system. This researcher agrees with that some nursing units would fall into that category, and some nursing units would be considered professional services, with high labor intensity, and high interaction and customization. Schmenner asserts that service operations managers must start to look for the similarities between their organizations and others in the service sector, in order to discern lessons leading to survival and prosperity. He sees a movement of

Table 2.3

Challenges for Service Managers

Characteristic	Challenge	Applies to
Low Labor Intensity	Capital Decisions Technological Advances Managing Demand to Avoid Peaks and Promote Off Peak Usage Scheduling Service Delivery	Service Factory/ Service Shop
High Labor Intensity	Hiring Training Methods Development & Control Employees Welfare Scheduling Work forces Control of Far-flung Locations Start-up of New Units Managing Growth	Mass Service/ Professional Service
Low Interaction/ Low Customization	Marketing Attention to Physical Surroundings Managing Rigid Hierarchy with Need for Standard Operating Procedures Giving "warmth" to service	Service Factory/ Mass Service
High Interaction/ High Customization	Fighting Cost Increases Maintaining Quality Reacting to Consumer Intervention in the process Managing Advancement of People Delivering Service Managing Flat Hierarchy with Loose Subordinate-Superior Relationships Gaining employee Loyalty	Service Shop/ Professional Service

Source: Schmenner, 1986

successful service firms "toward the diagonal" running from low labor intensity and low customer interaction and customization toward high labor intensity and high customer interaction and customization. His hypothesis is that the diagonal offers better control. Schmenner also sees movement "up the diagonal" as evidenced by simplification, specialization, and automation of procedures.

Schmenner also lists four sets of challenges for service managers which are shown in Table 2.3. His list of management challenges for those organizations characterized by high interaction and high customization are particularly appropriate for managers of nursing units. Objectives of nurse managers are discussed in Chapter III.

2.2.3.3 Strategies for Altering Competition in the Service Sector

Heskett [1986, 1987] reports on the high percentage of multi-site service firms whose field managers have responsibility for operations, personnel and marketing, with all three being of equal importance. He claims that in order for a service firm to achieve success, the firm must have a clear strategic service vision, and that such integration of systems is a part of that strategic vision. Such a vision includes four important elements: clearly targeted market segments, a well-defined service concept, a focused operating strategy, and a well-designed service delivery system. These elements are linked by the firm's positioning strategy and what Heskett calls value-cost leveraging, as well as the integration of systems. Value-cost leveraging is defined as the maximization of the difference between the value of the service to customers and the cost of providing it. Heskett notes that a service firm may also achieve success with a supplementary "inner-directed" strategic service vision, in which groups of employees are targeted. The focus of the other elements and the links between them now become employees instead of customers.

According to Porter [1980], there are three generic competitive strategies: overall cost leadership, which yields high profits through low cost, high volume and high market share; differentiation, which fosters profits through higher prices, high margins, and smaller volume and market share; and focus, which combines low costs and differentiation in an appeal to a select market niche. Heskett [1986] lists several service sector specific strategies in each of these categories, comparing a cost of service delivery to the level of service delivered, as perceived by the customer. Heskett's strategies for "achieving distance from the pack" are shown in Table 2.4.

2.2.4 Summary of Management Strategies in the Service Sector

Sasser, Olsen, and Wyckoff [1978] propose a view of service operations as the presentation of a "bundle" of goods and services to customers. Their bundle includes physical items offered to the customer, called facilitating goods; explicit services performed for the customer; and implicit services or psychological benefits received by the customer. Fitzsimmons and Sullivan [1982] expand the service "bundle" concept to include the facility in which the service takes place. The "bundle" concept is one more way of saying that the customer, the server and the place of service all must be considered when planning and executing strategies and tactics for service sector operations.

The preponderance of service sector authors and researchers clearly indicates that service sector organizations cannot be managed well unless strong consideration is given to the involvement of people with the service system. Those people may be employees or customers or both. In fact, the extent, the place, the timing, and the duration of the interaction of customers and employees with each other and with the service system is of critical importance in designing strategies to be more productive, to manage capacity, to grow, to diversify, to compete, to be more profitable, and, in general, to remain a viable organization. It is equally clear to this researcher that the interaction of customers and employees with each other and with the service system cannot be well managed without giving strong attention to work force staffing and scheduling strategies and practices. These staffing and scheduling strategies and practices are what determine who is available, with what skills, at what time and place, to serve which customers. The selection and timing of service offerings, the quality of service, the costs of service, customer satisfaction, and employee satisfaction are all influenced by staffing and scheduling strategies and practices in the service sector. This premise is not directly tested in this research. However, observations of successful service organizations suggest they do consider the strong linkages between staffing and scheduling issues and other organizational goals and objectives. Evidence of such linkages, suggested by this research, is discussed in Chapter IV.

2.3 IMPORTANCE OF SERVICE SECTOR RESEARCH

Presented in this section is a discussion of the status of operations management research, and the need for new directions in service operations management research.

Table 2.4

Competitive Strategies for Service Managers

Low-Cost Service Low Level of Service Differentiation	**Low Cost Service High Level of Service Differentiation**
Seek out low-cost customers Standardize a custom service Reduce the personal element Limit investment in the service network where possible Substitute off-line for on-line services	Do-it-yourself customization Standardize to improve control Reduce individual judgment in the service delivery process Manage supply and demand Develop a membership base Control through ownership Leverage scarce skills (Use experienced employees to manage those with less experience) Selectively apply high technology Substitute information for assets Manage the mix of people and equipment Manage the service triangle (the service company, servers, and customers) Focus on one basic service
High-Cost Service Low Level of Service Differentiation	**High Cost Service High Level of Service Differentiation**
	Make the intangible tangible Customize the standard product Increase training and value-added per employee Control quality Influence customers' expectations of quality

Source: Heskett, 1986

2.3.1 Status of Operations Management Research

Operations management research in the 1960s and 1970s tended to focus on manufacturing problems, usually of a micro-nature, with an emphasis on equipment-related issues rather than on people [Chase, 1980]. Chase [1980] reviews 134 operations management articles published in four journals during the late 1970s. He states "the dominant research strategy was problem identification, model formulation, and mathematical and/or computer manipulation of the model. Specific hypothesis testing and statistical analysis of results was less frequently observed." Chase calls for research that is more macro, or system-wide, in nature, as well as research that is more integrative, dealing with people and equipment. He also notes the need for more research in the service sector. The research reported herein is integrative, as it looks at staffing and scheduling decisions and the results of those decisions with respect to the environment in which those decisions are made.

Buffa [1980], discussing the state of operations management research at the beginning of the 1980s, notes "The past 20 years have produced great progress in terms of an understanding of how productive systems work, and the development and improvement of many very useful techniques." He notes the development of an expertise in defining and modeling problems of a "relatively narrow scope," and the evaluation of results of model manipulation by a "single-valued criterion." In general, an isolated subsystem has been the unit of analysis. Managerial acceptance has been lacking for more complex models , as they have been less likely to yield useful insights. Buffa reports that a group of managers in a panel discussion identified their dominant problems as "long range capacity planning, centralized versus decentralized control, organizational issues, and work force management." He calls for research which supports these concerns, and yields results which can be implemented. Such research should provide managers "with a process for making rational decisions by identifying the impact of environmental, intra- and inter-functional factors." Buffa suggests there are many "generic problems in service systems that justify research effort and many more industry oriented problems." Two topics recommended by Buffa for service system research are positioning strategy and capacity planning. Positioning strategy, as seen by Buffa, is concerned with whether the service is standardized or customized, and whether it is of high or low quality. Other operations management researchers and writers have discussed similar ideas about positioning strategy in services [Schmenner, 1986; Heskett, 1986]. Capacity planning, as discussed in Section 2.2.2, is closely concerned with staffing and scheduling issues in the service sector. This research looks at the correlations between positioning strategy, as discerned by first-line nursing managers, and staffing and scheduling policies.

2.3.2 Need for New Directions in Operations Management Research

Camerer [1985] calls for a redirection of research in business policy and strategy from inductive methodologies to deductive methodologies. Empirical observations not only should be used to induce assumptions, but to test hypotheses with rigor. A predictive ability is needed as well as the ability to evolve new theory from that theory already tested. This research uses empirical data to test hypotheses induced from empirical and "armchair" observations of earlier service sector researchers.

In 1982, several professional societies to which operations management researchers and practitioners belong supported the establishment of the Decision and Management Science Program (DMS) by the National Science Foundation (NSF) [Little, 1986]. The mission statement of DMS states:

> Thus the body of research supported by the program should possess *generality*, be based on *empirical* observation or be subject to empirical validation, and incorporate *social and behavioral* aspects. Processes should be characterized by models that are tested in operational contexts. Even though an individual project may not have all these characteristics, its evolution toward this end must be clear [Little, 1986].

Little [1986] reports on the consensus of a group of researchers who gathered to discuss research opportunities in the decision and managerial sciences. The research of organizational and managerial processes provide major opportunities. One area of opportunity is concerned with organization design for decision making. Little states:

> We would like to connect the decision making tasks to the design parameters of the organization, then relate the design to the eventual outcomes of the decision making, and finally relate those outcomes to relevant measure of mission performance.

Another area of concern is strategic management. Little says:

> An organization must sense its external environment and its internal state and then develop and execute short- and long-range plans. Needed are models to describe the environment and relate alternative strategic thrusts to outcomes and performance.

The research reported in this document has been performed in the spirit of these directives.

2.3.3 Directions for Research in Service Sector Operations

Mabert [1982], in a brief review of service sector research and applications papers, states the focus of service operations research has shifted from a technocratic bias to a more behavioral basis, with emphasis on the server and customer interaction. He notes progress in the development of a structure for integrating the design, planning and control of service operations, and notes the availability of computer-based systems to accomplish these functions. Mabert also notes the lack of integration present in published reports of service operations research. With regard to work force scheduling articles, he states

> Often the described work was limited in view and did not relate to other planning and operating activities in the organization. A number of work force scheduling articles looked at ways to determine number and timing of workers. However, they never considered the linkage with the employee complement size that constrains the number of workers available or the issue of which individual is to be assigned to a particular task, given vacations, days-off, seniority, etc.

The linkage between the size of the work force and the number of workers available to be scheduled is a basic, direct relationship. This relationship, as well as other less direct ties to the environment and operating conditions, is frequently ignored in research. Mabert calls for more research about databases themselves; what data to collect, and what data to maintain in order to address questions about integrated systems.

Sullivan [1982] states that service operations management (SOM) researchers must expand their horizons to include both traditional production concepts and complex behavioral considerations. He notes that past SOM research has emphasized equipment, not people, has tended to focus on subsystems, and has lacked an interfunctional perspective. Sullivan's view is that SOM research must consider the attitudes and behavior of employees, the role of the customer in the service delivery system, and the linkages between various functions as the service is produced and delivered. Part of this research looks at the way the customer (the patient) shapes the environment in which the service is provided. Some attempt has been made to consider integration by looking at flows of patients into and out of nursing units, and by considering degree of control over other types of workers on nursing units such as laboratory technicians, cleaning services, dieticians and therapists.

2.4 IMPORTANCE OF OPERATIONS STRATEGY RESEARCH

In this section a brief review of previous research in operations strategy, and a discussion of linkages of operations strategy to more tactical decisions are presented.

2.4.1 A Definition of Operations Strategy

During the late 1970s and throughout the 1980s concern for lagging productivity and intensified foreign competition caused American manufacturers to increase the amount of attention paid to the production function. As a result of this increased attention, several distinct strategies have evolved for managing operations and production in manufacturing organizations. Hayes and Wheelwright [1984] have written a great deal about operations strategy and how American firms must position themselves in order to return to a competitive stance in world manufacturing.

2.4.1.1 An Organizational Philosophy

In general, an operations strategy flows from an organization's overall business strategy which in turn is related to the organization's philosophy. Hayes and Wheelwright [1984] define a company philosophy as

> the set of guiding principles, driving forces, and ingrained attitudes that help communicate goals, plans and policies to all employees and that are reinforced through conscious and subconscious behavior at all levels of the organization.

Hayes and Wheelwright give examples of companies with strong philosophies in place. An organizational or company philosophy may both derive from and contribute to a corporate or organizational strategy. As an organization evolves, its organizational philosophy is likely to change, but a strong organizational philosophy may drive the formation of a corporate strategy. Thus, a reciprocity exists between organizational philosophy and organizational strategy.

2.4.1.2 An Organizational Strategy

An organization's strategy involves relating the efforts of the entire organization to the future of the organization [Krajewski and Ritzman, 1987]. Strategic planning involves answering such questions as where the organization is now; where the organization wants to be, in one year, five years or ten years; and how it can chart a course to arrive there. Strategic planning involves a broad examination of the organization's mission, its products, its services, its customers, and its employees, both now and in the future. Strategic planners must ask themselves what business the organization is in, who are the customers of the organization, what (broadly defined) products and services will meet those customers' needs, and in what business does the organization want to be in the future. In general, strategic planning is for a longer time horizon (one to ten years), is performed under conditions of uncertainty, with less structure, focuses on the whole organization, has an "ends" orientation, and tends to have an impact that is difficult to reverse [Krajewski and Ritzman, 1987].

For Hayes and Wheelwright [1984], corporate strategy specifies the businesses in which the corporation will participate, and the acquisition and allocation of resources to those businesses. A second level of strategy, a business strategy, is associated with a strategic business unit (SBU) within the overall corporate framework. According to Hayes and Wheelwright, an SBU may be a subsidiary, a division, or a product line within the firm. Because this research concentrates on the service sector, an SBU may also be considered as the set of parts of the organization required to deliver a specific line of services. For each SBU,

> A business strategy specifies (1) the scope of the business, in a way that links the strategy of the business to that of the corporation as a whole, and (2) the basis on which that business unit will achieve and maintain a competitive advantage [Hayes and Wheelwright, 1984].

According to Krajewski and Ritzman [1987] an organization is often better off if it identifies its distinctive competencies, those things the organization does particularly well. Taking advantage of these distinctive competencies may well allow an organization to develop a niche in the market place, which is one of the generic strategies described by Porter [1980].

This research focuses on hospital nursing units. A strategic business unit may be the entire hospital, or it may be the nursing unit from whom data has been collected, or it may be some intermediate level of organization within the hospital's organizational structure. Some of the services offered by hospitals, such as Emergency departments, Psychiatric services, Obstetrics and

Gynecology, or Pediatrics may certainly be thought of as divisions or service lines within the context of the entire hospital. If the nursing unit is a large one, comprising the entire "service line," it can be considered an SBU. As an example, most Emergency Departments would probably be considered SBUs. On the other hand, within a given hospital, many services lines are comprised of several nursing units. In such cases, each nursing unit would be part of an SBU, but would not be the entire SBU. For example, a hospital's obstetrics and gynecology services might be provided by several nursing units such as Labor and Delivery, Normal Newborn Nursery, High Risk Newborn Nursery, and Gynecological Oncology and Acute Care. Unless otherwise noted, this research treats nursing units as if they were subsets of SBUs, or operating units. The distinction is not of great importance, because the level of strategy which this research investigates most closely is operations strategy. Each nursing unit may be considered to have an operations strategy, whether the unit is an SBU or a subset of an SBU. Operations strategy is a functional strategy which, if strategy is thought of in a hierarchical sense, is one level below the strategy of a strategic business unit. Operations strategy is discussed in the next section.

2.4.1.3 Operations Strategy

A third level of strategies is the set of functional strategies. Functional strategies support the competitive advantage being sought by the business strategy. Examples of functional strategies are financial strategies, research and development strategies, marketing strategies, and operations strategies. According to Hayes and Wheelwright [1984], the functional strategies must be consistent with and linked to the business unit strategy if the SBU is to be successful.

The strategic level of interest in this document is the third level or functional strategy level. The specific function of interest is operations. In Hayes and Wheelwright [1984] and others, [Buffa, 1984; Skinner, 1978], strategy for this function is discussed as manufacturing strategy. For a review of issues pertinent to manufacturing strategy, see Chapter Two of Sharma [1987].

Operations strategy involves decisions about capacity, facilities, technology, vertical integration, the work force, quality, materials management, and structure of the organization [Hayes and Wheelwright, 1984]. According to Hayes and Wheelwright [1984], "Over time, management must make decisions in all these categories, each of which presents a variety of choices and can have a major impact on the manufacturing (operations) function's ability to implement and support the organization's business strategy." They argue that operations strategy is a pattern of the actual decisions made over time, and that, as an SBU's competitive strategy changes, changes must take place in the decisions made in all areas of operations. Hayes and Wheelwright also argue that an effective operations strategy must be internally consistent with the overall business strategy, with the other functional strategies, and across all decision categories of operations. Furthermore, an operations strategy must be externally consistent with the environment in which the organization operates. An operations strategy contributes to an SBU's competitive advantage by guiding the organization in providing the set of operational capabilities needed to pursue the chosen competitive business strategy.

Krajewski and Ritzman [1987] discuss a continuum of positioning strategies derived from the interaction of process structure and product structure, and ranging from a process focus to a product focus. See Figure 2.3. These positioning strategies are based on Hayes and Wheelwright's Product-Process Matrix [Hayes and Wheelwright, 1979, 1984]. However, the positioning strategies, as discussed by Krajewski and Ritzman, are equally valid for the service sector and the manufacturing sector. Ideas presented in the Service Process Matrix from Schmenner [1986], and shown in Figure 2.2, also are similar to those of Hayes and Wheelwright, but with a service sector orientation. The positioning strategies described by Krajewski and Ritzman [1987] align closely with the generic strategies proposed by Porter [1980]. A product-focus strategy is comparable to a low cost, high volume strategy. A process-focus strategy compares to a strategy of higher prices, high margins, and smaller volume. An intermediate focus may combine low costs and some product differentiation in an attempt to appeal to a select market niche.

2.4.2 Positioning Strategy Linkages to Work Force Decisions

According to operations management theorists, authors, and researchers, if consistency with the chosen positioning strategy is to be maintained, many operating strategy choices become evident [Hayes and Wheelwright, 1984; Krajewski and Ritzman, 1987; Buffa, 1984; Schroeder, 1985; Chase and Aquilano, 1985]. Some of these "consistent" choices are shown in Figure 2.3. The "consistency" of these decisions is largely untested, except by case study, other than by Sharma [1987], who tested positioning strategies in a manufacturing environment with a sample of 141 firms. Miller

A Continuum of Positioning Strategies

Product Volume:	One-of-a-kind or Very Low Volume	Moderate Volume Mix of Custom and Standard Products	High Volume for a Few Standard Products
Process Pattern:			
Jumbled Flows	**Process Focus** General Purpose Equipment Labor Intensive Products in early stages of life cycle Custom Design Small Facility Flexible Process Layout Variable-path Material Handling Emphasis on Product and Volume Flexibility Flexible Work Force Frequent Communication with Supervisors Fewer Staff Specialists Large Capacity Cushion and Imbalance Capacity hard to measure Long Delivery Times High Performance Design Quality Informal Procedures Large Number of Different Products		
Disconnected Line; Jumbled with some Dominant Flows	**Intermediate Strategy**	Medium to Large Batches Some dedicated Equipment Mixed Layout: Some line flows Statistical Quality Control	
Line Flows			**Product Focus** Standardized Products Long Life Cycles Short Delivery Times Consistent Quality Automated Inspection Formal Procedures Specialized Equipment Capital Intensive Vertical Integration Specialized Work Force Less frequent communication with supervisors Small Capacity Cushion Inflexible Product Layout Fixed-Path Material Handling

Source: Krajewski and Ritzman, 1987.

Figure 2.3
Positioning Strategy Linkages with Operating Decisions

and Roth [1986] have also surveyed a large number of manufacturing firms on three continents, and their work lends much support to the "consistent choices" theory.

From the case study observations and reports of operations management researchers certain "consistent" choices for a work force appear [Collier, 1985 and 1987; Peters and Waterman, 1982; Buffa, 1984; Hayes and Wheelwright, 1984; Krajewski and Ritzman, 1987]. If a process focus is chosen for the positioning strategy, the work force is likely to be flexible and have general purpose skills. In general, there is a fairly large capacity "cushion" to act as a buffer against uneven demand periods. This capacity takes the form of equipment or facility "hardware." Reliance on overtime or extra shifts or subcontracting of services helps with management of capacity imbalances. The work is generally labor intensive, with the work force being relatively large compared to the capital investment. Employees are likely to have a great deal of contact with their immediate supervisors, as priorities change quickly.

Scheduling of jobs and workers is very fluid, with a rapidly changing environment and much fluctuation in demand. The products or services are generally designed to individual customer specifications, with a very high emphasis on quality exhibited as high performance design. Because of this emphasis on customization, a large number of different products and services are likely to be offered [Krajewski and Ritzman, 1987].

If an organization has a product-focused positioning strategy, the work force is more likely to be specialized, because the emphasis is on producing standardized products or services. Delivery of customers orders is quicker, because inventories can be maintained, or because a standard service is being supplied. The quality emphasis is on consistency from one customer to another. More automation is found in the process, whether the item being produced is a good or a service. Capital investment per employee is much greater then in organizations with a process focus, so capital intensity is much greater. There is not so much contact with supervisory personnel, as task direction does not change often. Promotion channels are generally very formal, and formal procedures are likely to exist for many situations [Krajewski and Ritzman, 1987].

While this research does not allow for full testing of the "consistency" of work-force related choices in the service sector to positioning strategy, it makes a start in this direction by investigating management objectives and their linkages to various staffing and scheduling strategies.

2.4.3 Relationship of Operations Strategy in Hospitals to This Research

Managerial researchers have suggested the hypothesis that well run, profitable organizations are likely to have strong, identifiable "corporate cultures," quite similar to company philosophies, as defined above [Peters and Waterman, 1982]. An organization's culture, in turn, helps to shape its strategic planning. However, catastrophic events or major upheavals seem to bring about the need for strategic plans which have as their objective the changing of organizational philosophy or corporate culture. An example of major upheaval was the declining growth in manufacturing productivity witnessed during the seventies. A massive increase in successful foreign competition in automobiles and electronics was another major upheaval during the same period. These events have caused manufacturing firms to redefine their corporate strategies and to reassess their corporate philosophies in order to seize, maintain, or regain their competitive edges [Hayes and Wheelwright, 1984; Buffa, 1982].

The hospital segment of the health care industry is easily in as great a turmoil today as manufacturing in the United States was in, during the preceding decade. Demands for higher quality and lower cost are being placed on health care providers by the government, by major insurers, by corporate America, and by the average consumer [Snoke, 1987; Spiegel and Kavaler, 1986; Curtin and Zurlage, 1984]. Additionally, these groups are seeking a greater role in health care decision making. Continuing breakthroughs in technology provide the possibilities of longer lives for many, but at very high economic costs [Otten, 1989]. Ethical issues and concern for "quality of life" are intertwined with economic decisions.

The relationship between organizational philosophy and strategy is tangential to this research, in that many hospitals are very long-established organizations. Thus their organizational philosophies have had many years to become firmly entrenched [Heydebrand, 1973]. On the other hand, the entire industry is in under a great deal of pressure to respond to government and other directives to contain costs. The nursing shortage has been prolonged and shows no signs of abating. These events, and others have influenced many individual members of the hospital industry to reassess the organizational philosophies under which they operate. A result has been the redirection of organizational and operational strategies. The results of this research show that the need for redirection is clearer than the path of redirection.

A time for new operational strategies is at hand, if the hospital industry is to survive in some form in the future. One set of these operational strategies must relate to work force staffing and scheduling issues, and must be consistent with the overall hospital organizational philosophy and strategy, as well as other functional strategies for financing and marketing the hospital services. In addition, the work force staffing and scheduling strategies and policies must be integrated with other hospital operational strategies for capacity, quality, facilities, technology and organizational structure. Just as successful manufacturing firms have found their niches, so must individual hospitals. Just as for manufacturing firms, the strategic choices will not be the same for all hospitals. This research hopes to provide some guidance in what constitutes consistent choices for organizational and operational strategies.

2.5 PREVIOUS RESEARCH IN WORK FORCE STAFFING AND SCHEDULING: GENERAL MODELS

The purpose of this section and the next two sections is to provide selected examples of previous operations management (OM) research in the area of work force staffing and scheduling. Most models discussed in these three sections have been developed by OM researchers interested in producing optimal or near optimal solutions to selected scheduling or staffing problems under rigorous, well-defined conditions. In general, a generic or specific work force scheduling situation has been distilled to its essential characteristics in order to model the situation, study its behavior, and determine a "solution". These sections do not serve as a definitive review of all such work. Rather, the models discussed here serve to illustrate the interest of previous OM researchers in the characteristics of the work force, the operating environment, and the scheduling system. In addition, if the models presented here are viewed as having some relevance to practice, then the solution to or the underlying conditions of the model often seem to imply the existence of staffing and scheduling flexibility.

A work force may be flexible in its ability to change size rapidly (size flexibility), or it may be flexible in its ability to perform many tasks (job flexibility). Its flexibility may relate to the location in which the job is performed (place flexibility), or its flexibility may relate to reporting times, shift lengths, and days off (time flexibility). In addition, a work force may have the willingness to be reassigned frequently (reassignment flexibility) or combinations of two or more flexibilities. These facets of work force flexibility were displayed in Figure 1.3. Another consideration about work force flexibility is the proportion of the work force to which it applies. There may be a core of workers who are quite inflexible with respect to time, but very flexible with respect to jobs. Another part of the same work force may exhibit the opposite facets of flexibility. It is quite possible that none of the hypothesized flexibilities appear separately. This possibility lends difficulty to the measurement of the individual flexibilities. In Chapter IV, methods for measuring the various flexibilities are proposed.

Some of the hypotheses tested in the present research have as their bases combinations of characteristics investigated in the models discussed in this section. When the model, its background, or its solution has given rise to a conclusion related to a flexible work force, a null hypothesis is derived from that conclusion. Table 2.5 summarizes the null hypotheses drawn from the research discussed in this chapter. Other a priori hypotheses were listed in Chapter I, Table 1.3. Results of the tests of hypotheses in Table 2.5 and in Table 1.3 will be discussed in Chapter V.

Work force staffing and scheduling research reviewed in this section is largely concerned with general work force models not specific to a given industry. Work force staffing and scheduling models derive their characteristics from the work force, the operating environment, and the scheduling system. These characteristics influenced the design of the research instrument shown in Appendix A. A taxonomy of characteristics of models for work force staffing and scheduling is shown in Table 2.6. Also shown in these tables are some usual objective functions and solutions methodologies. One form of problem structure is that demands are given, and the size or the total cost of the work force needed to meet such demands is being minimized, subject to other constraints. Another form of the problem structure is to give the set of available employees, or the total amount of available budget, and maximize the demand that can be covered. Therefore, a set of the cost categories often found in staffing and scheduling problems is also included in the taxonomy given in Table 2.6.

2.5.1 Single Shift Models

Single shift models are the easiest to study, but do not represent a great deal of realism for most service sector industries. However, in situations where employees are always assigned to the same shift, or where the manager is mostly interested in the number of employees needed to cover daily demand, the single shift model represents the essence of the situation.

2.5.1.1 Single Shift Models with Constant Demand

OM researchers have looked at work force scheduling models for a single shift operation, open seven days a week, with constant demand during the week, and a different constant demand during the two weekend days. The objective of such research generally is to find the minimum number of workers needed to cover the weekday and weekend demand subject to a days-off constraint for the workers. Since demand is invariant from week to week, once an employee's work schedule has been determined, it need never change. Thus the work force schedule is "cyclical," in that it repeats every seven days. Baker [1976] surveys cyclical staffing models with these characteristics and some extensions.

Baker and Magazine [1977], Brownell and Lowerre [1976], and Lowerre [1977] all pose solutions to the single shift, constant demand problem. Their objective is to find the minimum size work force needed, subject to the constraint of each worker having one day off in the seven day cycle, or having two consecutive days off in the seven day cycle. Each researcher has developed (1) closed form expressions for the minimal work force size, and (2) algorithms to allocate the work force in order to meet demand requirements once the minimal size has been determined. Interest of academic researchers has tended to focus on computational efficiency and sophistication. In practice, the need for computing speed is not so great, as schedules for individual employees would flow from the allocation step, and workers would, presumably, have the same schedule forever, or until the demand level changes. If these models are to reflect a real work force scheduling situation, the workers themselves must be highly substitutable, one for the other. One conclusion that can be drawn is that when a high degree of substitutability exists, the workers being scheduled possess a low skill level. Another possible conclusion is that if workers are highly substitutable, they are a very stable work force in which all workers are well trained to do any job (employees have high job flexibility).

2.5.1.2 Single Shift Models with Fluctuating Demand

Baker [1974] gives an algorithm for finding the minimum number in the total work force for a facility operating seven days a week, for a single shift, with fluctuating manpower requirements each day of the week. The algorithm meets all staffing requirements and permits two consecutive days off for each employee. There is one class of employee being scheduled. It is assumed work force requirements are known and may vary daily over a weekly period. However, for a given day of the week, the requirements are known and constant for that day. For example, Monday's requirement is always the same. Baker states "this kind of problem is commonly encountered in public service and transportation organizations, and sometimes manufacturing firms as well." Tibrewala, Philippe and Browne [1972] present an algorithm for this same problem, which may be solved by hand, but may require a large number of iterations before a solution is reach (one iteration for each required worker). Baker's algorithm also may be implemented by hand, in one or two steps, but there is no report of it being field tested by actual managers. For this model to be useful to a manager, the workers being scheduled will have to be completely interchangeable, implying a very stable work force, a very well trained work

TABLE 2.5

SUMMARY OF WORK FORCE FLEXIBILITY HYPOTHESES DISCUSSED IN CHAPTER II

(Listed in Order of Appearance)

No.	Facet of Work Force Flexibility	Source of Inspiration	Null Hypothesis
2.1	JOB	Baker and Magazine [1977] Brownell and Lowerre [1976] Lowerre [1977]	The presence of job flexibility in the work force is unrelated to skill level of the work force.
2.2	JOB	Baker and Magazine [1977] Brownell and Lowerre [1976] Lowerre [1977]	The presence of job flexibility in the work force is unrelated to the employee turnover rate.
2.3	TIME	Baker [1974]	For continuous operations, the methods used to generate weekend schedules are unrelated to the presence of employee unions.
2.4	JOB VOLUME	Baker [1974]	The level of variability in demand from day-to-day, and from week-to-week is not related to volume or job flexibility in the work force
2.5	VOLUME	Bechtold [1981]	In the presence of cyclical and highly variable daily demands, an organizational goal of cost containment is unrelated to the mix of full-time and part-time workers employed.
2.6	TIME	Bechtold [1981]	In the presence of cyclical and highly variable daily demands, the proportion of full-time personnel employed is unrelated to the level of time flexibility of the work force.
2.7	TIME	Burns and Carter [1985]	Variability in demand is unrelated to the frequency with which schedules are generated.
2.8	TIME	Burns and Koop [1987]	The number of shifts being scheduled is unrelated to the level of time flexibility present in the work force.
2.9	VOLUME	Krajewski and Ritzman [1977]	The level of volume flexibility in the work force is unrelated to an organizational goal of providing outstanding service.

TABLE 2.5 (Continued)

SUMMARY OF WORK FORCE FLEXIBILITY HYPOTHESES DISCUSSED IN CHAPTER II

(Listed in Order of Appearance)

No.	Facet of Work Force Flexibility	Source of Inspiration	Null Hypothesis
2.10	VOLUME JOB, TIME PLACE	Krajewski and Ritzman [977]	An organizational goal of cost containment is unrelated to the level of time, job, place or volume flexibility found in the work force.
2.11	TIME JOB	Henderson and Berry [1977] Buffa, Cosgrove and Luce [1976]	The level of demand variability is unrelated to the combination of time and job flexibilities found n the work force.
2.12	PLACE	Mabert and Raedels [1977]	The number of locations being scheduled together is unrelated to the level of place flexibility in the work force.
2.13	JOB	Chase, Northcraft and Wolf [1984]	The level of job flexibility in the work force is unrelated to the performance of organizational goals.
2.14	TIME VOLUME	Mabert [1979] Krajewski, Ritzman, and McKenzie [1980] Davis and Reutzel [1981] Ritzman, Krajewski, and Showalter [1976]	The combination of demand variability and the goal of accomplishment of certain activities on a timely basis is unrelated to time and volume flexibility.
2.15	TIME JOB VOLUME	Krajewski & Thompson [1975]	The organizational goal of good customer service in combination with seasonal demand is unrelated to the level of time, job, or volume flexibility in the work force.

TABLE 2.6

A TAXONOMY OF WORK FORCE STAFFING AND SCHEDULING MODELS

Characteristics of the Work Force

A single class of employees	Multiple classes of employees Two classes of employees Full time versus part time Permanent versus temporary Two classes of full-time More than two classes One class may or may not be substitutable for another class
No attrition	Attrition considered
No training period - full productivity	Training period considered - full productivity immediately after n periods
All employees from the same source	More than one source of employees
Supervisor to employees ratio not considered	Supervisor to employee ratio considered
Employees assigned a permanent shift	Employees may rotate shifts
Employees assigned a permanent unit	Employees have no permanent unit assignments

Characteristics of the Scheduling System

Single shift	Multiple shifts Twenty-four hours-a-day operation Two shift start times Three shift start times More than three shifts Less than 24 hours-a-day operation Two shift start times Three shift start times More than three shifts
All shifts the same length	Shifts of varying length
No split shifts	Split shifts allowed
No overtime allowed	Overtime allowed: Limited versus unlimited
No undertime allowed	Undertime allowed: Limited versus unlimited
No work breaks considered	Work breaks considered
One work unit being scheduled	More than one work unit being scheduled
Days off need not be consecutive	Consecutive days off required

TABLE 2.6 (Continued)

A TAXONOMY OF WORK FORCE STAFFING AND SCHEDULING MODELS

Characteristics of the Operating Environment

Open seven days per week	Closed one or more days per week
Open 24 hours a day	Closed part of the day
Open year round	Closed part of the year
Weekends same as other days	Weekends special
Demand known	Demand unknown
Demand constant for all periods	Demand varies from period to period Pattern cyclical versus acyclical
Demand deterministic	Demand stochastic

Characteristics of the Objective Function of the Model

Minimize the number of employees needed, given a set of demands

Minimize total costs of staffing, given a set of demands

Maximize the coverage of demand or potential demand, given a set of employees

Maximize the coverage of demand, given a certain budget level

Cost Categories that may be Included in the Model

Payroll Costs	Administrative Costs
Hourly wages	Hiring costs
Salaries	Layoff or firing costs
Overtime costs	Training costs
Undertime costs	Supervisory costs
Benefits	
Shift differential	
Weekend or holiday differential	

Common Solution Methodologies

Hand Calculations	Computerized Solutions
Algebra	Linear Programming
Tableau Manipulation	Integer Programming
	Set Covering Problem
	Dynamic Programming
	Networks
	Quadratic Programming
	Artificial Intelligence
	Expert Systems

force, or a very low skill level requirement. All pairs of days-off are considered equal, implying a non-union operating environment. Stated as a conclusion, if weekends are not considered special for scheduling purposes, the operating environment is most likely to be non-union. The workers are being scheduled for a five-day work week, so the implication is that each employee works one eight-hour shift each day.

If requirements are allowed to vary from week-to-week as well as from day-to-day, then Baker's model [1974] must be resolved for each seven day period, yielding a work force size that fluctuates from week to week. Such frequent variations in work force size imply that hiring and layoff costs are nonexistent or very low, there is a readily available supply of labor, or that the skill requirements are fairly low, as there is no allowance for trainees. If Baker's model is to represent a practical situation, then a work force flexible with respect to size or to task is certainly the "solution" to the staffing problem. A conclusion derived from this model is, when there is high variability in demand from day-to-day, and from week-to-week, the work force will exhibit high flexibility with respect to job, or with respect to size of the work force (volume flexibility) or both.

Bechtold [1981] also studies the same problem but, in the second stage of the problem, when allocating employees to days, is concerned with spreading "slack" or extra workers to as many days as possible, instead of having them on all on one or two days. "Slack" workers appear in the problem because it is assumed employees are full-time, 40-hour-per-week workers, and must be assigned to five work days even if all requirements are met. Bechtold's point is that it is better to spread extra workers around, as a buffer against demand uncertainty. In practice, what is likely to happen is that some of the 40-hour-per-week workers will be replaced with part-time employees, so that there is no buffer. Alternately, these part-time workers may be expected to be flexible enough to come in to work when demand warrants their presence. Thus, they do serve as a buffer, but they are only paid when demand is high. A conclusion deduced from this situation is that if the assignment of a minimum number of full-time workers would result in a great deal of slack on a few days, some of the full-time workers are likely to be replaced by part-time employees. Another way to state this conclusion is that in the presence of cyclical and highly variable daily demands, a cost-conscious organization will very likely employ a mix of full-time and part-time workers. A complementary conclusion is that in the presence of cyclical and highly variable daily demands, an organization employing only full-time personnel will expect those employees to be flexible as to start times and length of shift on any given day (employees will have high time flexibility).

Burns and Carter [1985] also investigate solutions to a single shift model with variable demands. However, they do not treat all pairs of days-off as equal. In their model, each employee must have A weekends off in a cycle of B weeks. They also allow for 6 day work stretches, and try to minimize the number of these stretches. They admit that the single shift model is of more interest to academicians than to practitioners. In practice, the single shift model is used as a building block. However, the Burns and Carter [1985] algorithm for finding a lower bound to the number of needed employees has been used in labor negotiations in health care and in mining, when labor or management requests a change in the weekends-off arrangement. In addition, their algorithm has been applied by some real world managers to single shift problems. Burns and Carter point out that theirs is an iterative construction of schedules, and does not produce a master rotation, as did earlier work. However, they also point out the likelihood of changing demands, due to seasonality and growth, and suggest that master rotations outgrow their usefulness fairly rapidly, while a new iterative construction of schedules for the next B weeks can take into account a new set of demands. Their suggestion leads to the conclusion that when there is high variability in demand, schedules will be generated with greater frequency.

2.5.2 Multiple Shift Models

The consideration of multiple shifts adds more realism and more difficulty to the modeling situation. Burns and Koop [1987] present a multiple shift model with a great deal of realism, that can be and has been used by real service sector managers. They divide their constraint set into primary constraints and secondary constraints. The primary constraints are of two kinds: staffing (or demand) constraints, imposed by management; and scheduling (or schedule quality) constraints imposed by the work force, or by their union. The staffing constraints relate to how many workers must be present each weekday, and weekend day, for each shift. The scheduling constraints relate to average days off per week, weekend days off required, hours between shifts changes, and maximum number of consecutive shifts to be worked. Secondary constraints are those constraints not imposed by legal requirements, but are in the realm of employee special requests or desired features, such as a minimum number of shift changes, or certain days off.

The approach of Burns and Koop [1987] is fairly practical. It starts with an easy-to-compute lower bound on the number of workers needed and distributes the "off-weekends" evenly over the schedule of W weeks, where W = the number of workers being scheduled. A scheduler can use their predetermined modules to put together one or more schedules meeting the primary constraints of a particular situation, or the scheduler can build his or her own modules to meet the constraints. When more than one schedule is "optimal" based on the primary constraints, the manager can pick the schedule meeting the most secondary constraints. Burns and Koop have done work with the Alberta Canada Hospital Association and the Alberta Canada Nursing Association. Their modeling techniques incorporate many practical issues associated with staffing and scheduling. One of the extensions to their model includes work in scheduling 12-hour and 8-hour shifts for the same work unit. Their model does not allow for more than one class of employee, nor can demands vary across weekdays. They do understand the linkage between the staff that ultimately must be available to meet the customers' demands, and the schedule that must meet the employees' requirements. The employees scheduled by their model must be fairly flexible as to start times (they need to have time flexibility), as they change shifts fairly often. This observation leads to the conclusion that in a multi-shift environment, workers are very likely to be expected to be flexible with respect to time. Many other authors have researched the multiple shift problem, especially in the hospital context. These models are addressed in section 2.7.

Morris and Showalter [1983] performed a simulation study which combined the days-off problem with the shift scheduling problem. They simulated a variety of cyclic patterns, in which daily demand could vary in three ways and weekly demand could exhibit one of five patterns. Their simulation considered full-time workers who worked four hours, took an hour break, and then worked four more hours. Work could start at any hour of the day, with the objective of minimizing the number of employee hours needed to satisfy hourly demand requirements over the week. The workers being scheduled by their algorithm are expected to have a great deal of flexibility with respect to report times, although shift lengths are fixed (a facet of time flexibility).

Glover, McMillan and Glover [1984] discuss a heuristic approach for "automatically" scheduling employees of a variety of skill levels, a variety of shift lengths, and with deference to employees' availability. They consider their scheduling program an application of artificial intelligence, and they are quite vague about how it works. Although they recognize the need for real-world managers to consider different skill levels of employees when executing a weekly schedule, there is no evidence in the example given in the article that their heuristic really does this. Their work force is expected to have time flexibility, with respect to both shift length and start time, and size flexibility, as the number needed each week is allowed to vary widely.

Disaggregation is defined by Krajewski and Ritzman [1977] as the total process of going from aggregate work force staffing and production plans to more detailed plans. Their focus is primarily on models suitable for math programming solutions. They survey problems and research for manufacturing and service organizations for three levels of manpower decisions. The three levels of decisions for service organizations are: determining overall staff sizes; assigning employees to alternative shift schedules, and crew assignments, including the determination of days on and off; and determining short term reallocations and adaptations based on demand. In their survey they recognize and discuss the constraining linkages between the overall staff sizing problem, and the shift scheduling problem. Because uncertain demand in the service sector cannot be buffered by inventory, buffers are created by a work force that is flexible, or by overstaffing. From their discussion two conclusions may be drawn. First, if overstaffing is to be found in the service sector, it is most likely to be in an organization that is competing by providing outstanding service. Second, in environments in which cost containment is a strong managerial objective, a flexible work force is likely to be the primary buffer against demand uncertainty.

2.6 PREVIOUS RESEARCH IN WORK FORCE STAFFING AND SCHEDULING: SERVICE SECTOR SPECIFIC MODELS

This section considers staffing and scheduling research by operations management researchers in specific service sector industries outside of health care. A few well known OM studies dealing with the scheduling of telephone operators, bank employees, and postal workers are briefly reviewed in this section. The research presented in this section reflects the same concerns of those who researched the generic work force staffing and scheduling problem. However, this research concentrates on specific industries, so there is greater recognition of the role of customer contact and the role of demand uncertainty in the modeling and solution processes. For more breadth of coverage, the reader is referred to Aggrawal [1982]. Aggrawal reviews issues in work force scheduling in the service sector, outlines the characteristics of the problems in a variety of service industries, and gives selected references for 11 areas of concern in the service sector.

2.6.1 Models for High Customer Contact Situations

Henderson and Berry [1977] describe an algorithm for determining optimal shift schedules for operators in telephone exchanges. Requirements for telephone operators start with telephone call volume forecasts for 48 half hour periods or 96 quarter hour periods per day. These demands are then translated into the number of operators needed in each of the periods. This translation trades off customer service requirements for quick response with manpower costs. Operators are then scheduled to start at various times, and work for varying lengths of shifts which include a break period. These operators are expected to have high time flexibility. One of the reasons that these multiple shift start times are likely to work is that each operator performs a fairly standardized set of tasks and services, and there is no need for frequent contact with supervisors. Also, it is easy for a worker to take over from another worker, or to fill a vacant position, as the need to transfer information about what has happened on a previous shift is fairly low. This set of conditions leads to the conclusion that when high demand variability exists, high time flexibility of the work force is more likely to be found if job flexibility is low. (It should be noted that current technology may have mitigated the demand for operators. However, when an operator is needed, the operator is still in voice contact with the customer at some point in the service. The problem setting might apply equally well to a high volume customer service center, where orders, queries, and complaints come in by telephone round the clock.)

Buffa, Cosgrove and Luce [1976] also worked with the telephone operator problem, integrating several levels of the problem from demand forecasting to detailed operator assignments. They view the problem for a year at a time, forecasting overall manpower needs as well as training needs for new staff. They also produce a detailed schedule every five weeks, and allow for daily assignment adjustments for unexpected demand or personnel changes such as illness. They explicitly recognize the strategic implications of the overall manpower choices on the final day-to-day adjustments. The operators scheduled by their procedure are expected to have high time flexibility.

Mabert and Raedels [1977] investigated a heuristic procedure to assign part-time tellers in a multiple branch bank where tellers can be transferred between branches. The bank under consideration decided to reduce labor costs by employing a combination of full-time and part-time tellers. The bank's previous policy had been to employ full-time tellers only. This policy had resulted in considerable excess capacity. This situation is an example of full-time employees with little flexibility, in combination with part-time employees with time flexibility and place flexibility. A conclusion drawn from this study is employers having multiple locations are likely to require place flexibility from their part time workers.

Chase, Northcraft and Wolf [1984], do not deal with scheduling per se, but discuss the design of a high-contact service system. Using data gathered from a multiple branch savings and loan, they test two hypotheses relating the external environment to contact variables to outcomes. The external environment is measured by age of the branch, affluence of the surrounding area, and competition to the branch. Contact variables consist of two kinds.

Contact technology includes telephone, mail, drive-in windows, inside teller windows, and automatic teller machines. Contact roles include sales representatives, stock brokers, and loan officers. Contact training includes training for clerical duties, interpersonal skills, cross-training for other positions, and portfolio training. Outcomes are dollar amounts of deposits, number of depositors, and costs. The two hypotheses they propose are for improving the performance of high contact service operations. One hypothesis is to increase effectiveness, increase access to databases and develop more and/or better contact roles. The second hypothesis is to increase efficiency, pay greater attention to contact technologies and contact training. Chase, Northcraft and Wolf were unable to test hypotheses relating to databases, and to contact training, due to low variance among the branches of the savings and loan company in their study. However, contact roles and contact technologies were found to have favorable correlations with all three measured outcomes. A conclusion related to their hypothesis about contact roles, is that a work force with job flexibility (each worker can perform many roles) will be more effective.

2.6.2 Models for Lower Customer Contact Situations

In service operations with lower customer contact, sometimes referred to as quasi-manufacturing operations, there is an expectation that work force flexibility is not quite so important as a buffer from the volatility of customer demand. The distance of the operations from the customer generally creates a slight smoothing of demand, and an increase in the ability to forecast the total work load. A less flexible work force should be required. However, operations being performed under tight deadlines or with severely constrained resources still require flexibility of one kind or another from the work force, even if such operations are performed far from the customers' eyes. Some examples are bank check encoders, the majority of postal workers, and public utility equipment installers and repairers.

Bank check encoding is an activity performed far from the customers which carries with it measurable financial penalties if the job is not completed on time each day. Substantial fluctuations in check volume available to be processed occur from hour-to-hour, day-to-day, and week-to week within a month. Researchers who have studied this problem [Mabert, 1979; Krajewski, Ritzman, and McKenzie, 1980; Davis and Reutzel, 1981], as well as banks which must deal with the problem in practice, have concluded that the best work force for bank check encoding is a part time work force. Academics have developed algorithms for scheduling check encoders for a day or for a week, but in all cases, the work force is highly flexible with respect to starting time, and shift length. Because the work force is part time, and demand is so variable, the work force has high size flexibility also. Different numbers of workers may be employed each day. The employees on a given day are likely to be a mixture of those who work for the bank and those who work for an agency that furnishes temporary employees. These banking examples lead to the conclusion: In an environment with highly volatile demand and a time dependent activity, the work force is likely to possess time flexibility and size flexibility.

Postal workers, in the operations studied by Ritzman, Krajewski,and Showalter, [1976], also must meet rigid time constraints. Postal union requirements limit the flexibility of the work force, but part time workers and temporary seasonal workers are allowed within limits. Overtime is used, so the work force does have some time flexibility as well as size flexibility. The postal worker example supports the conclusion discussed above, and inspired by the bank check encoders.

Public utility workers who maintain and install equipment frequently work away from the customer. However, demands for their services are highly seasonal and dependent upon customer activities, as well as weather and long range construction plans of the company. The desire and responsibility for good customer service dictates a certain amount of time dependency to the fulfillment of demand. (Lengthy delays in new hookups, or in repairs of lines downed by storms will cause customers to complain to the state commission that regulates the public utility. Utilities generally have a high desire to avoid this sort of hassle.) Krajewski and Thompson [1975] introduce a manpower planning model for a public utility that considers attrition, training, seasonal demand, limited overtime, and four distinct groups of workers. A long training period of three years before a lineman reaches full productivity is incorporated in their model. Some, but not all, of the workers possess job flexibility, in that they can perform jobs other than their own. This model can be used for annual budgeting and can also be used for detailed monthly planning of manpower needs. While this model is a step higher in the disaggregation process than most of the shift scheduling models discussed here, it illustrates the need for concern with flexibility of the work force at all levels of the staffing and scheduling problem. The utility workers in the example studied by Krajewski and Thompson have some time flexibility exhibited by the allowance for limited overtime. They have some job flexibility exhibited by ability to exchange employees in one group, the most highly skilled one, for employees in other work groups. Also, they have some size flexibility, as some workers may be hired for some tasks on a seasonal basis. A conclusion arising from this example is that when the provision of good customer service is a strong managerial objective, and seasonal demand exists, the work force is likely to possess one or more types of flexibilities.

2.7 PREVIOUS RESEARCH IN WORK FORCE STAFFING AND SCHEDULING: HOSPITAL NURSING SPECIFIC MODELS

This section reviews research specifically related to health care, the hospital industry, and hospital nurse staffing and scheduling. The purpose here is to give a flavor of the external environment driving decisions in health care, and to show how this has affected research interests in hospital nurse staffing and scheduling. An attempt is made to convey the enormity of the hospital nurse staffing and scheduling issue, and to indicate the diversity of factors impacting on it.

Section 2.7.1 reviews some material establishing the background existing in health care today. Section 2.7.2 reviews some of the nursing management literature illustrative of nurse managers concerns in today's health care environment. Section 2.7.3 contains a review of operations management literature specifically related to hospital nurse staffing and scheduling. None of these sections is an exhaustive review of the literature available on these topics. The literature reported in Section 2.7.2 has been authored for the most part by health care practitioners and academicians, and tends to report on schedules, systems, and projects actually tried in one or a number of hospitals.

Even the normative or theory-driven literature in this section tends to be derived from realistic hospital systems. By contrast, the literature reported in Section 2.7.3 has been authored by operations researchers and operations management academicians. The focus is typically on the solution, usually in a mathematical format, to a particular staffing or scheduling situation, which has derived from a real situation is a real hospital. Section 2.7.3 does show the ongoing interest of operations management researchers with the hospital nurse staffing and scheduling "problem."

2.7.1 The Effect of Diagnostic Related Groups and Prospective Payment Systems on the Health Care Industry

At the beginning of the 1980s the Federal government began a switch in its reimbursement policies for patients treated in hospitals under the Medicare system. This switch in reimbursement policy has served as a major catalyst for the emphasis on cost containment found in most health care organizations today [Spiegel and Kavaler, 1986; Curtin and Zurlage, 1984]. Before 1981, hospitals were reimbursed for patient care on a "cost-of-service" basis. The hospital would determine the full cost of serving a given medicare patient, and the government would pay. Such a system did little to inspire cost efficiency, as hospital administrators knew they could recover their "costs" one way or another. In addition to inefficiencies, costs charged off to the government and to major insurers often included a share of the costs incurred by indigent patients and attributed through "operating overhead" to other patients. Cost containment pressures on hospitals were present, prior to 1980, but most of these pressures arose mostly from a macro perspective, in the guise of reducing the growth of health services as a share of the Gross National Product. Hospitals dealt with these pressures on a voluntary basis, and there was little focus on micro solutions to containing costs in individual hospitals, let alone, individual hospital units [Smith, Fottler, and Saxberg, 1981].

Since 1981, cost pressures on hospitals have exacerbated. A direct cause of the increased cost containment pressure is the prospective payment system (PPS) introduced by Medicare in 1981, and adopted by most state Medicaid programs and other third-party payers by the 1985. Hospitals now receive standard reimbursements for all patients with similar diagnoses. The Medicare PPS is based on a patient classification system, in which each patient's diagnosis is classified into one of 471 categories, known as Diagnostic Related Groups, or DRGs. Spiegel and Kavaler [1986] and Curtin and Zurlage [1984] have both detailed many of the effects of DRGs and PPS on hospitals in the 1980s. Hospitals have reexamined many of their operations as a result of PPS and DRGs. Outpatient services have tended to increase and inpatient services have tended to decrease. Outpatient services do not require an overnight stay. Inpatient hospital services are those services received by patients who have actually been admitted to the hospital. Improvements in medical technology, as well as reevaluations of operations forced by cost consciousness, have made this shift from inpatient care to outpatient care feasible for many procedures and treatments. Inpatient hospital services have tended to be reserved more and more for patients in need of a great deal of nursing care. Patients receiving care on an outpatient basis also may need nursing care, but the environment in which nursing care is provided is likely to be quite different than the environment in which inpatient nursing services are received.

Concern has been expressed by many about the ethics of cost containment and the possible outcome of rationing of health care [Fry, 1983]. Others in the health care industry have addressed the need for nursing professionals to be involved in the formulation of health care policy [Bradham, 1985; Hicks and Boles, 1984; Porter-O'Grady, 1987; and Wesbury, 1988]. The sentiment have been expressed by many health care professionals, in print and out, that DRGs and cost containment are here to stay. At a minimum, the influence of the cost containment thrust is likely to remain throughout the next decade [Spiegel and Kavaler, 1986; Snoke, 1987]. This emphasis on cost containment has forced all in the hospital industry to adopt a more business-like attitude with a focus on the "bottom line."

One of the purposes of this research is to gain insight into the environment in which nursing units operate. Spiegel and Kavaler [1986] discuss variables related to inpatient services. They are quite clear about the need for a hospital administrator to run a hospital without falling into a negative cash balance. They have this to say about managerial decisions made by hospital managers:

> Managerial decisions fall into two categories: those concerning the operations of the facility and those pertaining to the facility's structural organization. Operational variables include the overall cost containment environment, the hospital's case mix, the severity of illness issue, reimbursement for capital costs, medical technology, marketing services, and procedures know as "gaming the system." (They are referring to DRG "games" where patients are readmitted under other DRGs, in order to prolong the patients' stays.) Structural variables deal with items such as the type of institutional auspices, participation of trustees, legal aspects, physician/administration relations, implementation activities, and the creation of new positions to move the new reimbursement plan along.
>
> These administrative options are influenced by a wide range of vested interests inside and outside the hospital. However, there appears to be a consensus that PPS has effectively applied a business ethic to the management variables. Executives may be forced to make

> unpleasant choices under the banner of effective management principles. ...
>
> The operational components of hospital management are profoundly influenced by the all-encompassing blanket of cost containment ideology. In turn, that philosophy has stimulated the intensive business-like approach to running a hospital.

Many of the operational variables listed by Spiegel and Kavaler have been incorporated in the design of this research project. An attempt is made in the research instrument to determine the influence of cost containment, the variety of patients served, and the effects of technology on the individual nursing units being surveyed.

2.7.2 Effect of DRGs and PPS on Nursing Services

The nursing profession early on recognized that DRGs and PPS would affect nursing services [Grimaldi and Micheletti, 1982; Sovie, and others, 1985; Curtin and Zurlage, 1984; Kirby, 1986A]. As Kirby [1986A] concludes, in reviewing the challenge engulfing the nursing profession, "the current imperative facing health care institutions demand that we (the nursing profession) maintain quality while keeping the cost per case as low as possible and maintaining an appropriate market share." Kirby's statement summarizes the current focus of the hospital industry on low cost, high quality, and good customer service.

Centralization of capital intensive medical technology and the provision of highly skilled nursing services are two of the main reasons for hospitals to continue to exist in today's cost-conscious environment. Patients in need of a daily check by a physician are no longer kept in a hospital, unless a high level of nursing care also is needed. Patients requiring medical treatments that involve special technology or special medical skills are not kept in a hospital overnight unless treatment is continuous, or at very frequent intervals, and nursing care is also required. Patients in need of a reduced level of nursing care are discharged and assigned home health workers who stop by their patients' homes everyday or so for a few days or weeks after dismissal from the hospital. The net result is that patients in a hospital today are in need of highly skilled nursing care. The very cost pressures that have created the need for a higher level of nursing care in the hospital have forced hospitals to scrutinize every staffing and scheduling decision.

Becker and Foster [1988], in a study of nurse staffing patterns in multi-hospital systems, government hospitals, investor owned hospitals, and not-for-profit nongovernment hospitals, report an industry wide trend toward an increased reliance on registered nurses. Becker and Foster found the RN trend more pronounced at hospitals that are members of multi-institutional systems, and at private hospitals. They also found total staffing levels were generally higher for systems members. They conclude that organizational variables do have an impact on staffing decisions. However they did not control for patient acuity, payer mix or region, and they note that nurse staffing decisions depend on factors peculiar to the values and desires of individual institutions. Nursing researchers make a case that the registered nurse with a bachelor's degree in nursing (known in the nursing profession as an RN, BSN) is the most cost effective of the health care workers typically involved in the provision of hospital nursing services [Houston and Cadenhead,1986; Halloran,1983]. Such cost effectiveness stems from the ability of the registered nurse with a bachelor's degree in nursing to perform far more nursing duties than any other member of the nursing staff, by training, and by law. This ability makes the RN, BSN the most flexible (with respect to job flexibility) of nursing service providers.

A major concern in the nursing profession has been whether the reimbursement weights given to DRGs properly reflect the nursing services involved in providing nursing care to patients in a particular diagnostic related group [Cromwell and Price, 1988; Price and Lake, 1988; Reitz, 1985A, 1985B]. Measurement of the severity of patients' illness, in terms of the relationship to nursing care required also has been a long-time concern of the nursing profession [Spiegel and Kavaler, 1986; Curtin and Zurlage, 1984; Phillips, 1987; Kirby, 1986B; Jones, 1987]. Nursing hours per patient day is another well documented concern, highly related to measures of patient acuity [Kirby, 1986A, 1986B; Gorman and Borovies, 1985; VanPutte, and others, 1985]. Many have studied case mix and ways to manage it [Halloran and Kiley, 1984]. The emphasis on cost containment, DRGs, severity of illness measures, case mix studies and nursing hours per patient day are all part of a larger focus by the nursing profession on alternative ways to price their services [McCloskey, Gardner, and Johnson, 1987]. A strongly related issue, the definition, measurement, management and increasing of nursing productivity, also has received a great deal of attention [Curtin and Zurlage, 1986; Haas, 1984; Edwardson, 1985; Kirk and Dunaye, 1986; Herzog, 1985; Guthrie, and others, 1985].

Traditionally, nursing services have been charged as part of the cost of the hospital room. Many patients have little understanding of the "overheads" included in the room charges, nor do patients have an understanding of the hierarchy of nursing care providers. As one outcome of a cost containment focus, some hospitals have cut their nursing staff in an attempt to stem increases in patient room charges per diem. These cuts have been made with a double-edged sword, because such cuts have come at a time when hospital patients' needs for nursing services are increasing. Nursing managers and administrators have recognized the desirability of separating charges for nursing services from overhead charges included in hospital room rates. This desire for better accountability has motivated nursing professionals and others in the health care sector to do much research, at both practical and theoretical levels, on how to cost out nursing services. Better ways to determine the costs of nursing services are closely related to better ways to measure nursing productivity, and better ways to make decisions regarding tradeoffs among nursing resources. Nursing administrators who understand fully the cost of the services being provided under their management are in a stronger position to explain and defend those costs to other hospital administrators and health care executives. In addition, a better case can be made for the recovery of the costs of nursing services from insurers and other third party payers, if such costs are well defined. McCloskey, Gardner, and Johnson [1987] have compiled an annotated bibliography of 68 articles on the costing out of nursing services. These sources will not be repeated here.

The issue of the costing out of nursing services, more than any other single issue, tends to blend the strategic issues of hospital nurse staffing with the tactical issues of hospital nurse scheduling. The issue of who in the nursing care team does what, and how much it costs them to do it, is certainly of major concern to nurse managers, other health care managers, health care economists, and those who pay for health care services. Scheduling issues such as length of shifts, number of weekends worked, days on and off, and general flexibility of the nursing staff are intertwined with issues of the qualifications of nurses from temporary nursing services and in-house nursing pools [Brown and Lewin, 1982; Imig, and others, 1984; Ricci, 1984; Braun and Schweiger, 1983; Kellmann, 1983; Dias, and others, 1986; Jones and Brown, 1986]. Hospital and nursing management must make complex staffing decisions, both short and long term, related to the educational backgrounds of nursing personnel; permanence, compensation, and benefits of the nursing staff; and sources from which to obtain nurses. Complicating these decisions is a national nursing shortage [Buerhaus, 1987; Secretary's Commission on Nursing, 1988] (In a consistent vein, 89.7% of the respondents to the research instrument reported herein indicated that their hospitals operate with a shortage of registered nurses.)

The issue of relating nurse staffing levels to patient outcomes and cost is reviewed by Flood and Diers [1988]. They also review research relating length of patients' stay to other variables. Their own research shows staffing at adequate levels costs hospitals less than the practice of consistently short staffing, because patients' stays are shorter when adequate nursing care is received.

This research does not address directly the costing of nursing services. However, the research instrument has been designed to collect data about the kinds and numbers of nursing personnel, the shift lengths, the weekend schedules, and the ways that nurse managers make staffing and scheduling decisions. The survey instrument also asks for data about the patients, their characteristics, and how they are admitted and discharged. The role of the customer as an important input in most service systems is well agreed upon [Chase and Tansik, 1983]. Nurse managers recognize this importance quite well, which explains much of the nursing management research emphasis on patient acuity, severity of illness indices, and case mix. Curtin and Zurlage [1986], in discussing the definition and measurement of nursing productivity, state

> Human services are integrating phenomena which generate surplus value. For health services, productivity lies in the surplus values added in the course of access, attendance, treatment, education, rehabilitation and follow-up. Measurement begins with assessment of input status at T_1 of *both* served (physical and emotional status, personal characteristics,etc.) and server (resources available, server status at T_1,etc.). Measurement takes place in terms of negotiated outcomes for both the served and the server at T_2.

Furthermore, they define the primary consumer as the patient, and describe the outcomes of nursing practice as "the promotion, enhancement or restoration of persons to their optimal state of functional competence." Curtin and Zurlage also recognize there are several groups of secondary consumers: the physicians attending the patient, the patient's employer, the payer, the general public, and the nursing profession as a whole, and the health care community. They go on to state:

> For individual members of the public, outcome expectations are conditioned by degree of general education and opinion, and lifestyle. For professionals, negotiated outcome expectations are expressed in terms of practice standards and norms. For the community, acceptable outcomes are expressed in terms of statutes, regulation and case law. For health institutions, expected outcomes are seen in terms of income, community reputation and market share. Finally for payers outcome expectations are seen in terms of contractual obligations expressed in dollar limits, time limits and review of the care regimen.

For all of these stakeholders, the role of the nursing professional in provision of health services cannot be overlooked. Many factors will influence the ability to increase productivity in hospital settings in the next decade. Many uncertainties surround prospective operations of hospitals in the 1990s. The role of the hospital may change, technological breakthroughs will surely occur, and the attitude toward the funding of health care and services will continue to evolve. In spite of these uncertainties, unwell human beings and those who care for them will continue to be two major inputs to the process of transforming diseased, disabled or discomforted patients into healthy human beings.

2.7.3 The Interest of Management Scientists in The Hospital Nurse Staffing and Scheduling Problem

This chapter would not be complete if brief mention were not made of the some of the many operations managers, operations researchers, and management scientists who have delved into various aspects of the specific hospital nurse staffing and scheduling problem over the past three decades. Flagle [1962] gives an overview of the use of operations research techniques in the health services. He speaks of the need for hospital managers to understand "the stochastic and variable nature of the demand for service." He states, "Planning factors for staff ... have often been based upon number of beds, although patient needs, in terms of hours of nursing care in a given bed, may vary over a very wide range." Flagle gives four areas in which operations research techniques have been and will continue to be useful to health care administrators. His fourth area, the organization and scope of services, he views as the most challenging of all, as it focuses on the need for a broad measure of effectiveness with respect to changes in patient-care variables. He notes that most efforts to arrive at such measures have centered on nursing care. He recounts briefly an effort with which he was involved at Johns Hopkins Hospital. A method of allocation of nursing staff was devised that considered the variable nature of the need for staff, and succeeded in reducing the discrepancy between supply and demand [Connor, et al., 1961].

Wolfe and Young [1965A] give a set of combinations of factors with which patients may be categorized into requiring self-care, partial or intermediate care, and intensive or total care. They give a formula called a Direct Care Index which uses their list to determine the number of hours of total nursing care needed on a nursing unit. They also give results of a work sampling study in which nursing activities were grouped into eight major categories. From this study they derive a Productivity Index. They then give a procedure for allocation of nursing personnel, called controlled variable staffing, based on the Direct Care Index, and the Productivity Index. These procedures give the nurse manager quantitative information about the patient needs on each unit. In a second article, they describe a procedure for matching various skills and capabilities with specific tasks for patients in each of their three classifications [Wolfe and Young, 1965B].

Many attempts have been made to devise the perfect approach for scheduling nursing personnel subject to various constraints. Abernathy, Baloff, and Hershey [1971] discuss the problems associated with rising nursing salaries, pressures to contain costs, and a shortage of nursing. All of these problems are familiar to hospital managers today. Their recommendation is for frequent forecasting and aggregate budgeting, coupled with the use of short term adjustments to schedules, and the generous use of overtime, part-time staff, and float nurses to meet variation in demand. Abernathy, Baloff, Hershey, and Wandel [1973] formulate a planning and scheduling model for the nurse staffing process. The nurse staffing problem is viewed as having three decision levels: policy decisions, staff planning, and short-term scheduling subject to the constraints resulting from the first two decision levels. Their work and philosophy have greatly influenced this author in her thinking with respect to the strategic nature of the staffing problem in the service sector, and the way strategic staffing decisions impact tactical scheduling choices. They use stochastic programming, random loss functions, a chance constrained linear programming model, and iterative and noniterative procedures to solve problems decomposed into all three decision levels.

Warner and Prawda [1972] propose a large scale mixed integer quadratic programming model for allocation of a fixed number of nursing personnel in a number of skill classes to a number of units and shifts over a relatively short scheduling period. They model the cost of a shortage of nurses on a given shift or unit as a convex decreasing function. As additional nursing time is added, a point comes where the shortage cost is zero, and cannot be reduced below zero. As nursing time provided relative to patient care demanded is decreased, the cost of a shortage is modeled as increasing in a nonlinear fashion. Because the problem as Warner and Prawda formulate it gets very large very quickly, decomposition is the recommended technique for arriving at a solution. The inability to forecast demand accurately for a period longer than four days is one of the biggest drawbacks to use of this model in practice.

Many researchers have focused on cyclical scheduling techniques and mathematical programming as an answer to the nurse staffing and scheduling problem. Howell [1966] proposes a cyclical scheduling pattern for nursing staff, administered by a central office with floating staff to help deal with uneven demand across units. Maier-Rothe and Wolfe [1973] design a cyclical scheduling procedure to meet average staffing requirements, and an additional procedure for the adjustment of staffing twice daily in response to changes in patient care requirements. Rosenbloom and Goertzen [1987] present an algorithm for cyclical scheduling that can be implemented on a microcomputer. In their algorithm, a number of possible schedules are generated, and those that do not meet labor and other constraints are discarded. The remaining schedules are used to formulate an integer programming problem, the solution to which is used to generate the individual schedules of nurses.

Several researchers have recognized the need to consider the preferences of the nurses being scheduled. Miller, Pierskalla, and Rath [1976] formulate the nurse scheduling problem as a mathematical programming problem. Their objective function minimizes the total penalties for failure to provide minimum required coverage, and failure to consider nursing staff preferences for schedules. Their model is flexible enough to include a large number of constraints, and may be solved for part-time employee schedules as well as full-time employee schedules. Megeath [1978] reports the formulation of a schedule for a single unit that covers two classes of nursing staff, rotation between two shifts, coverage of week-ends, and is cyclical in nature. Nurses are allowed to express their preference for which cycle they want to start, and switches between the personnel are strictly the responsibility of the nurses wanting to switch. Smith, Bird, and Wiggins [1977] generate monthly schedules which incorporate individual preferences and nonroutine constraints. Their approach is computer-based, and requires a large amount of data collection on the individual preferences from period to period. Warner [1976] has a mathematical programming model which incorporates multiple classes of nursing personnel, a cyclical weekend coverage policy, and the ability to consider rotation between shifts, or permanent shift assignments for each nurse being scheduled. Another input is the aversion staff members have to certain schedules. Warner's objective function is to maximize the relative value of potential schedules to those being scheduled, subject to minimum coverage constraints over a six week planning horizon.

Warner [1976] points out that the scheduling decision, generally made for four to six weeks at a time, can really be made for one unit at a time, as there are few interdependencies among units. On the other hand, the allocation problem, which deals with last-minute staffing adjustments to meet variable demand, does have interdependencies between units. Trivedi and Warner [1976] present a computerized algorithm for assigning "float" nurses, those who does not have a permanent unit assignment, to the unit where they are most needed. Their algorithm works in real time as these assignments must be done at the beginning of each shift. It is based on severity of need, and the expected duration of that severity over an eight hour shift. Wright and Rhodes [1985] discuss a case study of a hospital with a computerized system that schedules all seven hundred nurses every six weeks, and performs allocations of available staff daily. The daily allocation procedure considers staff out due to illness, leave, attendance at courses, and escort duties. It tracks overtime, with an attempt to "fairly" assign overtime when it is needed.

Other researchers have attacked the front end of the problem and looked at the yearly budgeting procedures for determining the number and type of nursing personnel needed. Lowerre [1979] presents a method that ties personnel budgeting to scheduling, with a focus on quantifying policies on staff coverage, required rest periods, and fringe-benefit days granted to employees. A side benefit of his method is that it allows hospitals to accurately analyze the effects on staff size of adding another paid holiday. Kao and Tung [1981] develop a sophisticated aggregate planning model for nursing requirement planning. Their presentation begins with an elaborate forecasting model for predicting demands for nursing hours by nursing specialty. These needs are then incorporated into a linear programming model along with institutional constraints and patient care requirements. The output from their model gives the levels of permanent staff, overtime, and temporary help needed, by nursing service, nursing skill level and monthly time periods. They expand their model to evaluate the sizing and timing of a pool of float nurses. Kao and Queyranne [1985] expand upon the work of Kao and Tung [1981] by adding probabilistic demand to the aggregate planning model for hospital nursing services. After illustrating results that can be obtained with several elaborate models, they present a simple formula using a single period demand estimate that gives an approximation quite close to the solutions obtained from more precise methods.

Almost all research discussed in this section has been motivated by a situation at one or more real hospitals. Most researchers have included in their presentations an illustration of how their models have worked in a real hospital or in a real nursing unit. The interest of operations management researchers in the hospital nurse staffing and scheduling problem is not likely to wan in the next decade. The problem has been well described for many years. Multiple classes of personnel, overtime, weekend assignments, desires of individual nursing staff members, changing patient needs, and wide swings in demand for nursing services have been considered and modeled by various researchers. Many researchers understand the linkages between the levels of decision making involved in nurse staffing and scheduling. Attempts have been made to incorporate into many models the integrated nature of the problems of staff selection, monthly scheduling, and daily allocation to units and shifts. However, solutions that work across a number of situations seem to be elusive. The problem remains similar to attempting to "put one's arms around an elephant." The hospital nurse staffing and scheduling problem, which is, of course, many problems, is likely to continue to fascinate operations management researchers because it is a real set of problems. A "solution" is likely to yield satisfaction to the researcher in terms of real dollars of savings for the hospital involved. The problem will continue to be studied.

In practice, the staffing, scheduling and allocation of nurses to hospital nursing units remains partly art and partly science. It continues to be done without a great deal of computer support, and is fairly decentralized. (See Appendix C, questions 22 and 24.) This research study departs from previous research in looking at a large number of hospital nursing units. The design of the research instrument and the analysis of the data have been performed with a focus on operations management issues raised by many of the researchers cited above. The objective of this research has been to explore the commonalities and differences between nursing unit environments, their staffing and scheduling practices, and their ability to accomplish their goals. It is hoped that an overview of characteristics of many nursing units will provide additional insights into the role of staffing and scheduling flexibility in the nurse staffing and scheduling problem.

CHAPTER III

SUMMARY STATISTICS FOR THE HOSPITAL NURSE STAFFING AND SCHEDULING SURVEY

A well chosen work force provides a service sector organization with its most valuable asset. In many service sector organizations, production of a service by the employees, and consumption of that service by the clients is a simultaneous occurrence. This research study focuses on the role of flexibility in work force staffing and scheduling decisions in the service sector. Work force staffing and scheduling decisions impact upon cost, quality, productivity, and variety and volume of services offered. The contention of this researcher is that flexibility in staffing and scheduling allows service sector organizations to better meet their goals and objectives.

This research study presents results of the analysis of data on staffing and scheduling practices which were collected from 348 nursing unit managers in thirty-one hospitals. Hospital nurse staffing and scheduling was chosen for the focus of this study because health care is an important segment of the service sector, and hospitals represent a major portion of health care operations. In addition, hospital nursing staffing and scheduling operations represent a variety of characteristics often ascribed to pure services. Full time equivalent (FTE) Registered Nurses (RNs) often represent 25% or more of the personnel employed by hospitals, and the nursing staff payroll costs may be as much as 40 to 60% of hospitals' budgets. Over the last decade, hospitals have been under pressure to reduce expenses and to improve productivity. As a result of that pressure, much interest has centered on hospital nurse staffing and scheduling.

The purpose of this chapter is to summarize the results of the Hospital Nurse Staffing and Scheduling Survey conducted in the summer of 1988, under the auspices of The Ohio State University. The research instrument was a closed form questionnaire. Appendix A contains a facsimile of the research instrument. The research instrument was tested in 12 nursing units in three hospitals, after which the questionnaire was revised. The questionnaire was distributed to 700 nurse managers in 36 hospitals, through the Chief Nursing Officer of the hospital, the Research Committee of the hospital, or by direct personal contact by the researcher at a hospital nursing management meeting. The survey instrument was completed and returned by 348 nurse managers in 31 hospitals, for just under a 50% response rate. The data collection methodology is further described in Chapter I.

This chapter contains summary statistics and highlights for each section of the research instrument. Replies from all 348 respondents are used in analyses presented in this chapter, unless otherwise noted. Missing data have been treated as random occurrences unless otherwise noted [Cohen and Cohen,1983]. Appendix C contains detailed tables showing means and frequencies for each variable, based on all 348 respondents.

3.1 HOSPITAL PROFILES

Survey respondents were asked several questions that were descriptive of their hospitals. This section describes, in a summary fashion, as reported by the respondents, the hospitals whose nurse managers participated in the study. Almost all respondents (99%) report their hospitals offer acute care, while only

39% report that their hospitals offer long term care. Slightly more than 18% of the respondents are from hospitals that are operated for a profit, just over 22% of the respondents' hospitals are privately owned, and just under 22% of their hospitals are privately operated. Twenty percent of the units are from hospitals that are both privately owned and privately operated. Twenty-six percent of the nurse managers report that their hospitals have unionized nursing staff. Almost twelve percent report that their hospitals currently operate under a hiring freeze, and nearly 90% indicate that their hospitals currently operate with a shortage of Registered Nurses (RNs).

Virtually all respondents report that their hospitals pay shift differentials (a pay premium for working less desirable shifts) to nursing staff. However, only 16% pay unit differentials, or different pay rates for working on different units. Seventy-four percent of the respondents report that their hospital is a teaching hospital. Almost 16% of the units are in hospitals that are part of a large complex of hospitals located on one site. Just over 41% of the units are in hospitals that are part of a system of hospitals located on more than one site. Almost 9% of the respondents report that their hospital is a specialty hospital, with the specialities almost evenly divided between psychiatric hospitals and pediatric hospitals.

The last three questions of the survey dealt with hospital demographics such as the numbers of commissioned beds, active beds, nursing units, Registered Nurse staff members, nursing personnel in total, average daily patient census, and diagnostic related groups (DRGs) treated in the hospital. The respondents were also asked the occupancy rate of their hospital, as a percent, and the percent of patients on Medicare or other government supported treatment. Respondents were asked these questions about their own hospital, and, if appropriate, they were also asked about the entire single site complex, and about the multi-site system of which their hospitals were a part. These particular demographic questions were prefaced with a request to the respondent to leave the questions blank in this section of the questionnaire, if they did not know the answers. The demographic questions about the single site complexes, and about the multi-site systems had such low response rates as to be unusable, and will not be reported here. The response rates for the demographic questions for the respondents' own hospitals were lower than for any other set of questions, ranging from a high of 84% (291 respondents) for the number of active beds to a low of 19% (65 respondents) for the number of DRGs treated in the entire hospital. The percentage of responses in several of the categories are shown graphically in Figures 3.1, 3.2 and 3.3. Numerical results are shown in Appendix C.

3.1.1 Some Crosstabulations of Hospital Characteristics

Two-by-two frequency tables were created for pairs of the eight variables representing whether the hospital was operated for profit, private ownership of the hospital, private operation of the hospital, unionization of the hospital's nursing staff, current operation (at the time of the survey) under a hiring freeze, current operation under a nursing shortage, payment of unit differentials (different pay rates for working in different nursing units), and whether the hospital was a teaching hospital. Pairs of variables were tested for independence under the chi-square distribution. Those seven pairs of variables for which there is evidence to reject the hypothesis of independence

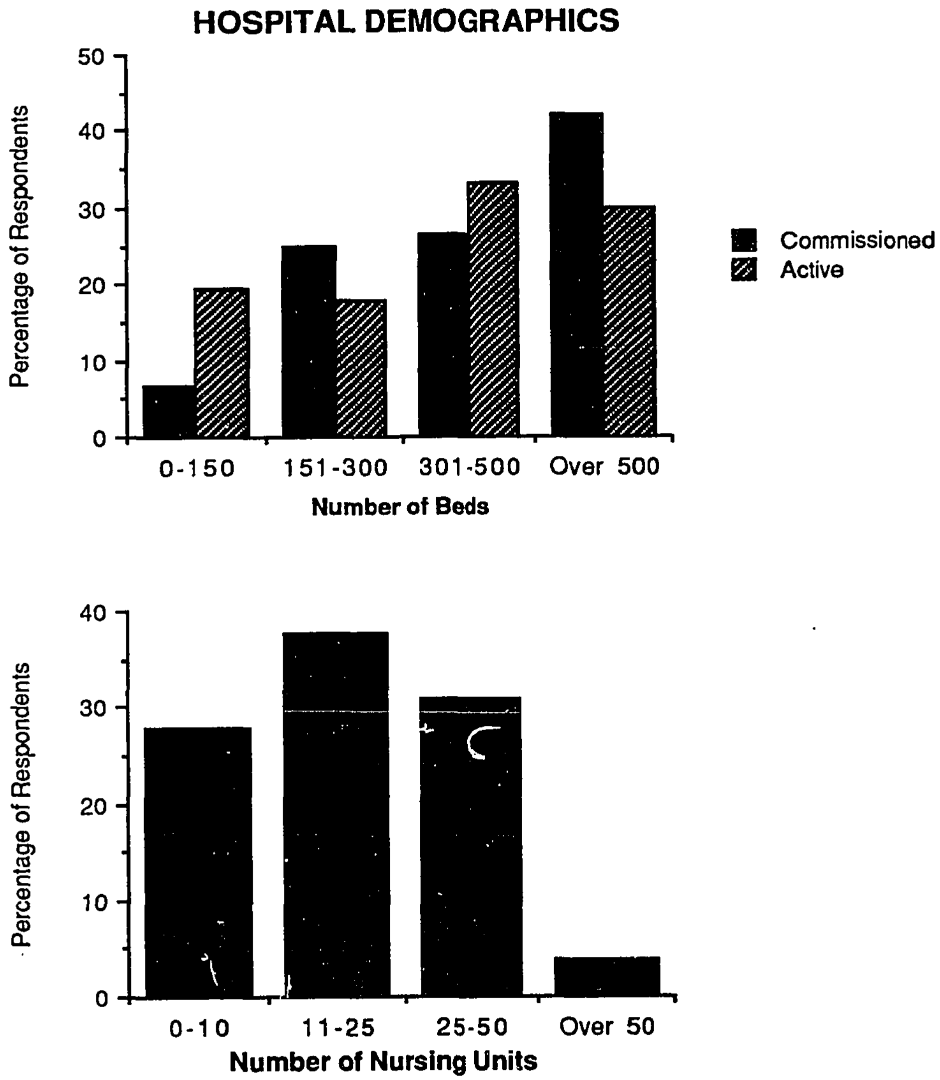
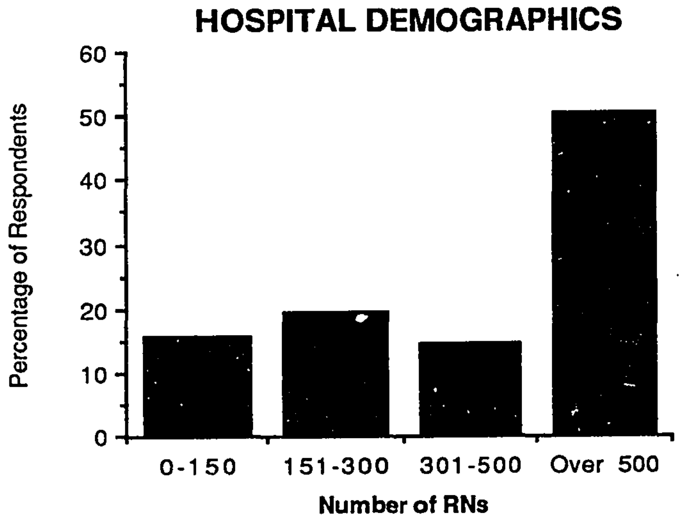


Figure 3.1

Hospital Demographics



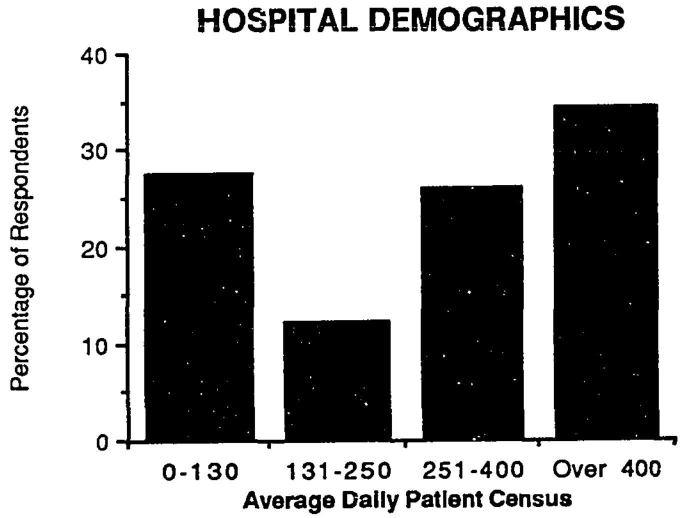
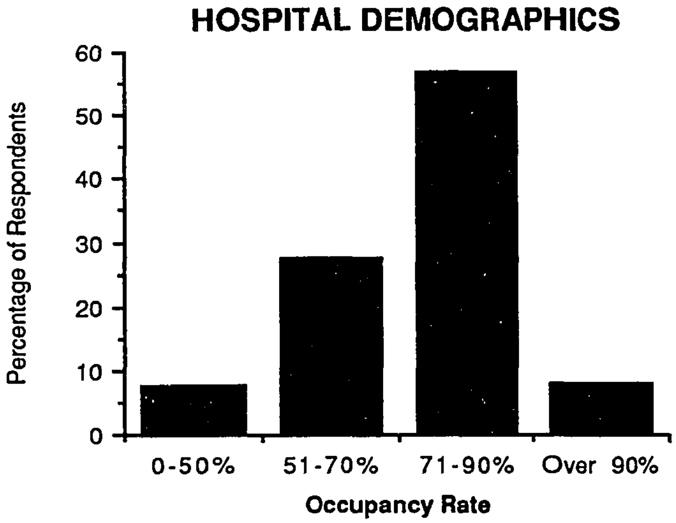


Figure 3.2

Hospital Demographics



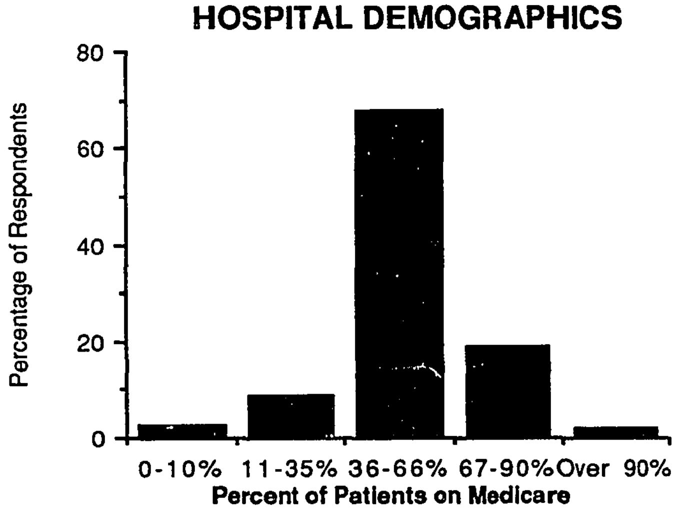


Figure 3.3

Hospital Demographics

are shown in Appendix D, Table D.1. It must be recalled in this section, that these data pertain only to the nursing units in this research study, and that inferences about relationships between the hospital characteristics reported in Table D.1 are to be made with care, if at all. Because this study is exploratory in nature, it does lend itself as a basis for new hypotheses and further testing. In addition, the pairs of variables whose independence appears to be in question may be examined in future research for their joint effect on other variables related to staffing and scheduling practices.

Examination of the contingency tables of the seven pairs of variables for which Table D.1 indicates a lack of independence points to evidence of several relationships between characteristics of hospitals whose nursing units participated in this study. The most obvious of these is that most of those hospitals which are privately operated are also privately owned. A surprising result is that the characteristic of being operated for profit appears to be independent of private ownership and independent of private operation. A less surprising result is that given that a hospital's nursing staff is unionized, the hospital is less likely to be privately owned or privately operated than if the hospital's nursing staff is not unionized. Conversely, given that a hospital is privately owned or privately operated, its nursing staff is less likely to be unionized than if the hospital is not privately owned or privately operated. Also, given a unionized nursing staff, there is a higher probability that the hospital pays unit differentials, that is, higher pay for working in certain units. Conversely, given that unit differentials are paid, the hospital is more likely to be unionized, than if unit differentials are not paid.

Nearly ninety percent of the nursing units in the study were in hospitals that operated with a nursing shortage. However, if a nursing unit was in one of the 18% of those in hospitals operated for profit , the nursing unit had an even higher probability than 90% of being in a hospital operating with a nursing shortage. Conversely, a nursing unit in a hospital operating with a nursing shortage, as opposed to operating without a nursing shortage, has a greater chance of being a hospital that operates for profit. In addition, if a hospital is operating with a nursing shortage, it is more likely to have a unionized nursing staff, than if a hospital is not operating with a shortage of nursing staff. Conversely, a hospital with a unionized nursing staff, has a higher probability of operating with a shortage than a hospital without a unionized nursing staff.

Nearly three-quarters of the nursing units in the study came from teaching hospitals. Given the characteristic of teaching hospital, it is more likely that the hospital is also operating with a nursing shortage, than if the hospital is not a teaching hospital. Conversely, given the situation of a hospital operating with a nursing shortage, it is only more likely to be a teaching hospital than is a hospital not operating with a shortage.

3.2 MANAGERIAL PROFILE OF THE NURSING UNITS

Respondents to the survey instrument were asked to indicate their title, the scope of their management responsibilities, their involvement in various decisions, and the number of times certain staffing and scheduling related decisions took place in their units. The single most common title, held by 31% of the respondents, was Head Nurse. A set of titles, which seemed to represent a trend for titling of first line nursing unit managers, were titles in which the word

"Manager" was preceded by a word or phrase descriptive of the responsibilities of the respondent. Such titles as Nurse Manager, Unit Manager, Nursing Unit Manager, and Clinical Nurse Manager together accounted for almost 32% of the respondents. Ten percent of the respondents were called either a Unit Coordinator, a Clinical Nurse Coordinator, or a Patient Care Coordinator. Almost seven percent were called Unit Directors or Program Directors, and about 15% of the respondents were Assistant Head Nurses, Assistant Coordinators, Assistant (Unit) Directors, or Assistant (Unit) Managers. Three percent of the respondents were Directors of Nursing.

The great majority of respondents, seventy percent, managed the nursing staff in one nursing unit. Fourteen percent of the respondents assisted in the management of one or more nursing units, and another fourteen percent managed nursing staff in two to five nursing units. Details may be found in Appendix C.

3.2.1 Respondent Involvement in Nursing Unit Decisions

Respondents were asked their level of involvement in twelve decisions related to the staffing and scheduling of their nursing units. They were also asked the frequency with which these decisions were made in their units. Six of these decisions could be considered strategic decisions, are discussed in Chapter I, and illustrated in Table 1.1. Hiring and firing nursing staff members, adding and deleting nursing staff positions, deciding compensation levels for nursing staff members, and determining the operating budget for the unit are considered more strategic than tactical. The categorization of these decisions as strategic is borne out by the frequency with which the decisions are made in most units. As discussed in Chapter I, one of the characteristics of strategic decisions is that they are made less frequently, and their impact is for a longer time period. Figure 3.4 shows the respondents' involvement in these six decisions, and the top graph in Figure 3.5 shows the frequency with which these six decisions were made.

The other six decisions about which respondents were asked, are considered more tactical in nature. The decision to authorize overtime, to authorize use of temporary nursing staff, to make nursing assignments for patient care, to determine the exact nursing staff working in the unit on a daily basis, to schedule the nursing staff, and to make shift adjustments to the schedule may be considered tactical in nature. This categorization is also borne out by the nurse managers responses to the questions about the frequency with which these decisions is made, with the exception of the decision to authorize the use of temporary nursing staff. The decision to use temporary nursing services on a given unit, or, for that matter, in a given hospital, is arguably either strategic or tactical, depending upon the frequency of the use. In question 14, 68% of the respondents say that in a typical month they had no temporary employees from an outside agency working in their units. However, less than half that many, 32% say they have no employees from other units or an in-house pool of nurses working on their units in a typical month. These figures are given as support for the dichotomous categorization of the authorization of use of temporary nursing services. Some hospitals have made the decision to have in-house nursing pools, so that the employees are not "temporary," but "belong" to the hospital. The "In-house Pool" nurses generally expect to be called to work a certain number of shifts or have promised to work a certain number of shifts in a given time period. On the other hand, a hospital may "authorize" the use of temporary employees infrequently, but the authorization is a blanket one, granting permission to nursing units to use them whenever necessary. Other hospitals may require a new "authorization" of each use. This entire question of the frequency of authorization of temporary nursing services, versus the frequency of their use, is an area for potential future research. The frequency with which these more tactical decisions are made is shown in the graph in the bottom half of Figure 3.5.

3.2.2 Crosstabulations of Management Responsibilities with Management Involvement

Three hundred thirty-seven of the respondents managed one nursing unit, two to five nursing units, or assisted in the management of one or more nursing units. The involvement in decision making by the respondents in these three categories were cross tabulated with their management responsibilities.

Results of such crosstabulations lend further support to the evidence presented in Figure 3.4 of the involvement of first line nursing managers in strategic decision making related to staffing and scheduling. Nursing unit managers are very likely (an 80% probability) to have full or partial responsibility for hiring new nursing staff, and are even more likely (an 85% probability) to have full or partial responsibility for terminating nursing staff. They are 90% likely to have partial responsibility or make recommendations on decisions to add new nursing positions, and 75% have partial responsibility or make recommendations about decisions to delete nursing positions. Setting compensation levels for nursing staff is the only area in which nursing unit managers are least likely to have input into the decisions process, with 31% of them reporting no input to that decision. This lack of input does not seem

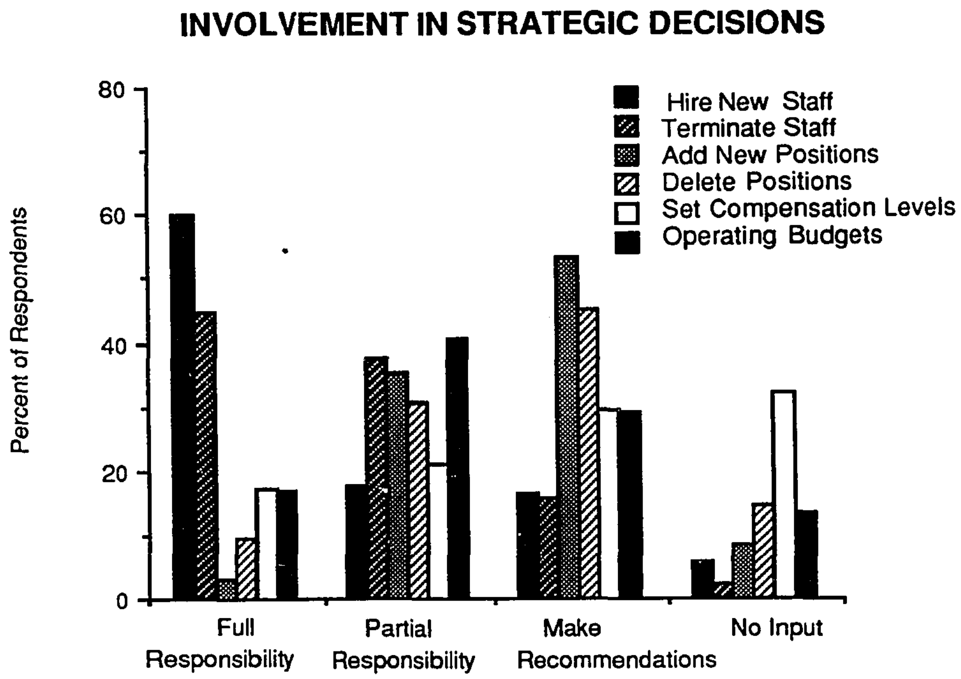
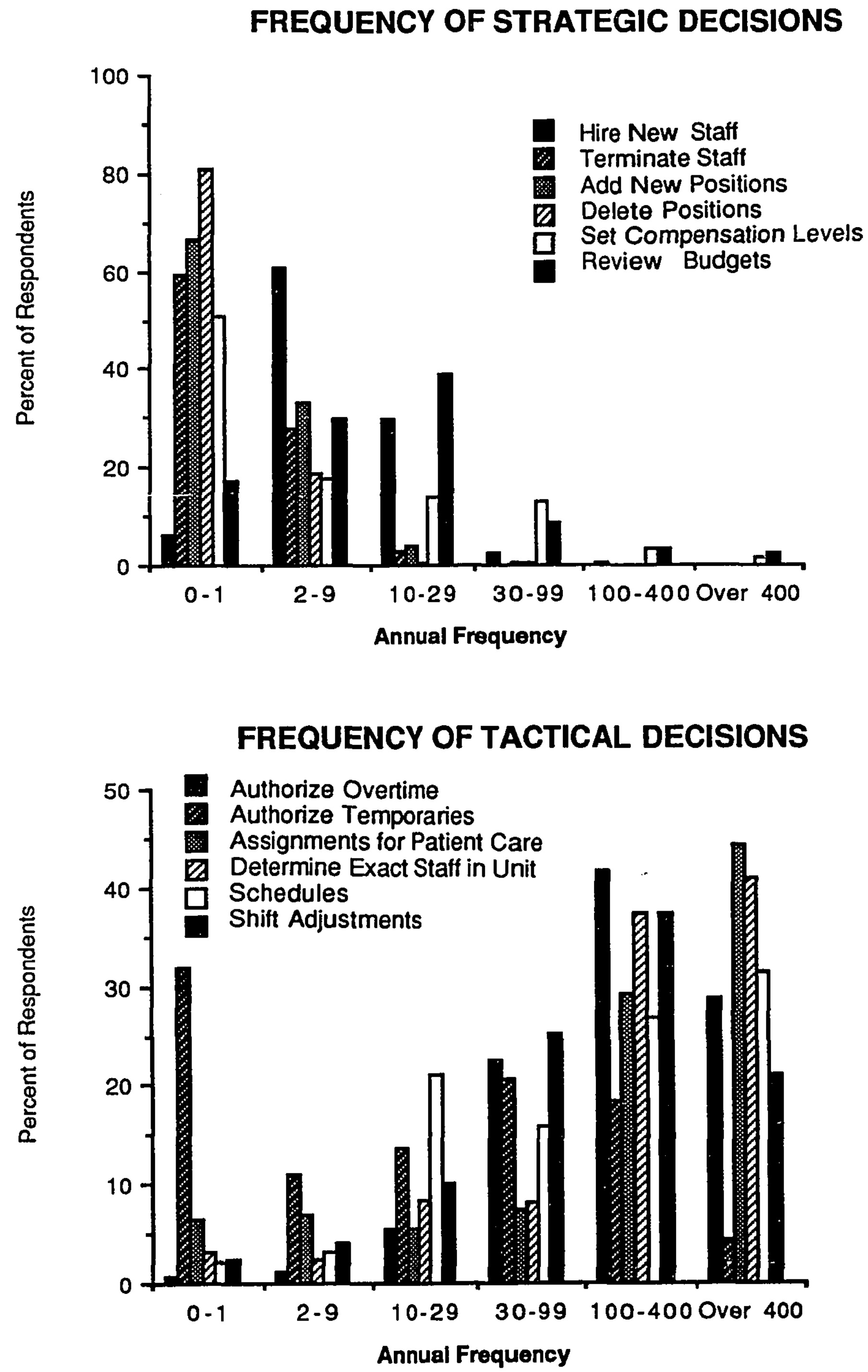


Figure 3.4
Involvement in Decision Making

surprising considering the lack of flexibility on this issue likely to exist in the hospitals with a union environment. Even in those hospitals without a nursing union, the hospital bureaucracy might well dictate wages and salaries. Even in this area, 40% of the nursing unit managers have full or partial responsibility to set compensations levels for their nursing staff. Nursing unit managers are likely to have full or partial responsibility for determining the operating budget for their unit. Assistant unit managers are not likely to have such responsibility, although 40% of the respondents serving as assistant nursing unit managers do make recommendations for the operating budget.



FREQUENCY OF STRATEGIC DECISIONS

FREQUENCY OF TACTICAL DECISIONS

Figure 3.5
Frequency of Decision Making

Ninety-five percent of the nursing unit managers have full or partial responsibility for authorizing overtime, scheduling nursing staff in their units, for determining the exact nursing staffing working in their units on a daily basis, and for making shift adjustments to the schedule. Seventy percent have full or partial responsibility for authorizing the use of temporary nursing services, and eighty percent have full or partial responsibility for making nursing assignments for patient care. The vesting of such responsibility with the nursing unit manager gives that first line manager the ability to utilize whatever flexibility is available in the work force.

3.3 PROFILES OF THE NURSING UNITS AND THEIR PATIENTS

A term which is frequently used in describing nursing units and their patients is the word "acuity." When used in an operations management sense, acuity is a term which relates inputs to outputs, in that it is a staffing ratio of nurses to patients. This section starts with a discussion of the use of the term "acuity" in the hospital profession. This discussion is presented in order to lay a foundation for the basis on which many of the statistics in the remaining sections of this chapter are analyzed, and to present the non-health care reader with a general overview of the meaning of acuity.

3.3.1 Acuity Distinctions in the Hospital Industry

In the hospital industry, one way the term "acuity" is used is to describe the ratio of nurses to patients so the concept of acuity is an important one when hospital nurse staffing is discussed. Acuity rates vary greatly from hospital to hospital depending upon the type of care offered and other factors. Acuity rates may also vary greatly from nursing unit to nursing unit within a hospital. The acuity rate for a nursing unit is one descriptor of the type of nursing care offered by the unit. A nursing unit which offers only long term care may have an acuity of .05. That is, there may be one nurse for 20 patients. Typical nursing units offering what is called acute care may have acuity ratios ranging from 0.2 to 3.0. In other words, in an acute care unit, there may be as few as one nurse for every 5 (or more) patients, or there may be as many as three (or more) nurses for each patient. Thus, acute care nursing units, by definition, have higher acuities than long term care nursing units. The meaning of acute care is discussed in the next section. A definition of long term care in given in section 3.3.1.3. See Table 3.1 for a summary of these distinctions.

The high end of the acuity range for acute care units, 1.0 to 3.0, is usually found in a subset of acute care units called critical care units. In practice, the term "acute care" is used to refer to those nursing units with acuities in the lower part of the (total acute care) range, and "critical care" is used to refer to those nursing units with higher acuity rates. Thus, in practice, the acute care units do not have as many nurses per patient as the critical care units. The distinction between acute and critical care is discussed further in section 3.3.1.2.

Just as acuity rates vary from hospital to hospital within the health care industry, and from unit to unit within a hospital, so do they vary from patient to patient within a unit. Every patient within a nursing unit has an "acuity rating" of his or her own. That acuity rating is the number of nurses required to care for that patient. Acuity rates for individual patients are determined in a myriad of ways which vary greatly from hospital to hospital, and may be stated on a per shift basis or a per day basis. For an individual whose heart has just stopped beating, and who is being restored to life and breathe with all that medical and nursing science can bring to the problem may have an acuity of 10 to 1, meaning, at that moment, the patient needs ten nurses. A patient in a nursing home who is able to do most of his or her own care may have an acuity of .02, or need only 1/50 of a nurse. In many nursing units, 88% of those in the study, patients' acuities are assessed at least once per day, and is a major input for determining short term staffing needs.

Table 3.1

Acuity Distinctions Between Different Types of Nursing Unit

Type of Unit Range	**Other Names Used in Practice**	**"Typical" Acuity[1]**
Acute Care		0.1 to 1.0[2]
Critical Care	Intensive Care	0.5 to 3.0[2]
Long Term Care	Chronic Care Custodial Care	0.02 to 0.5[2]

[1] Acuity is a ratio of nurses to patients. There are many different systems for determining acuity, and the range will vary, based on the system used.

[2] These ranges do not have to be mutually exclusive, and, in a typical hospital, they are not.

3.3.1.1 Acute Care Defined

Virtually all of the hospitals in the study are considered acute care hospitals; that is, they offer care to those who are acutely ill. That attribute was a criterion for selection into the study. The word "acute," as a descriptor of illness is defined as "having a sudden onset, sharp rise, and short course" [Webster, 1983]. Therefore, acute care hospitals specifically treat those suffering from acute conditions. These acute conditions include illnesses caused by bacteria and viruses, long term diseases having a sudden increase in pain level and discomfort, temporarily disabling conditions, and injuries. Examples of acute illnesses are pneumonia, meningitis, measles, chicken pox, flu, and food poisoning. The severity of the illness dictates whether or not the patient will require hospital care. Heart attacks, gall stones, kidney stones, lungs clogged by fluid, and tumors cutting off the functioning of vital organs are examples of evidence that a long term disease has suddenly worsened. Thus treatments such as surgery, chemotherapy, and dialysis are administered in acute care hospitals. Examples of temporarily disabling conditions and injuries are broken bones, childbirth, and injuries to limbs or internal organs that might be suffered as a result of an accident. These conditions are also treatable at an acute care hospital. Note that these are examples and not intended as an all inclusive list of conditions treatable at acute care hospitals.

3.3.1.2 Acute and Critical Care Compared

A subset of acute care units are those nursing units offering what is referred to as critical care. Webster's Dictionary [1983] lists "critical" as a synonym for "acute." However, this distinction between the two is added in a footnote to the definition of acute:

> ACUTE stresses intensification of conditions leading to a culmination or breaking point; CRITICAL adds to ACUTE implications of imminent change, of attendant suspense, and of decisiveness in the outcome [Webster, 1983].

This is exactly the distinction between "acute care" units and "critical care" units, as the terms are used in most hospitals. A patient with heart disease may suffer a mild heart attack, which may be thought of as a breaking point or a culmination of the patient's disease to the point where the disease sends a painful signal to the patient. Such a patient may be in need of acute care nursing for a few hours or days. The patient's life is not immediately threatened, but the patient is in a great deal of discomfort and pain, and is probably having difficulty breathing. Nursing care will focus on relieving the discomfort, monitoring the patient, and teaching the patient about the life-style ramifications of heart disease. Nurses assigned to care for this patient will probably be caring for several other patients at the same time. The acuity rate in the nursing unit where this patient is cared for probably will be considerably less than one nurse to one patient.

On the other hand, the patient may have suffered a very severe heart attack, or the patient's heart disease may have progressed to clogging every heart valve, and artery, and the patient is in need of urgent by-pass surgery. When the patient comes out of surgery, there may be a question about whether or not the patient will live (attendant suspense); a blood clot could cause immediate death, or the patient could get better very rapidly (imminent change); and the outcome will be life (at least for the near term) or death (decisiveness in the outcome). This patient is in need of critical care nursing. The patient will likely be monitored round the clock by a variety of electronic devices, the patient's breathing will be assisted, and the patient will be receiving medicine and nourishment intravenously. This patient is likely to be placed in a unit with a high acuity rate, perhaps two or more nurses to one patient. The nurse caring for this patient may only be caring for this patient.

Another term often interchangeable with critical care is intensive care. Webster [1983] defines "intensive care" as a noun or as an adjective for (a nursing) unit, meaning "having special medical facilities, services, and monitoring devices to meet the needs of gravely ill patients." In this research report, the term intensive care will mean the same thing as critical care and will refer to nursing units with acuity rates at the the high end of the range.

3.3.1.3 Long Term Care Defined

If patients have lingering illnesses, long term diseases, or permanently disabling conditions that preclude self care, or at least home care, they will be cared for in a facility offering long term care. Many acute care hospitals also offer long term care. Nearly forty percent of the nursing units in this study are in hospitals that offer both types of care. Other terms for long term care are chronic care and custodial care. That is, long term care is needed to treat chronic or ongoing diseases and conditions. Custodial care may be used to refer to long term care situations where the care-giver institution virtually has "custody" of the patient; that is, the care-giver institution becomes the patient's home for long periods. In this report, custodial care refers to any long term care situation.

3.3.1.4 Importance of These Distinctions

These distinctions between acute care, critical care, and long term care have been carefully delineated here. The reason is, as the reader will see from the results that follow, there is statistical significance in many of the measures in this study when the basis for separation is the type of care offered in the nursing unit. The type of care offered in a unit indicates the acuity of the patients, which in turn indicates the staffing ratio of nurses to patients. This staffing ratio is only one difference in the nursing units offering different types of nursing care. Nursing managers and other managers in hospitals know there is a difference in the environments as well as patient characteristics in nursing units offering different types of care. However, what is managerially obvious is not always statistically significant. It was of some comfort to this researcher to show statistically that the levels of technology, the levels of capital intensity, the acuity of patients, and other patient characteristics do differ statistically with the type of nursing care offered in the unit, and thus with the staffing ratio of the unit.

3.3.2 Unit Descriptors

Many different kinds of nursing units participated in the study. Thirty-one percent of the units were medical or surgical units, or medical and surgical units. Fifteen percent of the units were cardiac or medical and surgical intensive care units, and an additional nine percent were telemetry units. Another ten percent of the units were OB-GYN units, and nine percent were psychiatric and chemical dependency units. Seven percent were operating room and post-anesthesia care units, and almost nine percent were neonatal or pediatric units. Four percent were emergency departments, and four percent offered outpatient services. Rehabilitation units, home health care units, and hospice units were under two percent of the total. For details see responses to Questions 5 and 6 reported in Appendix C.

Seventy-one percent of the units in the study offer acute care. Forty-two percent offer critical care, and twenty percent offer long term care.

Crosstabulations of these characteristics show that six percent of the units in the study offer none of these types of care, and six percent offer all three types of care. Other combinations of these three types of care as represented by the nursing units in the study are shown in Figure 3.6.

3.3.3 Patient Descriptors

Nurse managers were asked to check the proportion of their patients with certain characteristics. Some of the characteristics were demographic, relating to age and gender, and other characteristics were related to acuity of the patients. The demographic questions asked what approximate proportion of the patients on the units were adult, children, infants (under age 2), and older adults (over age 60), and what proportion were female. These proportions are shown graphically in Figure 3.7. The acuity characteristics had to do with the proportion of the patients in the unit who were using or attached to catheters, intravenous solutions (IVs), heart and lung monitors, and respirators. The approximate proportions of patients possessing these acuity characteristics are shown in Figure 3.8. In addition, other acuity measures are related to the proportion of patients needing assistance in eating, walking, using the bathroom, and the proportion receiving therapy from another unit. Responses illustrated by these graphs are discussed below.

In examining the mode responses to the questions concerning patient characteristics, the "typical" unit has mostly adult patients, with children between the ages of 2 to 18 representing fewer than half of the patients, and no infants at all. About half the patients are age 60 or older and about half are female. In this "typical" unit, characterized by the modal responses, fewer than half the

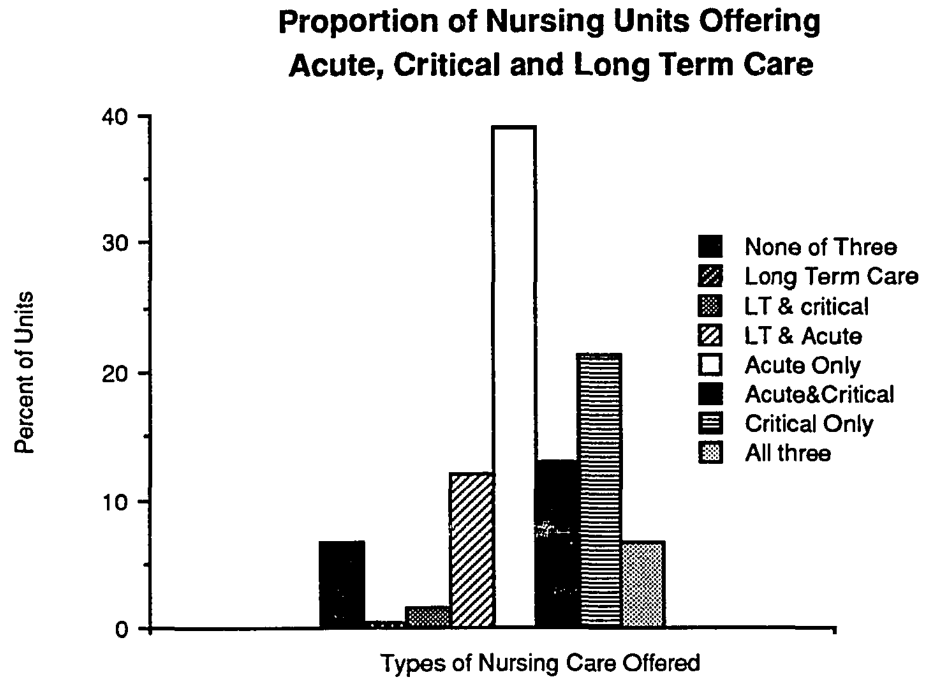


Figure 3.6

Proportion of Units Offering Acute, Critical and Long Term Care

patients are catheterized, but most have IVs. None have monitors or respirators. If should be noted that in the "second most typical" unit, all the patients would have monitors, so the presence or absence of monitors in a unit may well represent a readily available measure for the technological complexity of a nursing unit environment. In this "typical" unit, fewer than half of the patients need assistance in eating, or in walking, or in using the bathroom, and fewer than half are receiving therapy from another unit in the hospital.

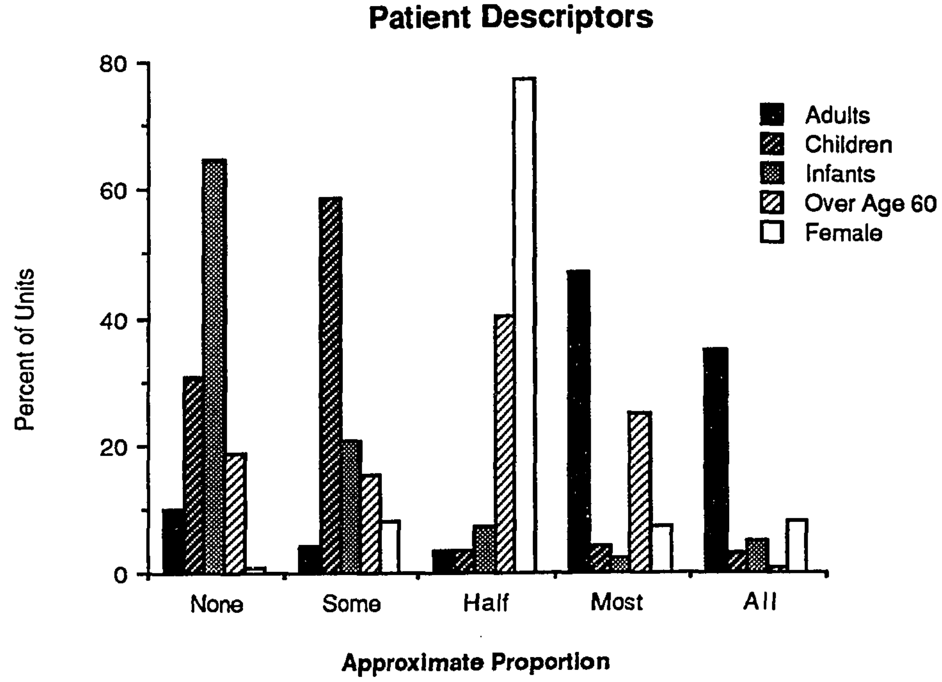


Figure 3.7

Age and Gender Descriptors of Patients

3.3.4 Patient Descriptor Differences by Category of Nursing Unit

This is an exploratory study, and one of the express purposes is to develop measures. An observation of nursing units in action leads easily to a priori hypotheses that responses to the questions concerning IVs, monitors, and respirators will differ between units offering acute care, and critical care. Other differences are not so apparent to the non-nurse observer. This researcher

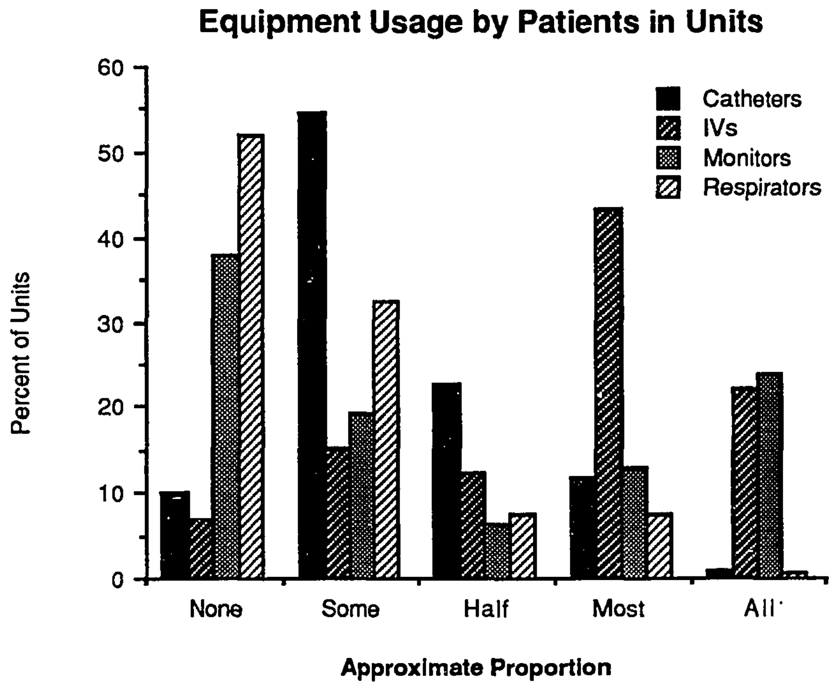


Figure 3.8

Acuity Descriptors of Patients

hypothesized that the responses to the patient descriptor questions have the potential to serve as environmental measures. Strictly speaking, the responses to question 8, dealing with patient descriptors, are ordinal variables. However, in order to test hypotheses about differences between nursing units, the responses to the patient descriptor variables in questions eight were treated as representing an underlying continuous distribution. Taking this "researcher license" allows analysis of variance to be used in order to test whether the mean responses differed with the type of care offered by the nursing unit.

Half the nursing units in the study were randomly selected to form a subset for testing hypotheses. This subset of the entire data set is called

Sample Number One (SN1) in this study. The residual data set is referred to as Sample Number Two (SN2). Both of these subsets of the entire data set contain responses from 174 surveys. This selection procedure is described in Chapter I. Analyses of variance (ANOVA) were performed using Sample Number One, and results were verified on Sample Number Two. In general, the hypotheses tested took this form:

> H_0: The mean value of a patient descriptor variable is the same regardless of the type of care offered by the nursing unit.

Data portrayed in Figure 3.6 suggest that interaction between care types should be considered. Therefore, means were compared for units offering four care types: neither acute or critical care, acute care only, both acute and critical care, and critical care only.

3.3.4.1 Results of Hypotheses Tests on Patient Descriptor Variables

Using a significance level of .05, the hypotheses dealing with age and gender variables were not rejected. However, for variables dealing with equipment attached to and used by patients, and variables concerned with some activities for which patients need assistance, the means were significantly different, statistically speaking, among units offering the four types of care described above. Tests of hypotheses using ANOVA on Sample Number One (SN1) and Sample Number Two (SN2) yielded the same results. Details of the hypothesis tests on all patient descriptor variables from Question 8 are shown in Table D.2 in Appendix D. For the units in this study, the following conclusions can be made. The proportion of adults on the units is not significantly different, by type of nursing unit. Nor are there significant differences in the mean proportions of children, infants, patients over sixty, or female patients, when the type of nursing unit is considered. Neither are there significant differences in the mean proportions of patients needing assistance in walking, patients needing assistance in using the bathroom or in patients receiving therapy from another unit.

Results of the hypotheses tests on the variables related to catheters, IVs, monitors and respirators lead to the conclusion that the proportion of patients utilizing these devices and equipment varies greatly with the type of care given. Table D.2 indicates that nearly all patients in units offering only critical care have IVs and monitors. In fact, all units, regardless of category, appear to have half or more of their patients on IVs. In general, the proportion of patients with each of these devices (catheters, IVs, monitors and respirators) changes as the type of care changes. This result is not a surprise but it does point to these variables as a distinguishing measure of the nursing unit environment. The proportion of patients needing assistance in eating also show a difference between types of care.

3.3.5 Differences in The Environment by Category of Nursing Unit

Respondents were asked to rate their units in comparison to other units in the hospital on nine characteristics related to technology and capital intensity. They were asked to use a seven point scale, where a rating of "1" indicated "much lower," a rating of "4" indicated "about the same," and a rating of "7" indicated "much higher. " One characteristic was average patient acuity, which received a mean rating of just over 5 points. The other characteristics were use of new technology for patient care, use of special equipment in patient care, use of computer technology for patient information, total value of equipment in your unit, value of equipment per bed in your unit, number of nursing staff per patient, value of equipment per nursing staff member, and variety of treatment from patient to patient. All of these received mean scores between 4.5 and 4.9. For details see Appendix C, question 9.

Some of these questions are designed to capture the difficulty of the task (patient acuity), and task flexibility required (variety of treatment from patient to patient). Others measure the use of technology in the unit (use of new technology and special equipment for patient care, and use of computer technology for patient information). Others intend to measure the capital intensity (total value of equipment in the unit, value of equipment per bed in your unit, and value of equipment per nursing staff member) versus labor intensity (number of nursing staff per patient) in the unit. Consequently, these measures were hypothesized to differ from one category of nursing unit to another.

3.3.5.1 Results of Hypothesis Tests on Environmental Variables

Analysis of variance (ANOVA) was used to test the differences between means for nursing units offering these four categories of care: (1) neither acute or critical care, (2) acute care only, (3) acute and critical care, and (4) critical care only. The ANOVA tests were performed on both Sample Number One (SN1) and Sample Number Two (SN2) as described above. The null hypothesis in each case was that the means did not differ among care categories. For all nine of these measures the null hypothesis was rejected, in both SN1 and SN2, at an alpha level of .01. The actual p-value of the F statistic was less than .0001 in 15 of 18 tests. For details of the values of the means, the F-statistics, and their p-values, see Appendix D, Table D.3. In each case there was a statistically significant difference between acute care only and critical care only (Alpha = .05). In several cases, other pairs of nursing care categories were shown to exhibit a statistically significant difference as well. These differences are shown in Table D.3.

In general, the results of these hypothesis tests support the obvious. The mean measure of the average acuity of patients and mean measure of the variety of treatment from patient to patient is higher in units offering critical care. The mean measures of the use of new technology and special equipment for patient care are higher in units offering critical care, as is the mean measure of the use of computer technology for patient information. The mean measures for total value of equipment in the unit, and the value of equipment per patient and per nursing staff member are much higher in critical care units than in acute care units. Even the mean measure of the number of nursing staff per patient is higher in critical care units. With the possible exception of the last observation, any nursing unit manager easily could have predicted these results as it is well known that critical care units are laden with equipment, much of it representative of the latest technology. Even though these results may be obvious, the results from this section lend a certain external validation to the survey instrument that is comforting to this researcher.

3.3.6 Differences in Length of Stay, Size of Unit, Admissions and Patient Census by Category of Nursing Unit

For nursing units participating in the study, the median average length of stay for patients was 4 to 6 days with 28% for the respondents, and 7 to 10 days a close second with 24% of the respondents. The median longest stay was over 90 days chosen by 35% of the respondents, while 31 to 90 days was selected by 30% of the respondents The overwhelming shortest length of stay was 0 to 1 days with 73% of the respondents choosing that option. For more details see Appendix C, question # 10.

Twenty-four percent of the nursing units reported between 29 and 37 beds in the unit, while 20% reported 21 to 28 beds. Most units in the study average fewer than 9 admissions per day, with 42% reporting an average of 4 to 8 admission per day, and 38% reporting between 0 and 3 average daily admissions. The highest number of daily admissions over the past year was 9 to 14 for 32% of the units, and 4 to 8 patients for another 32% of the units. Eighty-eight percent of the units report between 0 and 3 admissions as their lowest daily admissions over the past year. The responses for highest patient census over the past year closely reflect the responses for number of beds in the unit. Twenty-two percent of the nurse managers said their highest patient census was between 29 to 37 patients, and 20% choose 21 to 28 patients. The lowest patient census over the past year was 0 to 3 patients for 27% of the units, and 9 to 14 patients for 23% of the units. For more details see question 11 in Appendix C.

The responses to questions concerning the length of a patient's stay in the unit, the number of beds in the units, the number of daily admissions, and the patient census in the unit were coded as ordered categorical variables. For several analyses these coded responses were treated as continuous variables although, strictly speaking, they are not. Tests of the differences among mean responses for four different types of nursing care were performed using analysis of variance (ANOVA). Detailed results of these tests are shown in Appendix D, Table D.4. Both Sample Number One (SN1) and Sample Number Two (SN2) were used in the tests. A second set of tests was performed in which the response values were converted to the midpoints of the ranges represented by the original responses. With the exception of the mean value for the average patient census in Sample Number One, the results of the hypothesis tests were the same for both sets of tests. Therefore, the tables for the tests using the midpoint convention are not included with this report.

3.3.6.1 Results of Hypothesis Tests on Length of Stay, Size of Unit, Admissions and Census Variables

Based on the results of the hypotheses tested with ANOVA, and shown in Table D.4, acute care units tend to have longer average patient stays than units offering critical care only. This result is statistically significant in SN1, but not in SN2. The longest length of patient stay tends to be longer in an acute care unit than in a critical care unit. This result is statistically significant in SN1, but not in SN2, even though the same pattern of longest length of stay is observed. The shortest length of patient stay tends to be longer in an acute care unit than in a critical care unit. This result is statistically significant in SN2, but not in SN1, even though the same pattern of shortest length of stays is observed. There tend to be many more beds on acute care units than on critical care units. This result is statistically significant in both SN1 and SN2.

Results for average daily admissions are inconclusive. In the SN2, the critical care units have a higher mean value for the number of daily admissions than the acute care units. This result is statistically significant in SN2, but not in SN1, and the pattern of average daily admissions is reversed in SN1 from SN2. It is possible for critical care units to have a higher average number of daily admissions than acute care units regardless of size, because the patients may be in the critical care units for very short periods, sometimes less than a day, and the beds may be filled more frequently than in acute care units. In fact, the variable for number of beds on the unit (X1101) does not show a statistically significant correlation with the average number of daily admissions to the unit (X1102) in SN1.

Hypothesis tests of zero correlation between the pairs of variables representing the length of a patient's stay in the unit, the number of beds in the units, the number of daily admissions, and the patient census in the unit were conducted. These tests were also conducted on SN1 and SN2. Results of these correlational analyses are shown in Table D.5. For 45 pairs of variables tested for correlation, thirty pairs showed a statistically significant correlation in both sets of data. Findings indicate a very strong correlation, at least .65, between the average length of stay and the longest length of stay, and a very strong correlation, at least .51, between the average length of stay and the shortest length of stay. Average length of stay has a lower correlation , at most .25, with the number of beds in the unit. Units whose patients stay longer tend to be slightly larger units in terms of number of beds. Average length of stay has strong negative correlations with the average, highest, and lowest numbers of daily admissions. These correlations are at least -.53, -.57, and -.36 respectively. These relationships make sense, as units whose patients stay longer would be expected to have fewer new admissions each day than units whose patients have shorter stays. Average length of stay did not correlate significantly with average patient census. Mixed results were obtained for average length of stay with highest patient census, and lowest patient census. A weak but statistically significant correlation in one sample was not confirmed in the other sample for these pairs of variables.

The number of beds on a unit has strong positive correlations with the average, highest and lowest patient censuses. These correlations are at least .52, .60, and .41 respectively. These results are not surprising, as a unit with more beds would certainly be expected to have more patients. The number of beds on a unit does not correlate significantly with average, highest, or lowest daily admissions.

3.4 PROFILES OF THE NURSING STAFF

Respondents were asked several questions about the nursing staff in their units. Nursing staff was considered to be all who provide direct and indirect nursing care to patients. Included in these categories are all Registered Nurses (RNs), Licensed Practical Nurses (LPNs), and Nurse Assistants. The term "Nurse Assistants" was used to refer to all nurse aides, orderlies, nurse technicians, and all others who assist RNs and LPNs in direct and indirect nursing care of patients. Unit clerks, who are hired primarily to provide clerical or secretarial support to nursing units are not included as nurse assistants. Respondents were asked to use their own institution's definition of full time and part time employees, even though the definitions may vary widely from hospital to hospital. In this section of the research instrument, information was collected about the size and composition of the nursing staff, the nursing staff assignment practices, and various attributes of the staffing and scheduling process.

3.4.1 The Nursing Staff Assignment Model

Nursing staff assignment are made in a variety of ways, but most assignment practices fall roughly into one of five categories. The functional nursing model decrees that it is most efficient if each nursing staff member performs specified functions for all patients in a unit. For example, one nurse may take all the temperatures, one nurse may take all the blood pressures, and another nurse may give all the medications. Each nurse records on the patient's chart the results of the activities, tasks, or functions which have been performed on that patient by that nurse. Because of its efficiencies, the functional nursing staff assignment model is sometimes the default choice of nursing units that are badly understaffed. Just under four percent of the nursing units in this study report using the functional nursing staff assignment model.

The team nursing assignment model is one in which an RN leader coordinates all nursing functions for a group of patients, using the appropriate skills of the team members who may be other RNs, LPNs, or nurse assistants. Because there are legal constraints on the nursing functions that some team members may or may not perform, the functional assignment model may be used within the context of the team nursing approach. Each team member may be assigned certain functions to perform on all patients who are the team's responsibility. Eighteen percent of the units in the study report the use of team nursing to assign nursing staff members to patients.

The modular nursing model is one in which one nurse is assigned primary responsibility for the care of patients in certain proximate areas. One nurse performs all functions on the set of patients for whom the nurse is responsible. These patients will usually be in adjacent beds or rooms in the unit. Twenty-eight percent of the units in the study reported the use of modular nursing for staff assignments.

The primary care model is one in which one nurse has total 24-hour-a-day responsibility for the nursing care for a specific group of patients. The primary nurse coordinates care of a patient throughout the patient's stay on the nursing unit, over all shifts of the day, and on weekends, even if the primary care nurse is not on duty. Thirty-six percent of the units in the study use the primary care nursing assignment model.

The case management nursing assignment model is particularly applicable to patients with long term illnesses or very complicated cases requiring much coordination between different nursing units, social services, and other health professionals. One RN is assigned to monitor the progress of and provide assistance to a patient from pre-admission through post-discharge. The case manager nurse follows the progress of the patient through all stages of hospitalization, even when the patient is assigned to another unit. Under three percent of the units in the study use the case management assignment model. About six percent of the nursing units in the study use some other method than the five discussed here, and about four percent use a combination of methods.

The hypothesis that the nursing care assignment model did not differ by type of nursing units was tested using the Chi-Square test of independence. When the test was performed on the crosstabulations of five nursing staff assignment models with the four types of nursing units described in the previous section (neither acute or critical care, acute care only, acute and critical care, and critical care only) the hypothesis of independence was rejected. An observed Chi-square statistic of 31.265 had only a .002 probability of occurring by chance. Unfortunately, 7 of the 20 cells had fewer than 5 nursing units in them. The type of nursing unit offering neither acute or critical care accounted for only 5.6% of the units (18 of 324) in the test, but accounted for over half of the value of the observed Chi-square statistic. A second test of independence was performed using the five types of nursing staff assignment models, and three types of nursing units: those offering acute care only, those offering acute and critical care, and those offering critical care only. This time, the hypothesis of independence was not rejected. An analysis of individual cell contributions to the observed Chi-square statistic does show that the team nursing staff assignment model is less likely to be used in units offering only intensive care than it is in other types of units. Figures 3.9 and 3.10 show some of the relationships between nursing staff assignment models, and types of nursing units. For each type of nursing staff assignment model, Figure 3.9 shows the proportion of types of nursing units reporting the use of that model. For each type of nursing unit, Figure 3.10 shows the number of nursing units of using each staff assignment model.

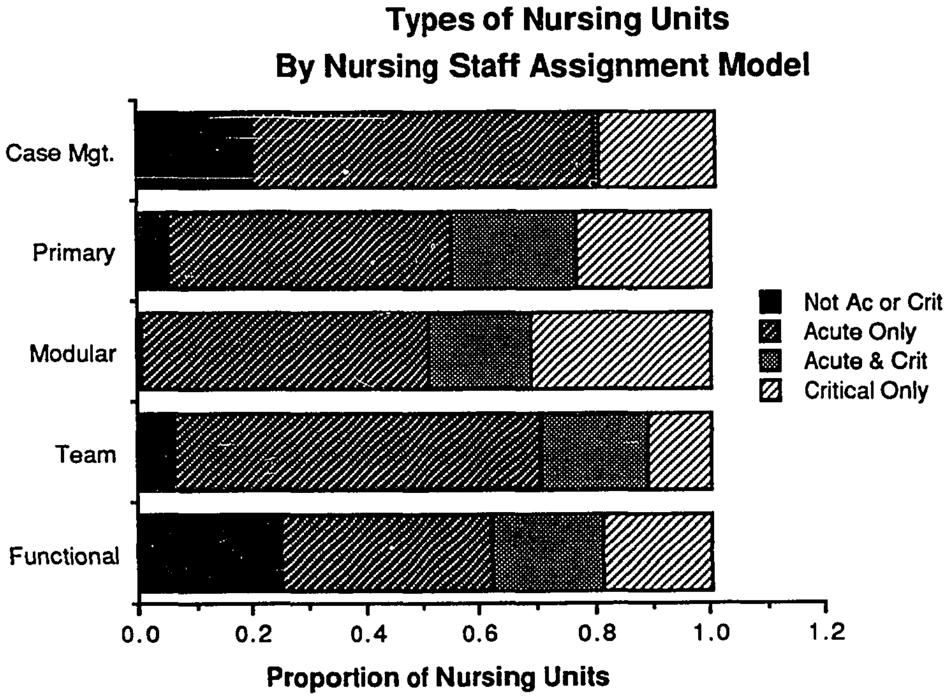


Figure 3.9

Proportion of Nursing Units Using each Type of Assignment Model

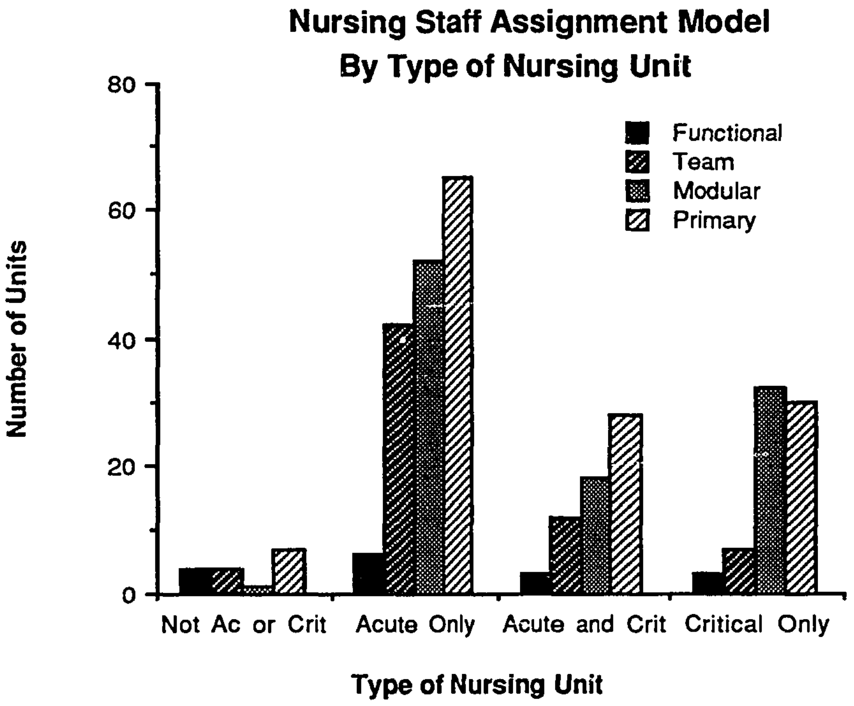


Figure 3.10

Number of Nursing Units Using each Type of Assignment Model

3.4.2 Characteristics of the Nursing Staff

3.4.2.1 Number of Nursing Staff on the Units in the Study

Of the nursing units whose managers responded to the study questionnaire, 46% had between one and three Registered Nurses (RNs) with a Bachelor's of Science Degree in Nursing (BSN) or a higher degree. Another 26% of the units had between four and seven RNs with a BSN. 36% of the units had between four and seven RNs without a BSN, and 30% had between eight and twelve RNs without a BSN. 46% of the units had no Licensed Practical Nurses (LPNs), and 33% had between one and three LPNs. 47% of the units had between one and three nurse assistants, 26% had no nurse assistants, and

22% had between four and seven nurse assistants. 78% of the units had between one and three unit clerks, and only 13% had no unit clerks. The total nursing staff was between thirteen and seventeen on 29% of the units, between eighteen and twenty-five on 24% of the units, and between eight and twelve on 22% of the units. For more details see question 16 in Appendix C.

For each type of nursing staff, the hypothesis was tested that the number of nursing staff was independent of the type of nursing unit. These tests were conducted using ANOVA on the values of the variables recoded to equal the median for each category of response. There were statistically significant differences in the number of RNs with BSNs, LPNs, and Nurse Assistants in both SN1 and SN2. There were no statistical differences in the number of RNs without BSNs, and unit clerks in either sample. In SN1, there were no statistical differences in the total number of nursing staff, but statistical differences did exist in the total number of nursing staff in SN2. Details of the results of these hypothesis tests are shown in Table D.9. Table 3.2 and Figure No. 3.11 show the mean number of nursing staff in each type of unit.

It should be noted that in section 3.3.6.1 the statistical difference in size of units when measured by number of beds was discussed. On average, acute care units have more beds than do critical care units. Information about the average number of beds in each type of nursing unit is given in Table 3.2. The relationship between mean staff size and mean number of beds by type of nursing unit supports the discussion about acuity in section 3.3.1.

3.4.2.2 Proportion of Types of Nursing Staff on the Units in the Study

Respondents were asked to select the category that best described the proportion of various types of nurses on their units during a typical month. The categories from which respondents could select were "None," "Fewer than Half," "Half," "Most," and "All." The details of this question are given in Appendix C, Question number 14. Forty-four percent of the units in the study reported that

Table 3.2

Mean Number of Nursing Staff By Type of Nursing Unit

Type of Unit	Long Term Care	Acute Care Only	Acute & Critical Care	Critical Care Only
		Number of Nursing Staff:		
RN Staff with BSN	2.02	3.81	5.10	4.94
RN Staff without BSN	6.37	7.10	8.00	8.41
LPN Staff	1.43	2.64	1.29	1.04
Nurse Assistants	2.74	3.37	2.25	1.54
Unit Clerks	1.78	2.06	1.99	2.03
Total Nursing Staff*	11.03	15.77	17.18	15.06
Mean Number of Beds	21.19	28.23	21.18	15.96
Number of Units	23	178	68	79

* Mean values for separate categories of staff do not add to the total because the responses were given in ranges and not single numbers. Also 15 units did not respond to the total nursing staff question.

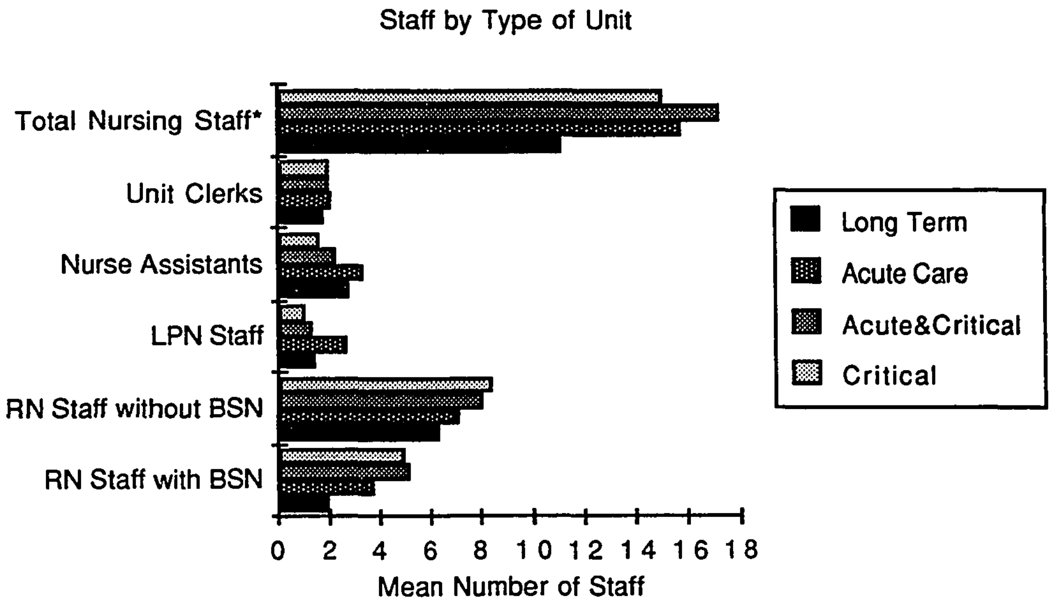


Figure 3.11

Number of RN Staff by Type of Nursing Unit

most of the nursing on their units during a typical month were Registered Nurses without Bachelor's of Science in Nursing (or equivalent) degrees, and twenty-seven percent of the respondents reported half of their nurses were in this category. Fifty-four percent of the units had fewer than half of their nurses in the category of Registered Nurse with a Bachelor's degree in Nursing; about 20% of the units had half their nurses in the RN, BSN category, and about 20% had no nurses at all in this category. Half of the units had no Registered Nurses with a clinical specialty; in 31% of the units, fewer than half of the nurses were RNs with a clinical specialty; but in 6% of the units all nurses had a clinical specialty. The term "Clinical Specialty" was not defined on the questionnaire, because in the test of the survey instrument, the lack of a definition did not appear to be a problem. However, there were a few questions from respondents regarding the meaning of this term, so it is not clear if this question is valid. Forty-five percent of the units had no Licensed Practical Nurses (LPNs), and fifty percent of the units had fewer than half of their nurses in the LPN category. Twenty-eight percent of the units report no nurse assistants, and 64% report that fewer than half of the nursing staff on their unit are nurse assistants. The term "nurse assistant" was defined on the questionnaire to refer to nurse aides, orderlies, nurse technicians, and all others who assist RNs and LPNs in direct and indirect patient care. It also was noted on the survey instrument that unit clerks and other secretarial and clerical assistants were not to be included as nurse assistants.

Most units appear to have the majority of their staff in the category of full-time employees of the hospital. Sixty-four percent of the units in the study report that most of their nursing staff are full-time employes, but only three percent of the units report all are full-time employees, and 22% report half are full-time employees. These figures are mirrored, as might be expected, in responses to the question regarding part-time employees. Sixty-four percent of the units report fewer than half of their nursing staff are part-time employees; 24% say that half are part-time employees; and six percent of the units have no part-time employees.

It also appears that the use of temporary employees from an outside agency, or even from an in-house pool is not pervasive. Sixty-eight percent of the units report no temporary employees from an outside agency working on their unit in a typical month; and twenty-nine percent of the units report fewer than half of the employees are from an outside agency. Thirty-two percent of the units report the use of no nurses from other units or from an in-house pool, and sixty-five percent of the units report fewer than half of the nursing staff on their unit in a typical month are from other units or an in-house pool.

Hypothesis tests were conducted using analysis of variance to test whether mean responses to the questions about the categories described above were the same for four types of nursing units. The four types of nursing units, also described in earlier sections, are those offering neither acute or critical care, those offering acute care only, those offering acute and critical care, and those offering critical care only. Summary results of these tests are shown in Table D.7 in Appendix D. There were no statistical differences between types of units for the proportion of RNs without BSNs, the proportion of RNs with BSNs, or the proportion with RNs with a clinical specialty. However, there were statistical differences between the proportion of LPNs and Nurse Assistants by type of nursing unit. Units offering acute care only had a mean response higher than units offering critical care only and higher than units offering both acute and critical care. These results were not unexpected. These results were found in Sample Number One (described earlier in the chapter) and verified on Sample Number Two.

3.4.2.3 Rating of Characteristics of the Nursing Staff

Nurse managers were asked to rate their units in comparison to other units in their hospital, on several characteristics related to nurse staffing. Detailed results are shown in question 15, in Appendix C. Ratings ranged from 1 to 7, with 1 meaning "much lower", 4 meaning "about the same," and 7 meaning "much higher." Nearly 85% of the respondents rated the pay rate for RN staff as "about the same" (4) as other units, while 13% gave their unit a higher rating than a 4. 88% said the pay rate for other nursing staff members was about the same as it was in other units with only 9% saying it was higher.

The need for unit orientation received the highest mean rating (5.22) of any of the nine items respondents were asked to rate in this section of the survey instrument. This question reflects to what extent orientation must be provided to the nursing staff who are assigned to the unit. If a nurse manager gave the need for unit orientation a very high rating, the nurse manager thinks employees working on the unit need much more orientation than they would need to work on other units in the hospital. Thus, a high rating on this question is a limiting factor in work force flexibility, as nursing staff from other units in the hospital, or outside the hospital cannot be used as easily. 32% gave their unit a 4; 18% gave their unit a 5; 24% gave their unit a 6; and 21% gave their unit a 7. Such responses do not bode well for flexibility, when 63% of nurse managers think their unit requires more orientation than other units in the hospital.

There is some evidence to suggest that the next three questions were misinterpreted by at least some of the respondents. These questions have to do with the ease of finding enough staff for any given shift, the ease of preparing schedules, and the ease of making shift adjustments. The intended response was that a high rating meant staff were much easier to find, or schedules were much easier to prepare, or shift adjustments were much easier to make. However, the responses to these questions were compared on an individual basis to the responses to questions 33 and 34 which deal with rating the complexity of the scheduling process, and the complexity of the shift adjustment process. The expectation of this researcher was that ease and complexity would be negatively correlated, and indeed, for some respondents, they were.

However, for some they seemed to be positively correlated. This result led this researcher to the conclusion that some respondents answered with a high rating when they meant "greater difficulty" as opposed to the expected meaning of "greater ease." Due to this confusion, the responses given when asked to rate one's unit with respect to ease of finding enough staff for any given shift, ease of preparing schedules, and ease of making shift adjustments will not be analyzed. Should a question of this nature be included in a follow up study, it will have to be reworded.

The responses to the next two ratings questions, use of pool nursing staff from inside the hospital, and use of pool nursing staff from outside agencies, were highly consistent with results reported above from question 14 in which few units reported the use of any such pool nurses. While 27% think they use in-house pool nurses about the same as other units, 50% of the units rate themselves much below other units in their hospital in their in-house pool use. 20% rate their units are about the same as other units in their use of nurses from an agency, but 70% rate their units below others in agency usage. When the majority of nursing units think their usage of pool nurses is lower than other units, as is the case here, it could be because they use none or a very limited number of pool nurses, a fact quite consistent with results of number 14.

Finally, 24% of the nursing units report their turnover rate for nursing staff is about the same as other units, but over 60% say their unit is lower. These results are interesting, in light of a nursing shortage, and may reflect efforts on the part of management to retain their current nurses.

When hypotheses were tested concerning differences between mean responses for different types of nursing units, only in the rating accorded the need for unit orientation was there a statistically different rating. The units offering critical care, and the units offering acute and critical has significantly higher ratings than the units offering acute care only. All other parts of this question showed no statistical difference between types of nursing units. Results, shown in detail in Table D.8, agree between SN1 and SN2.

3.5 PROFILES OF THE SCHEDULES OF THE NURSING STAFF

Respondents were asked about the scheduling options and procedures used in their units to schedule nursing personnel. Summary statistics for these questions are shown in Appendix C, questions 17, 18, and 19.

3.5.1 Characteristics of Nursing Staff Schedules

In question 17, respondents were asked how many of the nursing staff working in their units over the past three months have schedules with various characteristics. The most common (or modal) characteristics of schedules were a permanent unit assignment, fixed start times, no rotation between day and other shifts, a permanent shift assignment, a requirement to work a certain number of weekends, no split shifts, no fixed pattern of days on and off, and does not work the same days every week.

Almost 90% of the units in the study have most or all of their staff permanently assigned to their unit. Forty-five percent of the units said all their nursing staff had fixed start times, dictated by the hospital, and another 42 percent said most of their nursing staff had fixed start times. On the other hand, only 4% of the nursing units report that over half of their nursing staff have flexible start times, dictated by the employee.

Regular rotation between the day shift and other shifts is used to some extent by two-thirds of the units. One-third report that no employees rotate, and over one-fourth of the units report that only a few employees rotate between shifts. However, 28% of the units report that most or all of the employees rotate. Fifty percent of the units do report that most or all employees have a permanent day or evening shift assignment. Less than one percent of the units in the study report the use of split shifts.

Eighty-seven percent of the nursing staff are in units where they must work a required number of weekends, but only about 7% have staff that are permanently assigned to weekends. One-third of the units report no employees with a set pattern of days on and off, (such as 4 days on and 3 days off), but another third of the units report most or all of their nursing staff schedules do have a set pattern of days on and off. Thirty percent of the units have no one who works the same days each week, and another 43% have only a few who work the same days each week.

ANOVA was used to test the hypothesis for each characteristic that the mean response did not differ by type of nursing unit. The null hypothesis was accepted for every characteristic when tested on SN1, and was rejected only for the requirement of working a certain number of weekends, in SN2. In that sample it appears that units offering acute care have a slightly higher mean response, and units offering neither acute or critical care have a slightly lower mean response, than the other two types of units. The statistical conclusion to be drawn is that scheduling characteristics do not show a statistically significant difference by type of nursing unit. Details are shown in Table D.10, Appendix D.

3.5.2 Shift Lengths and Starting Times

In this section of the questionnaire, respondents were asked about the length of shifts in their units, and the number of starting times. Respondents could check multiple categories as their answers to the questions about shifts lengths. Over 90% of the units in the study have a regular RN shift length of 8 hours not including overtime. Over one-third of the units have a regular RN shift length of 12 to 16 hours not including overtime, and 12% of the units have a regular RN shift length of 9 to 11 hours. Almost 29% of the units have two regular shift lengths for RNs, and over 5% have three or four shift lengths. LPNs and nurse assistants overwhelmingly have 8 hour shift lengths, although, 15% and 4% of the units report two regular shift lengths for LPNs and nurse assistants, respectively. Over 70% of the units report 12 to 16 hours as the longest period likely to be worked, including overtime, but 7% report over 16 hours as the longest period. In one-third of the units eight hours is the shortest period likely to be worked, and in 56% of the units, one to four hours is the shortest period likely to be worked.

Results were very similar for weekends, with the exception that over 45% of the units have 12 to 16 hour shifts as the regular RN shift length on weekends. About 32% of the units have two regular lengths for RN shifts on weekends, and three percent have three or four regular shift lengths.

Slightly fewer than half the units report three shift starting times on weekdays, and nearly 29% report four or five times for shifts to start . About 8% of the units only have two shift starting times, and more than 10% of the units have six or more starting times for shifts. Results are similar for weekends, except 12% of the units have only 2 shift starting times, and only 7% of the units have six or more starting times.

Chi-square tests of independence were used on the entire data set to test the hypotheses that number of shift starting times were independent of the type of nursing unit. The hypotheses concerning the number of shift starting times being independent of the type of unit were rejected at a significance level of .0001 for the chi-square statistic. During weekdays, critical care units had more than the expected number of units with only two shift start times, and acute care units had more than the expected number of units with three start times. The results are more dramatic for weekends. About one-quarter of the critical care units comprise over half the units reporting two start times, and under half of the acute care units comprise over 60% of the units reporting three start times.

Hypotheses that shift lengths were independent of the type of nursing unit were also tested using the chi-square test of independence. Because there were virtually no units with regular RN shifts of less than 8 hours, and a small number with 10 hour shifts, a chi-square test of independence was performed using 8-hour shifts, 12-hour shifts, and multiple shift lengths. The hypothesis of independence was rejected at the .0001 level. Major contributors to the lack of statistical independence came from acute care units having more than their share of 8-hour shifts (consistent with 3 start times), units offering acute and critical care having more than their share of multiple length shifts, and units offering only critical care having more than their share of 12 hour shifts (again, consistent with 2 shift start times).

There also were statistical differences, significant at the .001 level, in the longest shift likely to be worked, including overtime. There were more units offering neither acute or critical care than expected with the longest shift of 9 or 10 hours. There were more units than expected offering both acute and critical care whose longest shift was more than 16 hours, and there were more than the expected number of critical care units whose longest shift was between 12 and 16 hours. There were no statistical differences in the shift lengths for LPNs and nurse assistants by type of nursing unit. There were no statistically significant differences in the shortest time period likely to be worked.

For weekend shifts, the hypothesis that the regular length of an RN shift was the same for all types of nursing units was rejected at the .0001 level. Acute care units had more than expected of 8 hour shifts, as did units offering neither acute or critical care. Units offering both acute and critical care, and units offering critical care only had more 12 hour shifts than expected, and units offering both acute and critical care had more multiple shift lengths than expected. For all other weekend shift lengths, those for LPNs and nurse assistants, and the longest and shortest period likely to be worked, the hypotheses that the shift lengths were independent of the type of unit were accepted at a significance level of .05.

3.5.3 Scheduling Adjustments

3.5.3.1 Frequency of Occurrence of Situations Requiring Adjustments

Respondents were asked with what frequency various situations arose in their units when they were making short term scheduling adjustments in order to match available nursing staff to needed nursing staff. Shortages of RNs are fairly frequent, with over half the units reporting a shortage at least once per week, and almost one quarter of the units reporting shortages daily or more frequently. Forty percent of the units report shortage of other nursing staff at least once per week, but only 11% report shortages of other nursing staff daily or more frequently. On the other hand, an oversupply of RNs is not a frequent occurrence, as over 60% of the units report such a situation occurs less than once a month, and 30% say it happens at least once a month, but not as often as once a week. Similarly, over two-thirds of the units report an oversupply of other nursing staff less than once per month, and nearly one-quarter of the units report an oversupply of other nursing staff at least once per month, but not weekly. Forty percent of the units report all beds being filled at least once per week, and 25% say all beds are filled daily. Four percent of the units report all beds filled more than once per day. In half of the units nurses work beyond their normal hours at least once per week, and in over one-fifth of the units, they do it daily. Six percent of the units report nurses working beyond their normal hours more than once per day. See question number 20 in Appendix C for more details.

Hypotheses were tested that each of these situations was independent of the type of nursing unit. At a .02 level of significance, using the chi-square statistic, the hypothesis that the frequency of a shortage of RNs was independent of the type of nursing unit was rejected. Acute care units had more frequent shortages than expected, and units offering neither acute or critical care had less frequent shortages than expected, as did units offering both acute and critical care. Similarly, at the .001 level of significance, the hypothesis is rejected that frequency of shortages of other nursing staff is independent of the type of nursing unit. Critical care units have shortages of other nursing staff (those that are not RNs) with much less frequency than expected. This circumstance may arise because critical care units tend to have fewer non-RN nursing staff members. The hypothesis that the frequency with which all beds are filled is independent of the type of nursing unit is rejected at the .012 level of significance. All beds appear to be filled more frequently than expected in critical care units, and less frequently than expected in acute care units. There are no statistically significant differences in the frequency with which an oversupply of RNs or other nursing staff occur, based on type of nursing unit. These events are infrequent in all types of nursing units. The frequency with which nurses work beyond their normal hours also appears to be independent of the type of nursing unit.

3.5.3.2 Frequency of Actions Taken in the Case of Staffing Mismatches

Respondents were asked with what frequency they took certain actions in response to the situation where the number of nursing staff available do not match the number of nursing staff needed. For details see question number 21 in Appendix C.

For a shortage of nursing staff of a short term duration the most frequently used options were use of voluntary overtime, extension of the hours of part time nursing staff, calling in nurses on their days off, use of hospital pool nurses, use of nurses from another unit, and hiring new permanent nursing staff, in that order. The least frequently used alternatives, in order of least used first, were mandating a reduction in days off, declining new admissions, discharging patients, use of mandated overtime, hiring nurses from an outside agency that supplies temporary nursing staff, and shifting patients to other units.

Results were extremely similar for a shortage of nursing staff that is expected to have a longer duration, except that hiring new permanent staff was the third most frequently used alternative.

For an oversupply of nursing staff of a short duration, use of voluntary vacation time is the most frequently used alternative, closely followed by sending unneeded nurses to other units, use of volunteer unpaid time off, assignment of nursing staff to other (non-nursing) duties in the unit, and solicitation of new admissions. Laying off or firing permanent nursing staff is almost never done. Other infrequent solutions to an oversupply of nursing staff are to mandate time off, to mandate vacation time, and to send nursing staff home with pay. Actions taken in the extremely unlikely event of an oversupply of nursing staff for a long duration closely followed the pattern of actions taken for an oversupply of a short duration.

ANOVA was used to test whether or not mean frequency of actions taken was the same regardless of the type of nursing unit. Results were mixed between SN1 and SN2. In SN1, the mean frequency with which hospital "pool nurses were used showed a statistically significant difference by unit type (p-value =.0125), as did use of nurses from another unit (p-value=.0018), and shifting patients to other units (p-value=.0008). Acute care units used hospital pool nurse more frequently than the other types of units. Acute care units, and units offering both acute and critical care used nurses from another unit more frequently,and critical care units shifted patients to another unit more frequently. Mean frequency of actions taken in case of an over supply of nursing staff did not vary statistically by type of unit in SN1.

In SN2, these results were not confirmed, except for the use of nurses from another unit which showed a statistically significant difference (p-value =.0029). Units offering only acute care and only critical care had a higher frequency of use of nurses from another unit than did the other two types of units. In SN2, there were statistically significant differences between types of units for use of voluntary overtime (p-value =.0177), use of mandated overtime (p-value =.0392), and use of mandated vacation time (p-value =.0191). While all types of units use voluntary overtime, critical care units in SN2 had the highest frequency of use. Similarly, all types of units use mandated overtime infrequently, but units offering neither acute or critical care and units offering critical care use use it even more infrequently than other types of units. Use of mandated overtime is used slightly more often by acute care units than other types, although no types of units use that option often. For a long term duration of a shortage of nursing staff, only the option of using nurses from another unit shows a statistical differences in the mean responses by type of nursing unit in both SN1 (p-value =.0300) and SN2 (p-value =.0379). Indications are that acute care units use this option slightly more frequently than other kinds of units in response to long term shortages. Details of the hypothesis tests are shown in Table D.11, Appendix D.

3.5.4 The Scheduling Process

3.5.4.1 Decentralization of The Scheduling Process

Most nursing units are decentralized when it comes to the scheduling process. Only 5% of all nursing units in the study report that their scheduling processes are centralized; that is, scheduling is performed by one person for several units. Thirteen percent of the units report their scheduling processes are somewhat decentralized, with several units cooperating, and sharing personnel if necessary. Fifty-five percent report the sharing of common nursing pool personnel, but with each unit doing its own schedules. Twenty-seven percent of the units in the study are completely decentralized, with no cooperation with other nursing units. Using a chi-square test of independence, there was no significant difference in decentralization of scheduling among different types of nursing units (p-value of chi-square is .32).

3.5.4.2 Assessment of Acuity for The Scheduling Process

Nine percent of the units in the study report that the assessment of patient acuity is not applicable to the determination of their staffing needs. Of the units for whom assessment of patient acuity is applicable to determination of their staffing needs, 59% of those units report that patient acuity is assessed more than once per day; 38% report acuity is assessed once per day or less frequently, and 3% report acuity is not assessed at all. The frequency with which acuity is assessed appears to be statistically independent of the type of nursing unit, for the units in this study (p-value of chi-square is .055).

3.5.4.3 Computerization of The Scheduling Process

Less than 1% of the nursing units report that their scheduling processes are completely computerized with no adjustments by human schedulers. Only 13% say they are somewhat computerized with some adjustment by human schedulers. Human schedulers have some computer support in 27% of the units, and 59% of the units have human schedulers who do the scheduling process with no computer support. The level of computer support does not appear to be statistically independent of the type of nursing units (p-value of chi-square is .012). Indications are that acute care units use computers in their scheduling process somewhat more than expected (in a statistical sense), and critical care units use them considerably less than expected.

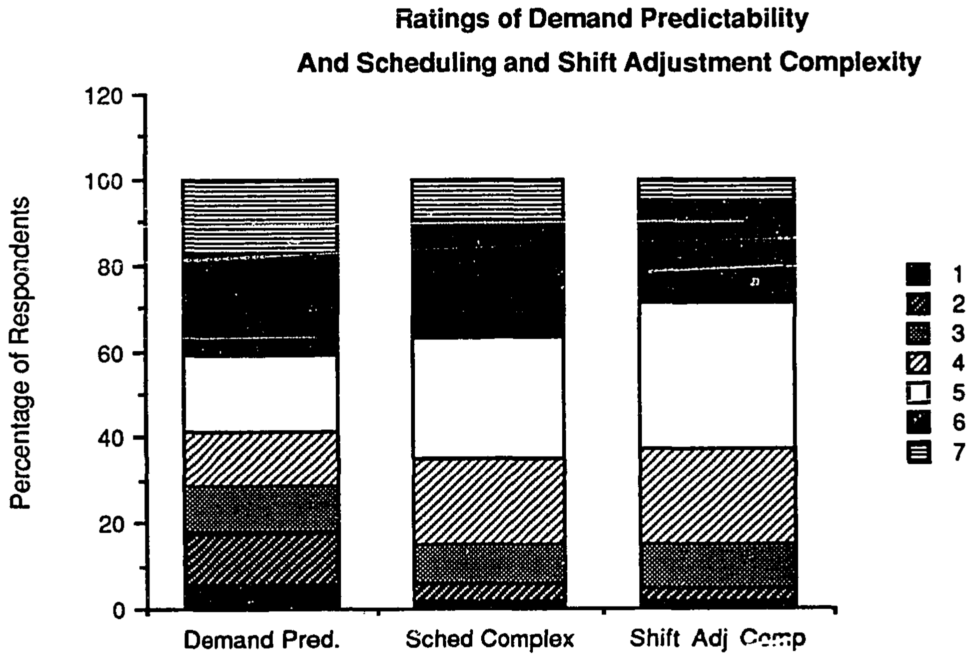
3.5.4.4 Complexity of The Scheduling Process

Respondents were asked to rate the predictability of demand for nursing services in their units, the complexity of the nursing staff scheduling process in their unit, and the complexity of the process of making shift adjustments to staffing. A seven point scale was used, with higher numbers indicating less predictability, and more complexity. Details of responses are given in Appendix C, questions 32, 33, and 34. Mean responses to all three questions were between 4 and 5. However, on the predictability question, 40% of the respondents considered the demand highly unpredictable (a rating of 6 or 7), while 18% considered it very predictable (a rating of 1 or 2). Very few respondents, 6% for the scheduling process, and 4% for the shift adjustment process, considered those processes very simple (a rating of 1 or 2). Over 55% considered the scheduling process to be of medium complexity (a rating of 3, 4, or 5), and 2/3 considered the shift adjustment process to be of medium complexity. Responses are shown graphically in Figure 3.12.

The test of the hypothesis that the mean rating of the predictability of demand is the same for all four types of nursing units produced an F-statistic with a p-value of .0045 in SN1, and .2420 in SN2. Results were mixed as to statistical significance, and direction of the results. In SN1, units offering acute and critical has the highest mean, or least predictability of demand, while the same type of units in SN2 had the lowest mean, or highest predictability of demand. See Table D.13 in Appendix D for more details.

The test of the hypothesis that the mean rating of the complexity of the nursing staff scheduling process is the same for all four types of nursing units produced an F-statistic with a p-value of .0140 in SN1, and .1518 in SN2. Here, too, results are mixed. In the units in SN1, there is a statistically significant difference between the mean ratings of units offering acute and critical care, and those offering acute care, with the units offering acute and critical care rating their scheduling processes as more complex. Not only is this result not confirmed in SN2, but the direction of the difference in means is just the opposite in SN2. See Table D.13 in Appendix D for more details.

The test of the hypothesis that the mean rating of the complexity of the shift adjustment process is the same for all four types of nursing units produced an F-statistic with a p-value of .0679 in SN1, and .2073 in SN2. Indications are that there are not significant differences in the mean ratings of the complexity of the shift adjustment process by type of nursing unit. See Table D.13 in Appendix D for more details.



A higher rating is less predictable, more complex

Figure 3.12

Ratings of Demand Predictability and Staffing and Shift Adjustment Complexity

3.6 ISSUES RELATED TO CONTROL AND VARIABILITY IN THE NURSING UNIT ENVIRONMENT

Several questions in the survey instrument related to the control held by nurse managers over nursing services in their units. Other data were collected related to the variability in demand for nursing services in their units. *Control* over nursing services was defined as the ability of nursing management to influence the timing and level of demand for nursing services, and the activity on the unit. *Variability* referred to changes in the unit, over some time period, in one or more operating variables such as the number of beds, number of patients, and number of nurses. Details of responses to these questions are given in Appendix C, questions 25 through 31, and 35 and 36.

3.6.1 Admissions and Discharges of Patients on the Unit

3.6.1.1 Summary Statistics on Admissions and Discharges

For the purpose of determining staffing needs, 40% of the nursing units in the study officially count admissions and discharges, and 35% include them unofficially. Fifteen percent count only current patients, and for the nearly 10% of remaining units, counting of admissions and discharges is not applicable to determination of number of staff needed. For more details see Appendix C, question number 25.

A test of the hypothesis of independence of the way in which admissions and discharges are included in the determination of staffing needs from the type of nursing unit was performed. Including only those units for whom the consideration of admissions and discharges is applicable to the determination of staffing needs, yielded a chi-square statistic with a p-value of .203. Therefore the hypothesis of independence is not rejected. No particular type of nursing unit appears to count or ignore expected admissions more than any other type of unit.

About 25% of the nursing units report that most or all of their admissions are scheduled 24 hours or more in advance. Another 45% of the units report that a few, up to about half, of their new admissions are scheduled in advance, while almost 30% report that none of their admissions are scheduled in advance. For more details see Appendix C, question number 26. When advance scheduling was tested for independence from the type of nursing unit, the chi-square statistic had a p-value of .141. No type of unit appears to schedule in advance more or less than any other type of unit.

With respect to knowing in advance about patients being discharged, respondents were asked if their hospital had a discharge rule. A discharge rule generally requires that the nursing unit be notified by a certain time of the day, such as 11 A.M. or Noon, if a patient is to be discharged from that nursing unit. In theory, a discharge rule, coupled with scheduling admissions in advance, can help reduce some uncertainties about the number of staff needed. Just over 40% of the units reported that their hospitals had discharge rules, and only a quarter of those units reported that the rule was always used. Nearly a quarter of the units with a discharge rule reported that it was never used. For more details see Appendix C, questions number 27 and 28. For those units answering "Yes" or "No" to the discharge rule question, a test of independence of the discharge rule from the type of nursing unit yielded a chi-square statistic with a p-value of .065. For the units in this study, acute care units are in hospitals with a discharge rule less often than expected.

Respondents were asked about what time of day four events were most likely to occur. The events were a scheduled admission, an unscheduled admission, a patient's discharge, and the peak demand for nursing services. More than one time period could be chosen, if two or more were equally likely. Considering the responses of all units, a scheduled admission is most likely to occur between 6 A.M. and Noon (67%), followed closely by Noon to 6 P.M. (61%). An unscheduled admission is most likely to happen between Noon and 6 P.M. (72%), and second most likely between 6 P.M. and Midnight (61%). Patients are most likely to be discharged between Noon and 6 P.M. (70%), and they are almost as likely to be discharged between 6 A.M. and Noon (64%). Peak demand for nursing services is most likely to occur between 6 A.M. and Noon (76%), and second most likely to occur between Noon and 6 P.M. (67%). The responses to these questions were not tested for independence from the type of nursing units, because the respondents could choose more than one time period for their responses. For more details see Appendix C, question number 29.

The number of sources from which patients can be admitted to the unit is one facet of the complexity of the environment in the unit. Nurse managers were asked about the proportion of patients entering their units from the patient's home, the emergency room, surgery, other units in their same hospital, and other nursing care units outside their hospitals. The intent of this question was to indicate whether all patients arriving on the unit came from one place, or from a variety of sources. Percentages of respondents in each category are shown in Figure 3.13. For more details see Appendix C, question number 30.

Similarly, the number of different places to which patients may be discharged is a facet of the complexity of the environment, as different patient destinations may require different procedures and paperwork. Nurse managers were asked the proportion of their patients who were discharged to the patient's home, to another unit in the same hospital, to a nursing care unit outside the hospital, or who died on their unit. Percentages of respondents in each category are shown in the Figure 3.14. For more details see Appendix C, question number 31. See Table D.12 in Appendix D for more details about the statistical tests (ANOVA) of differences between means for types of nursing units.

3.6.1.2 Hypotheses tests Regarding Sources and Destinations of Patients

Analysis of variance was used to test whether responses to questions 30 and 31 differed by type of nursing unit. The test of the hypothesis that the proportion of patients entering the unit directly from the patients home is the same for all four types of nursing units produced an F-statistic with a p-value of .0001 in SN1, and .0087 in SN2. Statistically speaking, it appears as if acute care units have a higher proportion of patients entering their units directly from home, than do units offering critical care only.

The test of the hypothesis that the proportion of patients entering the unit from the emergency room is the same for all four types of nursing units produced an F-statistic with a p-value of .1404 in SN1, and .0003 in SN2. Statistically speaking, evidence suggests that units offering neither acute or critical care have a lower proportion of patients entering their units from emergency rooms, than do units offering acute, critical, or acute and critical care.

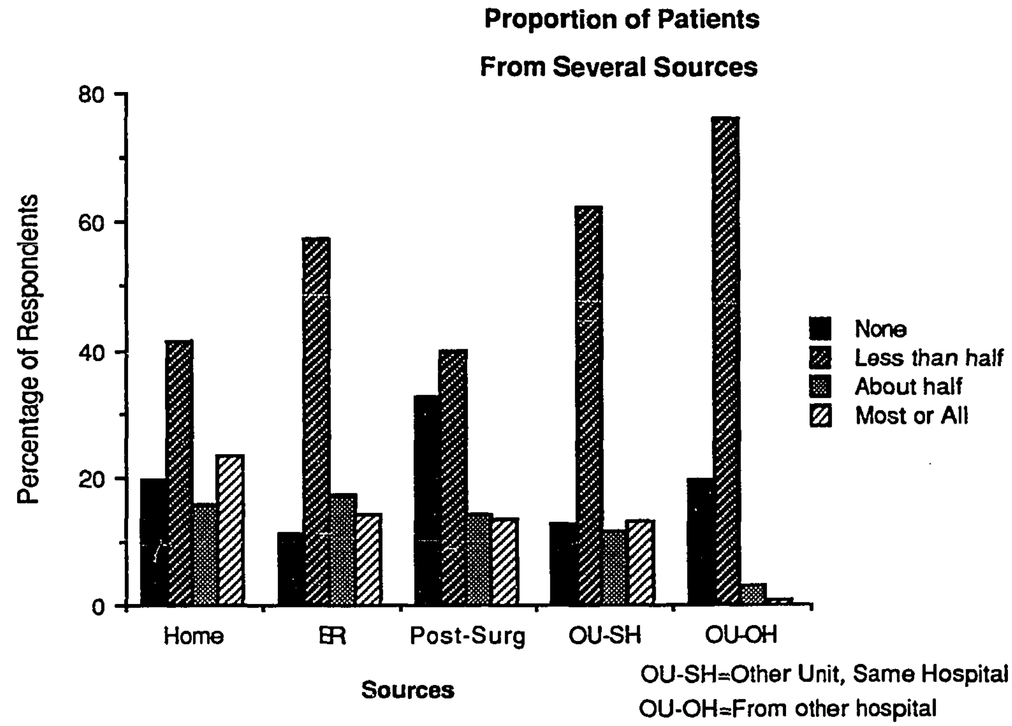


Figure 3.13

Sources of Patient Admissions

The test of the hypothesis that the proportion of patients entering the unit immediately after surgery is the same for all four types of nursing units produced an F-statistic with a p-value of .0155 in SN1, and .0023 in SN2. Statistically speaking, evidence suggests that units offering acute care only or critical only have a higher proportion of patients entering their units immediately after surgery, than do units offering neither acute or critical care and both acute and critical care. This result is not a surprise to an observer of hospital practice.

The tests of the hypotheses that the proportion of patients entering the unit from another unit in the hospital, and from another nursing care unit

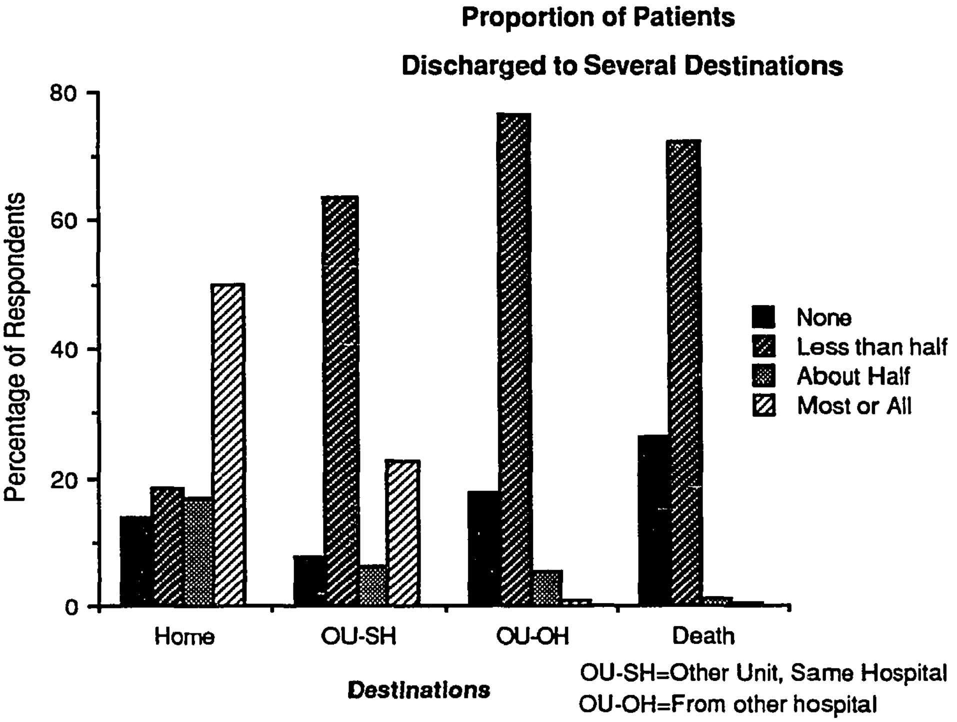


Figure 3.14

Destinations of Discharged Patients

outside the hospital are the same for all four types of nursing units produced F-statistics with higher p-values. These p-values were .1912 in SN1, and .7166 in SN2 for units in the same hospital, and .1714 in SN1 and .2417 in SN2 for nursing units outside the hospital. Statistically speaking, evidence suggests that there is little difference by type of nursing unit in the proportion of patients entering a nursing unit from another nursing unit, whether inside or outside the same hospital.

The test of the hypothesis that the proportion of patients being discharged from the unit directly to the patient's home is the same for all four types of nursing units produced an F-statistic with a p-value of .0001 in SN1, and in SN2. Statistically speaking, evidence suggests that units offering acute care only, or neither acute or critical care discharge more of their patients directly to the patient's home, than do units offering critical care only and both acute and critical care. This result is not unexpected.

The test of the hypothesis that the proportion of patients being discharged from the unit to another unit in the same hospital is the same for all four types of nursing units also produced an F-statistic with a p-value of .0001 in SN1, and in SN2. Statistically speaking, evidence suggests that units offering critical care only discharge more of their patients to other nursing units than do units offering neither acute or critical care, acute care only, or both acute and critical care. This result is not unexpected either.

The test of the hypothesis that the proportion of patients being discharged from the unit directly to a nursing care unit outside the hospital (such as a nursing home, or hospice) is the same for all four types of nursing units produced an F-statistic with a p-value of .0374 in SN1 and .1008 in SN2. There is some statistical indication that units offering only acute care discharge more of their patients to nursing units outside the hospital, than do other types of nursing units.

The test of the hypothesis that the proportion of patients claimed by death is the same for all four types of nursing units produced an F-statistic with a p-value of .0726 in SN1 and .0217 in SN2. There is some statistical indication that units offering critical care only and those units offering both acute and critical care have a higher proportion of patients die while on the unit than do other types of nursing units. This result, while not definitive, is not unexpected either. See Table D.12 in Appendix D for more details about the analysis of variance performed on the variables discussed in this section.

3.6.2 Rating the Extent of Nursing Management Control

Respondents were asked to rate on a seven point scale the extent to which the nursing management of their units had control over a number of items. A rating of "1" meant "No Control," and a rating of "7" meant "Very High Control." For details see Appendix C, Question 35. See Table D.13 in Appendix D for more details about the statistical tests (ANOVA) of differences between means for types of nursing units.

3.6.2.1 Rating of Control over Timing

In general, respondents reported low control over the timing of admissions to their units, with a mean rating of only 2.3. Control over the timing of discharges is also low, with a mean rating of 2.9. Control over timing of peak demand for nursing services is only slightly higher, with a mean of 3.0. Control over timing of personnel from non-nursing units working on the unit received a mean rating of 3.4. The proportion of respondents giving each rating is shown in Figure 3.15.

3.6.2.2 Rating of Control over Numbers

Nurse managers generally responded that they had low control, a mean rating of 2.5, over the number of patients on the unit, but they had high control, a mean rating of 5.2, over the number of nursing staff on duty at any time. In terms of control over the number of personnel from a non-nursing unit working on the

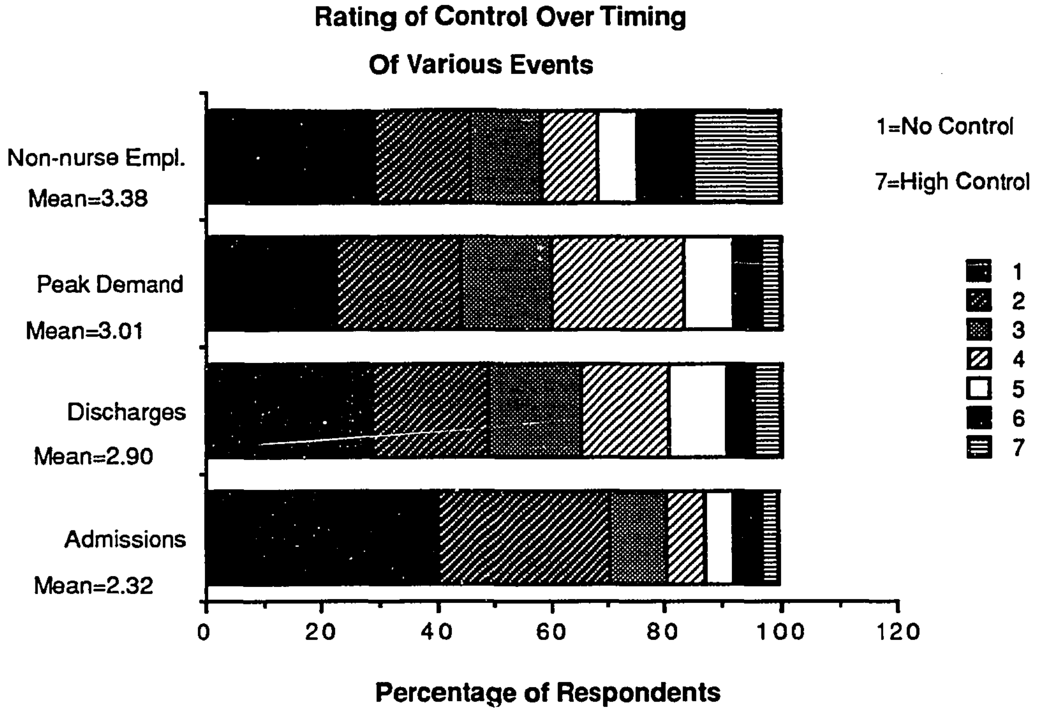


Figure 3.15

Rating of Control of Nursing Management Over Timing of Various Events on the Nursing Unit

unit at any time, the mean rating was the same as the mean rating for control over the timing of personnel from non-nursing units working on the unit, a mean of 3.4. The proportion of respondents giving each rating is shown in Figure 3.16.

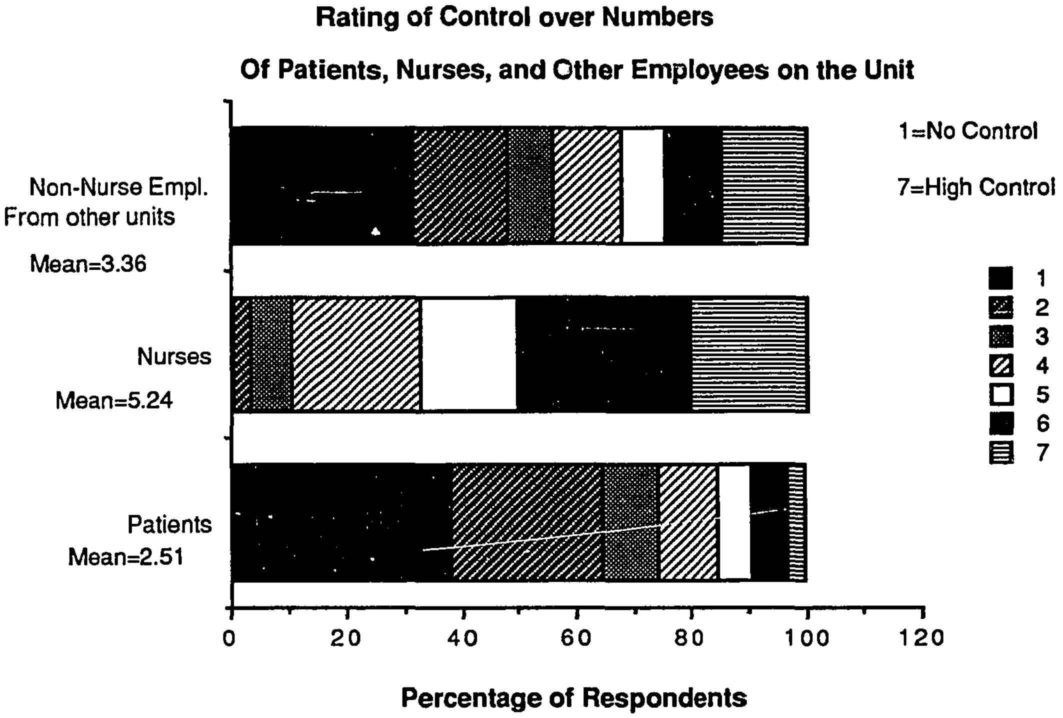


Figure 3.16

Rating of Control of Nursing Management Over Numbers of Patients, Nursing Staff, and Personnel from Non-nursing Units

3.6.2.3 Rating of Control over Determination of Staffing Needs

When asked about control over determination of short term staffing needs, nurse managers responded with a mean rating of 5.1, on a scale of 1 to 7. The mean for the rating of control over determination of long term staffing needs was slightly lower at 4.86. When asked to rate the control they had over matching needed number of nursing staff with the actual number on duty, their mean was 4.8. When rating control of matching budgeted number of nursing staff with the actual number on duty, their mean was 4.5. The proportion of respondents giving each rating is shown in Figure 3.17.

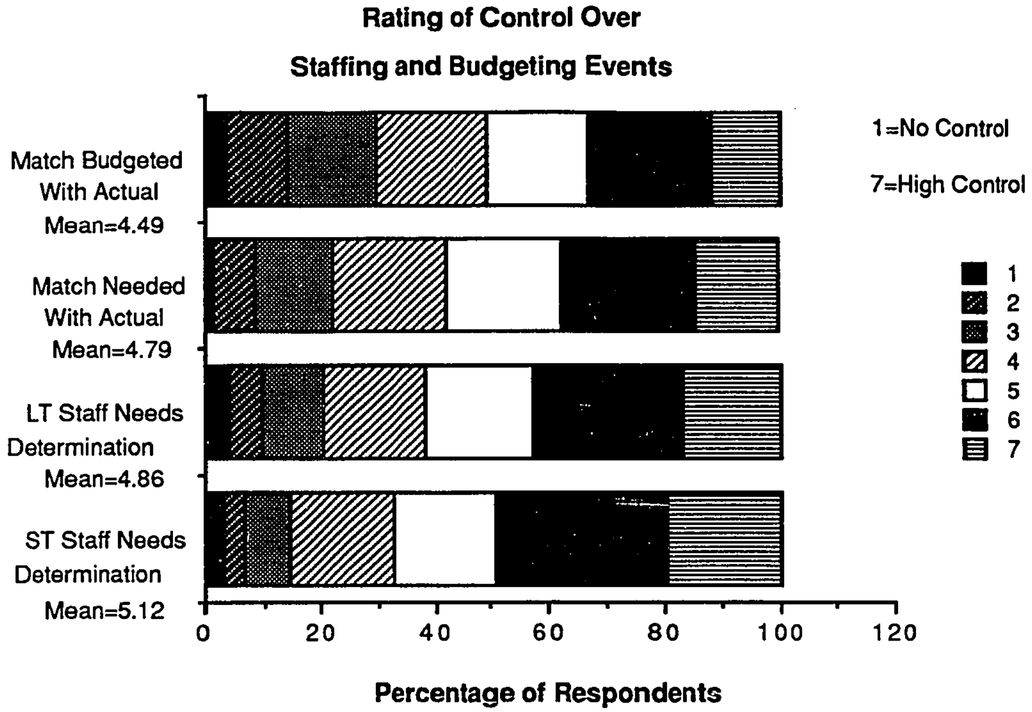


Figure 3.17

Rating of Control of Nursing Management Over Determination of Short and Long Term Staffing Needs and Matching Needed and Budgeted Staff with Actual

3.6.2.4 Hypothesis Tests with Control Ratings

A test of the hypothesis that the mean rating for control over timing of admissions to the unit is the same for all four types of nursing units produced F-statistics with p-values of .1659 in SN1 and .0941 in SN2. A test of the hypothesis that the mean rating for control over timing of discharges of patients from the unit is the same for all four types of nursing units produced F-statistics with p-values of .5205 in SN1 and .0347 in SN2. In SN2, acute care units had a statistically significant lower mean rating than critical care units did, indicating that acute care unit managers may feel they had less control over the timing of discharges, than do critical care unit managers. A test of the hypothesis that the mean rating for control over timing of peak demand for nursing services in the unit is the same for all four types of nursing units produced F-statistics with p-values of .2178 in SN1 and .3608 in SN2. In all likelihood, their control over timing of the demand for peak nursing services does not vary by type of nursing unit. A test of the hypothesis that the mean rating for control over timing of personnel from non-nursing units working on the unit is the same for all four types of nursing units yielded F-statistics with p-values of .3091 in SN1 and .0343 in SN2. In SN2, nursing units offering both acute and critical care appeared to have more control over the presence of non-nursing employees such as therapists, dieticians, lab technicians, and cleaning crews than did units offering acute care only.

A test of the hypothesis that the mean rating for control over the number of patients on the unit is the same for all four types of nursing units produced F-statistics with p-values of .7025 in SN1 and .0122 in SN2, for obviously mixed results. In SN2, units offering only critical care or only acute care have lower mean ratings than the other two types of units. A test of the hypothesis that the mean rating for control over the number of nursing staff on duty at any time is the same for all four types of nursing units yielded F-statistics with p-values of .0694 in SN1 and .0309 in SN2, for one of the few points of agreement between the two samples. Acute care units have a lower mean rating than critical care units do, on this variable. However, all types of units rate this particular area as one over which they have a fair amount of control. F-statistics with p-values of .0474 in SN1 and .1995 in SN2 were the result of a test of the hypothesis that the mean rating for control over number of personnel from non-nursing units working on their nursing units does not differ from unit to unit.

While the statistical significance may differ, one similarity between the two samples was that acute care units had the lowest mean rating of control over this variable, and critical care units had the highest rating of control over this variable, among the four types of units.

For the four remaining control variables, control over determination of short term staffing needs, control over determination of long term staffing needs, control over matching of needed number of nursing staff with the actual number on duty, and control over matching budgeted number of nursing staff with actual number on duty, hypothesis tests yielded F-statistics with p-values of ranging from .1294 to .6661. It is unlikely that, for units in this study, there is a significant difference in mean ratings for any of these variables by type of nursing unit. See Table D.13 in Appendix D for more details about the ANOVA performed on the variables discussed in this section.

3.6.3 Period to Period Variability in Operating Variables

3.6.3.1 A Working Definition of High Variability

One of the reasons for needing a flexible work force is to help cope with variability. Respondents were asked about high variability in operating variables from period to period. An example of what was meant by "high variability" was given on the research instrument. The example was "in a unit of 10 beds, if there are 7 patients on one shift, and 3 on the next, that would be considered high shift-to-shift variability. On the other hand, if the number of patients tends to remain the same for a 24-hour period, but there are 3 patients one day, and 7 on another day in the same week, that would be considered high day-to-day variability." Respondents were asked to check the shortest time period for which their units experience high variability from period to period. For categories that are fairly stable over time, they were asked to check "low variability." Other choices were "shift-to-shift," "day-to-day," "week-to-week," "month-to-month," and "year-to-year." Because there were very few responses in the category "year-to-year," it was combined with the "low variability" category for purposes of analysis. Because the response categories did not represent equal time periods, these variables were treated as categorical, as opposed to continuous. In order to test for possible differences between types of nursing units, chi-square tests of independence were used. For details about the percentage of respondents in each response category, see Appendix C, Question 36.

3.6.3.2 Analysis of Operating Variability

Respondents were asked about eleven different operating variables for which variability may be experienced. Some of the variables dealt with capacity and patients. These variables were total number of patient beds on the unit, total number of patient beds filled, acuity of individual patients, and the total acuity of all patients on the unit. Two of the variables dealt with direct and indirect patient care assignments for the nursing staff. One dealt with timing of peak demand for nursing services. Two others dealt with needed number of nursing staff on duty, and the actual number of nursing staff on duty. The last two concerned the differences between needed and actual nursing care hours, and between budgeted and actual nursing care hours.

The interesting thing about all of these variables was the bipolar nature of the distribution of the responses. In the majority of cases, respondents either choose "shift-to-shift" or "day-to-day," or they choose "low variability." The

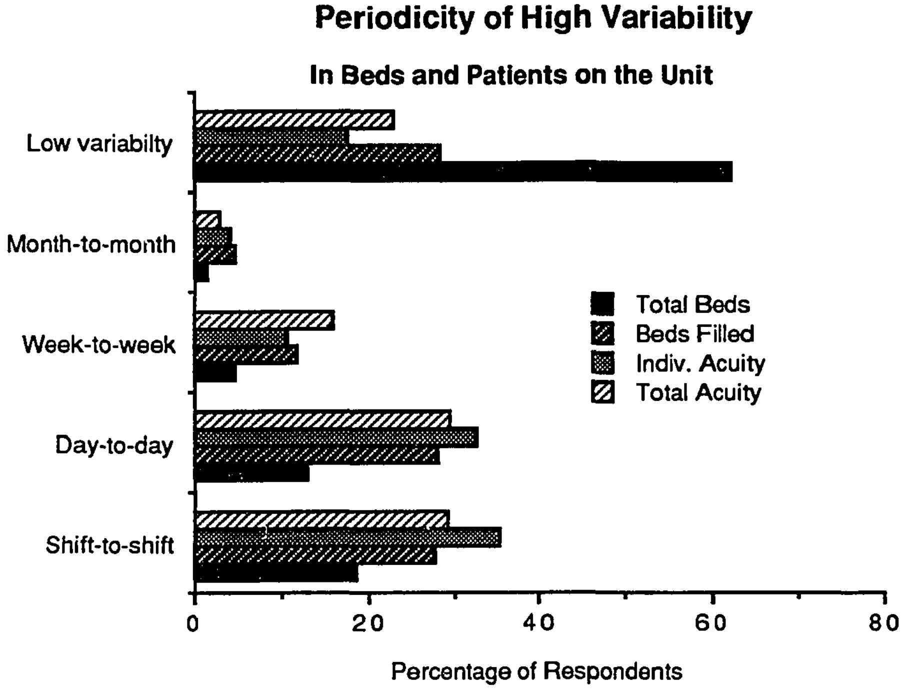


Figure 3.18

Period to Period Variability in Number of Beds and Patient Acuity

proportion of responses in each category for each variable are shown graphically in Figures 3.18, 3.19 and 3.20.

3.6.3.3 Independence of Operating Variability From the Type of Nursing Unit

Chi-square tests of independence were performed on all eleven variables in this section with the hypothesis that the variability of each variable was independent of the type of nursing unit. For the variability of the number of beds on the unit, the χ^2 statistic had a p-value of .179, high enough to accept

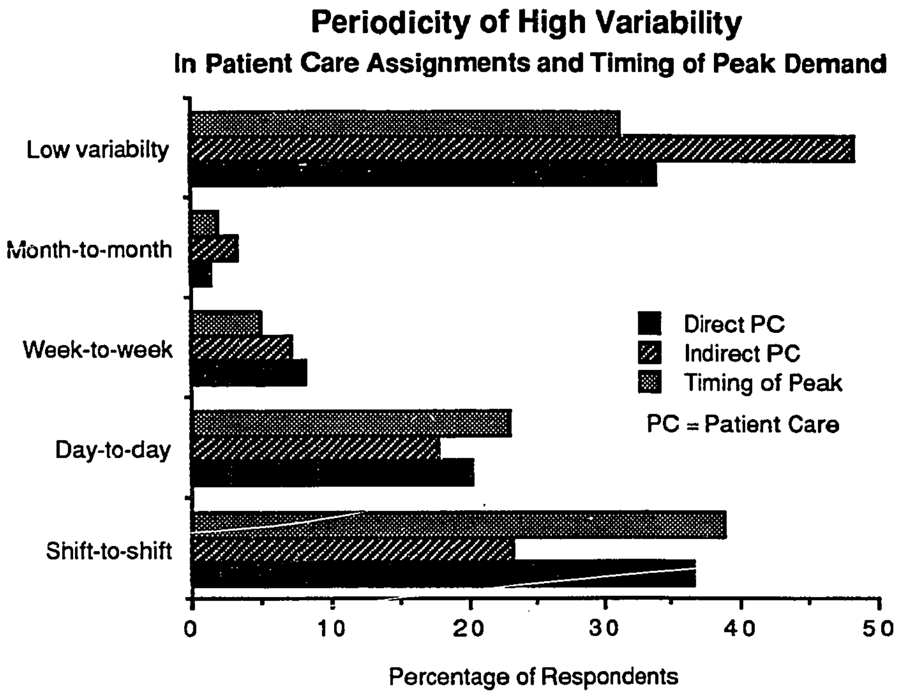


Figure 3.19

Period to Period Variability in Patient Care Assignments and Timing of Peak Demand

the hypothesis of independence of the type of nursing unit. For the variability in the number of beds filled, the χ^2 statistic had a p-value of .022. The high value of χ^2 is attributable to the fact that acute care units had more week-to-week variability than expected, while critical care units, and units offering both acute and critical care had less than expected. Also, units offering both acute and critical care had more shift-to-shift variability than expected in the number of beds filled.

The test of independence of the variability in the acuity of individual patients by type of nursing unit returned a χ^2 statistic with a p-value of .004.

This value was derived largely from acute care units having less shift-to-shift variability than expected, and more day-to-day variability than expected, while critical care units had just the opposite result. In addition, units offering both acute and critical care had more shift-to-shift variability than expected. Variability in the acuity of individual patients does not appear to be independent of the type of nursing unit.

The variability in the total acuity of patients on the units does not appear to be independent of the type of nursing unit either. The χ^2 statistic for this hypothesis test had a p-value of less than .0001. The high value of χ^2 was attributable to acute care units having more responses in the week-to-week variability category, and fewer in the shift-to-shift category, than statistically expected. Units offering acute and critical care, and critical care units had just the opposite situation. In addition, units offering neither acute or critical care had more low variability than statistically expected. These seven cells, out of twenty, contributed 29.27 to the observed χ^2 of 38.16, with 12 degrees of freedom.

Tests of independence of the variability in direct patient care assignments and in the variability in indirect patient care assignments with the type of nursing units yielded χ^2 statistics with p-values of .072, and .273, respectively. It is highly likely that variability in indirect patient care assignments is independent of the type of nursing unit. A test of independence of the variability in the timing of the peak demand for nursing services produced a χ^2 with a p-value of .472, suggesting strongly that variability in timing of peak demand for nursing services is independent of the type of nursing unit.

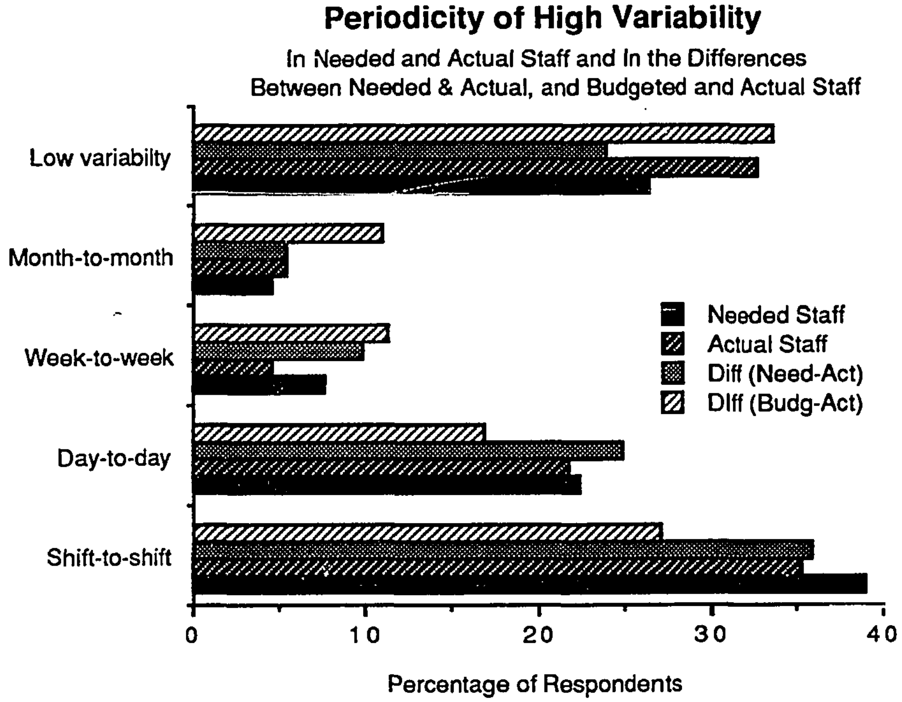


Figure 3.20

Period to Period Variability in Needed Staff, Actual Staff and the Differences Between Needed and Actual Staff and Budgeted and Actual Staff

A test of independence of variability in needed number of nursing staff on duty with type of nursing unit yielded an observed χ^2 of 21.628, with 12 degrees of freedom, and a p-value of .042. However, sparse cells, with a count of less than 5 observations, contributed to about 25% of that value of χ^2 . Another 25% can from the fact that acute care units had more week-to-week variability than statistically expected. Evidence is inconclusive about whether variability in the needed number of nursing staff on duty is independent of the type of nursing unit.

The other three variables, variability in actual number of nurses on duty, and variability in the differences between needed and actual, and between budgeted and actual, when tested for independence of the type of nursing unit, resulted in observed χ^2 values with p-values of .848, .103, and .149. In all likelihood, the values of these three variables are independent of the type of nursing unit.

3.6.4 Information Systems Available in Nursing Units

Nurse managers who responded to the survey instrument were asked about various information systems, computerized and otherwise, available to help in decision making in their units. Figure 3.21 and 3.22 show the proportion of units in the study having various types of information systems available. Virtually all units have a quality assurance system for nursing. Ten percent of the units have a computerized quality assurance system, and over ninety percent of the units have a non-computerized system for quality assurance. This finding is not surprising as accreditation by the Joint Commission on Accreditation of Health Care Organizations requires a quality assurance system. Ninety percent of the units have budget variance reporting systems, and over seventy percent of the units have productivity measurement systems. A computerized patient acuity system is available to 65% of the units, and a non-computerized patient acuity system is available to over 30% of the units. The majority of respondents also have access to patient information systems that provide information about patient admissions, patient accounting data, and xray and lab results. See Appendix C, question 37 for more details.

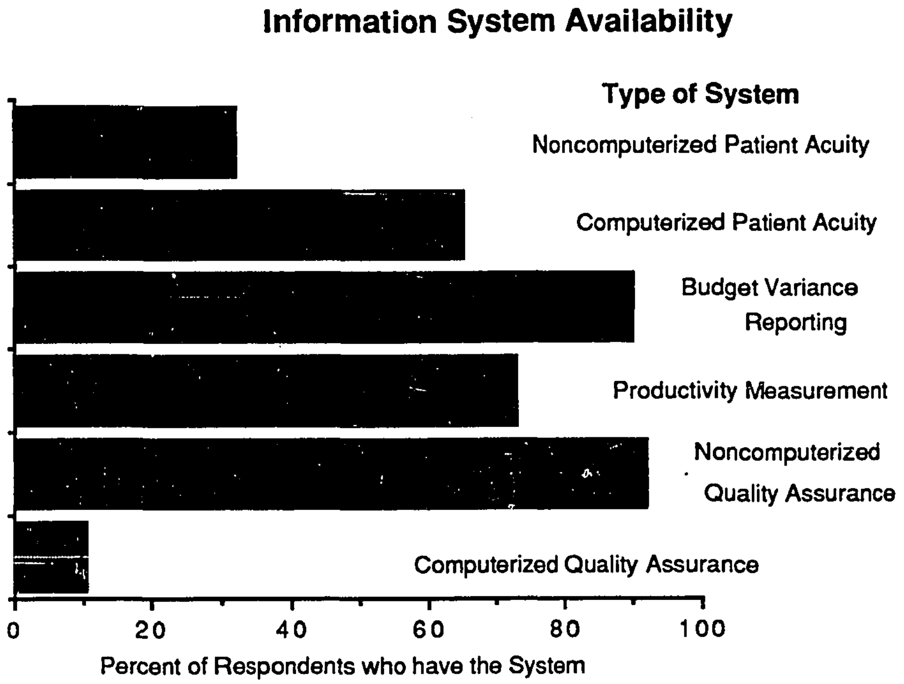


Figure 3.21

Information Systems in Nursing Units

3.7 MANAGEMENT OBJECTIVES IN THE NURSING UNIT

3.7.1 Ratings of the Importance of the Objectives

Nurse managers were asked to rate the importance to themselves, and the importance to top management of several objectives for nursing units. These objectives were developed from the operations management literature, the nursing literature, and from discussions with nurse managers. The objectives covered the areas of cost, work force flexibility, quality, and work force satisfaction. The twenty-one objectives about which respondents were queried are shown by category in Table 3.3.

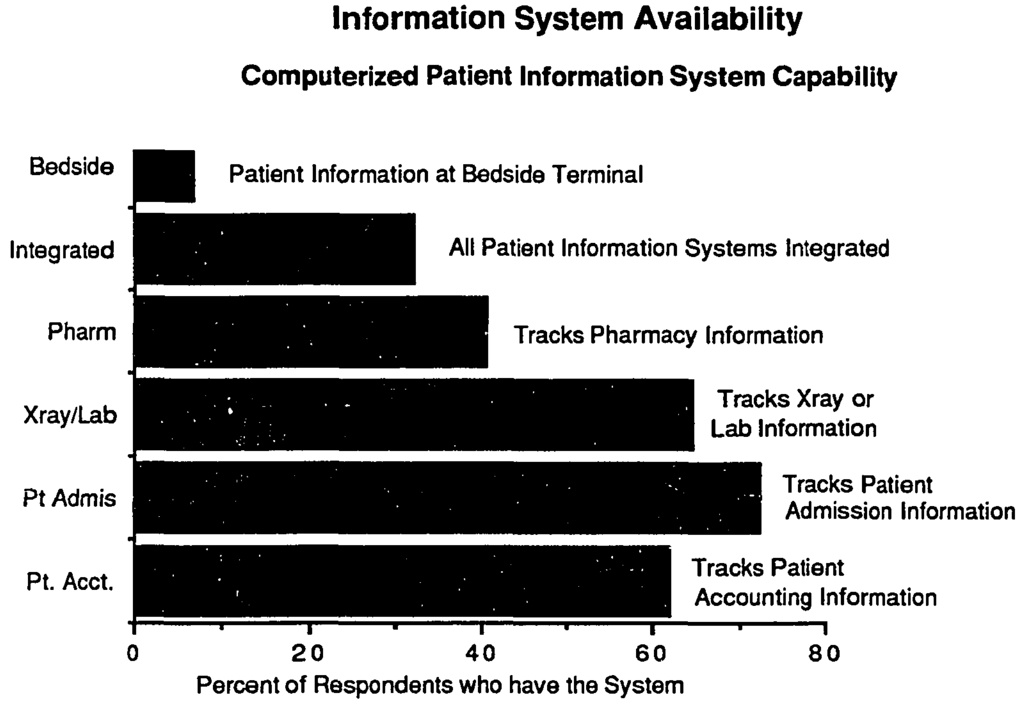


Figure 3.22

Patient Information Systems Used by Nursing Units

Respondents first were asked to rate the importance of these objectives to themselves using one of three ratings. The possible ratings were "No or Slight Importance," "Fair to moderate importance," and "Very high importance." Respondents also were asked to rate their perceptions of the importance of these same objectives to top management in their hospitals. Details of their responses are shown in Appendix C, question 38. Figures 3.23, 3.24, 3.25, and 3.26 show the mean ratings for each group of objectives.

3.7.1.1 Differences in Ratings of the Importance of the Objectives by Management Level

For each objective, a new variable was formed from the difference between respondents' ratings of importance to themselves, and their ratings of the perceived importance to top managers in their hospitals. These new variables were used to test the hypotheses that the ratings of importance were the same. Statistically speaking, the hypothesis being tested for each objective is that the mean difference is zero. This hypothesis is tested using the Student's t-statistic. If this hypothesis is rejected, it means that there is strong statistical evidence that the mean difference is not zero. Hypotheses tests were not done in order to discern the direction of the difference. However, the direction is discernible visually, from the graphs of means in Figures 3.23 through 3.26.

The hypothesis tests for mean differences not equal to zero in ratings of importance of objectives to nurse managers and to top management were performed on both Sample Number one (SN1) and Sample Number two (SN2). Results were remarkably similar for both samples, and are shown in Table D.16 in Appendix D. For the 15 of 21 objectives, the observed value of the Student's t-statistic had a p-value of less than .0001, or less than one chance in one thousand that the result had occurred by chance, in both SN1 and SN2. One objective,having a zero-error rate in dispensing medications, produced an observed t with a p-value of .0004 in SN1 and .0008 in SN2. For this objective, and the 15 others with a star (*) beside them in Table 3.3 the statistical

Table 3.3

Management Objectives for Nursing Units

Objective Number (1)		Description	Major Operations Focus
1	*	Containing costs	COST
2	*	Staying within budget	COST
3		Achieving a certain level of productivity	COST
4		Increasing productivity of nursing staff	COST
5		Utilizing expensive equipment assigned to your unit	COST
6	*	Being able to reduce staff levels quickly	FLEXIBILITY
7	*	Being able to increase staff levels quickly	FLEXIBILITY
8		Being able to offer a variety of nursing services	FLEXIBILITY
9		Being able to offer new nursing services quickly	FLEXIBILITY
10	*	Matching needed staff to actual number on duty	FLEXIBILITY
11	*	Conformance to JCAHO Standards	QUALITY
12	*	Having a zero-error rate in dispensing medicines	QUALITY
13	*	Achieving a certain level of quality of care	QUALITY
14	*	Improving the quality of care	QUALITY
15	*	Responding to patient requests within a certain time period	QUALITY
16	*	Correction of errors within a certain time period	QUALITY
17	*	Assigning equitable workloads to nursing staff	WORK FORCE SATISFACTION
18	*	Having a satisfied nursing staff	WORK FORCE SATISFACTION
19	*	Having a low turnover rate among nursing staff	WORK FORCE SATISFACTION
20	*	Considering nursing staff preference for certain schedules	WORK FORCE SATISFACTION
21	*	Considering nursing staff preference for specific days off	WORK FORCE SATISFACTION

(1) Numbered Arbitrarily

* Indicates an objective for which the rating of the importance to nurse managers differs statistically from the nurse managers' perceptions of the rating of importance to top managers. (p-values less than .001)

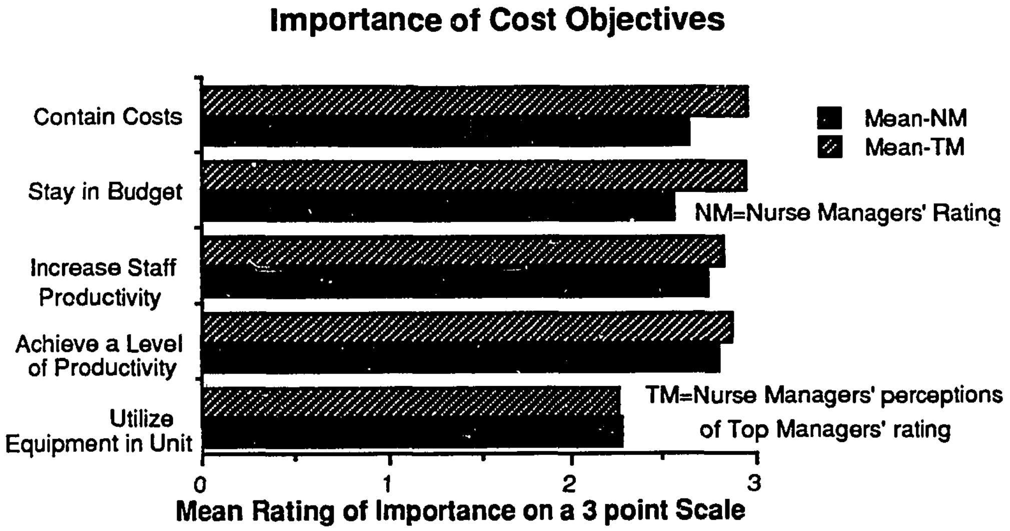


Figure 3.23

Rating of Importance of Cost Objectives

hypothesis of no difference in the rating of importance would be rejected at any significance level less than .001. For those 16 objectives the managerial conclusion could be drawn that nurse managers place a different importance on these objectives than the nurse managers perceive that top management places on these objectives.

For the objective, achieving a certain level of productivity, the observed t-statistics had p-values of .0781 in SN1 and .0553 in SN2. For one objective only, that of increasing productivity of the nursing staff, were results mixed between samples. The difference in importance of increasing productivity yielded a t-statistic with a p-value of .0090 in SN1 and .5018 in SN2. For these two objectives, both related to productivity, it is difficult to make a statistical statement, let alone a managerial one.

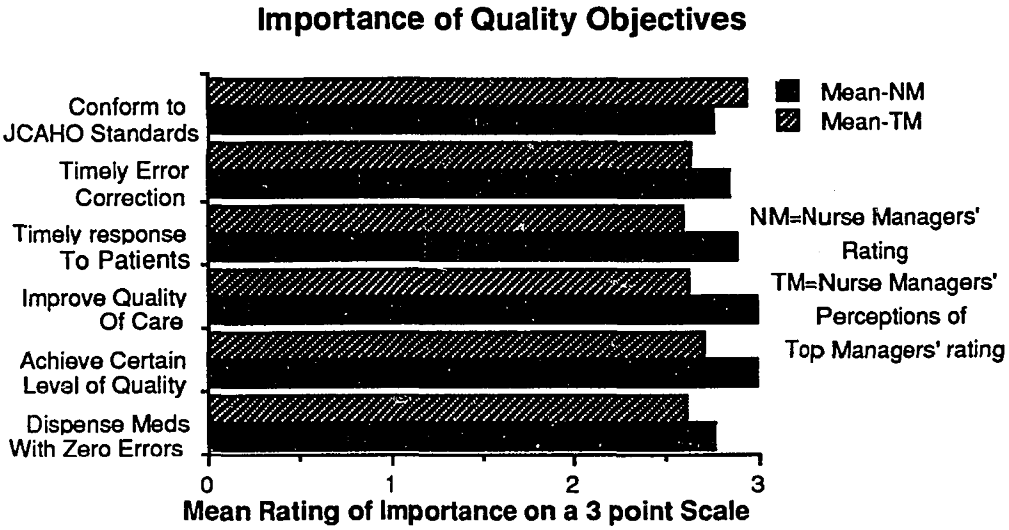


Figure 3.24

Rating of Importance of Quality Objectives

For three objectives the observed t-statistics had p-values close to or greater than 0.5 in both samples. These objectives were being able to offer new nursing services quickly, with p-values of .9233 in SN1 and .9219 in SN2; being able to offer a variety of nursing services, with p-values of .7184 in SN1 and .4985 in SN2; and utilizing expensive equipment in the unit, with p-values of .7336 in SN1, and .9999 in SN2. For these three objectives, the hypotheses of no differences in the importance to nurse managers and top managers are not rejected. Managerially speaking, the conclusion is there are no differences in importance of these three objectives to nurse managers from what they perceive to be the importance to top managers of their hospitals.

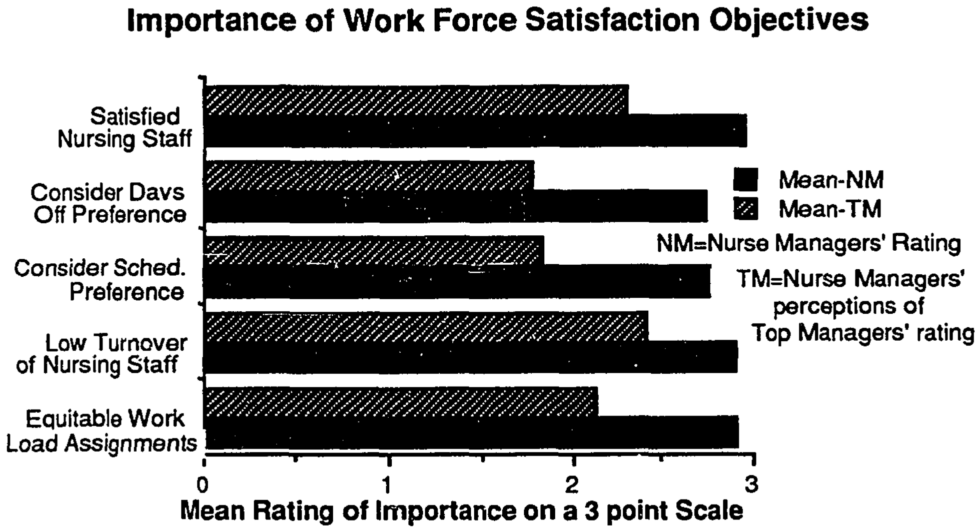


Figure 3.25

Rating of Importance of Work Force Satisfaction Objectives

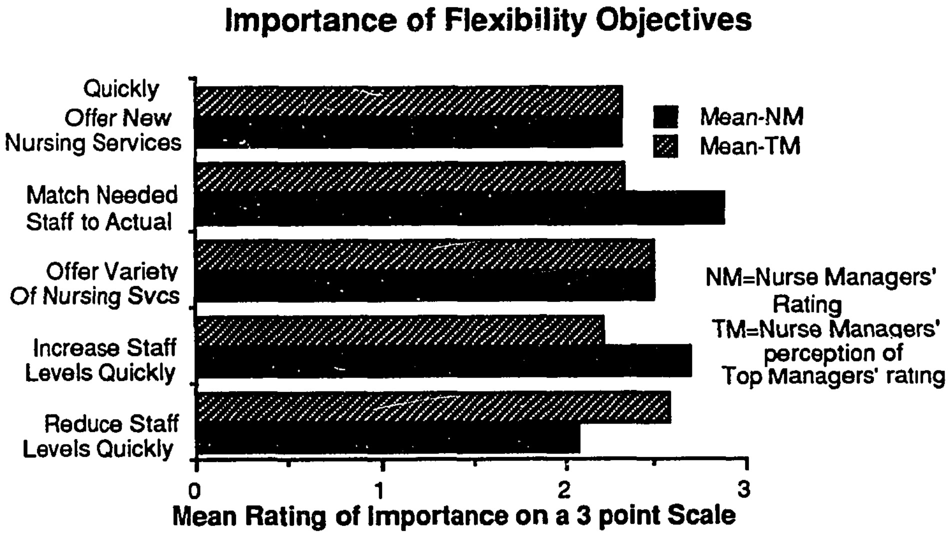


Figure 3.26

Rating of Importance of Resource Flexibility Objectives

3.7.1.2 Differences in Ratings of the Importance of the Objectives by Type of Nursing Unit

Analysis of variance was used to test whether mean ratings of importance of each objective differed by type of nursing unit. For only two objectives was the p-value of the observed F-statistic less than .05 in value. One objective was utilizing expensive equipment in the unit, which yielded an F-statistic with a p-value of .0027 in SN1 and a p-value of .0021 in SN2. Units offering both acute and critical care, and units offering critical care only had higher mean ratings of importance for this objective than other types of units. This result is not surprising, considering the amount of equipment found on these units.

The other objective was conformance to JCAHO (Joint Commission on Accreditation of Health Care Organizations) standards, the test of which produced an F-statistic with a p-value of .0415 in SN1, and .0486 in SN2. Mean responses from all types of units had high mean ratings on this objective, but units offering neither acute or critical care had the highest mean rating, followed closely by units offering both acute and critical care. Detailed results are shown in Table D.14.

3.7.2 Self-Ratings on the Performance of the Objectives

Nurse managers were asked to rate themselves on performance of the 21 objectives in Table 3.3. They were given five choices ranging from "poor," coded for analysis as a "1", to "excellent," coded as a "5." The midpoint of the range was "satisfactory," coded as a "3." Respondents could also choose a rating between satisfactory and excellent, which was coded as a "4," or a rating between poor and satisfactory which was coded as a "2." Respondents also

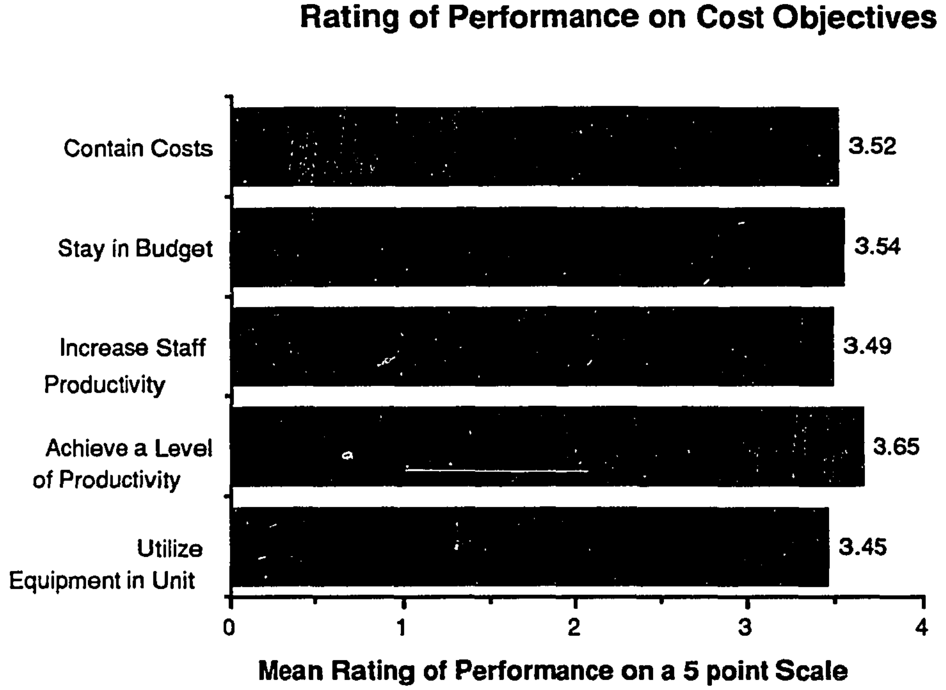


Figure 3.27
Self-Rating of Performance on Cost Objectives

could check that an objective was not applicable to their units. The "not applicable" responses were omitted from analysis. Details of responses are given in Appendix C, question 40. Their mean performance ratings are shown graphically in Figures 3.27, 3.28, 3.29, and 3.30.

3.7.2.1 Differences in Self-Ratings on Performance of the Objectives by Type of Nursing Unit

The hypotheses that there were no differences in performance ratings by type of nursing units were tested using analysis of variance. Detailed results are shown in Table D.15, Appendix D. The results were inconclusive. When

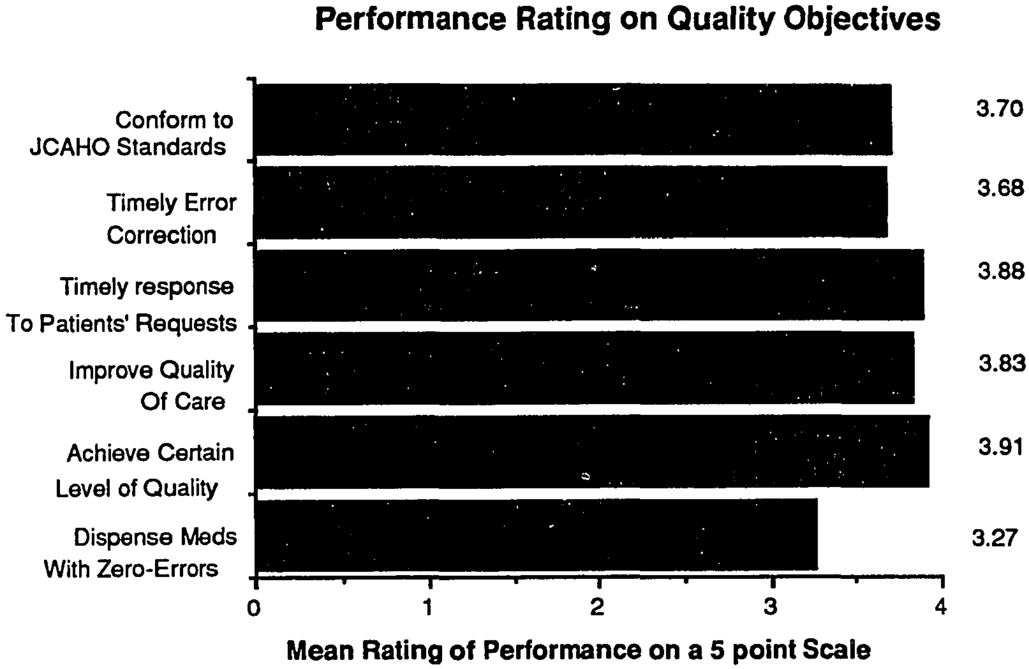


Figure 3.28
Self-Rating of Performance on Quality Objectives

seventeen of the twenty-one objectives were tested in SN1, the p-value of the F-statistic generated by the ANOVA ranged from .27 to .99. For these objectives it would appear there is no statistical or managerial difference in the self-ratings of performance. The other four objectives had p-values of .123 or less, one of which was less than .05. However, when these same hypotheses were tested in SN2, twelve of the hypothesis tests returned F-statistics with p-values of .123 or less, and seven of these F-statistics had p-values of .05 or less. The only objective for which the hypothesis can be firmly rejected in both samples is the hypothesis that there is no difference by type of nursing unit in the mean

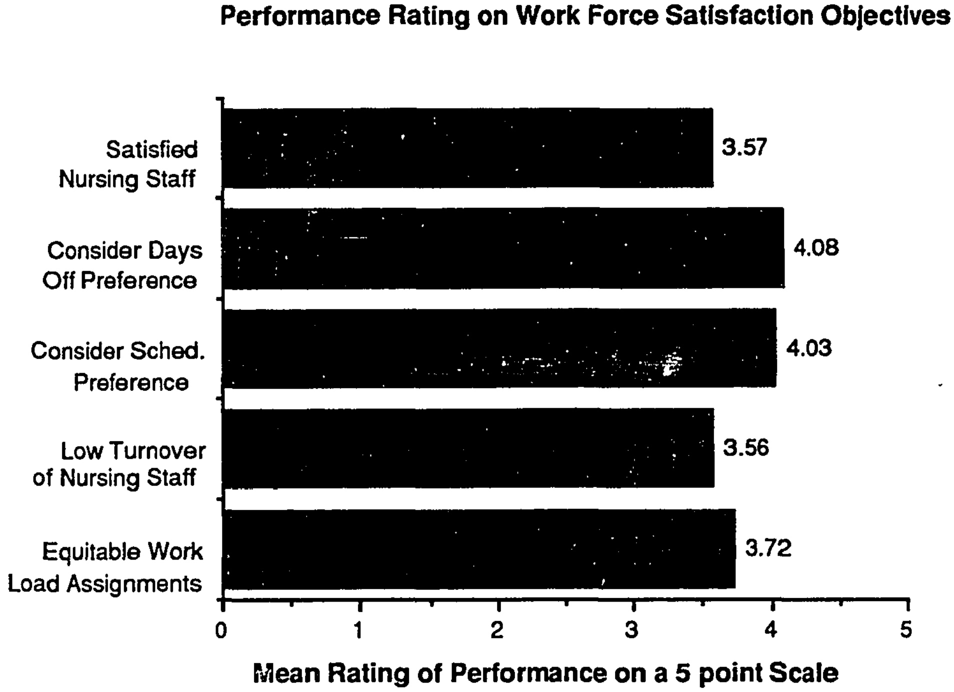


Figure 3.29
Self-Rating of Performance on Work Force Satisfaction Objectives

performance rating for utilizing expensive equipment assigned to the unit. The F-statistic for this test had a p-value of .0058 in SN1, and .0001 in SN2. In both samples, respondents from units offering critical care only rated themselves highest on performance of this objective. This result is not surprising, due to the highly capital intensive nature of critical care units. The other cost objectives whose hypothesis tests yielded F-statistics with p-values of less than .05 in SN2 but not in SN1 were achieving a certain level of productivity (SN2 p-value of .0022), and increasing productivity of the nursing staff (SN2 p-value of .0062), with critical care units having the highest mean in both cases. The flexibility

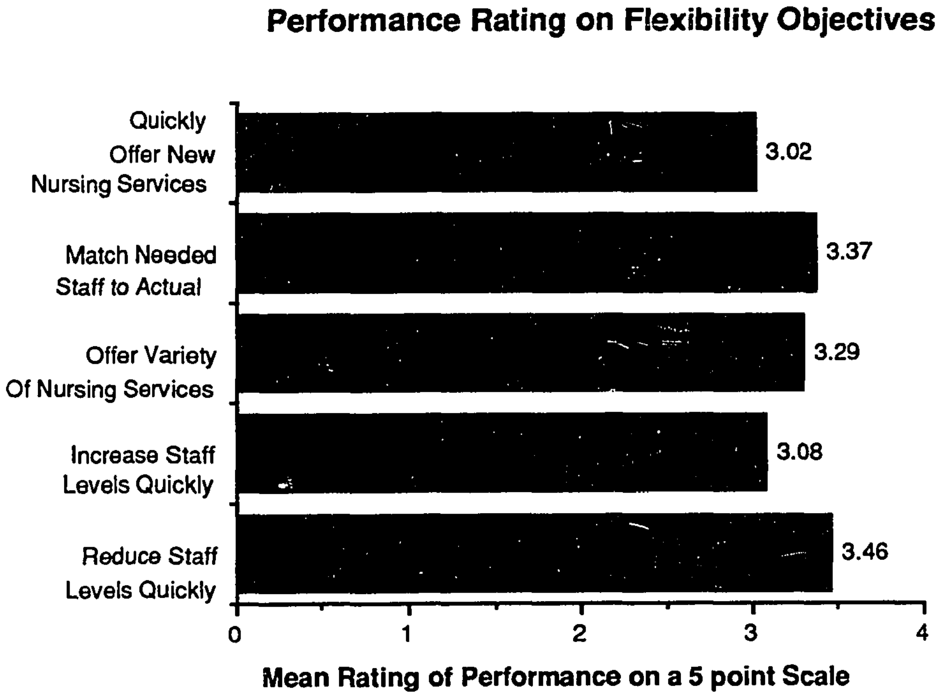


Figure 3.30
Self-Rating of Performance on Resource Flexibility Objectives

objectives whose hypothesis tests yielded F-statistics with p-values of less than .05 in SN2, but not in SN1, were being able to offer a variety of services (SN2 p-value of .0063), with units offering both acute and critical care highest; and matching needed staff to actual number on duty (SN2 p-value of .0151), with critical care units highest. The performance rating on assigning equitable workloads to nursing staff when tested for equal means among units was highest for critical units with a p-value of .0010 for the F-statistic in SN2. Finally, the other objective for which the hypothesis test that the mean performance rating did not differ by type of unit had a low p-value for the F-statistic was having a zero-error rate in dispensing meds (p-values of .0038 in SN2, and .0927 in SN1). The type of units having the highest mean were units offering neither acute or critical care in both samples.

3.8 THE POWER OF HYPOTHESIS TESTS

When testing hypotheses it is possible to err in two ways. One can reject the null hypothesis when it is true, and one can fail to reject the null when it is false. These two errors are customarily referred to as Type I error, and Type II error, respectively. Also by custom, the probability of making a Type I error is referred to as alpha (α), and the probability of making a Type II error is called beta (β). Attention in hypothesis testing frequently centers on the choice for α, as Type I error is often considered more serious. When α is set at .05, the hypothesis tester is stating that 1 chance out of 20 is an acceptable risk of rejecting the null hypothesis when it is actually true. In other words, a spurious rejection of the null hypothesis may occur 5% of the time.

In exploratory research such as this, one is just as interested in the ability to detect a given effect in a population if the effect is present. The probability of rejecting the null hypothesis is called the power of the hypothesis test, and is defined as $(1-\beta)$. Power may be increased by increasing α, or by increasing the sample size n. Also the larger the magnitude of the effect is in the population, or the greater the degree of departure there is from the null hypothesis, the greater the power. Power, α, n, and effect size are so related that when 3 of them are fixed, the fourth is completely determined [Cohen & Cohen, 1983]. As a rule-of-thumb, many researchers consider .80 to be the minimum acceptable value for power. Setting $(1-\beta)=.80$ means there is a 20% change of spuriously accepting the null hypothesis.

In order to estimate the power of the one-way analysis of variance hypothesis tests in this chapter, tables from Cohen and Cohen [1983] are used. The sample sizes in SN1 and SN2 for the tests reported in Appendix D generally ranged from 162 to 174. A few sample sizes were as low as 148, due to the non-applicability of the question to some of the units. Consider an effect size of .3 (a correlation coefficient of .3) with a sample size of 160. For an $\alpha=.05$, the power of the test is .97. That is, there is only a 3% chance of spuriously accepting the null hypothesis. If the effect size drops to .2, for an $\alpha=.05$, the power of the test drops to .72. Now there is a 28% chance of spuriously accepting the null hypothesis. If the sample size drops to 140, with $\alpha=.05$, power equals .95 and .66, for effect sizes of .3 and .2 respectively. That is, for an effect size of .2, there is still a 2/3 probability of detecting it.

For an $\alpha=.01$, a sample size of 160, and an effect size of .3, power is still a respectable .90. The probability that the null hypothesis will be accepted in error is 10%. If effect size drops to .2, power drops to .49. This value indicates that if an effect is present in 20% of the population, the probability of detecting it (49%) is about equal to the probability of not detecting it (51%). If the sample size is only 140, with $\alpha=.01$, power equals .85 and .42, for effect sizes of .3 and .2 respectively. That is, for an effect size of .3, there is still an 85% probability of detecting it, but for an effect size of .2, the chance is poor of detecting it.

It may be concluded that for most of the hypothesis tests performed in this chapter, the power to detect an effect of .3 (a characteristic shared by 30% of the population), is more than adequate; that is, it is 90% or higher. However, the power to detect an effect size of .2 is much lower, and that many effects of size .2 will go undetected due to limitations on the sample size.

3.9 CHAPTER SUMMARY

This chapter has provided an overview of the characteristics the managers, the staff, the patients, the environment, the schedules, and the objectives of the nursing units in this study. This chapter has also provided a look at ways in which four types of nursing units in this study differ statistically.

3.9.1 Summary of the Differences by Type of Nursing Unit

From the statistical analyses of the responses to the survey instrument, one conclusion that can be drawn is that many of the managerially notable differences in types of nursing units also are statistically detectable. There are statistically significant differences for different types of nursing units in the characteristics of the patients with respect to use of monitors, respirators, IVs, catheters and assistance needed in eating. There are statistically significant differences in average patient acuity, and use of new technology, special equipment, and computer technology for different types of nursing units. Differences by type of nursing unit in the total value of equipment, and value of equipment per patient, and per nursing staff member are detectable statistically. Differences by type of unit in the number of nursing staff per patient, and of the variety of treatment from patient to patient are statistically discernable.

There are strong indications that the average length of stay, and the longest length of stay are statistically different by type of nursing unit. The number of beds on the unit, the average patient census, and the lowest daily admissions also are statistically different by type of nursing unit. The average length of stay correlates quite highly with the longest length of stay, and the shortest length of stay. The average length of stay has a strong negative correlation with the average number of daily admissions. The average number of daily admissions correlates strongly with the highest and lowest numbers of daily admissions, and with the average, highest, and lowest patent censuses. The number of beds on the unit correlates strongly with the average patient census.

The proportion of time spent in direct nursing care by RN staff members is statistically different by type of nursing unit. The proportion and the number of nursing staff members that are RNs, LPNs, and nurse assistants are statistically different by type of nursing unit. The need for unit orientation also shows a difference by type of nursing unit. Pay rates, nursing staff turnover rate, use of pool nurses from inside the hospital, and use of temporary employees do not show a statistical difference by type of nursing unit. Ease of scheduling, ease of making shift adjustments, and ease of finding enough staff for any given shift do not seem to vary statistically by type of nursing unit. When short term adjustments are made in order to match needed staff to actual staff, frequencies of actions taken do not vary with statistical significance, except for the use of nurses from other units.

There are statistical differences by type of unit in the proportion of patients entering the unit from the patient's current residence, and immediately after surgery. There are statistical differences by type of unit in the proportion of patients leaving the unit to return to the patient's current residence, and to another unit in the hospital.

There do not appear to be statistically significant differences by type of nursing unit in control over timing of admission, discharges, peak demand or timing of non-nursing personnel working on the unit. There do not appear to be statistically significant differences by type of nursing unit in control over numbers of patients on the units, number of nursing staff on duty at any time, and numbers of personnel from non-nursing units working on the unit. There appears to be very high control over determination of short and long term nursing staff needs, and matching needed and budgeted nursing staff to the actual number on duty, but there is not a statistically significant difference by type of nursing unit.

The shortest time period for which high variability occurs appears to differ statistically by type of nursing unit for the number of beds filled, the acuity of individual patients, and the total acuity of all patients on the units. The shortest time period for which high variability occurs does not appear to differ statistically by type of nursing unit for the total number of beds in the unit, direct and indirect patient care assignments for the nursing staff, timing of peak demand, the actual number of nurses on duty, and the differences between needed and actual nursing care hours, and between budgeted and actual nursing care hours.

The importance of objectives does not appear to differ statistically by type of nursing unit, except for the objective of utilizing expensive equipment in the unit, which is given more importance by nurse manager of units offering both acute and critical care, and of units offering critical care only. The only other objective with a statistical difference in the importance rating by type of nursing unit is the objective of conformance to JCAHO standards. Nurse managers of all types of units gave this objective very high ratings, but they were highest in units offering both acute and critical care, and neither acute or critical care.

only mean performance rating which differed by type of nursing unit was the performance on the objective of utilizing expensive equipment in the unit. Nurse managers of units offering both acute and critical care, and of units offering critical care only gave themselves higher rating on this objective than did managers of other types of units.

CHAPTER IV

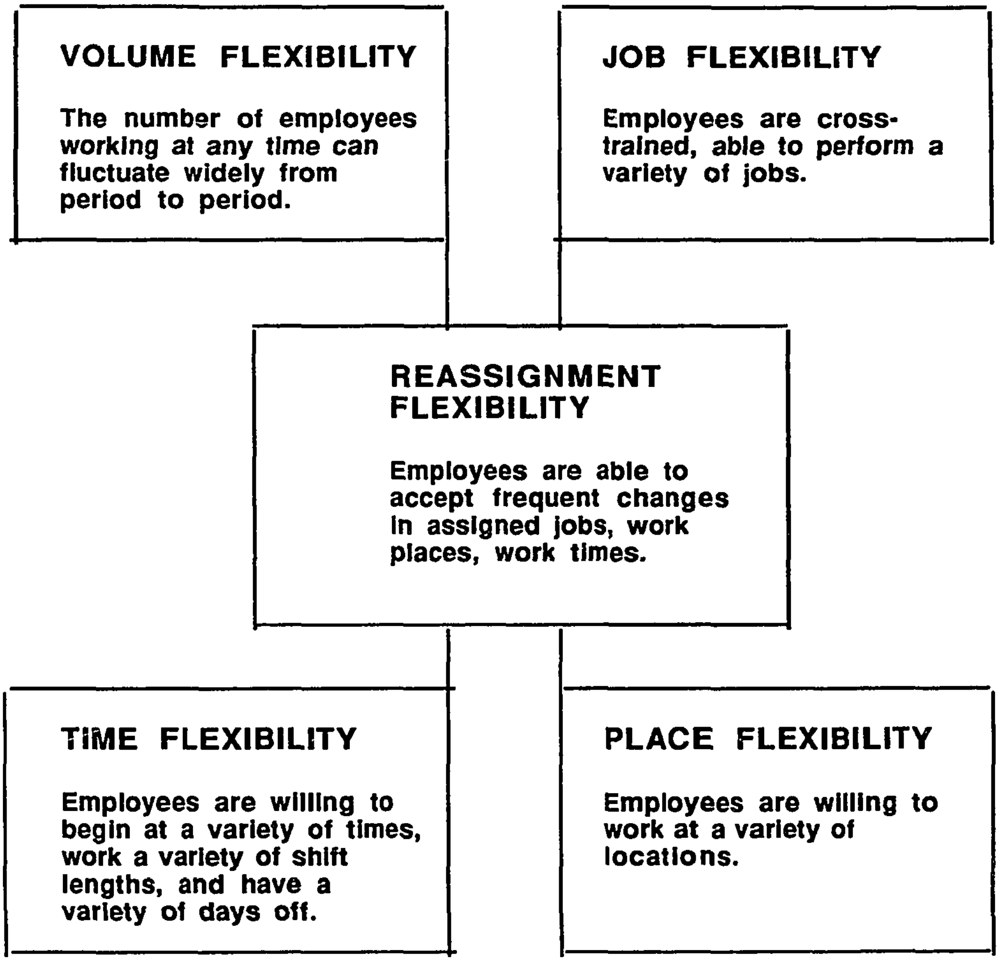
MEASUREMENT OF STAFFING AND SCHEDULING FLEXIBILITY

4.1 INTRODUCTION

In Chapter I, the importance of the selection and utilization of the work force in successful service sector operations is discussed. Most of the customers' demands must be served in the presence of the customer, and the nature and timing of customers' demands cannot always be accurately predicted in advance. If members of a service organization's work force are available who are capable of providing the services demanded on a timely basis, the service organization's ability to achieve its objectives should be enhanced.

Staffing and scheduling flexibility, as it is viewed in this research, is defined, discussed, and illustrated in Chapter I, in Figures 1.1, 1.2, and 1.3. The premise of this researcher is that as service organizations operate more hours, offer more services, and face more uneven and uncertain demand for services, the more they need a flexible work force. Staffing and scheduling flexibility is viewed, a priori, in this research as having five facets. These facets are illustrated in Figure 1.3, and repeated, in a slightly different format in Figure 4.1.

FIVE FACETS OF STAFFING AND SCHEDULING FLEXIBILITY



VOLUME FLEXIBILITY

The number of employees working at any time can fluctuate widely from period to period.

JOB FLEXIBILITY

Employees are cross-trained, able to perform a variety of jobs.

REASSIGNMENT FLEXIBILITY

Employees are able to accept frequent changes in assigned jobs, work places, work times.

TIME FLEXIBILITY

Employees are willing to begin at a variety of times, work a variety of shift lengths, and have a variety of days off.

PLACE FLEXIBILITY

Employees are willing to work at a variety of locations.

Figure 4.1

Five Facets of Staffing and Scheduling Flexibility

These five facets of staffing and scheduling flexibility, job flexibility, time flexibility, place flexibility, volume flexibility and reassignment flexibility, together or separately, allow the work force in a service organization to perform the buffering role that inventory traditionally played in a manufacturing environment. It should be noted here that as manufacturers apply techniques to reduce inventory, they, too, call on their work forces to be more flexible, but that is a topic for future research, and will be discussed briefly in Chapter VI.

This chapter is concerned with how to measure staffing and scheduling flexibility, as it has been defined in this study. This chapter is also concerned with the relationships between the flexibility measures and other characteristics of operations such as degrees of technology, capital intensity, and variability in the work place, and the size of the operating unit. Also of concern are relationships between measures of staffing and scheduling flexibility and the importance of certain operating objectives to the first-line manager. Finally, relationships are investigated between the flexibility measures and performance ratings of the first-line manager in achieving these operating objectives.

As discussed in Chapter I, hospital nurse staffing and scheduling operations have been chosen as a starting point for investigating staffing and scheduling flexibility. Data collected from 348 nursing unit managers in thirty-one hospitals have been analyzed in an attempt to establish baseline measures for staffing and scheduling flexibility, and to determine the relationship of staffing and scheduling flexibility to other environmental and managerial influences on operations. The focus of this study is on the individual nursing unit. Two data sets, each containing data from 174 respondents, were randomly created before the data were analyzed. This process is described in

Chapter I. The two data sets are referred to as Sample Number One (SN1) and Sample Number Two (SN2). The first sample (SN1) was used for development of the measures. The second sample (SN2) was used to confirm or fail to confirm the results in the first sample. In general, potential measures of staffing and scheduling flexibility were retained only when there was statistical agreement between the two sets. Exceptions made on theoretical bases are so noted in the discussion that follows. Once the staffing and scheduling flexibility measures were established, analyses using the measures were performed on other variables in SN1, and verified, or not, as the case may be, on variables in SN2. Results are presented in this chapter.

4.2 ANALYTIC PROCEDURES

For the five types of flexibility, five non-overlapping sets of variables initially were established. Each set contained possible candidates for compilation into a smaller set of variables that could be used as a measure of one of the types of flexibility. These initial sets of variables are shown in Table D.17, Appendix D. The sets of variables were analyzed with the objective of finding a small set of variables that could be used to measure each kind of flexibility. The steps taken in this analysis are described below. Table D.18, Appendix D contains the original list of variables from all five sets in numerical order, and indicates the disposition made of each variable originally under consideration. In the following sections is a discussion of the analytical techniques that led to reduction of the original list.

4.2.1 Creation of New Variables

Before these analyses were performed, a new set of variables was created from the responses to question 21, which originally had 42 parts (variables XA2101 through XB2121) . Question 21 on the survey instrument dealt with the frequency with which certain staffing actions were taken in the event of a mismatch of needed personnel with available personnel. For each action given, the respondents were to give the frequency with which the action was taken, both when the mismatch was of a short duration, and when the mismatch was of a longer duration. See Appendix A for the format of the question, and see Appendix C for the summary responses to the question. There were very high correlations between the responses for short and long term durations for each action. However the range of responses was limited to three choices for each action for each type of duration of mismatch. Twenty-one new variables were created which were the sums of the responses, for each action, for the short and long durations of mismatch. These new variables could take on five values. The summed variables correlated very highly ($r \geq .90$, in most cases) with the original variables for short and long durations, as would be expected when linear combination are formed.

The responses to the variables in question 4 (X401 through X412) represented number ranges of unequal widths, so the variables were ordinal. Factor analysis, one of the statistical techniques applied to the data in the exploration for measures of flexibility, works best with variables that are measured on interval or ratio scales. Therefore new variables were created by rescaling the responses to the variables in question 4 to represent the midpoints of the ranges. These new variables may be treated as continuous, for analysis purposes. Each of the newly created variables showed the same correlation pattern with other newly created variables from question 4 that had been exhibited by the original variables.

More variables were created by rescaling the responses to questions 10, 11, and 16 because the original responses to these questions represented uneven ranges of values. The responses were rescaled to the mid-points of the ranges for each response, thus creating variables with an interval measure, instead of categorical ones.

4.2.2 Initial Sets of Variables Chosen to Represent Flexibility

One problem that was encountered in classifying variables into representatives of each of the types of flexibility is that some variables clearly represent staffing and scheduling flexibility, but they do not clearly represent a single kind of flexibility. An example is the use of an in-house pool of nursing staff. Existence of such a pool is an indication of staffing and scheduling flexibility, but it may represent volume flexibility, place flexibility, job flexibility, time flexibility or reassignment flexibility. A pool of nurses who are employees of the hospital may only work when needed, so the presence of an in-house pool may well indicate volume flexibility for the units that use them, and for the entire hospital. Members of the pool usually are not assigned to a specific unit, which would indicate place flexibility. Some of the pool members may be able to perform a variety of nursing tasks in different types of units, which would indicate job flexibility. Other members of the pool might not be assigned to a specific time period, which would indicate time flexibility. Some members of the pool might be willing to be reassigned often, to new units, to new time slots, or to new types of work, which would indicate reassignment flexibility.

Without knowing the mechanism for utilizing a pool of nurses within a particular hospital (a topic for future research), it is difficult to say exactly which flexibilities are allowed by the pool. However, this researcher reasoned that a pool of nurses would always give volume flexibility to an individual unit; that is, a nurse manager could call upon members of the pool when the regular staff of the unit could not meet the demand for nursing services. However, members of an in-house pool almost surely have, by definition, the attribute of place flexibility, or the ability to work in many different places. This particular dilemma initially was solved somewhat arbitrarily by placing X1409, the proportion of nursing staff who are from other units or an in-house pool, and X2104, the frequency of use of hospital "pool" nurses when matching needed to actual, in the set of variables for place flexibility. The variable X1507, the rating of use of in-house pool nurses, was placed in the set of variables representing volume flexibility. As analyses proceeded, the variable X1409 was removed from place flexibility, and the variable X1507 was removed from volume flexibility, due to low correlation with other variables. X2104 was subsequently used as a part of the measure of volume flexibility. This discussion is included to demonstrate the exploratory nature of this research.

Also, this researcher had prior expectations of interactions between the five types of flexibility, as they have been defined herein, and, in fact, would have been quite surprised if such interactions did not exist. Some correlations were found between the different type of flexibility measures developed in this chapter, and are reported in a later section. As stated in Chapter II, it is quite possible that none of the hypothesized flexibilities appear separately, which complicates the measurement process.

4.2.3 Statistical Techniques Used to Analyze Flexibility Measures

4.2.3.1 Correlation Analysis

The first step taken in determining which members of these initial sets to use as representatives of the various flexibilities was to inspect correlations between the variables within each set. (See Table 1.4, and Section 1.5.3.2 for a discussion of appropriate correlations.) This inspection led to several paths of inquiry, the elimination of those variables which did not seem to be related to anything else, and the re-categorization of some variables into other sets. These correlational analyses were examined in a search for variables which correlated significantly with each other in both samples.

Statistical tables showing the results of the correlational analyses for both samples are available to the interested reader. Statistical tables showing the results of several factor analyses also are available. Table D.19 in Appendix D contains a full listing of available tables, and the address through which they may be obtained.

4.2.3.2 Common Factor Analysis

The second step was to perform a series of factor analyses on the remaining variables in each set. In general, these two steps led to a refinement of the sets of variables, and greatly reduced the number of variables involved in the measurement of each type of flexibility.

Factor analysis was chosen as a statistical technique to use because it helps one seek out patterned variation between variables. Factor analysis assumes that the observed variables are linear combinations of some underlying, but unobservable variables, which are called factors. Some of the factors are assumed to be common to two or more variables, and are called common factors, and some are assumed to be unique to each variable. By definition, the unique variables are not related to each other [Rummel, 1970; Kim and Mueller, 1978].

Consider the data matrix, in which rows represent individual subjects and columns represent each variable. In this case, the rows are hospital nursing units and the columns are questions in the survey instrument. The entries in the body of the data matrix are the values of the responses to the questions, made by each individual nursing unit manager. In factor analysis, the column vectors of the data matrix form a vector space. The position of a column vector in this space is determined by its values for each row. Each row may be thought of as a coordinate axis for this vector space. Vectors that are statistically interdependent will cluster together in this space, and may be thought of as forming the common factors. Factor analysis determines the minimum number of independent coordinate axes necessary to plot or reproduce the variation in vectors in the space. Each common factor forms one dimension. The dimensions may be interpreted as measures of the amount of ordered or patterned variation in data [Rummel, 1970; Kim and Mueller, 1978].

One of the problems with the use of factor analysis is the initial estimation of the proportion of the variance in the observed variables that is accounted for by the various common factors. In order to determine the unobserved common factors exactly, one first must know the proportion of the variance in the observed variables that is accounted for by these common factors. However, this proportion of variance, called the "communality" of each variable with the common factors, cannot be known until the "factor loadings" are known. The factor loadings are the weights measuring the variance contribution of each factor to each data vector. If the factor loadings were known, there would be no need to perform factor analysis. Thus a problem of circularity exists. A common solution technique is to start with an initial estimate of the communalities of each variable with the final factors, then find the loadings that result from these communalities. These loadings in turn produce a new set of communalities. If the initial set of communalities and the new set are virtually the same, the problem is considered solved. Otherwise, the new communalities are used as estimates of the final ones, and another set of loadings is determined, which, in turn, produces another set of communalities. This iterative process is repeated until agreement between the communalities output by two consecutive iterations shows very little change. In the SAS program [SAS, Version 5.18, 1985C] used by this researcher, "very little change" meant a change less than .001 in the communality of any one variable.

Two factoring methods were used: the unweighted least squares (ULS) method, and the maximum likelihood estimation (ML) method. Both have the objective of finding the factor solution that best fits the observed correlations. The ULS method examines the squared differences between the correlations produced under the model and the observed correlations, and iterates until these squared differences are at a minimum. An assumption must be made that K factors, with K less than the number of variables, are responsible for the observed correlations. In an exploratory factor analysis, such as this study, the researcher may start with K=1 factors, and add factors until a satisfactory solution, both in terms of statistics and theory, is reached. No assumption needs to be made about the distribution of the variables under consideration.

The method of maximum likelihood tries to find the underlying population parameters that would have the greatest likelihood of producing the observed correlation matrix. The disadvantage of the ML method is that multivariate normality of the variables is assumed. However, if the assumption of multivariate normality holds, inferences may be made about the population parameters, and several statistical tests are available for testing whether the number of factors are adequate.

The use of factor analysis involves two major indeterminacies. One of those is the problem of initial estimates for the prior communalities, which is discussed above. The second major indeterminacy is the number of common factors in the final model. Much guidance is given in the factor analysis literature [Rummel, 1970; Tucker and Lewis, 1973; Harmon, 1976; Kim and Mueller, 1978]. In the final analysis the researcher is best guided by the principle of parsimony and the reasonableness of the solution.

Factor analysis was quite useful in determining variables to use for volume and time flexibilities, because each of these flexibilities had many members in the initial set of variables thought to contribute to their measurement. Very simple measures are ultimately proposed for place flexibility and reassignment flexibility, but factor analysis also was useful in eliminating variables from the initial sets for these variables.

4.2.3.3 Power of the Statistical Tests

A note is appropriate at this point on the significance and the power of the correlational coefficient, known as the product moment r. The product moment correlational coefficient is the standard measure of linear relationship between two variables. It has the advantage of being a pure number, independent of units of measure. Its value varies from -1 to +1; thus, its absolute value gives the degree of relationship, and its sign indicates the direction of the relationship. For more about the product moment r, the reader is referred to Cohen and Cohen [1983]. The correlational coefficient may also be derived from the r^2 term, the coefficient of variance in an analysis of variance or a linear regression model. Other measures of correlation are discussed in Chapter I, section 1.4.3.2. Table 1.4 shows what correlational coefficients are appropriate under a variety of circumstances.

Statistical power has been discussed in section 3.8. Part of that section is reiterated here. The reader is referred to that section for a brief review of concepts of Type I error and Type II error. In exploratory research such as this, one is interested not only in the probability of rejecting the null hypothesis when it is true (α), but one is interested in the probability of failing to reject the null when it is false (β). The probability of rejecting the null hypothesis is called the power of the hypothesis test, and is defined as ($1-\beta$), and may be thought of as the ability to detect an effect if the effect is present. Power, α, the sample size n, and effect size are so related that when three of them are fixed, the fourth is completely determined [Cohen & Cohen, 1983]. As a rule-of-thumb, many researchers consider .80 to be the minimum acceptable value for power. Setting $(1-\beta)=.80$ means there is a 20% chance of spuriously accepting the null hypothesis.

In order to estimate the power of hypothesis tests of the significance of the product moment r (that is, is r different from zero?), tables from Cohen [1969] are used. The sample sizes in SN1 and SN2 for the flexibility measures developed here ranged from 142 to 174, though most were above 160. Cohen [1969] states "the state of development of much of behavioral science is such that not very much variance in the dependent variable is predictable." The same could be said about empirical research in operations management today.

Cohen [1969] makes this point prior to defining a "small," "medium," and "large" correlational effect (r) as .1, .3, and .5 respectively. These values of r translate to r^2 values of .01, .09, and .25, where r^2 is the proportion of variance in either of the two variables being correlated that may be accounted for by the variance of the other. An r^2=.01 may seem to be very small, but Cohen [1969] says it is not that unusual in the social sciences, and gives several examples of studies in which an r^2=.01 is indeed a significant proportion of variance accounted for. See Table 4.1 for the power of the test of significance of r for sample sizes of n ≥ 140, for four different effect sizes (values of r) and four different choices of α. As n gets closer to 174, the power increases slightly from the values shown in the table. For more information on statistical power, see Cohen [1969].

Table 4.1

Statistical Power for Hypothesis Tests of the Significance of the Correlational Coefficient

n≥140

Effect Size	α = .01	.025	.05	.10
.10	.12	.22	.32	.46
.20	.52	.66	.77	.86
.30	.90	.95	.98	.99
.40	.995+	.995+	.995+	.995+

For this study, the statistical power is such that a large effect, an r = .5 or more, will almost certainly be detected for any usual value of α. For a medium effect, an r = .3, there is also a very good chance that such an effect will be detected for an $\alpha = .01$, and an excellent chance of detecting such an effect for an $\alpha \geq .05$. For a effect of r = .2, and $\alpha = .10$, the power of the test is .86, or a 14% chance of spuriously accepting the null hypothesis. However, for a small effect, r = .1, there is a very poor chance of detecting an effect, regardless of the value of α. For $\alpha = .10$ the probability of spuriously rejecting the null hypothesis is greater than 50%. Therefore, a small effect almost surely will not be detected. For power of analysis of variance tests and simple regression see the discussion in section 3.8. Because this is exploratory research, and an attempt is being made to establish initial measures, correlations with a p-value of .10 or less will be considered significant, if such correlation occurs in both samples for a given pair of variables.

4.2.4 Elimination of Variables from Proposed Flexibility Measures

As the variable sets for each type of flexibility were examined for common factors, variables were eliminated from consideration as contributors to common factors on several grounds. Variables with low correlations with other variables were candidates for removal from the analyses. If a variable showed low correlation with other variables in the set, generally it would also have a low initial estimate for its communality with the other variables. The initial estimate of communality for each variable was its squared multiple correlation with all the other variables under consideration. The squared multiple correlation (SMC) is the correlation coefficient that results if a multiple regression is run using the variable in question as a dependent variable, and all of the other variables in the set as independent variables. If a variable has low individual correlations with other variables in a set, its squared multiple correlation is usually low too.

One of the estimation processes (maximum likelihood estimation) used to generate the factor loadings gave greater weights to variables with greater prior (initial) communalities, and lower weights to variables with low prior communality estimates. This estimation process would result in an even lower final communality of the variable with the common factors. In theory, using data that a common factor model fits perfectly, the squared multiple correlation is a lower bound for the final communality. However, using real data, for which a common factor model is only hypothesized, and for which prior and final communalities are estimates, the SMC does not serve as a lower bound for the final communality of a particular variable [Harmon, 1976; Rummel, 1970]. Thus, variables with low correlations with other variables in a set did not contribute much to common factors, and were eliminated.

A second statistical consideration was Kaiser's measure of sampling adequacy, which summarizes how small the partial correlations are, relative to the ordinary correlations. A guide to the use of this statistic suggests that a minimum acceptable value of the measure of sampling adequacy for an individual variable in a factor analysis is .5. If a variable's measure of sampling adequacy is less than .5 it should be removed from the analysis, or other variables with which it correlates should be included [SAS Statistics, 1985C].

When a variable exhibited low correlations with all other variables in the set, a low SMC with the other variables, a low final communality, and a low sampling adequacy measure, it was removed from the analysis at hand, unless there were compelling theoretical reasons for keeping it in the potential model.

A general approach taken by this researcher was first to run a factor analysis, asking for a Scree plot, and correlations. The Scree plot was evaluated for guidance on the number of factors that might be needed. The correlation table was studied for guidance on variables to eliminate. More factor analyses then were performed using the maximum likelihood (ML) method, and the unweighted least squares (ULS) method, for several different numbers of factors. Each solution was rotated for interpretability, first to an orthogonal solution by the Varimax method, and then, because there was no reason to believe the factors were uncorrelated with each other, to an oblique solution by the Promax method. For more details on these methods the reader is referred to a factor analysis text such as Rummel [1970], Harmon, [1976], or Kim and Mueller [1978]. These analyses were conducted on both samples, and results were compared between the ML and ULS methods, and between samples.

The assumption of multivariate normality, in general, did not hold in the data set under consideration. Much of the data was highly skewed. The real value from the factor analyses came from seeing which variables made contributions to the rotated solutions as more factors were added. As more factors were added, strong preference was given to retaining variables whose factor loadings tended to be high for both the ML method and the ULS method. In addition, high factor loadings, and prior and final communalities from Sample Number One were verified in Sample Number Two. As the analyses progressed, more variables were rejected than retained. Only those variables with a strong showing in both samples were retained as measures, with the exception of one of the measures of volume flexibility, which was retained on purely theoretical grounds. That measure is identified and discussed in section 4.3.4 below.

4.2.4.1 Elimination of Variables Representing Characteristics of the Staff

It became apparent that variables representing characteristics of the staff did not factor well with variables representing scheduling actions. The lack of common factors containing both staffing and scheduling characteristics was a disappointment to this researcher who had hoped to find patterns that clearly linked staffing characteristics with scheduling characteristics. In particular, variables from questions 14 and 17, representing the proportion of nursing staff with various characteristics, did not factor well with variables in questions 4 and 21, representing various scheduling actions. The final sets of variables chosen to represent volume flexibility, time flexibility, place flexibility, and reassignment flexibility originated from responses to parts of questions 4, 18, 19, and 21.

Correlational analyses were performed on the variables in questions 14 and 17, with the newly created flexibility measures, in order to determine if there were relationships between the flexibility measures and the characteristics of staff members. Results are reported in section 4.4.2.

4.3 RESULTING MEASURES OF STAFFING AND SCHEDULING FLEXIBILITY

Table 4.2 contains a list of the final variables chosen to measure place and reassignment flexibility in the remainder of this study. Final measures for time flexibility are in Table 4.3, and final measures for volume flexibility are in

Table 4.4. Measures for job flexibility were abandoned. Following is a discussion of each type of flexibility measure including a brief description of how it evolved.

4.3.1 Place Flexibility

There were originally six variables that were thought by this researcher to represent place flexibility. Two variables from the original six remain in the final measure (see Table 4.2). The variable representing the degree of centralization of the scheduling process (X22) was eliminated because, in SN1, it did not correlate highly with any of the other five variables. Also, although one could argue that the values assigned to it did represent some underlying degree of "centralization," the conservative classification of this variable is as a categorical one. Categorical variables should not be used as measures, because they represent the presence or absence of attributes, and not "how much" of an attribute is present.

The variable for the proportion of staff permanently assigned to a unit (X1707) correlated only weakly with the other four remaining variables. When a factor analysis was run, it had a low squared multiple correlation, a low sampling adequacy and a low final communality. Thus, it was eliminated as a measure. When the remaining four variables were factored, the variable representing the proportion of staff from other units or an in-house nursing pool seemed to form a factor by itself. Since a common factor, by definition, is common to two or more variables, this variable (X1409) was eliminated. The

TABLE 4.2

SETS OF VARIABLES FOR MEASUREMENT OF STAFFING AND SCHEDULING FLEXIBILITY

PLACE FLEXIBILITY

Name	Direction for High Flexibility	Variable Description
PLACFLEX	High	The sum of X2105 + X2116, described below. Measures the frequency of sharing nurses from another unit.

These variables were used to form the final PLACE Flexibility measure:

X2105	High	Frequency of use of nurses from another unit when matching needed to actual
X2116	High	Frequency of sending unneeded staff to other units when matching needed to actual

REASSIGNMENT FLEXIBILITY

Name	Direction for High Flexibility	Variable Description
REASSIGN	High	The sum of EXACT_ST + SCHEDULE + SHIFTADJ, defined below. Gives the number of times for potentially making new assignments of time, place, or job, and adjusting the volume of workers available.

These variables were used to form the final REASSIGNMENT Flexibility measure:

EXACT_ST	High	Recoded from X408, to represent midpoints of the ranges; the number of times in a year for determining exact staff working in your unit
SCHEDULE	High	Recoded from X409, to represent midpoints of the ranges; the number of times in a year for scheduling nursing staff in your unit
SHIFTADJ	High	Recoded from X410, to represent midpoints of the ranges; the number of times in a year for making shift adjustments to schedule

variable for the frequency of the use of in-house nursing pools (X2104) appeared to fit, both statistically and theoretically, as well, or better with volume flexibility, so X2104 was moved to volume flexibility.

The two remaining variables measuring place flexibility are really symmetrical variables. One (X2105) is the frequency with which nurses from another unit are used in the process of matching needed staff to actual staff, and the other (X2116) is the frequency with which unneeded staff are sent to other units when matching needed to actual. These two variables are added together to form the variable PLACFLEX, which is used in the remainder of the study to represent place flexibility. Two one-factor ULS factor analysis models, one from each sample, were formed with the final variables measuring place flexibility. Although two variables are not enough to form a unique common factor model, both these variables loaded highly on a single factor. The ML solutions were very similar. to the ULS solutions.

4.3.2 Reassignment Flexibility

The measurement of reassignment flexibility began with three variables as potential measures, and ended with three variables, but only one of them was the same variable (see Table 4.2), and that variable, X408, was recoded. The variable for the frequency of assigning staff to other duties within the unit when matching needed to actual (X2117) was removed due to extremely low correlation (close to 0.0) with the other variables, X407 and X408. Two variables, X409 and X410, originally considered to represent time flexibility, were a better statistical "fit" with reassignment flexibility, and conceptually, they represent reassignment flexibility as well as they represent time flexibility. At this point, the four variables under consideration were X407, the number of times in a year for making patient care assignments; X408, the number of times in a year for determining exact staff working in the unit; X409, the number of times in a year for scheduling nursing staff in the unit; and X410, the number of times in a year for making shift adjustments to the schedule. New variables were created by recoding the original responses to all four of these variables to the midpoints of the ranges represented by each response. The four new variables could now be treated as continuous, and also represented an estimate of the actual number of times these actions took place. X407 was removed from the measure because of low prior and final communality with the other three variables in a factor analysis. Three variables are not enough to obtain a unique solution to a factor analysis, but when a factor analysis was performed, all three remaining variables load heavily on a single factor in both SN1 and SN2. The maximum likelihood and unweighted least squares methods both gave the same results. Thus, the measure for reassignment flexibility, REASSIGN, was created by adding together the recoded variables from X408, X409, and X410. See Table 4.2 for the names of these new variables.

4.3.3 Time Flexibility

It was more difficult to determine measures for time flexibility because of the large number of potential variables originally thought by this researcher to represent time flexibility. However, many of them were methodically eliminated from the measure. See Table D.17 for the initial variable set, and see Table 4.3 for the final variables.

Time flexibility itself can have several dimensions. That is, flexibility can relate to start times, the length of time worked, the days worked, the ability of the work force to work overtime on short notice, or the willingness of the work force to take time off when demand is low or give up days off when demand is high. Some of these dimensions are hard to separate from volume flexibility. Several variables which were initially in the time flexibility set were removed, after a number of factor analyses, from time flexibility to volume flexibility. These variables, all from question 21, were related to the frequencies of certain actions taken when trying to match needed staff to actual staff. The variables moved from time flexibility to volume flexibility were the frequencies of using voluntary overtime (X2101), extending the hours of part-time staff (X2109), calling in staff members on their days off (X2110), and asking staff to take time off voluntarily as vacation (X2113) or without pay (X2118). The variables X2101, X2109, and X2110 were eventually eliminated from any measures due to low final communalities.

Two variables relating to the number of times staff schedules were prepared in a year (X409), and the number of times shift adjustments to the schedules were made (X410) were moved to reassignment flexibility, as noted in the previous section.

Variables relating to the length of shifts for LPN (Licensed Practical Nurses) staff members were removed because many units did not have LPNs. The absence of a response for this question caused the entire set of responses from a unit to be omitted from a particular analysis. In order to avoid elimination of all units without LPNs, and to keep the number of responses being analyzed as high as possible, the LPN shift length variables were dropped from the time flexibility measure. It should be noted that the correlations of the LPN shift length variables with the RN shift length variables were approximately .4, with p-values of .0001. Similar logic led to the removal of the Nurse Assistant shift length variables from the analysis.

The elimination of variables from question 17, which concerned proportions of staff members whose schedules had various characteristics, was discussed in section 4.2.4.1.

Several factor analyses were run, each time on a smaller set of variables, until the six variables shown in the bottom of Table 4.3 remained. These six variables were combined to form three separate measures of time flexibility, shown in the top of Table 4.3. One measure, RNSHIFT, represents the number of different regular shift lengths available for RN schedules, both during the week and the weekend. A second measure, RNDIFF, represents the difference between the longest and shortest times likely to be worked, including overtime, on weekdays and on weekends. The third measure, STARTTOT, represents the number of starting times for shifts on weekdays and on weekends.

A three-factor solution to a factor analysis model for the final six variables was among those analyses used to arrive at the three measures for time flexibility. The ULS and ML solutions for SN1 and SN2 are similar. Although there are not enough variables for a unique three-factor solution, in all models it is evident that the three pairs of variables, X18RN and X18RNWE, X18DIFF and X18DIFWE, and X1901 and X1902, form three separate factors.

TABLE 4.3

SETS OF VARIABLES FOR MEASUREMENT OF STAFFING AND SCHEDULING FLEXIBILITY

TIME FLEXIBILITY

Name	Direction for High Flexibility	Variable Description
RNSHIFT	High	The sum of X18RN and X18RNWE described below. Represents the number of RN regular shift lengths on weekdays and on weekends.
RNDIFF	High	The sum of X18DIFF and X18DIFWE described below. Represents the difference between the longest and shortest times likely to be worked including overtime on weekdays and on weekends.
STARTTOT	High	The sum of X1901 and X1902 described below. Represents the total number of starting times for shifts on weekdays and on weekends.

These variables were used to form the final three TIME Flexibility measures:

X18RN	High	One or more than one regular shift lengths for RNs without overtime on weekdays (from data in X1801). Takes on the values 1 or 2.
X18RNWE	High	One or more than one regular shift lengths for RNs without overtime on weekends (from data in X1806). Takes on the values 1 or 2.
X18DIFF	High	Scaled Difference between Longest and Shortest periods likely to be worked weekdays.(The difference between values of X1804 minus X1805, rescaled to the mid-points of the intervals.)
X18DIFWE	High	Scaled Difference between Longest and Shortest periods likely to be worked weekends. (The difference between values of X1809 minus X1810, rescaled to the mid-points of the intervals.)
X1901	High	Number of shift start times on weekdays
X1902	High	Number of shift start times on weekends
X1801		Length of Regular Weekday RN shift without overtime (more than one shift length may be indicated)
X1804		Longest period likely to be worked on weekdays
X1805		Shortest period likely to be worked on weekdays
X1806		Length of Regular Weekend RN shift without overtime (more than one shift length may be indicated)
X1809		Longest period likely to be worked on weekends
X1810		Shortest period likely to be worked on weekends

Interfactor correlations are in the vicinity of .3. As one would expect, there is some correlation between units with a large number of starting times and units with more than one regular shift length, and in a two-factor solution, these variables do seem to measure the same dimension of time flexibility. A topic for future research, probably requiring additional data, is to determine if the number of starting times and the number of shift lengths measure the same or different dimensions of time flexibility.

It is the contention of this researcher that a high measure for each of these dimensions of time flexibility, while undoubtedly complicating the scheduling process, is also a sign of high flexibility. Many of the units in the study have a high measure on one or more of the time flexibility measures. More than one shift length means staff are working eight hour shifts, twelve hour shifts, and perhaps even ten hour shifts in the same unit. In this study, about one third of the units have RN staff working more than one shift length. About half of those units have LPN staff working two different shift lengths, as well. Well over half of the units in the study report a difference of eight or more hours between the longest and shortest time likely to be worked, including overtime. Almost one-third of the units report at least a four hour difference between the longest and shortest times likely to be worked. About one-third of the units report four or more starting times.

There exists the possibility that different shift lengths, long differences in length of time worked, and a number of start times have arisen in response to a work force that is just the opposite of flexible. The nursing shortage is quite severe. About 90% of the units in the study are in hospitals that are operating with a shortage of RNs. Over 75% of the units in the study experience a shortage of RNs at least once per week. Ten percent of the units experience such a shortage more than once per day. Perhaps high values for the measures defined in Table 4.3 represent a work force that is dictating their terms, and their terms are quite diverse, thus leading to many shift lengths and start times.

A second possibility exists for some units. Perhaps both the hospital nursing unit and the employees desire a variety of shift lengths and start times, and a combination has been developed that is beneficial to both. That is, the work force is being flexible to its own benefit, and it is being flexible to the benefit of the nursing unit. This researcher suspects that both these scenarios exist in nursing units in this study. Future research with this data set, and with more data if necessary, will attempt to discern the differences between a "forced time flexibility" initiated by the work force, and a mutually beneficial flexibility.

4.3.4 Volume Flexibility

Volume flexibility was by far the most difficult of the flexibilities for which to determine measures. From the initial examination of the correlations within the volume flexibility set there appeared to be four groups of variables, each containing variables highly correlated with other variables in the same group, but not with variables not in that group. These four groups appeared to represent four separate strategies for obtaining volume flexibility.

One strategy appeared to be hiring and firing staff members as needed; that is, taking action to permanently change the number of nursing staff available. A second strategy appeared to be designed to temporarily change the number of nursing staff by the use of "pool" nurses from within the hospital, or the use of temporary nurses from an outside agency. The third strategy seemed to be to mandate changes in the number available; that is, overtime or involuntary time off is mandated. This strategy does not appear to be used frequently by the respondents to the study, but the variables representing these choices do correlate with each other. The fourth strategy appeared to be attempts to change the volume of patients available, by shifting patients to other units, declining admissions, and discharging patients. The action of soliciting new patients is used so infrequently that the strategy of changing the volume of patients would appear only to be used to lower the volume of demand.

It should be noted that as a prior hypothesis the variables which would relate to a fifth strategy, the voluntary use of overtime and time off without pay, were considered a part of time flexibility. These variables did correlate with each other, but did not correlate with other variables deemed to represent time flexibility. As the examination of the variable set progressed, the voluntary action variables from question 21 were grouped with volume flexibility, which, in hindsight, seemed to be a better arrangement. Table 4.4 contains the variables and measures developed for volume flexibility.

Many factor analyses were performed, and the results studied. Comparisons were made between ML and ULS models, and between SN1 and SN2, for purposes of eliminating variables. Final measures chosen represented the most obvious factors from the many factor analysis models examined. They also represent five strategies similar to the ones discussed above. These strategies for obtaining volume flexibility are to use voluntary time off (VOL_OFF), to mandate time off (MAND_OFF), to use nurses from an in-house pool or from an outside agency (USE_POOL), to discharge patients or to shifts them to other units (ELIM_PTS), and to make permanent changes in the level of staffing (PERM_CH).

TABLE 4.4

SETS OF VARIABLES FOR MEASUREMENT OF STAFFING AND SCHEDULING FLEXIBILITY

VOLUME FLEXIBILITY

Name	Direction for High Flexibility	Variable Description
VOL_OFF	High	The sum of X2113 and X2118 described below. The use of volunteer vacation time and time off without pay when demand for services is low.
MAND_OFF	Low	The sum of X2114 and X2119 described below. The use of mandated vacation time and time off without pay when demand for services is low.
USE_POOL	High	The sum of X2103 and X2104 described below. The use of temporary nursing services from within and from outside the hospital when demand for services is high.
ELIM_PTS	Low	The sum of X2107 and X2108 described below. Discharge patients or send them to other units when demand for services is high.
PERM_CH	High	The sum of HIRE, FIRE, ADD, and DEL_ETE described below. Hire, fire, add positions, and delete positions when demand for services fluctuates.

These variables were used to form the final five VOLUME Flexibility measures:

		Frequency of use of this action in the event of mismatches between the needed number of nursing staff and the actual number available:
X2103	High	Hiring temporary nursing staff from outside
X2104	High	Use of hospital "pool" nurses
X2107	Low	Patients are discharged
X2108	Low	Patients are shifted to other units
X2113	High	Use of voluntary vacation time
X2114	Low	Use mandated vacation time
X2118	High	Use of volunteer unpaid time off
X2119	Low	Use of mandated unpaid time off
		Recoded to represent midpoints of the ranges:
HIRE	High	From X401, the number of times in a year for hiring new nursing staff
FIRE	High	From X402, the number of times in a year for terminating nursing staff
ADD	High	From X403, the number of times in a year for adding nursing positions
DEL_ETE	High	From X404, the number of times in a year for deleting nursing positions

The last measure is questionable, because there was not agreement between the two samples of the variables that would be in such a factor, and, indeed, whether the factor was important enough to stay in the model. The measure was retained on the theoretical grounds that one way to change the volume of the work force is by means of permanent changes such as hiring or firing employees. Two other measures that this researcher would like to have retained would have represented the strategy of using overtime, both voluntary and mandatory, and the voluntary calling in of employees on their normal days off, when demand for nursing services exceeds the supply. The variables for these strategies had low prior and final communalities in all of the common factor models examined. Thus, they were discarded as measures. The ML solution yielded similar results.

4.3.5 Job Flexibility

Prospective measures for job flexibility were abandoned as none of the variables chosen prior to analysis correlated well enough with each other to form strong factors. A common factor model did not fit the data for this set of variables, nor did it fit any feasible subset of the original five variables thought to represent job flexibility. No one single variable in the research instrument seemed to capture the essence of job flexibility. Thus, the measurement of job flexibility will be left for future research.

4.3.6 Correlations Between The Flexibility Measures

Factor analyses of the flexibility measures together were performed. In the three factor model, the three measures of time flexibility load highly on one factor in SN1, for both the ML and ULS methods. SN2 offers a partial confirmation of these results. The variables for the number of regular RN shifts, and the difference between the longest and shortest times likely to be worked load very highly on one factor, while the measure of the number of start times loads on the same factor but not so highly.

Place flexibility and the use of pool nurses appear to be a single factor. This result is quite strong in SN1 and SN2, for both the ML and ULS methods. This researcher is led to the conclusion that place flexibility is a subset of volume flexibility. The presence of this factor confirms the nature of the dilemma discussed in section 4.2.2. Some variables clearly represent staffing and scheduling flexibility, but it is difficult to know exactly which type of flexibility, because they may in fact represent several types. In SN1, the measure of the number of times for making permanent changes is part of the same factor as the use of pool nurses and the place flexibility measure. However, this measure does not appear in this factor in SN2 .

In SN1, the *strategy of using voluntary time off* and the *strategy of using* mandatory time off appear to form a single factor. However, these results are not confirmed in SN2.

Reassignment flexibility, and the strategy of eliminating patients do not appear to be a part of any of the factors in the three-factor model in either sample. Both of these measures have low final communalities with the other measures, indicative of the fact that they are not highly correlated with any of the other measures. Such a result is desirable in this analysis, as it indicates those measures are not overlapping with other measures. Table 4.5 shows the correlations between the final measures for both SN1 and SN2. There are 13 correlations that are significant at the $\alpha = .10$ level in both samples. There are 14 pairs of correlations close to an absolute value of zero in both samples. In the development of measures the zero correlation situation is more desirable, as an r = 0 indicates the measures are measuring different things. Future studies can refine these measures in an attempt to eliminate correlations between them.

4.3.7 Scales for the Flexibility Measures

Table 4.6 contains information showing the means, standard deviations, medians and ranges for each flexibility measures for all units in the study. The measures for time flexibility, reassignment flexibility, and the permanent change measure in volume flexibility have values that have a real interpretation. That is, their values represent hours of difference, number of start times, number of shift lengths, number of times reassignments are made, and number of times permanent changes are made. However, values for the measure for place flexibility and the other measures for volume flexibility have no meaningful numerical interpretation, and can only be thought of as numbers that happen to range from 4 to 12. A value of 4 for one of these measures would mean almost no flexibility, and a value of 12 would mean very high flexibility. These measures could easily be converted to a scale ranging from 0 to 7, or 0 to 1 or whatever range the researcher wanted, as their values are purely arbitrary, as long as their relative value remains the same. In the remainder of this research the number assigned to the actual measure is immaterial, as standardized values for variables are used in correlations. In hypothesis tests using one-way analysis of variance, changing the range of the dependent variable would not change the p-value (probability of occurrence by chance) of the observed F statistic.

Table 4.5

Correlations between the Flexibility Measures

Correlation with:

Name of Variable:	PLACFLEX	REASSIGN	RNSHIFT	RNDIFF	STARTTOT	VOL_OFF	MAND_OFF	USE_POOL	ELIM_PTS	PERM_CH
PLACFLEX	***1.00***	-.01	.21	**-.13**	.02	**.34**	.06	**.47**	-.01	.24
REASSIGN	-.08	***1.00***	**.12**	.24	.13	-.07	-.03	.02	**.13**	.09
RNSHIFT	.01	**.13**	***1.00***	**.32**	**.43**	-.01	-.01	**.24**	-.02	.11
RNDIFF	**-.14**	.05	**.27**	***1.00***	.28	-.11	.01	-.05	**.18**	.02
STARTTOT	.08	.04	**.40**	.10	***1.00***	.01	.08	.08	**.16**	.10
VOL_OFF	**.24**	.06	-.02	.01	.01	***1.00***	**.36**	.03	.12	**.19**
MAND_OFF	.13	.01	-.02	-.19	.17	**.25**	***1.00***	.14	.12	.10
USE_POOL	**.44**	.04	**.14**	-.05	.06	.02	.06	***1.00***	-.02	**.27**
ELIM_PTS	-.03	**.12**	.14	**.19**	**.16**	.01	-.04	.06	***1.00***	-.03
PERM_CH	.02	.09	-.05	.10	-.11	**.12**	-.03	**.17**	.08	***1.00***

Correlations from SN1 are in the upper half of the diagonal.
Correlations from SN2 are in the lower half of the diagonal.
The diagonal has been printed in bold italics for ease of reading.
Significant correlations ($\alpha = .10$) that occur in both data sets are highlighted in boldface.
Pairs of nonsignificant correlations that are close to zero ($|r| < .10$) are underlined.

Table 4.6

Descriptive Statistics for the Flexibility Measures

```
                          SAMPLE NUMBER ONE
             DESCRIPTIVE STATISTICS FOR FLEXIBILITY MEASURES

VARIABLE        N      MEAN      STANDARD      MINIMUM      MAXIMUM     STD ERROR
                                 DEVIATION      VALUE        VALUE       OF MEAN

PLACFLEX       151    7.801325    1.814827   4.00000000    12.00000    0.1476886
REASSIGN       164  798.365854  478.076797   3.00000000  1500.00000   37.3315259
RNSHIFT        174    2.689655    0.884162   2.00000000     4.00000    0.0670281
RNDIFF         174   16.597701    8.827126   0.00000000    35.00000    0.6691827
STARTTOT       174    6.362069    1.994486   2.00000000    12.00000    0.1512016
VOL_OFF        146    8.226027    1.745025   4.00000000    12.00000    0.1444193
MAND_OFF       147    4.959184    1.599990   4.00000000    12.00000    0.1319649
USE_POOL       158    6.601266    1.878270   4.00000000    12.00000    0.1494271
ELIM_PTS       151    5.278146    1.677931   4.00000000    12.00000    0.1365481
PERM_CH        169   22.189349   29.685448   4.00000000   341.00000    2.2834960
```

```
                          SAMPLE NUMBER TWO
             DESCRIPTIVE STATISTICS FOR FLEXIBILITY MEASURES

VARIABLE        N      MEAN      STANDARD      MINIMUM      MAXIMUM     STD ERROR
                                 DEVIATION      VALUE        VALUE       OF MEAN

PLACFLEX       148    8.020270    1.786075   4.00000000    12.00000    0.1468144
REASSIGN       161  730.484472  427.033314   8.00000000  1500.00000   33.6549399
RNSHIFT        174    2.637931    0.860802   2.00000000     4.00000    0.0652573
RNDIFF         174   16.545977    7.603480   0.00000000    35.00000    0.5764183
STARTTOT       174    6.379310    1.841973   2.00000000    12.00000    0.1396396
VOL_OFF        145    8.455172    1.821855   4.00000000    12.00000    0.1512969
MAND_OFF       142    4.978873    1.446288   4.00000000    10.00000    0.1213698
USE_POOL       157    6.668790    1.813018   4.00000000    12.00000    0.1446945
ELIM_PTS       155    5.367742    1.639684   4.00000000    10.00000    0.1317026
PERM_CH        170   19.076471   21.492810   4.00000000   258.00000    1.6484232
```

4.4 LINKS TO OTHER VARIABLES

One of the purposes for developing measures of staffing and scheduling flexibility was to have a tool for relating staffing and scheduling measures to other characteristics of the work force, and the operating environment. In addition, measures were to be related to goals and objectives, and to performance measures. This section contains a brief discussion of significant relationships between the staffing and scheduling flexibility measures and other characteristics.

4.4.1 Statistical Techniques Used to Analyze Relationships Between Flexibility Measures and Other Variables

Correlational analysis and one-way analysis of variance were used to investigate relationships between the flexibility measures and other variables. In correlational analysis, the hypothesis being tested is that there is no correlation between the characteristic of interest and the flexibility measure. In one-way analysis of variance, the hypothesis being tested is that the mean values of a given flexibility measure are the same for all categories of the characteristic of interest. Because this study is exploratory, α =.10 was used as a cut-off point for significance of the observed test statistic (r in the correlations, F in the ANOVA). For the power of these statistical tests see the discussions in sections 3.8 and 4.2.3.3. In the discussion that follows, only the results that were significant in both sample number one and sample number two are reported.

Common factor analysis was used to develop some environmental factors using variables from questions 8 and 9. These environmental variables were then analyzed in conjunction with the flexibility measures.

4.4.2 Relationships with Other Staffing and Scheduling Variables

Included in each section are results of the correlation analyses, and analyses of variance performed on variables from questions 14, 16, and 17, for each flexibility measure. Table 4.7 contains a summary of significant results from question 14 and 16. Results for question 17 are in Table 4.8.

Question 14 dealt with the proportion of the nursing staff with various characteristics. From the significant correlations and ANOVA results shown in Table 4.7, the following conclusions were drawn. Units with a higher proportion of registered nurses with bachelor's degrees in nursing (RNs with BSN) (X1402) are more likely to have more regular shift lengths (RNSHIFT) than units with a lower proportion of RNs with a BSN. Units with some RNs with BSN are more likely to have more shift starting times (STARTTOT) than units with no RNs with BSN. Units with more RNs with BSN are less likely to use the policy of mandatory time off (MAND_OFF) to achieve volume flexibility.

Units that use some employees from temporary agencies (X1408) have a higher measure of place flexibility (PLACFLEX), and a higher measure on the volume flexibility measure of USE_POOL than do units who have no temporary nursing staff at all. Similarly, units that use some nursing staff from other units or an in-house nursing pool (X1409) have higher measures on PLACFLEX and USE_POOL than do units with no nurses from other units or from an in-house pool.

These relationships are not a surprise, since USE_POOL measures the frequency of use of nursing pools, and PLACFLEX, which correlates with USE_POOL, measures the ability of the staff to work in a number of places. Units that use some nurses from other units or an in-house nursing pool are also more likely to have more shifts lengths for RN staff than do units who use no nurses from other units.

Table 4.7
Significant Results
Of Correlation Analyses and Analyses of Variance
For Flexibility Measures with Staffing Characteristics
From Questions 14 and 16 (α =.10)

			Correlation		ANOVA	
Variable Name	Flexibility Measure	Sample Number	r	p-value	p-value of F	High to Low Rank of Categories
X1402*	RNSHIFT	1	.18	.0194		
		2	.15	.0546		
	STARTTOT	1			.0037	3,2,1
		2			.0009	2,3,1
	MAND_OFF	1	-.17	.0407		
		2	-.17	.0379		
X1408*	PLACFLEX	1	.28	.0004	.0003	2,1
		2	.22	.0085	.0157	2,1
	USE_POOL	1	.49	.0001	.0001	2,1
		2	.57	.0001	.0001	2,1
X1409*	PLACFLEX	1	.26	.0013	.0001	2,1
		2	.33	.0001	.0001	2,1
	RNSHIFT	1	.17	.0287	.0120	2,1
		2	.24	.0013	.0014	2,1
	USE_POOL	1	.47	.0001	.0001	2,1
		2	.51	.0001	.0001	2,1
X1601	RNSHIFT	1	.17	.0250	.0182	3,4,2,1
STAFBSN**		2	.14	.0710	.0618	4,3,1,2
	STARTTOT	1			.0075	2,4,3,1
		2			.0129	3,4,2,1
	RNDIFF	1	.17	.0228		
		2	.25	.0011		
	MAND_OFF	1	-.15	.0623	.0691	2,1,4,3
		2	-.21	.0135	.0416	2,1,4,3
	USE_POOL	1			.0213	3,2,4,1
		2			.0196	3,4,2,1
X1602	PERM_CH	1	.25	.0011		
STAFRN**		2	.45	.0001		
X1606	RNDIFF	1			.0781	2,4,7,6,5,3
STAFALL**		2			.0043	7,2,6,3,5,4
	STARTTOT	1	.21	.0054	.0038	6,7,2,5,4,3
		2	.27	.0004	.0100	7,6,5,4,3,2
	MAND_OFF	1			.0464	6,3,7,2,4,5
		2			.0636	2,6,3,5,4,7
	PERM_CH	1	.26	.0008	.0158	7,6,3,5,4,2
		2	.32	.0001	.0009	7,6,5,4,3,2

* For the ANOVA, this variable was recoded to fewer values than the original range of responses, because of sparse responses at some levels.

** This variable was recoded from the X16 variable immediately above it on this table. It was recoded to the mid-points of the ranges of the responses in order to represent the actual number of staff in each category. It was used for the correlational analysis.

Table 4.8

Significant Results
Of Correlation Analyses and Analyses of Variance
For Flexibility Measures with Staffing Characteristics
From Question 17 (α =.10)

			Correlation		ANOVA	
Variable Name	Flexibility Measure	Sample Number	r	p-value	p-value of F	High to Low Rank of Categories
X1701*	PLACFLEX	1	.15	.0747		
		2	.15	.0754		
X1702*	RNSHIFT	1			.0646	2,1
		2			.0078	2,1
X1705*	STARTTOT	1			.0050	4,5,3
		2			.0856	4,5,3
	RNDIFF	1	.19	.0108	.0232	4,5,3
		2	.23	.0023	.0064	4,5,3
X1706*	REASSIGN	1	.16	.0397	.0122	2,1
		2	.20	.0085	.0269	2,1
X1707*	PLACFLEX	1	-.18	.0253	.0396	3,4,5
		2	-.15	.0768	.0622	3,4,5
X1709*	PLACFLEX	1	-.24	.0035	.0370	1,2,3,4
		2	-.22	.0072	.0529	1,3,2,4
X1710*	RNSHIFT	1	.16	.0397	.0635	2,1
		2	.20	.0085	.0121	2,1
	USE_POOL	1	-.15	.0666		
		2	-.18	.0232		

* For the ANOVA, this variable was recoded to fewer values than the original range of responses, because of sparse responses at some levels.

The questions from No. 16, dealing with the actual number of staff in various categories bore out some of the results discussed above. See Table 4.7 for details. RNSHIFT, STARTTOT, and RNDIFF, the three time flexibility measures, were all higher for units with 1 or more RN with BSN staff members, than the same measures were for those units who had no RN with BSN staff. X1601 and its continuous counterpart, STAFBSN, had a negative correlation with the volume flexibility measure, MAND_OFF. Units with zero to three RNs with BSN used the mandatory time off strategy more than the units with four or more RNs with BSN. Units with 4 to 7 RNs with BSN used nursing pools at a higher rate than units with no RNs with BSN. The registered nurse with a bachelor's degree in nursing is the most cost effective of the health care workers typically involved in the provision of hospital nursing services [Houston and Cadenhead,1986; Halloran,1983]. By training and by law, the RN with a BSN can perform far more nursing duties than any other member of the nursing staff. It is likely that units that have such staff members suffer shortages of staff, and do not need to use the mandatory time off policies, but do need to use nursing pools to achieve volume flexibility. The fact that all three dimensions of time flexibility are greater in units with any staff members in the RN with BSN category, may reflect one of the scenarios discussed in the end of section 4.3.3. RNs with BSN may be in such short supply that they dictate the terms of their employment.

Units with a higher number RNs without BSN (X1602 or STAFRN) have a positive correlation with the volume flexibility measure of PERM_CH. That is, units with more RNs without BSNs make more permanent staff changes. This measure may well be a reflection of the overall size of the unit, as units with higher numbers of total nursing staff (X1606 or STAFALL) very definitely had higher measures for the PERM_CH dimension of volume flexibility. Not unexpectedly, the larger the unit, the higher its measure on the time flexibility dimension of STARTTOT. One would expect a unit with a large number of employees to have more starting times. ANOVA performed with X1606 showed significant differences by total number of staff in the unit for the mean measures of RNDIFF and MAND_OFF. However, the direction of the difference was unclear, as the two samples gave conflicting results. See Table 4.7 for details.

Variables from question 17 also dealt with the proportion of staff whose schedules had various characteristics. Significant relationships between the flexibility measures and question 17 are shown in Table 4.8. Units with a higher proportion of employees with fixed start times dictated by the hospital (X1701) have a higher measure of place flexibility. This relationship makes sense, because if start times are fixed it is easier to trade employees with other units. Units who have any employees at all with flexible start times dictated by the employee (X1702) have a higher number of regular shift lengths for RNs than units with no employees with flexible start times.

Units in which most of the staff work required weekends (X1705) have a higher number of starting times (STARTTOT) and a longer difference in the time likely to be worked (RNDIFF) than units in which all of the staff or half or fewer of the staff work required weekends. One theory that might explain these phenomena is that perhaps when all or only a few staff members work weekends there is less need for time flexibility than when most but not all staff work on some weekends. Perhaps there is difficulty scheduling around those who do not work weekends, so more time flexibility is needed. Units with some nursing staff on a permanent weekend assignment (X1706) have a higher measure on reassignment flexibility (REASSIGN), than units with no nursing staff with a permanent weekend assignment. This particular result seems counter-intuitive to this researcher; it seems that if some staff are permanently assigned to weekends, schedules would not have to be prepared so frequently. However, having staff with a permanent weekend assignment is actually a loss of flexibility, and perhaps schedules and shift adjustments do have to be made more often to make up for this loss.

As expected, the proportion of staff permanently assigned to a unit (X1707) has a negative correlation with place flexibility, as does the proportion of staff who work the same days each week (X1709). Any permanent work assignment to a single place or to the same days each week appears to lessen the ability to trade staff with other units. Although only a few units have staff who work split shifts (X1710), the proportion of staff who do work split shifts has a positive correlation with the time flexibility dimension of RNSHIFT. Split shifts and more than one shift length go hand in hand. The proportion of staff with split shifts has a negative correlation with the volume flexibility measure of USE_POOL. Apparently the use of split shifts provides a buffer against volume fluctuation similar to that provided by the use of nursing pools.

4.4.3 Relationships with Unit and Patient Descriptor Variables

Relationships also were investigated between variables in question 8, patient descriptors, and question 9, technology descriptors of the unit. The objective was to find sets of variables that could be combined and still be representative of the original variables. Correlation analysis and factor analysis, techniques which were discussed in Section 4.2.3, were used in the analyses of the variables in questions 8 and 9. Results of these analyses led to the creating of PT_AGE equal to X801 minus X802 minus X803 plus X804, which represented the proportion of patients who were adults, children, infants, and over sixty years of age, respectively. A high value for this variable meant a unit had more adults. A low value for this variable meant a unit had more infants or children. Also combined into a single variable were X807, X808, and

X809, which represented the proportion of patients with IVs, monitors, and respirators, respectively. This new variable was called PT_EQUIP to represent a measure of the patients attached to equipment. Variables X810, X811, and X812, the proportions of patients needing assistance in various activities, were combined to form one variable called PT_ASST. PT_TECH was formed as the sum of X902 and X903, which represented ratings of the use of new technology for patient care, and the use of special equipment in patient care. CAPINTEN, for capital intensity, equaled the sum of X905, X906 and X908, which represented the total value of equipment in the unit, the value of equipment per bed, and the value of equipment per nursing staff member, respectively. In addition, a single "patient technology and capital intensity" variable, TOT_TECH, was formed from X902, X903, X905, X906, and X908.

Factor analysis was performed on variables from questions 8 and 9. Variables with weak correlations were eliminated. The maximum likelihood technique of estimation, squared multiple correlations for prior communality estimates, and an oblique rotation by the Promax method have been used. The unweighted least squares method of estimation yielded similar results and is not included. This researcher looked at solutions ranging from two through seven factors. While four factors is not a perfect "fit", the factors after four are only weakly distinguishable. The Scree plot indicated that factors beyond three may not be of much importance. This researcher's interest in the use of factor analysis here was the same as for the development of flexibility measures. The search was for variables that seemed to represent the same aspect of patient or unit characteristics, and could therefore be combined. The factor analysis was performed in order to provide evidence that those variables grouped together in this analysis do represent the same aspect of patient or unit characteristics.

Because the variables in questions 8 and 9 represent underlying continuous values, only correlation analyses were performed with the flexibility factors. See Table 4.9 for the details of significant correlations in both samples. The age of the patients has a negative correlation with the volume flexibility measure ELIM_PTS. Apparently units with younger patients, infants or children, are more likely to be able to discharge their patients or send them to other units when demand for nursing services in the unit exceeds supply.

PT_EQUIP, PT_TECH, CAPINTEN, and TOT_TECH, which altogether really reflect the technological level in the unit, and X901, the rating of the average patient acuity, all have a positive correlation with RNDIFF. The higher the technology in the unit, and the greater the acuity of the patient, the greater the difference in the longest and shortest times likely to be worked. High values for these variables would be indicative of critical care units, so one conclusion is that critical care units are more likely to have a big difference between the longest and shortest time worked. Knowledge of practice bears this out.

X907, the rating of the number of nursing staff per patient, also correlates positively with RNDIFF, and has a negative correlation with PLACFLEX. Units with a higher number of staff per patient are likely to be critical care units, and these units had a greater need for unit orientation, which would tend to decrease place flexibility. Units with high values for CAPINTEN and TOT_TECH also have high measures for the ELIM_PTS measure of volume flexibility. These units also tend to be units offering critical care, so what these units lack in place flexibility, they tend to make up in the ability to send

Table 4.9

Significant Results of Correlation Analyses Flexibility Measures with Staffing Characteristics From Questions 8 and 9 (a=.10)

Variable Name	Flexibility Measure	Sample Number	r	p-value
PT_AGE	ELIM_PTS	1	-.24	.0053
		2	-.20	.0223
PT_EQUIP	RNDIFF	1	.23	.0023
		2	.26	.0008
PT_ASST	PLACFLEX	1	.20	.0189
		2	.33	.0001
PT_TECH	RNDIFF	1	.24	.0020
		2	.22	.0048
CAPINTEN	RNDIFF	1	.17	.0266
		2	.26	.0006
	ELIM_PTS	1	.17	.0426
		2	.19	.0181
TOT_TECH	RNDIFF	1	.21	.0086
		2	.24	.0020
	ELIM_PTS	1	.20	.0186
		2	.18	.0288
X901	RNDIFF	1	.22	.0043
		2	.18	.0189
X907	PLACFLEX	1	-.27	.0008
		2	-.18	.0316
	RNDIFF	1	.14	.0780
		2	.16	.0333

PT_AGE = X801 - X802 - X803 + X804
PT_EQUIP = X807 + X808 + X809
PT_ASST = X810 + X811 + X 812
PT_TECH = X902 + X903
CAPINTEN = X905 + X906 + X908
TOT_TECH = PT_TECH + CAPINTEN

patients to other units when demand for services is high. In other words, the staff do not have place flexibility but the patients do.

4.4.4 Other Significant Correlations with the Flexibility Measures

Other correlations between variables that describe the unit and the flexibility measures were significant in both samples. In this section are comments about the correlations with significant values for r in both samples. There are also comments about significant results obtained from ANOVAs performed with the flexibility measures and some of the categorical variables.

The number of admissions to a unit had a negative correlation with place flexibility. The number of admissions and the patient census correlated positively to the number of starting times for shifts. Similarly, units with more beds, and a higher census have a higher measure for the number of permanent changes made. Units with more beds are more likely to use mandatory time off to solve staff overages. These findings are consistent with the findings related to the number of staff in the unit. In general, as reported in Chapter III, there was correlation between staff size and the number of patients in the unit.

Units who admit more patients directly from the emergency room have greater place flexibility, as do units who discharge more patients to nursing care facilities outside the hospital. Units whose patients enter the units immediately after surgery are more likely to use a nursing pool than units whose patients come from other sources.

Another set of variables, those in question 20, also deal with the environment. The responses to these variables represented the frequency with which certain conditions occur. The response categories were not equal intervals, so Spearman rank order correlations were used to investigate relationships between these variables and the flexibility measures. The frequency of a shortage of RNs correlated positively with the measures USE_POOL, PLACFLEX, STARTTOT, and PERM_CH. It makes sense that units with frequent shortages use nursing pools and have more place flexibility. The number of starting times is correlated to a high rating of the turnover of nursing staff in the unit. This correlation could account for the permanent changes being made more frequently.

A high rating of the unpredictability of demand correlates with a high measure for the use of voluntary time off. Not surprisingly, a high rating for the complexity of the scheduling process correlates with a high value for the number of starting times for shifts.

Two other questions, numbers 22 and 24 respectively, were about the centralization and computerization of the the nursing staff scheduling process. ANOVAs were performed with these variables and the flexibility measures. USE_POOL was the only measure to yield a significant difference for categories of these variables. Units that are fairly decentralized but share a common pool of nurses do use a nursing pool more often than those units that are completely decentralized, and more often than those units that are somewhat decentralized, sharing personnel when necessary. There were too few units that are completely centralized to make a definitive comparison with the other types of units. However, indications are that the usage of nursing pools in units with completely centralized scheduling is closer to that of the fairly decentralized units.

Even fewer units had a completely computerized scheduling process so it is difficult to make any statements about the use of nursing pools in units whose scheduling is completely computerized. However, the other three categories represented different degrees of human involvement with the scheduling process. In both samples, the units whose scheduling process was carried out by humans with no computer support had the highest measure on USE_POOL. Almost 60% of the units fall into this category.

4.4.5 Links to Objectives of the Nursing Unit

Another new set of variables was created from the responses to parts A and B in question 38. Twenty-one objectives for the management of nursing units were given in question 38 (see Appendices A and C). Nurse managers were asked to rate the importance they attached to each of these objectives. They were also asked to rate the importance attached to the objectives by top management. The responses to these two rating questions were added together to create a "total importance" variable for each objective. Not unexpectedly, these "total importance" variable values correlated quite highly with the original variables values. They also correlated highly with each other. However, a major disappointment of this study was that they did not correlate very highly with the flexibility measures. The correlations that were found all make sense, but they could easily have occurred by chance. Those significant correlations that did occur in both samples are reported in Table 4.10.

Of the eight correlations between importance of objectives and flexibility measures, seven of them are dimensions of volume flexibility. Two of the stronger correlations are between the objective of being able to reduce staff levels quickly, and the measures of the use of voluntary time off and mandatory time off. In addition, those units with a high rating on the importance of achieving a certain level of quality are less likely to have a high number of regular shift lengths for RNs.

4.4.6 Links to Performance Ratings

In question 40, nurse managers were asked to rate their own performance on the objectives in question 38. From this researcher's point of view, in a perfect world, the objectives would influence the flexibility measures, and the flexibility measures would, in turn, influence the performance ratings on those objectives. In this same perfect world, these relationships would be quite evident. It would be easy to show that certain objectives influence the presence or absence of certain types of flexibilities, and that the presence or absence of those flexibilities affects the performance ratings on those objectives. However, if one thing is clear, it is that the world is not perfect! Not only were there very few matching significant correlations between the objectives of the nursing unit and the flexibility measures, but there were even fewer significant correlations between the flexibility measures and the nursing unit managers' performance ratings on those twenty-one objectives. Those correlations that were found provided no links between the importance of operating objectives, flexibility measures, and performance ratings. The few pairs of performance rating and flexibility measures that did have a matching correlation between both samples could easy have occurred by chance, although they are logical relationships. Those correlations that were found are reported in Table 4.10 below the double dashed lines.

A high measure of reassignment flexibility appears to be related to high performance ratings on having a satisfied nursing staff, having a low turnover of nursing staff, and giving preference for certain schedules. The performance

Table 4.10

Significant Results
of Correlation Analyses
Flexibility Measures with Staffing Characteristics
From Question 38 on Importance of Nursing Unit Objectives
and Question 40 on Performance Ratings (α =.10)

Variable Name	Objective Description	Flexibility Measure	Sample Number	r	p-value
XT3801	Cost containment	MAND_OFF	1	.17	.0450
			2	.14	.0938
XT3802	Stay within budget	USE_POOL	1	.14	.0663
			2	.14	.0774
XT3803	Reduce staff levels quickly	VOL_OFF	1	.32	.0001
			2	.15	.0694
		MAND_OFF	1	.24	.0043
			2	.26	.0024
XT3804	Increase staff levels quickly	MAND_OFF	1	.14	.0912
			2	.17	.0493
XT3809	Match needed to actual staff	VOL_OFF	1	.28	.0060
			2	.15	.0729
XT3813	Achieve a certain level of quality	RNSHIFT	1	-.25	.0010
			2	-.23	.0020
XT3818	Satisfied nursing staff	VOL_OFF	1	.14	.0885
			2	.16	.0609
X4004	Increase staff levels quickly	PLACFLEX	1	-.14	.0878
			2	-.17	.0436
X4018	Satisfied nursing staff	REASSIGN	1	.19	.0147
			2	.14	.0700
X4019	Low turnover rate	REASSIGN	1	.15	.0553
			2	.18	.0261
		STARTTOT	1	-.15	.0598
			2	-.14	.0816
X4020	Give preference for certain schedules	REASSIGN	1	.20	.0147
			2	.16	.0548

ratings on these three objectives, not coincidentally, are also highly related to each other. Having a high number of starting times appears to have a mild negative correlation with having a low turnover. A high measure of place flexibility appears to have a weak negative correlation with the ability to increase staff levels quickly. Perhaps a unit that has place flexibility shares its staff on a regular basis with other units. Therefore, when staff is needed on short notice, perhaps the staff already may be committed to other units.

4.5 SUMMARY

Staffing and scheduling flexibility has been defined in Chapter I as potentially having five facets. Initial measures for four of those facets of staffing and scheduling flexibility have been presented in this chapter. Single measures have been developed for place flexibility and for reassignment flexibility. Three correlated but separate measures have been developed for time flexibility, and five measures have been developed for volume flexibility. Job flexibility measures have been left for future research. Evidence has been presented that significant correlations exist between some of the flexibility measures and some of the environmental conditions in nursing units. Limited evidence has been presented linking the importance of various operating objectives of the nursing unit to the staffing and scheduling flexibility measures. Even less evidence links the staffing and scheduling measures to the performance ratings of nurse managers. It is left to future research to refine these measures, develop new ones, if necessary, and to continue the search for links between objectives and performance.

CHAPTER V

RESULTS OF HYPOTHESIS TESTS WITH THE FLEXIBILITY MEASURES

5.1 INTRODUCTION

In Chapters I and II several hypotheses were stated about staffing and scheduling flexibility. One of the purposes of this study was to examine those hypotheses in an attempt to reject the null hypotheses. The purpose of this chapter is to show the results of the tests of those hypotheses. Table 5.1 and Table 5.2 contain the hypotheses from Chapter I and Chapter II, respectively, along with the results of hypothesis tests with the staffing and scheduling flexibility measures. Hypotheses appear in the order in which they first appeared in Chapter I and II. Hypotheses which are rejected and their implications are discussed briefly in the sections 5.2.1 and 5.2.2.

5.1.1 Review of the Staffing and Scheduling Flexibility Measures

Chapter IV contains the definitions and the development of measures of staffing and scheduling flexibility. A single measure was developed for place flexibility (PLACFLEX) reflecting the ability to exchange nursing staff with other units. A single measure was also developed for reassignment flexibility (REASSIGN) reflecting the sum of the number of times the exact staff working in the unit is determined, the number of times nursing staff are scheduled, and the number of times shift adjustments are made. Three related but separate measures were developed for time flexibility. They are RNSHIFT, which reflects the number of regular length shifts for RNs for weekdays and weekends; RNDIFF, which is the difference between the longest and shortest times likely to be worked, for weekdays and weekends; and STARTTOT, the total number of starting times for shifts on weekdays and weekends. Five measures were developed for volume flexibility. They were VOL_OFF, measuring the use of voluntary time off when adjusting to an oversupply of nursing staff; MAND_OFF, measuring the use of mandated time off when adjusting to an oversupply of nursing staff; USE_POOL, measuring the use of nursing pools when adjusting to an undersupply of nursing staff; ELIM_PTS, measuring the use of shifting patients to other units or discharging them when adjusting to an undersupply of nursing staff; and PERM_CH, measuring the number of times permanent changes are made involving hiring or firing personnel, or adding or deleting positions. No measure was developed for job flexibility. For more about how the measures were developed, see Chapter IV, section 4.3.

5.1.2 Review of Procedures Used in Hypotheses Tests

Most of the hypotheses were tested using correlational analysis. In a few cases, analysis of variance was used, if the independent variable was categorical. See Chapter 4, sections 4.2.3.1 and 4.4.1, for a discussion of the statistical tests used. See sections 3.8 and 4.2.3.3 for a discussion of the statistical power of the tests. Data for this study were collected from 348 nursing unit managers. The responses from study participants were divided into two samples, called Sample Number One (SN1) and Sample Number Two (SN2).

Table 5.1

Staffing and Scheduling Hypotheses From Chapter I Tested with Staffing and Scheduling Flexibility Measures (α =.10)

Hyp. No.	Flexibility Measure	Variables Used in Test	Results	Null Hypothesis
1.1	JOB		Not Tested	The level of **job flexibility** present in the work force is not related to the variety of services an operating unit provides.
1.2	RNDIFF, STARTTOT STARTTOT	X705 X706	Rejected Rejected	The level of **time flexibility** present in the work force is not related to the number of hours per day, and the number of days per week that a unit operates.
1.3	PLACFLEX	X22	Not Rejected	The level of **place flexibility** present in the work force is not related to presence or absence of centralized scheduling of the work force.
1.4	All TIME VOL_OFF	X32 X32	Not Rejected Rejected	Demand uncertainty is not related to the levels of **time and volume flexibility** found in the work force.
1.5	REASSIGN	X32	Not Rejected	The level of **reassignment flexibility** in the work force is not related to demand uncertainty.
1.6	JOB		Not Tested	The level of **job flexibility** is unrelated to demand uncertainty.
1.7	ALL	XT3815 XT3817	Not Rejected Not Rejected	The presence or absence of one or more types of **staffing and scheduling flexibility** is unrelated to an organizational goal of providing quick service.
1.8	RNSHIFT	X1402 X1401	Rejected Not Rejected	The number of shift lengths used (**time flexibility**) are unrelated to the skill of the work force.
1.9	STARTTOT	X1401 X1402	Not Rejected Not Rejected	The number of start times used (**time flexibility**) are unrelated to the skill of the work force.

Table 5.1 (Continued)

Staffing and Scheduling Hypotheses
From Chapter I
Tested with Staffing and Scheduling Flexibility Measures
(α =.10)

Hyp. No.	Flexibility Measure	Variables Used in Test	Results	Null Hypothesis
1.10	RNSHIFT STARTTOT	X2001 X2001	Not Rejected Rejected	The scarcity of the work force is unrelated to the number of shift lengths, and start times used **(time flexibility)**.
1.11		X22 versus X24	Not Rejected	The use of computers in the scheduling process is unrelated to the degree of centralization of the scheduling process.
1.12	RNSHIFT RNDIFF STARTTOT	X24 X24 X24	Not Rejected Not Rejected Not Rejected	The use of computers in the scheduling process is unrelated to the number of scheduling options **(Time Flexibility)**.
1.13	REASSIGN	RNSHIFT RNDIFF STARTTOT	Rejected Not Rejected Not Rejected	The frequency with which schedules are generated (**reassignment flexibility**) is unrelated to the number of scheduling options (the level of **time flexibility**) available.
1.14		STAFALL (X1606) versus X24	Not Rejected	The size of the work force being scheduled is unrelated to the computerization of the scheduling process.
1.15		X1704 and X1707 versus X24	Not Rejected Not Rejected	The proportion of workers with permanent work assignments and permanent work shifts is unrelated to the computerization of the scheduling process.
1.16		X32 versus X24	Not Rejected	Demand uncertainty is unrelated to the computerization of the scheduling process.
1.17		SHIFTADJ (X410) versus X32	Not Rejected	The frequency of last minute adjustments to the schedule is unrelated to demand uncertainty.

Table 5.1 (Continued)

Staffing and Scheduling Hypotheses
From Chapter I
Tested with Staffing and Scheduling Flexibility Measures
(α =.10)

Hyp. No.	Flexibility Measure	Variables Used in Test	Results	Null Hypothesis
1.18		X309 versus X22	Rejected	The degree of control over the scheduling process held by first-line managers is unrelated to the centralization of the scheduling process.
1.19		X1503 versus PT_TECH	Rejected	The degree of orientation to the work place required for employees is unrelated to the level of technology in the work place.
1.20		X1503 versus CAPINTEN	Rejected	The degree of orientation to the work place required for employees is unrelated to the level of capital intensity.
1.21	MAND_OFF	XT3801	Rejected	The presence of **time and volume flexibility** is unrelated to a goal of cost containment.
	All other VOLUME	XT3801	Not rejected	
	All TIME	XT3801	Not Rejected	
1.22	PLACFLEX	XT3813	Not Rejected	The presence of **place and job flexibility** in the work force is unrelated to a goal of high quality operations.
	JOB		Not Tested	

Table 5.2

Staffing and Scheduling Hypotheses From Chapter II Tested with Staffing and Scheduling Flexibility Measures (α =.10)

Hyp. No.	Flexibility Measure	Variables Used in Test	Results	Null Hypothesis
2.1	JOB		Not Tested	The presence of job flexibility in the work force is unrelated to skill level of the work force.
2.2	JOB		Not Tested	The presence of job flexibility in the work force is unrelated to the employee turnover rate.
2.3		X1705 and X1706 versus X4106	Not Rejected Rejected	For continuous operations, the methods used to generate weekend schedules are unrelated to the presence of employee unions.
2.4	JOB VOL_OFF MAND_OFF USE_POOL	X3607 X3607 X3607 X3602	Not Tested Not Rejected Not Rejected Not Rejected	The level of variability in demand from day-to-day and week-to-week is not related to volume or job flexibility in the work force.
2.5		For X3602≤2, & for X3607≤2, XT3801 versus X1406 and X1407	Not Rejected Not Rejected	In the presence of cyclical and highly variable daily demands, an organizational goal of cost containment is unrelated to the mix of full-time and part-time workers employed.
2.6	RNSHIFT RNDIFF STARTTOT	For X3602≤2, & for X3607≤2, TIME flexibility versus X1406	Not Rejected	In the presence of cyclical and highly variable daily demands, the proportion of full-time personnel employed is unrelated to the time flexibility of the work force.
2.7		X3602 and X3607 versus SCHEDULE	Not Rejected Not Rejected	Variability in demand is unrelated to the frequency with which schedules are generated.
2.8	RNDIFF STARTTOT	RNSHIFT	Rejected Rejected	The number of shifts being scheduled is unrelated to the level of time flexibility present in the work force.

Table 5.2 (Continued)

Staffing and Scheduling Hypotheses
From Chapter II
Tested with Staffing and Scheduling Flexibility Measures
(α =.10)

Hyp. No.	Flexibility Measure	Variables Used in Test	Results	Null Hypothesis
2.9	All VOLUME	XT3815	Not Rejected	The level of volume flexibility in the work force is unrelated to an organizational goal of providing outstanding service.
2.10	MAND_OFF	XT3801	Rejected	An organizational goal of cost containment is unrelated to the level of time, job, place or volume flexibility found in the work force.
	All other VOLUME	XT3801	Not Rejected	
	All TIME	XT3801	Not Rejected	
	PLACFLEX	XT3801	Not Rejected	
	REASSIGN	XT3801	Not Rejected	
	JOB		Not Tested	
2.11	STARTTOT	X3602,X3607	Not Rejected	The level of demand variability is unrelated to the combination of time and job flexibilities found in the work force.
	RNDIFF	X3602, X3607	Not Rejected	
	RNSHIFT	X3602, X3607	Not Rejected	
	JOB		Not Tested	
2.12	PLACFLEX	X22	Not Rejected	The number of locations being scheduled together is unrelated to the level of place flexibility in the work force.
2.13	JOB		Not Tested	The level of job flexibility in the work force is unrelated to the performance of organization goals.
2.14		For X3602 and X3607		The combination of demand variability and the goal of accomplishment of certain activities on a timely basis is unrelated to time and volume flexibility.
	STARTTOT	XT3815	Not Rejected	
	RNDIFF	XT3815	Not Rejected	
	RNSHIFT	XT3815	Not Rejected	
	PLACFLEX	XT3815	Rejected	
	USE_POOL	XT3815	Rejected	
2.15		For X3602=4 & for X3607=4		The organizational goal of good customer service in combination with seasonal demand is unrelated to the level of time, job, or volume flexibility in the work force.
	All TIME	XT3815	Not Tested	
	All VOLUME	XT3815	Not Tested	
	JOB		Not Tested	

See section 1.4.3.3 for more details involving this data split. All hypotheses were first tested in SN1. If a statistically significant result was obtained in SN1, the result was verified in SN2. Results are reported in this chapter only if there was statistical significance in both samples and the signs matched. Because this is an exploratory study, an $\alpha=.10$ was chosen as the significance level for the hypothesis tests.

5.2 DISCUSSION OF REJECTED HYPOTHESES

This section contains a brief discussion of the hypotheses in Tables 5.1 and 5.2 for which the null hypothesis was rejected. None of the hypotheses relating to job flexibility were tested because of the inability to develop measures for job flexibility with the data in this study. In addition, hypothesis 2.15 was not tested. There were too few units who indicated variability in demand that could be called seasonal , so a meaningful hypothesis test could not be conducted. In general, for nursing units in this study, variability in demand fluctuated by shift, by day, by week, or it fluctuated very little at all. Correlations of the flexibility measures with the variables in the hypotheses in Tables 5.1 and 5.2 were examined. Some of the hypotheses in Tables 5.1 and 5.2 did not involve the flexibility measures. The correlations for the variables investigated in these hypotheses were also examined.

5.2.1 Hypotheses from Chapter I

Hypothesis 1.2, that the level of time flexibility present is not related to the number of hours per day and the number of days per week, was rejected because two of the variables measuring time flexibility, RNDIFF and STARTTOT were significantly correlated with the characteristic of being open seven days a week, and STARTTOT was correlated with being available 24 hours a day. This result lends support to the argument that more time flexibility is needed if a service sector organization operates around the clock, seven days a week.

Only one measure of volume flexibility, VOL_OFF, correlated with the rating of demand uncertainty to give slight evidence that hypothesis 1.4 should be rejected. The fact that other measures of volume flexibility and no measures of time flexibility were related to the rating of demand uncertainty means that the rejection is a very weak one.

Hypothesis 1.8, that the skill level of the work force is not related to the number of shift lengths used, is rejected because there is a positive correlation between the proportion of RNs with BSNs in a unit and the number of shifts lengths. The reason for this could be the scarcity reason cited in Chapter IV. RNs with BSN are not only the highest skilled nursing personnel likely to be found in a nursing unit, but the the most scarce of any category of nursing staff. They may be dictating their terms, with include starting at a variety of times. A related result is the rejection of hypothesis 1.10, that the scarcity of the work force is unrelated to the number of start times. Units which experience more frequent shortages of RNs have more start times.

The measure of reassignment flexibility is mildly correlated with the time flexibility measure, RNSHIFT. This correlation is shown in Table 4.5. However, the measure REASSIGN is not correlated with the other measures of time flexibility, so hypothesis 1.13, that the frequency with which schedules are generated is unrelated to the number of scheduling options, is not strongly rejected.

Hypothesis 1.18, that the degree of control of the first-line manager over the scheduling process is unrelated to the centralization of the scheduling process, is rejected. There is a strong negative correlation, about -.3 in both samples, between the responsibility of the nurse manger for scheduling and the centralization of the scheduling process.

There is evidence to soundly reject hypothesis 1.19, that the need for unit orientation is unrelated to the level of technology in the work place. There is a very strong correlation, +.57, in both samples, between the need for unit orientation and the measure of patient technology developed in Chapter IV. Similarly, there is a very strong correlation, over +.5, between the need for unit orientation and the capital intensity measure developed in Chapter IV. These results would indicate that there is a higher need for nursing staff to be oriented to the unit in critical care units. This need for unit orientation would be a barrier to place flexibility and the use of nursing pools, and may explain why other flexibilities, such as time flexibility are found in such units.

Hypothesis 1.21, stating that a goal of cost containment is unrelated to the presence of time and volume flexibility is only weakly rejected. The only measure of volume flexibility that correlates with a goal of cost containment is the policy of mandating time off, and that correlation is only about .17. No other measures of volume or time flexibility correlate with this goal.

5.2.2 Hypotheses from Chapter II

Most hypotheses coming from Chapter II, which originated in the operations management scheduling literature, were not rejected. One which was mildly rejected was hypothesis 2.3, that states that methods used to generate weekend schedules are unrelated to the presence of employee unions. There is evidence in this study that having nursing staff permanently assigned to weekends is correlated, +.16 or more, with the presence of unions for nursing staff. This result could have occurred by chance, if hospitals with union members also happened to have nursing staff permanently assigned to week ends. The proportion of nursing staff who work some required weekends was not related to the presence of unions.

Hypothesis 2.8, that the number of shifts being scheduled is unrelated to the level of time flexibility present, is difficult to test, because one of the measures developed for time flexibility, RNSHIFT, is the number of shift lengths nursing staff work. However, there is evidence to reject hypothesis 2.8, because the measure RNSHIFT is correlated with the other measures of time flexibility, RNDIFF (+.3), and STARTTOT (+.4).

Hypothesis 2.10 is actually an expanded version of hypotheses 1.21, in which the lack of relationship between a goal of cost containment and time and volume flexibility measures could only be rejected for the mandatory time off measure. Measures of place and reassignment flexibility do not exhibit relationships with cost containment either.

There is some slight evidence to reject part of hypothesis, 2.14, that the combination of demand variability and the goal of accomplishment of certain activities on a timely basis is unrelated to time and volume flexibility. It was tested performing ANOVAs for each category of response to the questions about the variability in total number of patient beds filled (X3602), and in variability in timing of the peak demand for nursing services (X3607). The importance of the goal of responding to patient requests within a certain time was treated as the independent variable, and each of the time and volume flexibilities were treated as the dependent variables, in turn. Units with a year to year variability in the number of beds filled had mean measures for place flexibility different by importance of the timely response to patient requests, for a significance of .10 (the p-value of F was .0957 in SN1, and .0857 in SN2.) Units for whom timely response to patients' requests was less important had lower measures of place flexibility.

A similar result was found for units with a day to day variability in the timing of peak demand for nursing services. There was a significant difference in the use of nursing pools, by importance of the timely response to patients' requests. However, the results were the opposite in SN1 and in SN2. In one sample, the units to whom timely response was less important scored higher on the USE_POOL measure, and in the other sample, units to whom timely response was more important scored higher on USE_POOL. Altogether, there is little evidence to reject hypothesis 2.14 at all.

5.3 SUMMARY

This researcher had hoped that more hypotheses could be rejected, and that stronger evidence would be available for those hypotheses that were rejected. It is possible that time flexibility and reassignment flexibility are so prevalent in the hospital industry that the data collected in this study do not provide measures for the other flexibilities that are strong enough to be used in hypothesis testing. However, this research study had presented baseline measures with which to measure staffing and scheduling flexibilities, and some hypotheses involving these measures have been tested. Future research can refine these measures so that these and other hypotheses related to staffing and scheduling can be tested. One avenue of future research will use this database to develop a total measure of staffing and scheduling flexibility. The ideal measure will allow the components of the measure to be examined to see just how much each type of flexibility contributes to the total. In this same vein of research, the nursing units possessing high flexibility measures for one type of staffing and scheduling will be examined to see if they are correspondingly low on others. If units with high time flexibility are selected out of this particular database, it is possible that relationships between various environmental and staffing variables and the other kinds of flexibility will become more apparent.

CHAPTER VI

CONCLUSIONS AND FURTHER RESEARCH

6.1 CONCLUSIONS FROM THE STUDY

6.1.1 A View of the Relationships Between Objectives, Staffing and Scheduling Flexibilities, and An Organization's Performance

The premise of this researcher is that objectives of an organization and the characteristics of its operating environment consciously or unconsciously shape the staffing and scheduling policies used by the organization. In turn, these staffing and scheduling policies influence the accomplishment of the organization's objectives. This relationship is not necessary straightforward. The view of these relationships currently espoused by this researcher has evolved from this study and is illustrated in Figure 6.1.

The environment will certainly play a role in determining the objectives of an organization. Sequentially, the chosen objectives are likely to shape the part of the environment that is under the organization's control. The objectives and the controllable part of the environment also determine what the staffing strategies and scheduling policies will be. These staffing strategies and scheduling policies are a determinant of the types of staffing and scheduling flexibilities present in the work force. How well or poorly an organization performs on its objectives is the result of many factors, some of which are not

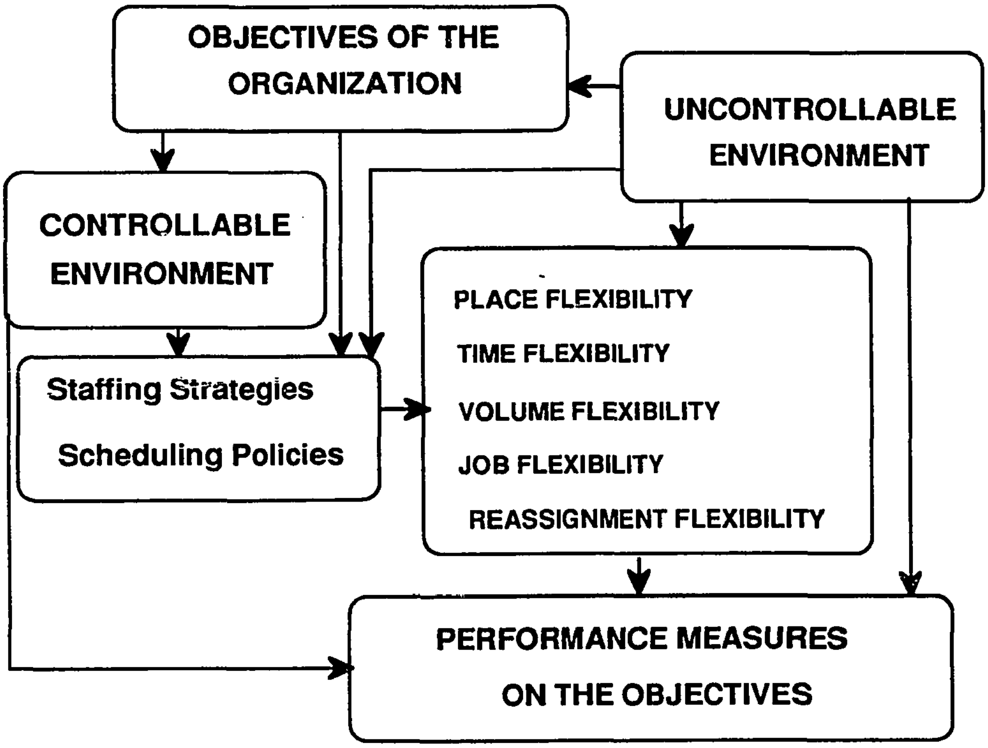


Figure 6.1

A Model for Relationships between An Organization's Objectives, The Environment, Staffing and Scheduling Flexibilities and Performance Measures

under its control. The set of staffing and scheduling flexibilities is only one influence on performance ratings. However, the uncontrollable part of the environment also influences staffing and scheduling policies, as many such policies are in place in order to gain control of the uncontrollable and to buffer against uncertainty. The uncontrollable part of the environment also exerts a direct influence on the organization's performance of its objectives. This study shows that clear linkages between an organization's objectives, its staffing and scheduling actions, and the performance on those objectives are not easy to establish.

The service sector covers a very wide spectrum of businesses and organizations, with a myriad of characteristics along multi-dimensional continuums. Because of this variety it is entirely possible that some of the facets of staffing and scheduling flexibility are more apparent in some service sector industries than in others. In the hospital industry, the nursing service contingent seemed to possess clearly measurable time flexibility, place flexibility, and reassignment flexibility. Some of the dimensions of volume flexibility also appeared to be measurable. However other dimensions of volume flexibility, such as the frequency of the use of overtime, might appear to be more measurable in other service industries that did not exhibit such heavy use of time, place, and reassignment flexibility.

It also may be possible to link goals to various staffing and scheduling flexibilities, and those flexibilities to performance measures, by examining a single flexibility measure at a time. Surely this is one avenue for future research. It also is possible that linkages from operating goals to performance measures are so complex that decisions and their effects will have to be traced, much like following an audit trail. The data collected in this study might not be in the right form to perform such an exercise, but that avenue also exists for future research. More possibilities for future research with this database and its extensions are discussed in section 6.2.

6.1.2 Review of Significant Contributions

One of the contributions of this study is the framework given in Chapter I for strategic and tactical issues related to staffing and scheduling (see Tables 1.1 and 1.2). This researcher has no argument with those who would consider the strategic issues of staffing and scheduling as a subset of process design issues. No matter what they are called, the set of decisions given in Table 1.1 has ramifications for how capacity will be utilized, how customer service will be performed, and how the quality of the service is perceived by the customer. The results of the set of decisions in Table 1.1, whether made consciously or by default, dictate to whom the assignments listed in Table 1.2 will be made. What skills the work force will have, and what hours and days they will be available, and how they will be compensated surely will influence how the objectives of the organization will be carried out. There are many decisions to be made when designing a work force staffing and scheduling system, and this researcher invites other researchers and operations management scholars and practitioners to add to the list presented in Chapter I.

A second contribution is the definition of the concept of staffing and scheduling flexibility. Staffing and scheduling flexibility was defined as having five facets: job, volume, time, place, and reassignment. No other operations management researcher or writer known to this researcher has defined this concept. Not only has staffing and scheduling flexibility been defined but measures have been developed for four of the five facets of staffing and scheduling flexibility as it is defined in Chapter I, and illustrated in Figure 1.3. This researcher invites others to propose additional flexibilities for service sector work forces.

A third contribution is the development of the research instrument. This questionnaire can serve as a basis for development of research instruments for additional studies of staffing and scheduling flexibility and other issues in the service sector. Other researchers wishing to collect empirical data from service sector organizations can adapt this questionnaire or at least learn from the successes and failures of this researcher. A copy of the research instrument is shown in Appendix A.

A fourth contribution stems from the second and third contributions. The research instrument was used to collect data with which measures of four of the five facets of flexibility were developed. The measures for reassignment flexibility and for the three dimensions of time flexibility have as their bases real numbers. Reassignment flexibility is measured by a single variable whose value reflects the total sum of the approximate number of times in a year the exact staff working in a unit is determined plus the number of times nursing staff are assigned new schedules plus the number of times last minute shift adjustments are made to accommodate changing demand.

Time flexibility is measured by three variables. One of those variables represents whether there are one or more than one regular shift lengths for RNs both during the week and during the weekend. A second time flexibility measure is based on the total number of starting times for shifts for weekdays and weekends. A third flexibility measure represents the total difference between the longest and shortest period likely to be worked for weekdays and weekends. See Table 4.6 for the ranges and other statistics involving these variables. One of the measures of volume flexibility, the one reflecting the frequency with which permanent changes are made, is also based on an approximation of the total number of times hiring, firing, adding positions, and deleting positions is done in a year.

The measures for the place flexibility variable and for the variables representing the remaining four of five dimensions of volume flexibility have measures that are based on an arbitrary scale. This arbitrary scale could be adjusted to any scale a researcher desired. A relatively high value for the measure would indicate a great likelihood of using that strategy or action when adjusting for mismatches between the supply and demand of nursing staff. These measures and their development are discussed extensively in Chapter IV.

Earlier speculation by this researcher suggested the strong possibility of interaction between the flexibility measures. Table 4.5 bears out the presence of some correlation between these measures, but it is not as great as this researcher expected. Place flexibility does seem to correlate highly with the three dimensions of time flexibility, as well as with the volume flexibility measure related to the use of nursing pools. These results are not unexpected. Further investigations are planned which will treat the units in the study as subjects in an experimental design, and interaction between the four types of flexibility will be examined more thoroughly.

A fifth contribution was the development of a nonproprietary database on hospital nurse staffing and scheduling. Summary statistics are presented in Appendix C and discussed in Chapter III. Results of analyses for different types of nursing units based on patient acuity also are discussed in Chapter III. Tables for results of these analyses are shown in Appendix D. Much of Chapter

III focuses on the differences between units offering acute care only, critical care only, and both acute and critical care. The statistical differences found between these types of units parallel known managerial differences in acuity of patients, capital intensity of the environment, and in types of staff. Scheduling differences were not so evident.

Differences in the importance of various objectives were not statistically distinguishable from one type of unit to the next, with the exception of the objective of utilizing expensive equipment in the unit which was more important to critical care units. Self performance ratings on the objectives also did not vary significantly by type of unit, except for the performance rating on the utilization of expensive equipment, for which critical care units rated themselves more highly. Units which are highly capital intensive not only seem to consider it important to utilize the expensive equipment in their units; they seem to think they do a good job at it, as well.

The goal of the study, stated in Chapter I, of developing linkages between the operating environment, the organization's objectives, and staffing and scheduling policies was only partially achieved. Measurable differences existed in the environments and the types of staff, but not in the schedules. Some objectives and some performance ratings were linked to some staffing and scheduling flexibilities. However, the staffing and scheduling flexibilities did not serve to link objectives with performance ratings.

A lesser contribution is a comprehensive review of service sector characteristics gathered from many sources, and shown in Chapter 2, Table 2.1. In addition, the operations management staffing and scheduling literature, the great majority of which is modelling based, is briefly reviewed and hypotheses about staffing and scheduling flexibility are extracted from the modeling literature. These hypotheses, shown in Table 2.5, for the most part are not given in the articles referenced, but are this researcher's view of the hypotheses that would have to be rejected if the model under discussion is to have real world application. Many of the hypotheses created in this manner were not rejected (see Table 5.2). However, this lack of rejection can be attributed to one of at least three reasons. One of these reasons is that this researcher may have misconstrued the situation necessary for the model to have applicability. A second reason may be that the model does not have applicability in real service sector situations. A third possibility is that the variables collected in this study, which was performed in hospital units, or the values of the variables themselves, do not apply to the hypotheses. A different set of hypotheses might be rejected if a different service sector industry were chosen. In other words, the hypotheses proposed in Table 2.5, and similarly in Table 1.3, may not have universal applicability in the service sector due to the diversity of the service sector.

6.1.3 Review of Significant Findings

After measures for staffing and scheduling flexibility were developed they were used to test the hypotheses proposed in Chapters I and II. They were also used to investigate relationships with other staffing variables and with other characteristics of the environment of hospital nursing units.

The study was able to link the importance of some objectives to some of the flexibility measures developed. Some of the measures of volume flexibility were related to the importance of cost-related objectives. The strategy of mandating time off in the event of an oversupply of nursing staff was positively related to the importance of the goal of cost containment. The strategies of mandating time off and of asking for voluntary time off in the event of an oversupply of nursing staff were positively related to the importance of the goal of being able to decrease staff levels quickly. It would appear that units to whom cost containment is important do not want to pay employees when they are not needed. Similarly, units to whom the ability to have fewer nurses on hand, given short notice, would logically want to send those nurses home when they are not needed. If they won't go voluntarily, their departure is mandated. The strategy of using nursing pools in the event of an undersupply of nursing staff is positively related to the importance of staying within budget. Nursing units to whom the budget "bottom line" is important presumably do not want to keep an oversupply of nursing staff on the regular payroll. Units to whom it is important to be able to increase staff quickly also show a greater inclination to use the mandatory time off policy as a means of volume flexibility. This finding reflects an approach that is the opposite of use of nursing pools. If a unit wants to be able to increase its staff quickly, it may keep many nurses on the roster as regular employees, but reserves the right to send them home when they are not needed, whether they wish to go or not. The importance of being able to match needed to actual staff is also related to the volume flexibility measure of frequency of the use of voluntary time off. It is interesting to note that the importance of a satisfied nursing staff was related to the policy of asking for volunteers to take time off in the event of an oversupply of nurses, thus reflecting a humanistic note.

Not surprisingly, the importance of the goal of achieving a certain level of quality is negatively related to the time flexibility measure reflecting the total number of RN shift lengths. Units to whom quality level is most important have fewer RN shifts. It may be more difficult to control the quality level when a nursing unit has employees working a number of shift lengths because the supervision of some of the employees may fall to more than one supervisor during the employee's normal shift. In addition, employees who work long hours may suffer fatigue, and adversely affect quality.

There are indications of some relationships between the environment and the staffing and scheduling flexibilities. These findings include statistically significant relationships between time flexibility and the number of days of the week and hours of the day that nursing units operate, and between time flexibility and the skill level of the work force. Time flexibility also has a positive relationship to the scarcity of the work force. Reassignment flexibility is positively related to a good performance in keeping employee turnover low. A higher need for orientation to the work place accompanies higher levels of capital intensity and technology. These results and others are summarized in Tables 4.7 through 4.10., and in Tables 5.1 and 5.2.

In addition, data are presented in Appendix D showing differences among different types of nursing units based on patient acuity. Statistically significant differences are found in patient characteristics, the nursing unit environment, and in staff characteristics.

6.1.4 Objectives Accomplished

This study set out to develop five measures of staffing and scheduling flexibility. Initial measures were developed for four types of staffing and scheduling flexibility. These measures have been discussed in detail in Chapter IV. Several hypotheses were proposed that would be tested with these measures. The results of the tests of these hypotheses were discussed in Chapter V.

It may be concluded from this study that work force flexibility, while clearly present in many hospital nursing units, is a difficult concept to measure precisely. It is even more difficult to measure the links between work force flexibility and the objectives of the nursing unit, the nursing unit environment, and the effect of work force flexibility on the accomplishment of organizational goals and objectives. Further research is needed to improve measures representing the controllable and noncontrollable influences on staffing and scheduling flexibilities, and on an organization's performance.

6.1.5 Additional Comments on the Measures

Relatively simple measures for place flexibility and for reassignment flexibility have been developed in this study. Limited evidence suggests that place flexibility may be linked to the importance of a few objectives but there is also slight evidence that the presence of place flexibility actually may decrease performance on several other objectives. More work is needed here to clarify the role of place flexibility, and to refine its measurement. The presence of reassignment flexibility does not appear to be linked clearly to the importance of any objectives, but there is strong evidence that greater reassignment flexibility is useful to many nursing managers in accomplishing objectives of a satisfied nursing staff, having a low turnover, and considering nursing staff preferences for certain schedules. Further studies would be useful in confirming this finding.

Measures for time flexibility and volume flexibility are not so simple, and seem to have several facets themselves. The "measure" for time flexibility involves the measurement of the number of different shift lengths available for which employees must or may be scheduled, the number of starting times for shifts, and the difference between the longest and shortest periods likely to be worked. Further research is needed to show if these measures are enough, too few, or too many to capture the essence of time flexibility. Slight evidence suggests that high time flexibility measures may have negative correlations with the importance of goals related to quality. There is stronger evidence that one of the measures in particular, the number of regular shift lengths for RNs, appears to have a negative correlation with the importance of the objective of achieving a certain level of quality of care. It should be noted that this particular objective received a very high rating of importance from all respondents, but apparently, it is slightly less important in nursing units that have multiple shift lengths than in those that have only one shift length. It should also be noted that none of the time flexibility measures seem to be correlated at all with the performance ratings on any of the quality objectives. The effect of time flexibility on measures of performance appears mixed. There is some evidence to suggest that having a large number of starting times may decrease the nurse manager's ability to have a low turnover among the nursing staff. There is less conclusive evidence that suggests that a large number of start times have a detrimental effect on the performance of several objectives, while the other two facets of time flexibility may have a positive effect on several objectives. Clearly, more research is needed here to clarify these relationships.

Volume flexibility was more difficult to measure in this study. Results of the current study show that a variety of strategies are employed for coping with changes in volume. One evident strategy is the use of temporary nursing services, either from a pool established within the hospital, or from an agency outside the hospital. Voluntary time off and mandatory time off for nursing staff members seem to be two other strategies for coping with changes in volume of services demanded. Strangely, the counterparts of these actions, voluntary and mandatory overtime or loss of time off, do not seem to be measurable in the current study, at least not with the statistical techniques that were employed. A fourth strategy, weakly measurable here, is the elimination of patients, or the off-loading of demand. Patients are sometimes discharged or shifted to other units in order to cope with demand exceeding capacity. Apparently, the declining of new admissions is not a part of that strategy, nor is its counterpart, the soliciting of new admissions. Similarly, the strategy of making permanent changes, that is, hiring or terminating of employees, or adding and deleting positions was only weakly measurable. These five strategies for dealing with changes in volume of demand appear to be unrelated. That is, use of one does not suggest or preclude use of another. As with time flexibility, further research is needed to show if these measures are enough, too few, or too many to capture the essence of volume flexibility.

6.2 SUGGESTIONS FOR FURTHER RESEARCH

Many questions remain unanswered at this point in the project. An analysis of the data collected in this research study has suggested a number of avenues for a continuing stream of research. First, additional analyses will be conducted on the existing data. This study has concentrated on examining staffing and scheduling flexibility at the nursing unit level. Because policies for staffing and scheduling are frequently made at a higher level than the unit level, an examination will be made of similarities within hospitals, and a comparison will be made between hospitals. Four hospitals had enough units participate in the study that cell sizes are sufficient for analysis of variance to be carried out using the original two sample plan. Preliminary investigations in this direction indicate that importance of various objectives for nursing units varies from hospital to hospital, as would be expected in a competitive environment. Linkages between objectives and staffing and scheduling strategies that were not apparent at the nursing unit level may come to light when examined at the hospital level.

In addition, the role of hospital demographics in staffing and scheduling will be investigated in greater detail than it was in this study. Some of the characteristics whose effects are to be investigated are the presence or absence of nursing unions, the designation of "teaching hospital," the size of the hospital in number of beds, and the average daily patient census.

Additional analyses of existing data also will be performed by extracting subsets of the data having a particular characteristic, such as multiple shift lengths for RN staff, or high variability in operating variables or a high rating on performance of certain objectives. Units with the given characteristic will be compared with units lacking in the given characteristic, to see if particular staffing and scheduling patterns and certain patterns of environmental variables occur. Logistic regression is one possible statistical technique that will be applied in this analysis. A further analysis will involve individual types of nursing units, such as medical-surgical units, coronary care units, or obstetrics units in order to compare staffing patterns and scheduling practices.

Another unresolved issue of some importance is alluded to in Figure 1.1. The question of whether flexibility resides in the work force or in the organization remains unanswered at this point. Some hospitals are offering time flexibility because their potential work forces are in short supply and are dictating terms to the hospitals. On the other hand volume flexibility may reside with the work force and may apply only to work forces not in a state of scarcity. Place flexibility may be available in the work force, but the organization does not take advantage of it. Reassignment flexibility may be necessary due to turnover of clients. Does each facet of staffing and scheduling flexibility have an organizational side and a work force side? Or can the facets only be measured when the organization takes advantage of a particular facet? These are questions which may or may not be answerable with the current database, but which need resolution if research on this topic is to continue.

Two types of follow-on studies are planned at this time. First, data will be collected from additional hospitals in order to confirm the stronger findings presented herein, as well as to clarify other relationships suggested by the data. The survey research instrument will be revised in order to reflect the need for some additional types of data, and the elimination of some questions. Second, hospitals participating in the original study may be asked to participate in a longitudinal study so that changes over time can be analyzed. In-depth case studies of several units from the original study may be conducted in order to better understand the operational implications of ongoing changes in the health care industry. An attempt will be made to measure the effects of such changes on the need for staffing and scheduling flexibility.

In the long term, this researcher plans to revise the survey instrument so that data may be collected from other service sector organizations in order to refine the concept and measurement of staffing and scheduling flexibility. The scope of service operations will be enlarged to include services provided by firms whose primary classification is manufacturing. As competitive organizations embark upon the decade of the nineties, trends toward more automation, higher quality products, lower inventory levels, better communications with vendors and customers, and an emphasis on excellent customer service are apparent in both the service and manufacturing sectors. As more automation is used in both sectors, those jobs remaining for humans are likely to require one or more kinds of staffing and scheduling flexibility. The human work force increasingly will be called upon to act as a buffer against uncertainties in demand that cannot be eased by better communications and technology. Many workers will be required to have high job skills and the ability to a respond to a wide variety of situations. Use of employment pools of temporary workers will become even more commonplace as "permanent" solutions to "temporary" aberrations of demand.

From conversations over the past year and a half with nurse managers and floor nurses, this researcher speculates that over the next decade hospital nursing services will continue to shift "out of the hospital" toward the formation of more nursing pools that will service one or more hospitals in large metropolitan areas. The drive to contain costs may well result in the breakout of the costs of nursing services away from the room charge where such costs have long resided as part of the "overhead." Many hospitals have already moved in this direction. Such a move does not necessarily reduce costs to the patient, but it lowers the hospital's "pass-through" costs to the patients because now nursing services can be billed separately, just as medical services have been for a long time. Hospitals may well cease to be the employers of nurses. Most nurses will work for nursing services who contract with hospitals to meet a certain level of demand at a certain price. If the supply of RNs remains scarce, RNs may well dictate their terms of time and place to the nursing services instead of the hospital. The services, which are likely to supply a number of hospitals, will be able to absorb aberrations in demand better than a single hospital. This spreading of the variance already has contributed to the formation of many in-house pools. However, once hospitals give up the direct hiring of nurses and learn the joys of dealing only with one (or a few) central agency for the supply of nursing staff, this researcher predicts the hospitals will be happy to be rid of the problem of staffing. They will be happy to "place an order" daily or weekly with the nursing service. Nursing services will probably reward employees financially who are willing to be flexible with respect to time. In fact, employees who are flexible with respect to time may have to be flexible with respect to place or job. It could well be that one or more types of flexibility will be required for those employees of nursing services.

One other comment indirectly related to the results of this study is that with the current shortage nurses are in a position of strength and they can heavily influence their own working hours. What has happened in the past is that when shortages of nursing personnel diminish, the hospitals stop offering the flexible hours to nurses. Nurses have traditionally liked to work hours like twelve hour shifts on weekends if it means they don't have to do it as often. When these types of schedules are withdrawn, the nurses who really wanted to work certain schedules are likely to withdraw from the profession and soon the condition of scarcity has reappeared. Nursing is a profession with strong entry barriers, such as education and licensure. The compensation is generally not high enough to serve as an effective exit barrier, so working a schedule that pleases them and that is not available in another profession is one of the things that keeps hospital nurses in the profession. Hospitals who return to dictating the nursing schedules, instead of allowing themselves to be dictated to by their nurses probably hasten the reappearance of a nursing shortage, at least at the local site.

This research has contributed a framework with which to consider staffing and scheduling concerns. In addition, initial measures for four types of staffing and scheduling flexibility have been developed. This researcher contends that organizations that consider staffing and scheduling related issues as part of their overall operations strategy are far more likely to be successful in the coming decade. It is the hope of this researcher that this study has contributed to the understanding of work force staffing and scheduling issues.

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APPENDIX A

THE RESEARCH INSTRUMENT

The Ohio State University

Hospital Nurse Staffing and Scheduling Survey

The Ohio State University

Hospital Nurse Staffing and Scheduling Survey

Dear Nurse Manager:

Thank you for your willingness to participate in this survey. This questionnaire is for a research project being conducted at Ohio State University. It is designed to be answered by nurse managers in hospitals, and will take about 40 minutes to complete. Your hospital has granted permission for you to participate.

The **purpose** of this research project **is to gain insight into the staffing and scheduling practices of hospital nursing units,** and the relationships between those practices and the environment in which the nursing unit operates. **You, as a nurse manager, can provide valuable input about your unit,** its practices, its goals, and its operating environment. There are many different ways in which goals may be accomplished, and each hospital operating environment has its own special characteristics so there are no "right" or "wrong" answers to these questions. **We need your response to make our study a success.** Please answer the questions as they relate to the unit for which you have primary responsibility. Should you manage more than one unit, please answer for the unit that consumes the largest portion of your time.

If you have any questions about the study or the questionnaire, please call Sue P. Siferd at 614-457-7761 or 614-292-5233 or Larry P. Ritzman at 614-292-0258. If you would like a copy of the results, please complete the attached postcard with your name and address. **Responses will be held in the strictest confidence,** and results will be reported only for summary data and aggregated results. ***Your name will not be linked with this questionnaire in*** any way. By returning the questionnaire, your consent to participate is implied.

Please send the completed questionnaire to Sue P. Siferd, Management Sciences Department, 301 Hagerty Hall, 1775 South College Road, Ohio State University, Columbus, Ohio 43210-1399. **A self-addressed, postage-paid envelope is included** for your convenience. **Please return the questionnaire within two weeks.**

Again, thank you for your time and effort. We value your thoughtful participation.

Larry P. Ritzman
Professor of Operations Management

Sue P. Siferd
Project Coordinator

The Ohio State University
1775 South College Road
Columbus, Ohio 43210-1399

Hospital Nurse Staffing and Scheduling Survey

Most of the questions in this survey relate to your unit. A **few** questions **deal** with **your entire hospital.** In the context of this questionnaire, **a unit has a nurse manager,** head nurse or nursing supervisor. In your hospital, a unit may be called a ward, wing or floor. Some **examples of units,** as the word is used in this questionnaire, are Medical, Surgical, Intensive Care, Cardiac Care, Oncology, Gynecology, Maternity, Young Adult, Neonatal nursery, and Burn units.

If you are associated with more than one unit, **please answer with reference to the unit which consumes most of your time. Please answer all questions.** If you do not know an exact answer, **please use your best judgment** to give an approximate answer. If a question is clearly irrelevant to your hospital or unit, please answer "NA" for "Not Applicable."

All information furnished by you about your hospital and your unit will be kept strictly confidental.

YOUR POSITION AND MANAGEMENT RESPONSIBILITIES

1. Title of your Position ________________________________

2. Which of the following best describes the scope of your nursing management responsibilities?
   - ☐ Manage all nursing staff in the hospital
   - ☐ Manage nursing staff in more than 5 units but not the entire hospital
   - ☐ Manage nursing staff in 2 to 5 units
   - ☐ Manage nursing staff in 1 unit
   - ☐ Assist in management of nursing staff in 1 or more units
   - ☐ Other responsibility

3. What is the level of your involvement in the following decisions:

	Have full responsibility	Have partial responsibility	Make recommendations	Have no input
Hiring new nursing staff	☐	☐	☐	☐
Terminating nursing staff	☐	☐	☐	☐
Adding new nursing positions	☐	☐	☐	☐
Deleting nursing positions	☐	☐	☐	☐
Authorizing nursing overtime	☐	☐	☐	☐
Authorizing use of temporary nursing staff	☐	☐	☐	☐
Making nursing assignments for patient care	☐	☐	☐	☐
Determining the exact nursing staff working in your unit daily	☐	☐	☐	☐
Scheduling nursing staff in your unit	☐	☐	☐	☐
Making shift adjustments to the schedule	☐	☐	☐	☐
Deciding compensation levels for nursing staff	☐	☐	☐	☐
Determining the operating budget for your unit	☐	☐	☐	☐

4. **Which range best approximates** the **number of times** the following decisions are made or actions are taken in your unit during **a one year period?**

	0-1	2-9	10-29	30-99	100-400	Over 400
Hiring new nursing staff	☐	☐	☐	☐	☐	☐
Terminating nursing staff	☐	☐	☐	☐	☐	☐
Adding new nursing positions	☐	☐	☐	☐	☐	☐
Deleting nursing positions	☐	☐	☐	☐	☐	☐
Authorizing nursing overtime	☐	☐	☐	☐	☐	☐
Authorizing use of temporary nursing staff	☐	☐	☐	☐	☐	☐
Making nursing assignments for patient care	☐	☐	☐	☐	☐	☐
Determining the exact nursing staff working in your unit	☐	☐	☐	☐	☐	☐
Scheduling nursing staff in your unit	☐	☐	☐	☐	☐	☐
Making shift adjustments to the schedule	☐	☐	☐	☐	☐	☐
Deciding compensation levels for nursing staff	☐	☐	☐	☐	☐	☐
Reviewing the operating budget for your unit	☐	☐	☐	☐	☐	☐

DESCRIPTION OF YOUR UNIT AND YOUR PATIENTS

This section deals with descriptions of your unit and your patients. Please answer for conditions as they currently exist.

5. **Descriptive name** of your unit (such as Medical- Surgical unit, Adolescent Psychiatry, OB-GYN, etc.) :______________

____

6. If your unit has a **specialty**, please describe it:______________________________

____

7. **Which phrases best describe the nursing services in your unit. Please check all that apply.**
   - ☐ Acute care, but not critical care
   - ☐ Critical care
   - ☐ Custodial care
   - ☐ Available year round
   - ☐ Available 7 days a week
   - ☐ Available 24 hours per day

8. This question concerns characteristics of patients in your unit. Please check the category that best describes the proportion of patients on your unit with the given characteristic. Patients may fall into several categories.

	None	Fewer than half	About half	Most	All
Adults	☐	☐	☐	☐	☐
Children, ages 2 through 18	☐	☐	☐	☐	☐
Infants, under age 2	☐	☐	☐	☐	☐
Age 60 and older	☐	☐	☐	☐	☐
Female	☐	☐	☐	☐	☐
Are catheterized	☐	☐	☐	☐	☐
Have IVs	☐	☐	☐	☐	☐
Have monitors	☐	☐	☐	☐	☐
Have respirators	☐	☐	☐	☐	☐
Need assistance in eating	☐	☐	☐	☐	☐
Need assistance in walking	☐	☐	☐	☐	☐
Need assistance in using bathroom	☐	☐	☐	☐	☐
Are receiving therapy from another unit	☐	☐	☐	☐	☐

9. For each of the characteristics listed below, please **rate your unit in comparison to other units in your hospital.** (1 ="Much lower," 4="About the same," and 7 = "Much higher.")

	Lower 1	2	3	4	5	6	7 Higher
Average patient acuity	☐	☐	☐	☐	☐	☐	☐
Use of new technology for patient care	☐	☐	☐	☐	☐	☐	☐
Use of special equipment in patient care	☐	☐	☐	☐	☐	☐	☐
Use of computer technology for patient information	☐	☐	☐	☐	☐	☐	☐
Total value of equipment in your unit	☐	☐	☐	☐	☐	☐	☐
Value of equipment per bed in your unit	☐	☐	☐	☐	☐	☐	☐
Number of nursing staff per patient	☐	☐	☐	☐	☐	☐	☐
Value of equipment per nursing staff member	☐	☐	☐	☐	☐	☐	☐
Variety of treatment from patient to patient	☐	☐	☐	☐	☐	☐	☐

10. Please indicate **which time periods** best represent each of the following for patients on your unit:

	0-1 Days	2-3 Days	4-6 Days	7-10 Days	11-14 Days	15-30 Days	31-90 Days	Over 90 Days
Average length of stay	☐	☐	☐	☐	☐	☐	☐	☐
Longest length of stay	☐	☐	☐	☐	☐	☐	☐	☐
Shortest length of stay	☐	☐	☐	☐	☐	☐	☐	☐

11. **Please** indicate the **range** which best represents the **number** in each category **on your unit.**

	0-3	4-8	9-14	15-20	21-28	29-37	38-50	Over 50
Number of **beds** on your unit	☐	☐	☐	☐	☐	☐	☐	☐
Average daily admissions	☐	☐	☐	☐	☐	☐	☐	☐
Highest daily admissions over past year	☐	☐	☐	☐	☐	☐	☐	☐
Lowest daily admissions over past year	☐	☐	☐	☐	☐	☐	☐	☐
Average patient census	☐	☐	☐	☐	☐	☐	☐	☐
Highest patient **census** over past year	☐	☐	☐	☐	☐	☐	☐	☐
Lowest patient census over past year	☐	☐	☐	☐	☐	☐	☐	☐

DESCRIPTION OF NURSING STAFF ON YOUR UNIT

This section concerns **characteristics of the nursing staff used on your unit.** Your nursing staff is considered to be **all who provide direct and indirect patient care.** Included are RNs, LPNs, and **nurse assistants.** The term "**nurse assistants** " is used to refer to **nurse aides, orderlies, nurse technicians and all others who assist RNs and LPNs in direct and indirect patient care.** Not included **as nurse assistants** are clerical or secretarial support, such as **unit clerks.** When asked about **full time and part time** employees, please use **your institution's definition.**

12. Which model most closely describes the basis for **nursing staff assignment practices** in your unit?

☐ **Functional nursing** in which each nursing staff member performs specified functions for all patients in a unit.

☐ **Team nursing** in which an RN leader coordinates all nursing functions for a group of patients, using appropriate skills of the team members (RNs, LPNs, and nursing assistants).

☐ **Modular nursing** in which one nurse is assigned primary responsibility for the care of patients in certain proximate areas.

☐ **Primary nursing** in which each RN has total 24-hour-per-day responsibility for the patient care of a specific group of patients.

☐ **Case management nursing** in which one RN monitors the progress of and provides assistance to a patient from pre-admission, through post-discharge. The case manager nurse follows the progress of the patient through all stages of hospitalization, even when the patient is assigned to another unit.

☐ None of these models. Please describe briefly the model in your unit.

---

13. Please check the **approximate proportion of time spent in direct patient care** during a 24-hour period, by each of the following categories of personnel.

	None	Some	Most	All	No staff in this category
RN staff members	☐	☐	☐	☐	☐
LPN staff members	☐	☐	☐	☐	☐
Nurse assistants	☐	☐	☐	☐	☐
Unit Clerks	☐	☐	☐	☐	☐

14. Consider the **nursing staff used on your unit during a typical month.** Please check the category that best describes the **proportion of nursing staff** with the given characteristic. Some categories **are overlapping.**

	None	Fewer than half	About half	Most	All
RNs without BSN	☐	☐	☐	☐	☐
RNs with BSN or higher	☐	☐	☐	☐	☐
RNs with clinical specialty	☐	☐	☐	☐	☐
LPNs	☐	☐	☐	☐	☐
Nurse assistants	☐	☐	☐	☐	☐
Permanent full-time employees of the hospital	☐	☐	☐	☐	☐
Permanent part-time employees of the hospital	☐	☐	☐	☐	☐
Temporary employees from an outside agency	☐	☐	☐	☐	☐
Nurses from other hospital units or inhouse pool	☐	☐	☐	☐	☐

15. For each of the characteristics listed below, please rate your unit in comparison to other units in your hospital. (1 ="Much lower," 4 ="About the same," and 7 = "Much higher" or "Much greater.")

	Lower 1	2	3	4	5	6	7 Higher
Pay rate for RN staff	☐	☐	☐	☐	☐	☐	☐
Pay rate for other nursing staff members	☐	☐	☐	☐	☐	☐	☐
Need for unit orientation	☐	☐	☐	☐	☐	☐	☐
Ease of finding enough staff for any given shift	☐	☐	☐	☐	☐	☐	☐
Ease of preparing schedules	☐	☐	☐	☐	☐	☐	☐
Ease of making shift adjustments	☐	☐	☐	☐	☐	☐	☐
Use of pool nursing staff from inside hospital	☐	☐	☐	☐	☐	☐	☐
Use of pool nursing staff from outside agency	☐	☐	☐	☐	☐	☐	☐
Turnover rate for nursing staff	☐	☐	☐	☐	☐	☐	☐

16. Approximately how many of each category of nursing staff are assigned to your unit during a typical 24-hour *period?*

	0	1-3	4-7	8-12	13-17	18-25	Over 25
RNs with BSN or higher degree	☐	☐	☐	☐	☐	☐	☐
RNs without BSN	☐	☐	☐	☐	☐	☐	☐
LPNs	☐	☐	☐	☐	☐	☐	☐
Nurse assistants	☐	☐	☐	☐	☐	☐	☐
Unit Clerks	☐	☐	☐	☐	☐	☐	☐
Total nursing staff on all shifts	☐	☐	☐	☐	☐	☐	☐

SCHEDULING OPTIONS AND SCHEDULING PROCEDURES ON YOUR UNIT

This section deals with the options and procedures used by your unit in scheduling nursing personnel.

17. *Consider the nursing staff (from any source) who worked in your unit over the past three months.* How many have schedules with the following characteristics.

	None	A Few	About Half	Most	All
Have fixed start times (always start at same time, dictated by hospital)	☐	☐	☐	☐	☐
Have flexible start times (start at different times, dictated by employee)	☐	☐	☐	☐	☐
Rotates regularly between day shift and other shifts	☐	☐	☐	☐	☐
Have a permanent *shift assignment (such as permanent days or evenings)*	☐	☐	☐	☐	☐
Work a required number of weekends in a given time period	☐	☐	☐	☐	☐
Are permanently assigned to weekends (a weekend work program)	☐	☐	☐	☐	☐
Have a permanent *assignment to your unit*	☐	☐	☐	☐	☐
Have a fixed pattern of days on and off (such as 3-on, 2-off)	☐	☐	☐	☐	☐
Work the same days every week	☐	☐	☐	☐	☐
Work split *shifts* (such as 4 hours on, a *few off,* and 4 more hours on)	☐	☐	☐	☐	☐

18. Please check the category of hours that best describes the following scheduling characteristics in your unit for weekdays and weekends. *If more than one answer applies to a given characteristic, please check all hour categories that* apply. For example, if RNs on weekdays work 8 and 12-hour shifts, please check both categories.

	1-4 *Hours*	5-6 *Hours*	7-8 *Hours*	9-11 *Hours*	12-16 *Hours*	Over 16 *Hours*	Does Not *Apply*
For weekdays:							
Length of regular RN shift without overtime	☐	☐	☐	☐	☐	☐	☐
Length of regular LPN shift without overtime	☐	☐	☐	☐	☐	☐	☐
Length of regular nurse assistant shift without overtime	☐	☐	☐	☐	☐	☐	☐
Longest period likely to be worked including overtime	☐	☐	☐	☐	☐	☐	☐
Shortest period likely to be worked	☐	☐	☐	☐	☐	☐	☐
For weekends:							
Length of regular RN shift without overtime	☐	☐	☐	☐	☐	☐	☐
Length of regular LPN shift without overtime	☐	☐	☐	☐	☐	☐	☐
Length of regular nurse assistant shift without overtime	☐	☐	☐	☐	☐	☐	☐
Longest period likely to be worked including overtime	☐	☐	☐	☐	☐	☐	☐
Shortest period likely to be worked	☐	☐	☐	☐	☐	☐	☐

19. **During a 24-hour period how many shift start times do you normally have scheduled?**

Weekdays:	☐ 0-1	☐ 2	☐ 3	☐ 4 or 5	☐ 6 or 7	☐ 8 or more
Weekends:	☐ 0-1	☐ 2	☐ 3	☐ 4 or 5	☐ 6 or 7	☐ 8 or more

20. When making **short term scheduling adjustments** to match nursing staff on duty to nursing staff needed, how often do the following situations occur in your unit?

	Less than <u>once per month</u>	At least once per <u>month but not weekly</u>	At least once per <u>week but not daily</u>	<u>Daily</u>	More than <u>once per day</u>
A shortage of RNs	☐	☐	☐	☐	☐
A shortage of other nursing staff	☐	☐	☐	☐	☐
An oversupply of RNs	☐	☐	☐	☐	☐
An oversupply of other nursing staff	☐	☐	☐	☐	☐
All beds are filled	☐	☐	☐	☐	☐
Nurses work beyond their normal hours	☐	☐	☐	☐	☐

21. This question concerns that situation in which ***the number of nursing staff available do not match the number of nursing staff needed.*** With what frequency do you take the following actions, in the given circumstance? Check all that apply.

	<u>For a short term duration</u>			<u>For a long term duration</u>		
	<u>Never</u>	<u>Sometimes</u>	<u>Always</u>	<u>Never</u>	<u>Sometimes</u>	<u>Always</u>
<u>For a shortage of nursing staff:</u>						
Use voluntary overtime	☐	☐	☐	☐	☐	☐
Use mandated overtime	☐	☐	☐	☐	☐	☐
Hire temporary nursing staff from outside	☐	☐	☐	☐	☐	☐
Use hospital "pool" nurses	☐	☐	☐	☐	☐	☐
Use nurses from another unit	☐	☐	☐	☐	☐	☐
Decline new admissions	☐	☐	☐	☐	☐	☐
Discharge patients	☐	☐	☐	☐	☐	☐
Shift patients to other units	☐	☐	☐	☐	☐	☐
Extend hours of part-time nurses (if available)	☐	☐	☐	☐	☐	☐
Call in nurses on assigned day off	☐	☐	☐	☐	☐	☐
Mandate a reduction in days off	☐	☐	☐	☐	☐	☐
Hire new permanent nursing staff	☐	☐	☐	☐	☐	☐
<u>For an overage of nursing staff:</u>						
Use voluntary vacation time	☐	☐	☐	☐	☐	☐
Use mandated vacation time	☐	☐	☐	☐	☐	☐
Send unneeded nursing staff home with pay	☐	☐	☐	☐	☐	☐
Send unneeded nursing staff to other units	☐	☐	☐	☐	☐	☐
Assign nursing staff to other duties within unit	☐	☐	☐	☐	☐	☐
Use volunteer unpaid time off	☐	☐	☐	☐	☐	☐
Mandate unpaid time off	☐	☐	☐	☐	☐	☐
Lay off or fire permanent nursing staff	☐	☐	☐	☐	☐	☐
Solicit new admissions	☐	☐	☐	☐	☐	☐

22. In making **nursing staff scheduling decisions** would you say the process is

- ☐ **Centralized** - performed by one person for several units.
- ☐ **Somewhat decentralized** - several units cooperate, sharing personnel when necessary.
- ☐ **Fairly decentralized** - each unit does its own scheduling but share common nursing pool personnel.
- ☐ **Completely decentralized** - each unit does its own scheduling with no cooperation among units.

23. For the purpose of **determining staff needs, patient acuity** is assessed

☐ More than once per day ☐ At most, once per day ☐ Not at all ☐ Not applicable

24. With respect to the **computerization of the scheduling process**, would you say it is

- ☐ <u>Completely computerized</u> with no adjustments by human schedulers
- ☐ <u>Somewhat computerized</u> with some adjustments by human schedulers
- ☐ Carried out by human schedulers with <u>some computer support</u>
- ☐ Carried out by human schedulers with <u>no computer support</u>

ADMISSIONS AND DISCHARGES OF PATIENTS FROM YOUR UNIT

This section deals with where and when patients are admitted into your unit, as well as where patients go when they are discharged from your unit. Please **use the past year** as your reference point.

25. For the purpose of **determining staff needs, expected admissions and discharges are**
    ☐ Officially counted ☐ Included by unofficial adjustments ☐ Ignored (Only current patients are counted) ☐ Not applicable

26. What proportion of **total admissions** to your unit are **scheduled 24 or more hours in advance?**
    ☐ None ☐ A few ☐ About half ☐ Most ☐ All

27. Does your hospital **have a** rule governing discharges? ☐ Yes ☐ No ☐ Not applicable

28. If so, is the discharge rule used: ☐ Always ☐ Most of the time ☐ Sometimes ☐ Never ☐ Not applicable

29. For the events listed, please check the **most typical time** period for the **event to occur** in **your unit.** If two time periods **are** equally typical, please check both of them. Consider **a scheduled admission to be one you know about 24 or more hours ahead of time.**

	Midnight <u>to 6 AM</u>	6 AM <u>to Noon</u>	Noon <u>to 6 PM</u>	6 PM <u>to Midnight</u>
A scheduled admission	☐	☐	☐	☐
An unscheduled admission	☐	☐	☐	☐
A patient's **discharge**	☐	☐	☐	☐
Peak demand for nursing service	☐	☐	☐	☐

30. What proportion of patients **enter your unit from the following places?**

	<u>None</u>	<u>Fewer than half</u>	<u>About half</u>	<u>Most</u>	<u>All</u>
Directly from the patient's current residence	☐	☐	☐	☐	☐
From the Emergency Room	☐	☐	☐	☐	☐
Immediate post-surgical	☐	☐	☐	☐	☐
From another unit in your hospital	☐	☐	☐	☐	☐
From a nursing care unit outside your hospital	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐

31. What proportion of patients **leave your unit to go to the following places?**

	<u>None</u>	<u>Fewer than half</u>	<u>About half</u>	<u>Most</u>	<u>All</u>
Directly to the patient's current residence	☐	☐	☐	☐	☐
To another unit in your hospital	☐	☐	☐	☐	☐
To a nursing care unit outside your hospital	☐	☐	☐	☐	☐
Death	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐

NURSING SERVICES - CONTROL AND VARIABILITY

The next set of questions deals with the control over and the variability in demand for nursing services experienced by your **unit over various time periods. Control over nursing services refers** to the ability of nursing **management to influence** the timing and level of demand for nursing services and the activity on the unit. **Variability refers** to changes, over some time period, in one or more operating variables, such as the number of beds, number of patients, or number of nurses. **Non-nursing** units refer to units such as housekeeping, pharmacy, food service, and other units not staffed by nursing personnel.

32. Please circle the rating you give the predictability of demand for nursing services in your unit.
    Very predictable 1 2 3 4 5 6 7 **Highly unpredictable**

33. Please circle the rating you give the complexity of the nursing staff scheduling process in your unit.
    Very simple 1 2 3 4 5 6 7 **Highly complex**

34. Please circle the rating you give the complexity of the process of making staffing shift adjustments in your unit.
    Very simple 1 2 3 4 5 6 7 **Highly complex**

35. **Please rate the extent to which the nursing management of your unit has control over the following:**

	No Control	1	2	3	4	5	6	7	Very High Control
Timing of									
Admissions to your unit		☐	☐	☐	☐	☐	☐	☐	
Discharges from your unit		☐	☐	☐	☐	☐	☐	☐	
Peak demand for nursing services		☐	☐	☐	☐	☐	☐	☐	
Personnel from non-nursing units working on your unit		☐	☐	☐	☐	☐	☐	☐	
Number of									
Patients on the unit		☐	☐	☐	☐	☐	☐	☐	
Nursing staff on duty at any time		☐	☐	☐	☐	☐	☐	☐	
Personnel from non-nursing units working on your unit		☐	☐	☐	☐	☐	☐	☐	
Determination of									
Short term nursing staff needs		☐	☐	☐	☐	☐	☐	☐	
Long term nursing staff needs		☐	☐	☐	☐	☐	☐	☐	
Matching of									
Needed number of nursing staff with the actual number on duty		☐	☐	☐	☐	☐	☐	☐	
Budgeted number of nursing staff with the actual number on duty		☐	☐	☐	☐	☐	☐	☐	

36. **This question is concerned with high variability in operating variables from period to period.** *For example, in a unit of 10 beds, if there are 7 patients on one shift, and 3 on the next, that would be considered high* shift-to-shift variability in number of patients. On the other hand, if the number of patients tends to remain the same for a 24-hour period, but there are 3 patients one day, and 7 on another day in the same week, that would be considered high day-to day variability. **For each category below, please check the shortest time period for which your unit experiences high variability from period to period. If a category is fairly stable over time, please check the low variability column.**

	High Variability occurs:					
	Shift to Shift	Day to Day	Week to Week	Month to Month	Year to Year	Low Variability
Total number of patient beds in your unit	☐	☐	☐	☐	☐	☐
Total number of patient beds filled	☐	☐	☐	☐	☐	☐
Acuity of individual patients	☐	☐	☐	☐	☐	☐
Total acuity of patients on the unit	☐	☐	☐	☐	☐	☐
Direct patient care assignments for nursing staff	☐	☐	☐	☐	☐	☐
Indirect patient care assignments for nursing staff	☐	☐	☐	☐	☐	☐
Timing of the peak demand for nursing services	☐	☐	☐	☐	☐	☐
Needed number of nursing staff on duty	☐	☐	☐	☐	☐	☐
Actual number of nursing staff on duty	☐	☐	☐	☐	☐	☐
Difference between needed and actual nursing care hours	☐	☐	☐	☐	☐	☐
Difference between budgeted and actual nursing care hours	☐	☐	☐	☐	☐	☐

37. **To what extent are these systems in place in your hospital?**

	Have throughout the hospital	Have in your unit but not everywhere	Have in some units but not in your unit	Do not have in your unit; others-unknown	Do not have in the hospital
Computerized quality assurance system for nursing	☐	☐	☐	☐	☐
Noncomputerized quality assurance system for nursing	☐	☐	☐	☐	☐
Productivity measurement system	☐	☐	☐	☐	☐
Budget Variance Reporting System	☐	☐	☐	☐	☐
Computerized Patient Acuity System	☐	☐	☐	☐	☐
Noncomputerized Patient Acuity System	☐	☐	☐	☐	☐
A Computerized Patient Information System which:					
Tracks patient accounting information	☐	☐	☐	☐	☐
Tracks patient admission information	☐	☐	☐	☐	☐
Tracks xray and/or lab information	☐	☐	☐	☐	☐
Tracks pharmacy information	☐	☐	☐	☐	☐
Integrates all patient information systems	☐	☐	☐	☐	☐
Displays patient information on bedside terminals	☐	☐	☐	☐	☐
Allows charting directly on the computer	☐	☐	☐	☐	☐
Allows computerized care planning	☐	☐	☐	☐	☐

MANAGEMENT OBJECTIVES FOR YOUR NURSING UNIT

This section is about some of the goals and objectives you and your hospital's top management would like for your unit to accomplish.

38. The following have been identified in the current literature as possible management objectives for nursing units. **In the first three columns below, please rate the importance that you attach to these objectives** in managing your unit. **In the last three columns, please rate the importance attached to these objectives by top management.**

For No. 39 ⇓	Importance to you			**Importance to Top Management**		
	None or slight	Fair to moderate	Very high	None or slight	Fair to moderate	Very high
☐ Containing costs	☐	☐	☐	☐	☐	☐
☐ *Staying within budget*	☐	☐	☐	☐	☐	☐
☐ Being able to reduce staff levels quickly	☐	☐	☐	☐	☐	☐
☐ Being able to increase staff levels quickly	☐	☐	☐	☐	☐	☐
☐ Being able to offer a wide variety of nursing services	☐	☐	☐	☐	☐	☐
☐ Achieving a certain level of productivity	☐	☐	☐	☐	☐	☐
☐ Increasing productivity of nursing staff	☐	☐	☐	☐	☐	☐
☐ Utilizing expensive equipment assigned to your unit	☐	☐	☐	☐	☐	☐
☐ Matching needed staff to actual number on duty	☐	☐	☐	☐	☐	☐
☐ Assigning equitable workloads to nursing staff	☐	☐	☐	☐	☐	☐
☐ Conformance to JCAHO Standards	☐	☐	☐	☐	☐	☐
☐ Having a zero-error rate in dispensing meds	☐	☐	☐	☐	☐	☐
☐ Achieving a certain level of quality of care	☐	☐	☐	☐	☐	☐
☐ Improving the quality of care	☐	☐	☐	☐	☐	☐
☐ Responding to patient requests within a certain time period	☐	☐	☐	☐	☐	☐
☐ Correction of errors within a certain time period	☐	☐	☐	☐	☐	☐
☐ Being able to offer new nursing services quickly	☐	☐	☐	☐	☐	☐
☐ Having a satisfied nursing staff	☐	☐	☐	☐	☐	☐
☐ Having a low turnover rate among nursing staff	☐	☐	☐	☐	☐	☐
☐ Considering nursing staff preferences for certain schedules	☐	☐	☐	☐	☐	☐
☐ Considering nursing staff preferences for specific days off	☐	☐	☐	☐	☐	☐

39. **Please place a check beside the** five objectives above **that most guide your actions in the day-to-day management of your unit.** Use the boxes to the left of the objectives listed above.

40. **Please rate your own performance** on these objectives in managing your unit.

	Poor		Satisfactory		Excellent	Not applicable
Containing costs	☐	☐	☐	☐	☐	☐
Staying within budget	☐	☐	☐	☐	☐	☐
Being able to reduce staff levels quickly	☐	☐	☐	☐	☐	☐
Being able to increase staff levels quickly	☐	☐	☐	☐	☐	☐
Being able to offer a wide variety of nursing services	☐	☐	☐	☐	☐	☐
Achieving a certain level of productivity	☐	☐	☐	☐	☐	☐
Increasing productivity of nursing staff	☐	☐	☐	☐	☐	☐
Utilizing expensive equipment assigned to your unit	☐	☐	☐	☐	☐	☐
Matching actual number of nurses on duty to needed number	☐	☐	☐	☐	☐	☐
Assigning equitable workloads to nursing staff	☐	☐	☐	☐	☐	☐
Conformance to JCAHO Standards	☐	☐	☐	☐	☐	☐
Having a zero-error rate in dispensing meds	☐	☐	☐	☐	☐	☐
Achieving a certain level of quality of care	☐	☐	☐	☐	☐	☐
Improving the quality of care	☐	☐	☐	☐	☐	☐
Responding to patient requests within a certain time period	☐	☐	☐	☐	☐	☐
Correction of errors within a certain time period	☐	☐	☐	☐	☐	☐
Being able to offer new nursing services quickly	☐	☐	☐	☐	☐	☐
Having a satisfied nursing staff	☐	☐	☐	☐	☐	☐
Having a low turnover rate among nursing staff	☐	☐	☐	☐	☐	☐
Considering nursing staff preferences for certain schedules	☐	☐	☐	☐	☐	☐
Considering nursing staff preferences for specific days off	☐	☐	☐	☐	☐	☐

DESCRIPTION OF YOUR HOSPITAL

This section deals with descriptions of your hospital. Please answer for conditions as they currently exist.

41. Which descriptions fit your hospital? Please check **all** that apply.

☐ Offers acute care
☐ Offers long term care
☐ Operated for profit
☐ Privately owned
☐ Privately operated
☐ Has a unionized nursing staff
☐ Currently operates under a hiring freeze
☐ Currently operates with a shortage of RNs
☐ Pays shift differentials to nursing staff
☐ Pays unit differentials *(different pay for work in different units)* to nursing staff
☐ Is a teaching hospital
☐ Is part of a large complex of hospitals located on one site
☐ Is part of a hospital system located on many sites
☐ Is a specialty *hospital. If so, specialty is*____________________

42. Please give the following information about your hospital, if it is known to you. If the answer is unknown, please leave the question blank. Use figures for 1987. If your hospital is part of a complex, please answer for your hospital only.

Number of commissioned beds	☐0-75	☐76-150	☐151-300	☐301-500	☐Over 500
Number of active beds	☐0-75	☐76-150	☐151-300	☐301-500	☐Over 500
Number of nursing units	☐0-10	☐11-25	☐26-50	☐51-100	☐Over 100
Number of RN staff members	☐0-75	☐76-150	☐151-300	☐301-500	☐Over 500
Total number of nursing personnel	☐0-150	☐151-300	☐301-600	☐601-1000	☐Over 1000
Average Daily Patient Census	☐0-60	☐61-130	☐131-250	☐251-400	☐Over 400
Occupancy rate (percent)	☐0-30%	☐31-50%	☐51-70%	☐71-90%	☐Over 90%
Number of DRGS treated in entire hospital.	☐ 0-50	☐51-100	☐ 101-300	☐ Over 300	☐ DRG Exempt
Percent Patients on Medicare or other government supported treatment?	☐ 0-10%	☐ 11-35%	☐ 36-66%	☐ 67-90%	☐ 91-100%

43. If your hospital is part of a single site complex, please give this information for the complex:
If unknown, leave blank, or check here ☐ if not applicable.

Number of hospitals in the complex ____________

Number of commissioned beds	☐0-200	☐201-400	☐401-600	☐601-900	☐Over 900
Number of active beds	☐0-200	☐201-400	☐401-600	☐601-900	☐Over 900
Number of RN staff members	☐0-200	☐201-400	☐401-600	☐601-900	☐Over 900
Average Daily Patient Census	☐0-80	☐81-200	☐201-400	☐401-600	☐Over 600
Occupancy rate (percent)	☐0-30%	☐31-50%	☐51-70%	☐71-90%	☐Over 90%

44. If your hospital is part of a multi-site system, please give this information for the system:
If unknown, leave blank, or check here ☐ if not applicable.

Number of hospitals in the system ____________

Number of commissioned beds	☐0-250	☐251-500	☐501-800	☐801-1200	☐Over 1200
Number of active beds	☐0-250	☐251-500	☐501-800	☐801-1200	☐Over 1200
Number of RN staff members	☐0-250	☐251-500	☐501-800	☐801-1200	☐Over 1200
Average Daily Patient Census	☐0-200	☐201-400	☐401-650	☐651-1000	☐Over 1000
Occupancy rate (percent)	☐0-30%	☐31-50%	☐51-70%	☐71-90%	☐Over 90%

The opposite page is intentionally blank. Please use it for any additional comments you might have about nurse scheduling.

Thank you for your time, energy, and thoughtfulness in completing this questionnaire. We appreciate your efforts!!!

APPENDIX B

LIST OF VARIABLES AND THEIR CLASSIFICATIONS

APPENDIX B

LIST OF VARIABLES AND THEIR CLASSIFICATIONS

NAME	DESCRIPTION	TYPE OF DATA	RANGE OR NO. OF LEVELS
HOSPID	Hospital Identification Number	Nominal	32
RESPONID	Respondent Identification Number	Nominal	348
X1	Title of Position	Nominal	21
MGR	Same as X1 - Recoded to 3 levels	Nominal	3
X2	Scope of Management Responsibilities	Nominal/Ordinal	6/5
	Level of Involvement in these decisions:		
X301	Hiring new nursing staff	Nominal/Ordinal	4/(1-4)
X302	Terminating nursing staff	Nominal/Ordinal	4/(1-4)
X303	Adding Nursing positions	Nominal/Ordinal	4/(1-4)
X304	Deleting Nursing positions	Nominal/Ordinal	4/(1-4)
X305	Authorizing nursing overtime	Nominal/Ordinal	4/(1-4)
X306	Authorizing Temporary nursing staff	Nominal/Ordinal	4/(1-4)
X307	Making patient care assignments	Nominal/Ordinal	4/(1-4)
X308	Determine exact staff daily	Nominal/Ordinal	4/(1-4)
X309	Scheduling nursing staff in your unit	Nominal/Ordinal	4/(1-4)
X310	Making shift adjustments to schedule	Nominal/Ordinal	4/(1-4)
X311	Determine compensation levels for nursing staff	Nominal/Ordinal	4/(1-4)
X312	Determine operating budget for your unit	Nominal/Ordinal	4/(1-4)
	Number of times these decisions are made:		
X401	Hiring new nursing staff	Nominal/Ordinal	4/(1-6)
X402	Terminating nursing staff	Nominal/Ordinal	4/(1-6)
X403	Adding Nursing positions	Nominal/Ordinal	4/(1-6)
X404	Deleting Nursing positions	Nominal/Ordinal	4/(1-6)
X405	Authorizing nursing overtime	Nominal/Ordinal	4/(1-6)
X406	Authorizing Temporary nursing staff	Nominal/Ordinal	4/(1-6)
X407	Making patient care assignments	Nominal/Ordinal	4/(1-6)
X408	Determine exact staff daily	Nominal/Ordinal	4/(1-6)
X409	Scheduling nursing staff in your unit	Nominal/Ordinal	4/(1-6)
X410	Making shift adjustments to schedule	Nominal/Ordinal	4/(1-6)
X411	Determine compensation levels for nursing staff	Nominal/Ordinal	4/(1-6)
X412	Determine operating budget for your unit	Nominal/Ordinal	4/(1-6)
X5	Name of Unit	Nominal	18
UNIT	Same as X5 - Recoded to 8 levels	Nominal	8
UNIT_DES	Description of Unit Specialty	Nominal (Character)	348

NAME	DESCRIPTION	TYPE OF DATA	RANGE OR NO. OF LEVELS
X701	Unit offers acute care	Nominal	2
X702	Unit offers intensive care	Nominal	2
X703	Unit offers custodial care	Nominal	2
X704	Unit available year round	Nominal	2
X705	Unit available 7 days a week	Nominal	2
X706	Unit available 24 hours a day	Nominal	2
	Proportion of patients in the unit who are:		
X801	Adults	Ordinal	5
X802	Children, ages 2 through 18	Ordinal	5
X803	Infants, under age 2	Ordinal	5
X804	Age 60 or over	Ordinal	5
X805	Female	Ordinal	5
X806	Catheterized	Ordinal	5
X807	Have IVs	Ordinal	5
X808	Have monitors	Ordinal	5
X809	Have respirators	Ordinal	5
X810	Need assistance in eating	Ordinal	5
X811	Need assistance in walking	Ordinal	5
X812	Need assistance in using bathroom	Ordinal	5
X813	Receive therapy from another unit	Ordinal	5
	Rating of Unit compared to other units on:		
X901	Average Patient Acuity	Ordinal/Interval	1-7
X902	Use of New Technology for patient care	Ordinal/Interval	1-7
X903	Use of Special Equipment in patient care	Ordinal/Interval	1-7
X904	Use of Computer tech. for patient info.	Ordinal/Interval	1-7
X905	Total value of equipment in unit	Ordinal/Interval	1-7
X906	Value of equipment per bed in unit	Ordinal/Interval	1-7
X907	Number of nursing staff per patient	Ordinal/Interval	1-7
X908	Value of equipment per nursing staff member	Ordinal/Interval	1-7
X909	Variety of treatment from patient to patient	Ordinal/Interval	1-7
	Time periods representing length of patients' stays:		
X1001	Average	Ordinal	8
X1002	Longest	Ordinal	8
X1003	Shortest	Ordinal	8
	Range indicating the number of ____ on your unit:		
X1101	Number of beds	Ordinal	8
X1102	Average daily admissions	Ordinal	8
X1103	Highest daily admissions over past year	Ordinal	8
X1104	Lowest daily admissions over past year	Ordinal	8
X1105	Average patient census	Ordinal	8
X1106	Highest patient census over past year	Ordinal	8
X1107	Lowest patient census over past year	Ordinal	8
X12	Model for Nursing Staff Assignment Practices	Nominal	18
ASNMODEL	Same as X12 - recoded to 6 levels	Nominal	6

NAME	DESCRIPTION	TYPE OF DATA	RANGE OR NO. OF LEVELS
	Proportion of time spent in direct patient care by:		
X1301	RN staff members	Ordinal	4
X1302	LPN staff members	Ordinal	4
X1303	Nurse assistants	Ordinal	4
X1304	Unit Clerks	Ordinal	4
	Proportion of nursing staff with characteristic:		
X1401	RNs without BSN	Ordinal	5
X1402	RNs with BSN	Ordinal	5
X1403	RNs with clinical specialty	Ordinal	5
X1404	LPNs	Ordinal	5
X1405	Nurse assistants	Ordinal	5
X1406	Permanent full time employees of hospital	Ordinal	5
X1407	Permanent part time employees of hospital	Ordinal	5
X1408	Temporary employees from outside agency	Ordinal	5
X1409	From other units or in-house pool	Ordinal	5
	Rating of Unit compared to other units on:		
X1501	Pay rate for RN staff	Ordinal/Interval	1-7
X1502	Pay rate for other nursing staff	Ordinal/Interval	1-7
X1503	Need for unit orientation	Ordinal/Interval	1-7
X1504	Ease of finding enough staff for any given shift	Ordinal/Interval	1-7
X1505	Ease of Preparing Schedules	Ordinal/Interval	1-7
X1506	Ease of Making Shift Adjustments	Ordinal/Interval	1-7
X1507	Use of in-house pool nurses	Ordinal/Interval	1-7
X1508	Use of pool nurses from outside agency	Ordinal/Interval	1-7
X1509	Turnover rate for nursing staff	Ordinal/Interval	1-7
	Range indicating the number of each type of nursing staff assigned to unit:		
X1601	RNs with BSN	Ordinal	7
X1602	RNs without BSN	Ordinal	7
X1603	LPNs	Ordinal	7
X1604	Nurse Assistants	Ordinal	7
X1605	Unit Clerks	Ordinal	7
X1607	Total nursing staff on all shifts	Ordinal	7
	Proportion of Staff whose schedules have:		
X1701	Fixed Start Times	Ordinal	5
X1702	Flexible Start Times	Ordinal	5
X1703	Regular rotation between day and other shifts	Ordinal	5
X1704	A Permanent Shift Assignment	Ordinal	5
X1705	Work a required number of weekends	Ordinal	5
X1706	Permanently assigned to weekends (Weekend Work Program)	Ordinal	5
X1707	Permanent Assignment to your unit	Ordinal	5
X1708	Fixed Pattern of days on and off	Ordinal	5
X1709	Work the same days every week	Ordinal	5
X1710	Work split shifts (4 hour son, a few off, 4 more on)	Ordinal	5

NAME	DESCRIPTION	TYPE OF DATA	RANGE OR NO. OF LEVELS
	Category reflecting shift length for weekdays:		
X1801	Regular RN shift without overtime	Ordinal	7
X1802	Regular LPN shift without overtime	Ordinal	7
X1803	Regular nurse assistant without overtime	Ordinal	7
X1804	Longest period likely to be worked	Ordinal	7
X1805	Shortest period likely to be worked	Ordinal	7
	Category reflecting shift length for weekends:		
X1806	Regular RN shift without overtime	Ordinal	7
X1807	Regular LPN shift without overtime	Ordinal	7
X1808	Regular nurse assistant without overtime	Ordinal	7
X1809	Longest period likely to be worked	Ordinal	7
X1810	Shortest period likely to be worked	Ordinal	7
X1901	Number of shift start times on weekdays	Ordinal	6
X1902	Number of shift start times on weekends	Ordinal	6
	Frequency of occurrence of these situations when making short term scheduling adjustments:		
X2001	Shortage of RNs	Ordinal	5
X2002	Shortage of other nursing staff	Ordinal	5
X2003	Oversupply of RNs	Ordinal	5
X2004	Oversupply of other nursing staff	Ordinal	5
X2005	All beds are filled	Ordinal	5
X2006	Nurses work beyond their normal hours	Ordinal	5
	Frequency with which actions taken when number of staff available do not match number of staff needed:		
	For A Short Term Shortage of nursing staff:		
XA2101	Use voluntary overtime	Ordinal	3
XA2102	Use mandated overtime	Ordinal	3
XA2103	Hire temporary nursing staff from outside	Ordinal	3
XA2104	Use hospital "pool" nurses	Ordinal	3
XA2105	Use nurses from another unit	Ordinal	3
XA2106	Decline new admissions	Ordinal	3
XA2107	Discharge patients	Ordinal	3
XA2108	Shift patients to other units	Ordinal	3
XA2109	Extend hours of part-time nurses (if available)	Ordinal	3
XA2110	Call in nurses on assigned day off	Ordinal	3
XA2111	Mandate a reduction in days off	Ordinal	3
XA2112	Hire new permanent nursing staff	Ordinal	3
	For a Short Term Overage of nursing staff:		
XA2113	Use voluntary vacation time	Ordinal	3
XA2114	Use mandated vacation time	Ordinal	3
XA2115	Send unneeded nursing staff home with pay	Ordinal	3
XA2116	Send unneeded nursing staff to other units	Ordinal	3
XA2117	Assign nursing staff to other duties within unit	Ordinal	3
XA2118	Use volunteer unpaid time off	Ordinal	3
XA2119	Mandate unpaid time off	Ordinal	3
XA2120	Lay off or fire permanent nursing staff	Ordinal	3
XA2121	Solicit new admissions	Ordinal	3

NAME	DESCRIPTION	TYPE OF DATA	RANGE OR NO. OF LEVELS
	For A Long Term Shortage of nursing staff:		
XB2101	Use voluntary overtime	Ordinal	3
XB2102	Use mandated overtime	Ordinal	3
XB2103	Hire temporary nursing staff from outside	Ordinal	3
XB2104	Use hospital "pool" nurses	Ordinal	3
XB2105	Use nurses from another unit	Ordinal	3
XB2106	Decline new admissions	Ordinal	3
XB2107	Discharge patients	Ordinal	3
XB2108	Shift patients to other units	Ordinal	3
XB2109	Extend hours of part-time nurses (if available)	Ordinal	3
XB2110	Call in nurses on assigned day off	Ordinal	3
XB2111	Mandate a reduction in days off	Ordinal	3
XB2112	Hire new permanent nursing staff	Ordinal	3
	For a Long Term Overage of nursing staff:		
XB2113	Use voluntary vacation time	Ordinal	3
XB2114	Use mandated vacation time	Ordinal	3
XB2115	Send unneeded nursing staff home with pay	Ordinal	3
XB2116	Send unneeded nursing staff to other units	Ordinal	3
XB2117	Assign nursing staff to other duties within unit	Ordinal	3
XB2118	Use volunteer unpaid time off	Ordinal	3
XB2119	Mandate unpaid time off	Ordinal	3
XB2120	Lay off or fire permanent nursing staff	Ordinal	3
XB2121	Solicit new admissions	Ordinal	3
X22	Degree of centralization of the nursing staff scheduling process	Nominal	4
X23	Frequency with which patient acuity is assessed	Nominal	3
X24	Degree of computerization of the scheduling process	Nominal	4
X25	How admissions and discharges are included in the nurse staff scheduling process	Nominal	3
X26	Proportion of total admission scheduling 24 hours in advance	Ordinal	5
X27	Is there a rule governing discharges?	Nominal	2
X28	Frequency of use of the discharge rule	Nominal	4
	Time periods in which event is most likely to occur:		
X2901	Scheduled admission	Nominal	6
X2902	Unscheduled admission	Nominal	6
X2903	Patient's discharge	Nominal	6
X2904	Peak demand for nursing services	Nominal	6

NAME	DESCRIPTION	TYPE OF DATA	RANGE OR NO. OF LEVELS
	Proportion of patients who enter unit from:		
X3001	Patient's current residence	Ordinal	5
X3002	The Emergency Room	Ordinal	5
X3003	Immediate post-surgical	Ordinal	5
X3004	Another nursing unit in the hospital	Ordinal	5
X3005	A nursing care unit outside your hospital	Ordinal	5
X3006	Other place	Ordinal	5
	Proportion of patients who leave your unit to go to:		
X3101	Patient's current residence	Ordinal	5
X3102	Another unit in your hospital	Ordinal	5
X3103	Nursing care unit outside your hospital	Ordinal	5
X3104	Death	Ordinal	5
X3105	Other place	Ordinal	5
	Rating of the following in your unit:		
X32	Predictability of demand for nursing services	Ordinal/Interval	1-7
X33	Complexity of the nurse scheduling process	Ordinal/Interval	1-7
X34	Complexity of making shift adjustments to staffing	Ordinal/Interval	1-7
	Rating of the extent to which the nursing management of your unit has control over the following:		
X3501	Timing of admissions to your unit	Ordinal /Interval	1-7
X3502	Timing of Discharges from your unit	Ordinal /Interval	1-7
X3503	Timing of peak demand for nursing services	Ordinal /Interval	1-7
X3504	Timing of personnel from non-nursing units working on your unit	Ordinal /Interval	1-7
X3505	Number of patients on the unit	Ordinal /Interval	1-7
X3506	Number of nursing staff on duty at any time	Ordinal /Interval	1-7
X3507	Number of personnel from non-nursing units working on your unit	Ordinal /Interval	1-7
X3508	Determination of short term nursing staff needs	Ordinal /Interval	1-7
X3509	Determination of long term nursing staff needs	Ordinal /Interval	1-7
X3510	Matching of needed number of nursing staff with the actual number on duty	Ordinal /Interval	1-7
X3511	Matching of budgeted number of nursing staff with the actual number on duty	Ordinal /Interval	1-7
	Shortest period in which high variability is experienced with the following:		
X3601	Total number of patient beds in your unit	Nominal/Ordinal	6
X3602	Total number of patient beds filled	Nominal/Ordinal	6
X3603	Acuity of individual patients	Nominal/Ordinal	6
X3604	Total acuity of patients on the unit	Nominal/Ordinal	
X3605	Direct patient care assignments for nursing staff	Nominal/Ordinal	6
X3606	Indirect patient care assignments for nursing staff	Nominal/Ordinal	6
X3607	Timing of the peak demand for nursing services	Nominal/Ordinal	6
X3608	Needed number of nursing staff on duty	Nominal/Ordinal	6
X3609	Actual number of nursing staff on duty	Nominal/Ordinal	6
X3610	Difference between needed and actual nursing care hours	Nominal/Ordinal	6
X3611	Difference between budgeted and actual nursing care hours	Nominal/Ordinal	6

NAME	DESCRIPTION	TYPE OF DATA	RANGE OR NO. OF LEVELS
	Extent to which these systems are in place in the		
X3701	Computerized quality assurance system for nursing	Nominal	5
X3702	Noncomputerized quality assurance system for nursing	Nominal	5
X3703	Productivity measurement system	Nominal	5
X3704	Budget Variance Reporting System	Nominal	5
X3705	Computerized Patient Acuity System	Nominal	5
X3706	Noncomputerized Patient Acuity System	Nominal	5
	A Computerized Patient Information System which:		
X3707	Tracks patient accounting information	Nominal	5
X3708	Tracks patient admission information	Nominal	5
X3709	Tracks xray and/or lab information	Nominal	5
X3710	Tracks pharmacy information	Nominal	5
X3711	Integrates all patient information systems	Nominal	5
X3712	Displays patient information on bedside terminals	Nominal	5
X3713	Allows charting directly on the computer	Nominal	5
X3714	Allows computerized care planning	Nominal	5
	Rating of (A) Importance to the respondent (B) Importance to top management of		
XA3801 XB3801	Containing costs	Nominal/Ordinal	3
XA3802 XB3802	Staying within budget	Nominal/Ordinal	3
XA3803 XB3803	Being able to reduce staff levels quickly	Nominal/Ordinal	3
XA3804 XB3804	Being able to increase staff levels quickly	Nominal/Ordinal	3
XA3805 XB3805	Being able to offer a wide variety of nursing services	Nominal/Ordinal	3
XA3806 XB3806	Achieving a certain level of productivity	Nominal/Ordinal	3
XA3807 XB3807	Increasing productivity of nursing staff	Nominal/Ordinal	3
XA3808 XB3808	Utilizing expensive equipment assigned to your unit	Nominal/Ordinal	3
XA3809 XB3809	Matching needed staff to actual number on duty	Nominal/Ordinal	3
XA3810 XB3810	Assigning equitable workloads to nursing staff	Nominal/Ordinal	3
XA3811 XB3811	Conformance to JCAHO Standards	Nominal/Ordinal	3
XA3812 XB3812	Having a zero-error rate in dispensing meds		
Nominal/Ordinal	3		
XA3813 XB3813	Achieving a certain level of quality of care	Nominal/Ordinal	3
XA3814 XB3814	Improving the quality of care	Nominal/Ordinal	3
XA3815 XB3815	Responding to patient requests within a certain time period	Nominal/Ordinal	3
XA3816 XB3816	Correction of errors within a certain time period	Nominal/Ordinal	3
XA3817 XB3817	Being able to offer new nursing services quickly	Nominal/Ordinal	3
XA3818 XB3818	Having a satisfied nursing staff	Nominal/Ordinal	3
XA3819 XB3819	Having a low turnover rate among nursing staff	Nominal/Ordinal	3
XA3820 XB3820	Considering nursing staff preferences for certain schedules	Nominal/Ordinal	3
XA3821 XB3821	Considering nursing staff preferences for specific days off	Nominal/Ordinal	3

NAME	DESCRIPTION	TYPE OF DATA	RANGE OR NO. OF LEVELS
	Is the objective in the top 5 objectives that most guide your actions in managing the unit daily?		
X3901	Containing costs	Nominal	2
X3902	Staying within budget	Nominal	2
X3903	Being able to reduce staff levels quickly	Nominal	2
X3904	Being able to increase staff levels quickly	Nominal	2
X3905	Being able to offer a variety of nursing services	Nominal	2
X3906	Achieving a certain level of productivity	Nominal	2
X3907	Increasing productivity of nursing staff	Nominal	2
X3908	Utilizing expensive equipment assigned to the unit	Nominal	2
X3909	Matching needed staff to actual number on duty	Nominal	2
X3910	Assigning equitable workloads to nursing staff	Nominal	2
X3911	Conformance to JCAHO Standards	Nominal	2
X3912	Having a zero-error rate in dispensing meds	Nominal	2
X3913	Achieving a certain level of quality of care	Nominal	2
X3914	Improving the quality of care	Nominal	2
X3915	Responding to patient requests within a certain time period	Nominal	2
X3916	Correction of errors within a certain time period	Nominal	2
X3917	Being able to offer new nursing services quickly	Nominal	2
X3918	Having a satisfied nursing staff	Nominal	2
X3919	Having a low turnover rate among nursing staff	Nominal	2
X3920	Considering nursing staff preferences for certain schedules	Nominal	2
X3921	Considering nursing staff preferences for specific days off	Nominal	2
	Self Performance Rating on each of these objectives:		
X4001	Containing costs	Ordinal/Interval	1-5
X4002	Staying within budget	Ordinal/Interval	1-5
X4003	Being able to reduce staff levels quickly	Ordinal/Interval	1-5
X4004	Being able to increase staff levels quickly	Ordinal/Interval	1-5
X4005	Being able to offer a variety of nursing services	Ordinal/Interval	1-5
X4006	Achieving a certain level of productivity	Ordinal/Interval	1-5
X4007	Increasing productivity of nursing staff	Ordinal/Interval	1-5
X4008	Utilizing expensive equipment assigned to the unit	Ordinal/Interval	1-5
X4009	Matching needed staff to actual number on duty	Ordinal/Interval	1-5
X4010	Assigning equitable workloads to nursing staff	Ordinal/Interval	1-5
X4011	Conformance to JCAHO Standards	Ordinal/Interval	1-5
X4012	Having a zero-error rate in dispensing meds	Ordinal/Interval	1-5
X4013	Achieving a certain level of quality of care	Ordinal/Interval	1-5
X4014	Improving the quality of care	Ordinal/Interval	1-5
X4015	Responding to patient requests within a certain time period	Ordinal/Interval	1-5
X4016	Correction of errors within a certain time period	Ordinal/Interval	1-5
X4017	Being able to offer new nursing services quickly	Ordinal/Interval	1-5
X4018	Having a satisfied nursing staff	Ordinal/Interval	1-5
X4019	Having a low turnover rate among nursing staff	Ordinal/Interval	1-5
X4020	Considering nursing staff preferences for certain schedules	Ordinal/Interval	1-5
X4021	Considering nursing staff preferences for specific days off	Ordinal/Interval	1-5

NAME	DESCRIPTION	TYPE OF DATA	RANGE OR NO. OF LEVELS
	Do the following describe your hospital?		
X4101	Offers acute care	Nominal	2
X4102	Offers long term care	Nominal	2
X4103	Operated for profit	Nominal	2
X4104	Privately owned	Nominal	2
X4105	Privately operated	Nominal	2
X4106	Has a unionized nursing staff	Nominal	2
X4107	Currently operates under a hiring freeze	Nominal	2
X4108	Currently operates with a shortage of RNs	Nominal	2
X4109	Pays shift differentials to nursing staff	Nominal	2
X4110	Pays unit differentials (different pay for work in different units) to nursing staff	Nominal	2
X4111	Is a teaching hospital	Nominal	2
X4112	Is part of a large complex of hospitals located on one site	Nominal	2
X4113	Is part of a hospital system located on many sites	Nominal	2
X4114	Is a specialty hospital		
X4115	If so, type of specialty	Nominal	3
	Range containing the number of each of the following for your hospital:		
X4201	Number of commissioned beds	Nominal/Ordinal	5
X4202	Number of active beds	Nominal/Ordinal	5
X4203	Number of nursing units	Nominal/Ordinal	5
X4204	Number of RN staff members	Nominal/Ordinal	5
X4205	Total number of nursing personnel	Nominal/Ordinal	5
X4206	Average Daily Patient Census	Nominal/Ordinal	5
X4207	Occupancy rate (percent)	Nominal/Ordinal	5
X4208	Number of DRGS treated in entire hospital	Nominal/Ordinal	5
X4209	Percent Patients on Medicare or other government supported treatment	Nominal/Ordinal	5
	Range containing the number of each of the following for your hospital's single site complex		
X4301	Number of Hospitals in the Complex	Interval	
X4302	Number of commissioned beds	Nominal/Ordinal	5
X4303	Number of active beds	Nominal/Ordinal	5
X4304	Number of RN staff members	Nominal/Ordinal	5
X4305	Average Daily Patient Census	Nominal/Ordinal	5
X4306	Occupancy rate (percent)	Nominal/Ordinal	5
	Range containing the number of each of the following for your hospital's multi-site system		
X4401	Number of Hospitals in the System	Interval	
X4402	Number of commissioned beds	Nominal/Ordinal	5
X4403	Number of active beds	Nominal/Ordinal	5
X4404	Number of RN staff members	Nominal/Ordinal	5
X4405	Average Daily Patient Census	Nominal/Ordinal	5
X4406	Occupancy rate (percent)	Nominal/Ordinal	5
X45	Indicator variable for those who made comments	Nominal	2

APPENDIX C

SUMMARY OF RESPONSES
TO
THE RESEARCH INSTRUMENT

The Ohio State University
Hospital Nurse Staffing and Scheduling Survey
Conducted Summer, 1988

SUMMARY OF RESPONSES TO THE HOSPITAL NURSE STAFFING AND SCHEDULING SURVEY

YOUR POSITION AND MANAGEMENT RESPONSIBILITIES

1. Title of your position:

Percentage of Respondents	Response
31.6	(Nurse, Clinical Nurse, Unit, or Nursing Unit) **Manager**
30.8	**Head Nurse**
10.4	(Unit, Clinical Nurse, or Patient Care) **Coordinator**
6.6	(Unit or Program) **Director**
14.9	**Assistant** (Head Nurse, Unit Director, Coordinator, Manager)
2.9	**Director of Nursing**
2.8	Other title

2. Which of the following best describes the scope of your nursing management responsibilities?

Percentage of Respondents	Response
0.9	Manage all nursing staff in the hospital
0.9	Manage nursing staff in more than 5 units but not the entire hospital
13.5	Manage nursing staff in 2 to 5 units
70.1	Manage nursing staff in 1 unit
13.8	Assist in management of nursing staff in 1 or more units
0.6	Other responsibility
0.3	NO ANSWER

3. What is the level of your involvement in the following decisions:

	Percentage of Respondents in each category:					
Category No.	1 Have full responsibility	2 Have partial responsibility	3 Make recommendations	4 Have no input	Mean Response	N
Hiring new nursing staff	60.1	17.6	16.5	5.8	1.68	346
Terminating nursing staff	44.7	37.5	15.6	2.3	1.76	347
Adding new nursing positions	3.2	35.2	53.3	8.4	2.67	347
Deleting nursing positions	9.6	30.6	45.2	14.6	2.64	343
Authorizing nursing overtime	72.3	23.7	2.3	1.7	1.34	346
Authorizing use of temporary nursing staff	32.4	38.4	17.4	11.7	2.08	333
Making nursing assignments for patient care	63.6	15.2	17.2	4.1	1.62	343

3. What is the level of your involvement in the following decisions:

	Percentage of Respondents in each category:					
Category No.	1 Have full responsibility	2 Have partial responsibility	3 Make recommendations	4 Have no input	Mean Response	N
Determining the exact nursing staff working in your unit daily	62.4	29.8	6.6	1.2	1.47	346
Scheduling nursing staff in your unit	79.8	13.5	4.3	2.3	1.29	347
Making shift adjustments to the schedule	74.9	20.2	2.9	2.0	1.32	342
Deciding compensation levels for nursing staff	17.3	21.1	29.5	32.1	2.76	346
Determining the operating budget for your unit	16.7	40.6	29.1	13.5	2.39	347

4. Which range best approximates the number of times the following decisions are made or actions are taken in your unit during a one year period?

Percentage of Respondents in Each Catgory:

Category No:	1 0-1	2 2-9	3 10-29	4 30-99	5 100-400	6 Over 400	Mean Response	N
Hiring new nursing staff	6.4	61	29.7	2.3	0.6	0.0	2.30	344
Terminating nursing staff	69.2	27.9	2.9	0	0.0	0.0	1.34	344
Adding new nursing positions	66.3	32.8	0.6	0.3	0.0	0.0	1.35	344
Deleting nursing positions	80.9	18.5	0.3	0.3	0.0	0.0	1.20	341
Authorizing nursing overtime	0.6	1.2	5.5	22.4	41.6	28.8	4.90	344
Authorizing use of temporary nursing staff	31.9	11	13.7	20.6	18.5	4.2	2.95	335
Making nursing assignments for patient care	6.5	7	5.6	7.3	29.3	44.3	4.79	341
Determining the exact nursing staff working in your unit daily	3	2.4	8.4	8.1	37.3	40.9	4.97	335
Scheduling nursing staff in your unit	2.1	3	21	15.7	26.9	31.4	4.57	335
Making shift adjustments to the schedule	2.4	4.1	10.1	25.1	37.3	21	4.54	338
Deciding compensation levels for nursing staff	50.8	17.8	13.9	12.7	3.3	1.5	2.04	331
Reviewing the operating budget for your unit	17.3	29.5	38.9	8.8	3.2	2.3	2.58	342

DESCRIPTION OF YOUR UNIT AND YOUR PATIENTS

5&6. **Summary of Descriptions of Units and Specialties**

Unit Description and Specialty	No. of Units	Percent
Medical-Surgical Units	66	19.0
Surgical Units	22	6.3
Medical Units	20	5.7
Cardiac Intensive Care Units	17	4.9
Other Medical & Surgical Intensive Care Units	35	10.1
OB, Labor & Delivery, Normal Newborn Nursery	34	9.8
Medical & Surgical Telemetry /Stepdown Units	32	9.2
Psychiatry & Chemical Dependency Units	32	9.2
Emergency Department	14	4.0
Post Anesthesia Care Units	13	3.7
Operating Room (Includes OR-Recovery Room Units)	13	3.7
Neonatal & Pediatric Intensive Care Units	11	3.2
General Pediatrics in a general hospital	10	2.9
Medical & Surgical Pediatrics in a pediatric hospital	9	2.6
Outpatient clinics & Services (Nonsurgical/nonemer.)	8	2.3
Outpatient or Ambulatory Surgery	6	1.7
Rehabilitation Units	4	1.1
Home Health Care & Hospice	2	0.6
TOTAL	348	100.0

7. Which phrases best describe the nursing services in your unit. Please check all that apply.

Percent with Characteristic		N
70.7	Acute care, but not critical care	348
42.2	Critical care	348
20.4	Custodial care	348
86.5	Available year round	348
79.3	Available 7 days a week	348
89.4	Available 24 hours per day	348

8. This question concerns characteristics of **patients in your unit**. Please check the category that best describes the **proportion** of patients on your unit with the given characteristic. Patients may fall into several categories.

Percentage of Respondents in each category:

Category	1 None	2 Fewer than half	3 About half	4 Most	5 All	Mean Response	N
Adults	10.1	4.2	3.6	47.2	35.0	3.93	337
Children, ages 2 through 18	30.8	58.6	3.3	4.2	3.0	1.90	331
Infants, under age 2	64.7	20.5	7.3	2.4	5.1	1.63	331
Age 60 and older	18.7	15.4	40.2	24.8	0.9	2.74	331
Female	0.9	8.0	77.4	7.4	6.2	3.10	337
Are catheterized	10.0	54.6	22.7	11.8	0.9	2.39	339
Have IVs	7.0	15.2	12.3	43.3	22.2	3.58	342
Have monitors	37.9	19.1	6.2	12.9	23.8	2.66	340
Have respirators	52.1	32.5	7.4	7.4	0.6	1.72	338
Need assistance in eating	14.8	46.8	17.8	13.9	6.6	2.51	331
Need assistance in walking	13.6	35.6	21.1	23.3	6.3	2.73	331
Need assistance in using bathroom	12.0	32.0	25.1	24.9	6.0	2.81	334
Are receiving therapy from another unit	26.1	41.1	14.7	13.8	4.2	2.29	333

9. For each of the characteristics listed below, please rate your unit in comparison to other units in your hospital. (1 ="Much lower," 4="About the same," and 7 = "Much higher.")

Percentage of Respondents in each category:

	Lower 1	2	3	4	5	6	7Higher	Mean	N
Average patient acuity	3.9	4.2	6.8	17.3	19.6	26.8	21.4	5.11	336
Use of new technology for patient care	5.1	6.6	8.1	24.6	19.5	17.4	18.9	4.74	334
Use of special equipment in patient care	6.3	6.9	5.4	17.4	20.4	21.6	21.9	4.91	333
Use of computer technology for patient information	6.3	7.5	4.5	54.6	11.0	7.5	8.7	4.13	335
Total value of equipment in your unit	5.9	7.6	10	22.6	17.9	15.6	20.3	4.67	340
Value of equipment per bed in your unit	5.4	9.0	9.6	27.2	14.7	18.3	15.9	4.55	334
Number of nursing staff per patient	3.5	7.0	12.9	24.6	19.4	17.9	14.7	4.61	341
Value of equipment per nursing staff member	5.4	7.8	8.4	33.7	16.1	15.8	12.8	4.46	335
Variety of treatment from patient to patient	2.6	4.7	9.7	22.9	24.3	23.5	12.3	4.81	341

10. Please indicate which time periods best represent each of the following for patients on your unit:

Percentage of Respondents in each category:

Category No.	1	2	3	4	5	6	7	8		
	0-1 Days	2-3 Days	4-6 Days	7-10 Days	11-14 Days	15-30 Days	31-90 Days	Over 90 Days	Mean Category	N
Average length of stay	16.3	11.5	28.4	24.2	7.6	6.6	3.9	1.5	3.38	331
Longest length of stay	12.4	2.4	2.7	2.4	2.4	12.7	30.0	34.8	6.12	330
Shortest length of stay	73.0	17.9	2.7	2.1	0.6	1.8	1.2	0.6	1.53	330

11.Please indicate the range which best represents the number in each category on your unit.

Percentage of Respondents in each category:

Category No.	1	2	3	4	5	6	7	8	Mean	
	0-3	4-8	9-14	15-20	21-28	29-37	38-50	Over 50	Category	N
Number of beds on your unit	0.9	9.0	17.6	17.0	20.3	23.6	10.1	1.5	4.66	335
Average daily admissions	37.9	41.5	8.1	3.0	4.2	2.1	1.2	2.1	2.16	335
Highest daily admissions over past year	4.8	32.1	32.4	14.7	6.0	2.7	4.2	3.0	3.25	333
Lowest daily admissions over past year	87.6	5.7	1.5	2.1	1.2	0.6	0.3	0.9	1.31	331
Average patient census	2.4	12.9	20.4	14.1	26.6	13.2	5.7	4.8	4.36	334
Highest patient census over past year	0.6	5.4	14.3	14.6	20.3	21.5	14.0	9.3	5.16	335
Lowest patient census over past year	27.2	18.2	23.0	17.6	7.5	2.4	1.2	3.0	2.86	335

DESCRIPTION OF NURSING STAFF ON YOUR UNIT

12. Which model most closely describes the basis for nursing staff assignment practices in your unit?

Percent of Respondents	
2.0	No Answer
3.7	Functional nursing in which each nursing staff member performs specified functions for all patients in a unit.
17.8	Team nursing in which an RN leader coordinates all nursing functions for a group of patients, using appropriate skills of the team members (RNs,LPNs, and nursing assistants).
27.9	Modular nursing in which one nurse is assigned primary responsibility for the care of patients in certain proximate areas.
36.2	Primary nursing in which each RN has total 24-hour-per-day responsibility for the patient care of a specific group of patients.
2.6	Case management nursing in which one RN monitors the progress of and provides assistance to a patient from pre-admission, through post-dischargeThe case manager nurse follows the progress of the patient through all stages of hospitalization, even when the patient is assigned to another unit.
5.7	Other
4.2	Combinations of nursing assignment models

13. Please check the approximate **proportion of time spent in direct patient care** during a 24-hour period, by each of the following categories of personnel.

	Percentage of Respondents in each category:					
Category No.	1	2	3	4		
	None	Some	Most	All	Mean Response	N
RN staff members	0.0	7.6	61.4	31.0	3.23	342
LPN staff members	7.5	18.8	46.9	26.8	2.93	213*
Nurse assistants	7.5	33.8	43.2	15.4	2.67	266*
Unit Clerks	78.5	18.8	2.0	0.7	1.25	298*

* Percentages do not include those units who report no staff in this category of personnel.

14. Consider the **nursing staff used on your unit during a typical month.** Please check the category that best describes the **proportion of nursing staff** with the given characteristic. Some categories are **overlapping.**

	Percentage of Respondents in each category:						
Category No.	1	2	3	4	5		
	None	Fewer than Half	Half	Most	All	Mean Response	N
RNs without BSN	3.4	21.3	26.7	43.7	4.9	3.25	348
RNs with BSN or higher	19.0	54.0	19.8	6.6	0.6	2.16	348
RNs with clinical specialty	49.7	30.7	6.9	7.2	5.5	1.88	348
LPNs	44.8	50.3	3.7	0.9	0.3	1.61	348
Nurse assistants	27.6	63.5	6.9	2.0	0.0	1.83	348
Permanent full-time employees of the hospital	2.9	7.5	22.4	64.4	2.9	3.57	348
Permanent part-time employees of the hospital	5.7	64.4	23.9	5.5	0.6	2.31	348
Temporary employees from an outside agency	68.1	29.3	2.0	0.3	0.3	1.35	348
Nurses from other hospital units or inhouse pool	32.2	65.2	2.6	0.0	0.0	1.70	348

15. For each of the characteristics listed below, please rate your unit in comparison to other units in your hospital.
(1 ="Much lower," 4 ="About the same," and 7 = "Much higher" or "Much greater.")

	Percentage of Respondents in each category:								
	Lower 1	2	3	4	5	6	7 Higher	Mean	N
Pay rate for RN staff	0.3	0.3	1.2	84.6	9.0	3.8	0.9	4.17	344
Pay rate for other nursing staff members	0.3	0.9	1.5	88.4	5.5	3.0	0.3	4.08	328
Need for unit orientation	0.6	0.3	4.1	32.1	18.1	23.9	21.0	5.22	343
Ease of finding enough staff for any given shift	5.6	8.2	11.7	34.6	19.9	14.1	5.9	4.21	341
Ease of preparing schedules	2.9	7.0	10.8	41.8	23.1	10.5	3.8	4.22	342
Ease of making shift adjustments	3.3	5.1	10.4	45.8	21.4	8.9	5.1	4.24	336
Use of pool nursing staff from inside hospital	24.4	12.8	14.4	27.5	12.2	7.2	1.6	3.18	320
Use of pool nursing staff from outside agency	54.2	8.1	7.4	20.1	5.3	4.6	0.4	2.29	284
Turnover rate for nursing staff	19.1	22.9	19.7	23.5	8.5	4.7	1.5	2.99	340

16. Approximately how many of each category of nursing staff are assigned to your unit during a typical 24-hour period?

	Percentage of Respondents in each category:								
Category No.	1	2	3	4	5	6	7	Mean	
	0	1-3	4-7	8-12	13-17	18-25	Over 25	Response	N
RNs with BSN or higher degree	12.9	46.3	25.6	11.2	2.6	0.9	0.6	2.49	348
RNs without BSN	3.4	19.5	35.6	29.6	7.2	2.9	1.7	3.33	348
LPNs	45.7	33.0	19.3	1.7	0.3	0.0	0.0	1.78	348
Nurse assistants	26.1	46.8	22.1	3.4	1.1	0.3	0.0	2.07	348
Unit Clerks	13.5	77.9	8.3	0.0	0.3	0.0	0.0	1.96	348
Total nursing staff on all shifts	0.3	3.6	10.8	21.6	28.5	24	11.1	4.91	333

SCHEDULING OPTIONS AND SCHEDULING PROCEDURES ON YOUR UNIT

This section deals with the options and procedures used by your unit in scheduling nursing personnel.

17. Consider the nursing staff (from any source) who worked in your unit over the past three months. How many have schedules with the following characteristics.

Percentage of Respondents in Each Category:

Category No.	1	2	3	4	5		
	None	A Few	About Half	Most	All	Mean	N
Have fixed start times (dictated by hospital)	5.2	4.6	3.2	42.2	44.8	4.17	348
Have flexible start times (dictated by employee)	57.5	38.2	1.7	2.3	0.3	1.50	348
Rotates regularly between day shift and other shifts	33.3	26.1	12.4	25.9	2.3	2.38	348
Have a permnt. shift assignment(days or evenings)	4.6	31.9	14.7	23.0	25.9	3.34	348
Work required number of weekends in a given time pd.	7.5	2.0	3.7	25.3	61.2	4.32	348
Are permanently assigned to weekends	60.1	33.0	0.9	1.1	4.9	1.58	348
Have a permanent assignment to your unit	6.3	2.9	2.0	39.9	48.9	4.22	348
Have a pattern of days on and off (such as 3on, 2off)	33.9	25.3	8.0	23.0	9.8	2.49	348
Work the same days every week	30.7	42.5	5.5	14.9	6.3	2.24	348
Work split shifts(ex. 4 on, a few off, and 4 more on)	93.1	6.0	0.3	0.3	0.3	1.09	348

18. Please check the category of hours that best describes the following scheduling characteristics in your unit <u>for weekdays and weekends</u>. If more than one answer applies to a given characteristic, please check <u>all</u> hour categories that apply. For example, if RNs on weekdays work 8 and 12-hour shifts, please check both categories. (Percents total more than 100% because of multiple responses on the part of those to whom the question applied. Therefore the mean is not computed.)

Percentage of Respondents in Each Category:

Category No.	1	2	3	4	5	6			
	1-4 Hours	5-6 Hours	7-8 Hours	9-11 Hours	12-16 Hours	Over 16 Hours	2 Shifts	3 or 4 Shifts	N
For weekdays:									
Length of regular RN shift without overtime	1.2	1.2	91.2	12.0	33.4	0.6	28.7	5.3	341
Length of regular LPN shift without overtime	0.0	0.5	97.5	4.0	13.0	0.0	15.0	0.0	200
Length of regular nurse assistant shift without overtime	0.7	0.4	96.3	2.9	4.8	0.0	3.7	0.7	273
Longest period likely to be worked including overtime	0.3	0.0	3.8	17.5	71.1	7.3			343
Shortest period likely to be worked	56.3	9.1	33.6	0.0	0.9	0.0			339
For weekends:									
Length of regular RN shift without overtime	0.6	0.9	82.4	8.7	45.2	0.6	32.2	3.4	323
Length of regular LPN shift without overtime	0.5	1.0	95.9	3.0	14.7	0.0	15.2	0.0	197
Length of regular nurse assistant shift without overtime	2.0	0.8	93.7	2.0	6.7	0.0	4.3	0.4	255
Longest period likely to be worked including overtime	0.3	0.3	4.9	16.4	70.5	7.6			329
Shortest period likely to be worked	55.6	6.5	36.1	0.3	1.5	0.0			324

19. During a **24-hour period** how many **shift start times** do you normally have scheduled?

Percentage of Respondents in Each Category:

Category No.	1	2	3	4	5	6		
	0 or 1	2	3	4 or 5	6 or 7	8 or more	Mean	N
Weekdays:	4.6	7.8	48.6	28.6	6.6	3.8	3.36	346
Weekends:	9.1	12.2	42.8	29.2	4.9	1.8	3.14	329

20. *When making* **short term scheduling adjustments** *to match nursing staff on duty to nursing staff needed, how often do the following situations occur in your unit?*

Percentage of Respondents in Each Category:

Category No.	1 **Less than once per month**	2 **At least once per month but not weekly**	3 **At least once per week but not daily**	4 **Daily**	5 **More than once per day**	**Mean Response**	**N**
A shortage of RNs	6.1	17.8	52.2	13.1	10.8	3.05	343
A shortage of other nursing staff	23.5	24.8	40.2	8.7	2.8	2.42	323
An oversupply of RNs	61.2	30.1	8.4	0.3	0.0	1.48	335
An oversupply of other nursing staff	67.9	24.2	7.5	0.3	0.0	1.40	318
All beds are filled	18.3	13.0	39.8	25.2	3.7	2.83	322
Nurses work beyond their normal hours	4.7	17.7	50.1	21.2	6.2	3.06	339

21 A & B. This question concerns that situation in which the number of nursing staff available do not match the number of nursing staff needed. With what frequency do you take the following actions, in the given circumstance? Check all that apply.

Percentage of Respondents in Each Category:

Category No.	1A	2A	3A			1B	2B	3B		
	For a short term duration					**For a long term duration**				
	Never	Sometimes	Always	Mean	N	Never	Sometimes	Always	Mean	N
For a shortage of nursing staff:										
Use voluntary overtime	1.4	44.3	54.2	2.53	345	4.4	53.6	42.0	2.38	319
Use mandated overtime	72.1	26.1	1.8	1.30	337	76.0	22.7	1.3	1.25	313
Hire outside temp. nursing staff	65.4	32.5	2.1	1.37	338	64.3	32.9	2.8	1.39	319
Use hospital "pool" nurses	22.2	62.0	15.8	1.94	342	24.7	56.6	18.8	1.94	320
Use nurses from another unit	6.1	77.1	6.7	1.91	341	23.2	69.3	7.5	1.84	319
Decline new admissions	76.9	23.1	0.0	1.23	338	78.1	21.9	0.0	1.22	315
Discharge patients	74.9	23.3	1.8	1.27	331	75.1	23.6	1.3	1.26	309
Shift patients to other units	61.7	36.4	1.8	1.40	332	60.8	38.5	0.6	1.40	309
Extend hours of part-time nurses	7.1	73.8	19.1	2.12	340	7.5	74.6	17.9	2.10	319
Call in nurses on assigned day off	8.7	83.4	7.8	1.99	344	14.1	77.8	8.1	1.94	320
Mandate a reduction in days off	91.7	8.3	0.0	1.08	339	90.3	9.7	0.0	1.10	320
Hire new permanent nursing staff	46.9	46	7.2	1.60	335	19.9	64.8	15.3	1.95	321

21 A & B. This question concerns that situation in which the number of nursing staff available do not match the number of nursing staff needed. With what frequency do you take the following actions, in the given circumstance? Check all that apply.

Percentage of Respondents in Each Category:

Category No.	1A	2A	3A			1B	2B	3B		
	For a short term duration					For a long term duration				
	Never	Sometimes	Always	Mean	N	Never	Sometimes	Always	Mean	N
For an overage of nursing staff:										
Use voluntary vacation time	3.9	72.2	23.9	2.20	335	8.9	67.2	23.8	2.15	302
Use mandated vacation time	75.9	22.6	1.5	1.26	328	74.7	23.7	1.7	1.27	300
Send unneeded nursing staff home(Paid)	70	26.7	3.3	1.33	330	70.3	26.3	3.3	1.33	300
Send unneeded nursing staff to other units	12.5	68.5	19.0	2.07	336	15.0	64.1	20.9	2.06	306
Assign nursing staff to duties within unit	22.3	74.7	3.0	1.80	336	31.9	63.8	4.3	1.72	301
Use volunteer unpaid time off	13.7	70.8	15.5	2.01	329	18.9	65.3	15.8	1.97	297
Mandate unpaid time off	78.1	20.4	1.5	1.23	329	77.7	20.9	1.4	1.24	296
Lay off or fire permanent nursing staff	93.7	6.0	0.3	1.07	332	89.6	10.0	0.3	1.10	299
Solicit new admissions	53.4	34.8	11.8	1.58	322	51.2	32.6	16.2	1.65	291

22. In making nursing staff scheduling decisions would you say the process is

N	Percent	
341	5.3	Centralized - performed by one person for several units.
341	12.9	Somewhat decentralized - several units cooperate, sharing personnel when necessary.
341	54.5	Fairly decentralized - each unit does its own scheduling but share common nursing pool personnel.
341	27.3	Completely decentralized - each unit does its own scheduling with no cooperation among units.

23. For the purpose of determining staff needs, patient acuity is assessed

More than once per day	At most, once per day	Not at all	Not applicable	N
53.4%	34.7%	2.6%	9.3%	343

24. With respect to the computerization of the scheduling process, would you say it is

N	Percent	
339	0.9	Completely computerized with no adjustments by human schedulers
339	13.3	Somewhat computerized with some adjustments by human schedulers
339	27.1	Carried out by human schedulers with some computer support
339	58.7	Carried out by human schedulers with no computer support

This section deals with where and when patients are admitted into your unit, as well as where patients go when they are discharged from your unit. Please use the past year as your reference point.

N

25 For the purpose of determining staff needs, expected admissions and discharges are
40.7 % Officially counted 34.5% Included by unofficial adjustments 15.3% Ignored (Only current patients are counted) 9.4 % Not applicable 339

26. What proportion of total admissions to your unit are scheduled 24 or more hours in advance?
28.4% None 39.1% A few 7.4 % About half 23.7% Most 1.5% All 338

27. Does your hosptial have a rule governing discharges?
41.8 %Yes 35.0% No 16.3 % Not applicable 0.6 % Unknown 337

28. If so, is the discharge rule used:
9.5 % Always 12.8% Most of the time 19.2 % Sometimes 10.4% Never 47.9% Not applicable 328

29. For the events listed, please check the most typical time period for the event to occur in your unit. If two time periods are equally typical, please check both of them. Consider a scheduled admission to be one you know about 24 or more hours ahead of time. (Percents total more than 100% because of multiple responses on the part of those to whom the question applied. Therefore the mean is not computed.)

Percentage of Respondents in Each Category:

	Midnight to 6 AM	6 AM to Noon	Noon to 6 PM	6 PM to Midnight	Multiple Categories	N
A scheduled admission	2.5	66.9	60.6	5.6	32.0	284
An unscheduled admission	36.5	43.8	71.7	61.2	62.5	304
A patient's discharge	0.7	64.1	70.4	15.9	40.2	301
Peak demand for nursing service	5.0	75.9	66.9	22.2	52.9	320

30. What proportion of patients enter your unit from the following places?

Percentage of Respondents in Each Category:

Category No.	1	2	3	4	5		
	None	Fewer than half	About half	Most	All	Mean	N
Directly from the patient's current residence	19.7	41.2	15.7	22.6	0.9	2.44	345
From the Emergency Room	11.2	57.5	17.1	13.6	0.6	2.35	339
Immediate post-surgical	32.6	39.9	14.1	10.6	2.9	2.11	341
From another unit in your hospital	12.8	62.5	11.6	9.3	3.8	2.29	344
From a nursing care unit outside your hospital	19.7	76.2	3.2	0.6	0.3	1.86	345
Other	62.9	31.3	2.0	2.6	1.2	1.48	345

31. What proportion of patients leave your unit to go to the following places?

Percentage of Respondents in Each Category:

Category No.	1	2	3	4	5		
	None	Fewer than half	About half	Most	All	Mean	N
Directly to the patient's current residence	13.9	18.3	16.8	48.3	1.7	3.07	345
To another unit in your hospital	7.8	63.8	6.1	18.6	3.8	2.47	345
To a nursing care unit outside your hospital	17.4	76.5	5.2	0.9	0.0	1.90	345
Death	26.4	72.2	1.2	0.3	0.0	1.75	345
Other	75.9	22.0	0.9	0.9	0.3	1.28	345

NURSING SERVICES - CONTROL AND VARIABILITY

The next set of questions deals with the control over and the variability in demand for nursing services experienced by your unit over various time periods. Control over nursing services refers to the ability of nursing management to influence the timing and level of demand for nursing services and the activity on the unit. Variability refers to changes, over some time period, in one or more operating variables, such as the number of beds, number of patients, or number of nurses. Non-nursing units refer to units such as housekeeping, pharmacy, food service, and other units not staffed by nursing personnel.

32. Please circle the rating you give the predictability of demand for nursing services in your unit.

Very predictable	1	2	3	4	5	6	7	Highly unpredictable	Mean	N
Percentage of Respondents:	5.5	12.5	10.8	12.8	17.8	23.3	17.2		4.64	343

33. Please circle the rating you give the complexity of the nursing staff scheduling process in your unit.

Very simple	1	2	3	4	5	6	7	Highly complex	Mean	N
Percentage of Respondents:	1.5	4.4	9.3	19.8	28.2	26.7	10.2		4.90	344

34. Please circle the rating you give the complexity of the process of making staffing shift adjustments in your unit.

Very simple	1	2	3	4	5	6	7	Highly complex	Mean	N
Percentage of Respondents:	1.5	2.9	10.6	22.6	33.4	23.8	5.3		4.76	341

35. Please rate the extent to which the nursing management of your unit has control over the following:

Percentage of Respondents in Each Category:

	No Control 1	2	3	4	5	6	Very High 7 Control	Mean	N
Timing of									
Admissions to your unit	40.1	30.4	10.0	6.5	5.3	4.7	2.9	2.32	339
Discharges from your unit	28.6	20.5	16.4	15.2	10.1	4.8	4.5	2.90	336
Peak demand for nursing services	22.3	21.7	16.0	23.4	8.9	4.7	3.0	3.01	337
Personnel from non-nursing units working on your unit	28.9	17.2	12.0	10.5	6.8	9.8	14.8	3.38	325
Number of									
Patients on the unit	38.1	26.5	9.4	10.9	5.6	6.2	3.2	2.51	339
Nursing staff on duty at any time	0.3	3.2	7.1	22.1	17.1	30.0	20.3	5.24	340
Personnel from non-nursing units working on your unit	31.2	16.7	8.3	11.7	7.7	9.9	14.5	3.36	324
Determination of									
Short term nursing staff needs	3.0	3.6	8.0	18.0	18.3	29.3	19.8	5.12	338
Long term nursing staff needs	3.8	5.9	10.6	18.3	18.9	26.0	16.5	4.86	339
Matching of number of nursing staff									
Needed with the actual number on duty	1.5	6.8	13.6	19.9	20.2	23.4	14.5	4.79	337
Budgeted with the actual number on duty	3.6	10.4	15.4	19.8	18.0	21.0	11.8	4.49	338

36. This question is concerned with high variability in operating variables from period to period. For example, in a unit of 10 beds, if there are 7 patients on one shift, and 3 on the next, that would be considered high shift-to-shift variability in number of patients. On the other hand, if the number of patients tends to remain the same for a 24-hour period, but there are 3 patients one day, and 7 on another day in the same week, that would be considered high day-to-day variability. For each category below, please check the shortest time period for which your unit experiences high variability from period to period. If a category is fairly stable over time, please check the low variability column.

Percentage of Respondents in Each Category:

Category No.	1	2	3	4	5	6		
		High Variability occurs:						
	Shift to Shift	Day to Day	Week to Week	Month to Month	Year to Year	Low Variability	Mean Response	N
Total number of patient beds in your unit	18.6	12.8	4.6	1.5	2.1	60.4	4.37	328
Total number of patient beds filled	27.6	27.9	11.8	4.6	0.6	27.6	3.06	323
Acuity of individual patients	35.2	32.7	10.5	4.0	0.0	17.6	2.54	324
Total acuity of patients on the unit	29.0	29.3	16.0	2.8	0.3	22.5	2.84	324
Direct patient care assignments for nursing staff	36.5	20.2	8.0	1.2	0.6	33.4	3.10	326
Indirect patient care assignments for nursing staff	23.2	17.9	7.2	3.4	0.3	48.0	3.84	319
Timing of the peak demand for nursing services	39.0	22.9	5.0	1.9	0.0	31.3	2.95	323
Needed number of nursing staff on duty	39.0	22.4	7.7	4.6	0.0	26.4	2.83	326
Actual number of nursing staff on duty	35.3	21.8	4.6	5.5	2.1	30.7	3.10	326
Difference between needed and actual nursing care hours	35.9	24.8	9.8	5.5	1.5	22.4	2.79	326
Difference between budgeted and actual nursing care hours	27.0	16.9	11.3	11.0	4.6	29.1	3.37	326

37. Are these **systems in place** in your unit?

% responding

YES		N
10.4	Computerized quality assurance system for nursing	337
91.8	Noncomputerized quality assurance system for nursing	332
72.8	Productivity measurement system	328
90.0	Budget Variance Reporting System	332
64.9	Computerized Patient Acuity System	339
32.1	Noncomputerized Patient Acuity System	290
	A Computerized Patient Information System which:	
62.2	Tracks patient accounting information	331
72.3	Tracks patient admission information	335
64.7	Tracks xray and/or lab information	334
40.6	Tracks pharmacy information	335
32.0	Integrates all patient information systems	325
6.9	Displays patient information on bedside terminals	337
5.6	Allows charting directly on the computer	338
10.7	Allows computerized care planning	337

38. The following have been identified in the current literature as possible management objectives for nursing units. In the first three columns below, please rate the importance that you attach to these objectives in managing your unit. In the last three columns, please rate the importance attached to these objectives by top management.

Percentage of Respondents in Each Category:

Category No.	1A None or slight	2A Fair to moderate	3A Very high	Mean	N	1B None or slight	2B Fair to moderate	3B Very high	Mean	N
Containing costs	0.3	34.9	64.8	2.65	341	0.0	3.5	96.5	2.96	341
Staying within budget	1.5	40.8	57.8	2.56	341	0.0	5.6	94.4	2.94	339
Being able to reduce staff levels quickly	22.6	47.6	29.8	2.07	336	8.3	25.4	66.4	2.58	339
Being able to increase staff levels quickly	1.8	27.0	71.2	2.69	337	13.7	52.5	33.7	2.20	335
Being able to offer a variety of nursing services	7.1	36.0	56.9	2.49	339	4.7	40.9	54.3	2.50	337
Achieving a certain level of productivity	0.3	19.7	80.0	2.80	340	0.0	13.8	86.2	2.86	340
Increasing productivity of nursing staff	0.3	24.9	74.8	2.74	341	1.5	15.4	83.1	2.82	337
Utilizing expensive equipment assigned to your unit	15.6	41.9	42.5	2.27	334	16.5	41.0	42.5	2.26	334
Matching needed staff to actual number on duty	0.0	11.8	88.2	2.88	340	8.9	49.1	42.0	2.33	338
Assigning equitable workloads to nursing staff	0.0	10.4	89.6	2.90	338	18.6	50.7	30.7	2.12	339
Conformance to JCAHO Standards	0.6	22.4	77.1	2.76	340	0.6	5.6	93.8	2.93	339
Having a zero-error rate in dipensing meds	2.1	20.6	77.3	2.75	339	4.4	31.0	64.6	2.60	339
Achieving a certain level of quality of care	0.0	1.2	98.8	2.99	341	3.5	23.2	73.3	2.70	341
Improving the quality of care	0.0	2.4	97.6	2.98	340	6.2	25.3	68.5	2.62	340
Responding to pt. requests within a certain time pd.	0.3	12.6	87.1	2.87	340	4.7	31.5	63.8	2.59	340
Correction of errors within a certain time pd.	0.0	17.1	82.9	2.83	339	3.9	29.3	66.8	2.63	334
Being able to offer new nursing services quickly	8.6	51.0	40.4	2.32	337	9.9	47.9	42.2	2.32	334
Having a satisfied nursing staff	0.0	3.8	96.2	2.96	339	10.6	48.2	41.2	2.30	340
Having a low turnover rate among nursing staff	0.3	8.6	91.2	2.91	339	9.2	39.8	51.0	2.41	337
Considering nursing staff pref.for certain schedules	0.3	23.5	76.2	2.76	340	30.0	55.6	14.4	1.84	340
Considering nursing staff pref. for specific days off	0.0	26.2	73.8	2.74	340	33.6	54.3	12.1	1.78	339

39. Please place a check beside the five objectives above that most guide your actions in the day-to-day management of your unit. (Only two-thirds of the respondents answered this questions, perhaps because it was placed in an odd position on the questionnaire.) Because the responses were coded as "No" = 0, and "Yes" = 1, the mean response and the proportion choosing the given objective as one of their top five guiding objectives for day-to-day management are the same.

(Percent of Respondents=Mean *100)

Rank		Mean	Std. Dev.	N
6	Containing costs	0.319	0.467	232
8	Staying within budget	0.254	0.436	232
(Tie)16	Being able to reduce staff levels quickly	0.052	0.221	232
(Tie)11	Being able to increase staff levels quickly	0.176	0.382	232
19	Being able to offer a variety of nursing services	0.030	0.171	232
7	Achieving a certain level of productivity	0.280	0.450	232
10	Increasing productivity of nursing staff	0.241	0.429	232
21	Utilizing expensive equipment assigned to your unit	0.008	0.092	232
4	Matching needed staff to actual number on duty	0.466	0.500	232
5	Assigning equitable workloads to nursing staff	0.371	0.484	232
(Tie)11	Conformance to JCAHO Standards	0.177	0.382	232
15	Having a zero-error rate in dipensing meds	0.065	0.246	232
2	Achieving a certain level of quality of care	0.483	0.464	232
3	Improving the quality of care	0.246	0.501	232
9	Responding to pt. requests within a certain time pd.	0.246	0.431	232
(Tie)16	Correction of errors within a certain time pd.	0.052	0.222	232
20	Being able to offer new nursing services quickly	0.017	0.130	232
1	Having a satisfied nursing staff	0.763	0.426	232
13	Having a low turnover rate among nursing staff	0.134	0.341	232
14	Considering nursing staff pref. for certain schedules	0.116	0.322	232
(Tie)16	Considering nursing staff pref. for specific days off	0.052	0.222	232

40. Please rate your performance on these objectives in managing your unit.

	Percentage of Respondents in Each Category:						
Category No.	1	2	3	4	5		
	Poor		Satisfactory		Excellent	Mean	N
Containing costs	1.2	4.8	47.2	34.3	12.5	3.52	335
Staying within budget	1.2	5.8	44.5	34.8	13.7	3.54	328
Being able to reduce staff levels quickly	1.4	9.2	45.8	29.2	14.6	3.46	295
Being able to increase staff levels quickly	5.5	20.0	41.5	26.5	6.5	3.08	325
Able to offer a wide variety of nursing services	2.6	11.3	49.2	28.5	8.4	3.29	309
Achieving a certain level of productivity	0.3	4.4	38.2	44.1	13.0	3.65	338
Increasing productivity of nursing staff	0.3	7.2	44.7	39.0	8.7	3.49	333
Utilizing expensive equipment assigned to your unit	2.0	5.8	50.8	28.1	13.2	3.45	295
Matching number of nurses on duty to number needed	1.2	15.9	36.2	38.0	8.7	3.37	334
Assigning equitable workloads to nursing staff	0.0	6.0	32.0	45.2	16.8	3.72	334
Conformance to JCAHO Standards	0.3	3.3	37.4	43.7	15.3	3.70	334
Having a zero-error rate in dipensing meds	0.9	13.5	49.4	29.8	6.4	3.27	326
Achieving a certain level of quality of care	0.0	1.5	24.6	55.2	18.7	3.91	337
Improving the quality of care	0.3	3.0	27.2	52.4	17.2	3.83	338
Responding to pt. requests within a certain time pd.	0.0	1.8	29.1	48.0	21.0	3.88	333
Correction of errors within a certain time period	0.0	4.1	37.9	43.8	14.2	3.68	338
Being able to offer new nursing services quickly	3.9	20.2	49.8	21.2	4.9	3.02	307
Having a satisfied nursing staff	0.3	7.1	40.1	40.4	12.1	3.57	339
Having a low turnover rate among nursing staff	1.2	12.1	35.3	32.6	18.7	3.56	331
Considering nursing staff preferences for schedules	0.6	4.0	21.9	39.2	34.2	4.03	329
Considering nursing staff pref erencesfor specific days off	0.6	1.8	23.6	36.6	37.5	4.08	331

DESCRIPTION OF YOUR HOSPITAL

This section deals with descriptions of your hospital. Please answer for conditions as they currently exist.

41. Which descriptions fit your hospital? Please check all that apply.

N	percent	
348	98.9	Offers acute care
348	39.4	Offers long term care
348	18.4	Operated for profit
348	22.4	Privately owned
348	21.8	Privately operated
348	26.4	Has a unionized nursing staff
348	11.5	Currently operates under a hiring freeze
348	89.7	Currently operates with a shortage of RNs
348	99.4	Pays shift differentials to nursing staff
348	16.4	Pays unit differentials (different pay for different units) to nursing staff
348	74.1	Is a teaching hospital
348	15.5	Is part of a large complex of hospitals located on one site
348	41.4	Is part of a hospital system located on many sites
348	8.9	Is a specialty hospital. If so, specialty is
	4.6	Psychiatric Hospital
	4.3	Children's Hospital

42. Please give the following information about your hospital, if it is known to you. If the answer is unknown, please leave the question blank. Use figures for 1987. If your hospital is part of a complex , please answer for your hospital only.

Number of commissioned beds	0-75	76-150	151-300	300-500	Over 500	N
Percent of respondents	0.4	6.4	24.7	26.5	42.0	283
Number of active beds	0-75	76-150	151-300	300-500	Over 500	N
Percent of respondents	1.4	17.9	17.9	33.0	29.9	291
Number of nursing units	0-10	11-25	25-50	51-100	Over 100	N
Percent of respondents	27.7	37.7	30.8	3.5	0.3	289
Number of RN staff members	0-75	76-150	151-300	300-500	Over 500	N
Percent of respondents	2.8	12.7	19.3	14.6	50.5	212

42. Please give the following information about your hospital, if it is known to you. If the answer is unknown, please leave the question blank. Use figures for 1987. If your hospital is part of a complex , please answer for your hospital only.

Total number of nursing personnel	0-150	151-300	301-600	601-1000	Over 1000	N
Percent of respondents	1.4	16.4	17.4	24.6	40.1	207
Average Daily Patient Census	0-60	61-130	131-250	251-400	Over 400	N
Percent of respondents	2.8	24.8	12.2	26.0	34.3	254
Occupancy rate (percent)	0-30%	31-50%	51-70%	71-90%	Over 90%	N
Percent of respondents	0.4	7.1	27.5	56.9	8.2	255
Number of DRGS treated in entire hospital	0-50	51-100	101-300	Over 300	DRG Exempt	N
Percent of respondents	12.3	13.0	27.7	38.5	7.7	65
Patients on Medicare (%)or other government supported treatment?	0-10%	11-35%	36-65%	67-90%	91-100%	N
Percent of respondents	2.8	8.5	67.6	19.0	2.1	142

Summary responses to questions no. 43 and 44 are not reported due to a high nonresponse rate.

APPENDIX D

RESULTS OF ANALYSES PERFORMED IN CHAPTER III AND IV

Table D.1

Pairs of
Hospital Descriptor Variables
Failing to Pass The Chi-Square Test of Independence
Using an $\alpha = .05$

Variable Description	Percent of Responding units in such a hospital	Name	Variable X4105	X4106	X4108
Operated for Profit	18.4	X4103			6.522 0.011
Privately Owned	22.4	X4104	261.413 0.000*	18.163 0.000*	
Privately Operated	21.8	X4105		14.837 0.000*	
Has a Unionized Nursing Staff	26.4	X4106	14.837 0.000*		4.849 0.028
Operates under a Hiring Freeze	11.5	X4107			
Operates under a Nursing Shortage	89.7	X4108			
Pays Unit Differentials	16.4	X4110		10.640 0.001	
Is a Teaching Hospital	74.1	X4111			5.231 0.022

N = 348 UNITS IN ALL CASES

Top No. in the Table	Chi-Square Value
Bottom No. in the Table	Probability of Occurrence

* A Probability of 0.000 indicates the probability of occurrence of a particular x^2 value is less than 0.001.

Table D.2
Results of Hypotheses Tests
For Patient Descriptor Variables
For Four Types of Nursing Units

		Type of Nursing Unit												
		1		2		3		4						
Variable	Variable	Not Acute or Critical		Acute Only		Both Acute & Critical		Critical Only		ANOVA Root	P-value	Grand	Total	Statistically Different
Description	Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N	Pairs***
Proportion of Patients who are:														
Adults	X801													
SN1		3.85	14	3.90	84	3.91	33	3.98	41	1.202	0.9863	3.92	172	None
SN2		3.13	8	4.08	91	3.73	30	3.94	36	1.219	0.1379	3.93	165	None
Children	X802													
SN1		1.69	13	1.96	82	1.78	32	1.78	40	0.829	0.4748	1.86	167	None
SN2		2.38	8	1.93	89	2.16	32	1.66	35	0.921	0.0860	1.94	164	None
Infants	X803													
SN1		1.77	13	1.51	80	1.79	34	1.84	39	1.086	0.3560	1.67	166	None
SN2		1.50	8	1.41	90	2.09	33	1.59	34	1.030	0.0163	1.59	165	(2,3)
Over 60	X804													
SN1		2.58	12	2.76	80	2.53	34	2.83	42	1.053	0.5873	2.72	168	None
SN2		2.38	8	2.80	89	2.48	31	2.97	35	1.067	0.2079	2.75	163	None
Female	X805													
SN1		3.15	13	3.25	80	3.06	34	2.98	42	0.659	0.1525	3.14	169	None
SN2		3.00	8	3.14	93	3.13	32	2.83	35	0.642	0.0995	3.07	168	None
Total	SN1		14		84		34		42				174	
N Available'	SN2		9		94		34		37				174	

Table D.2 (Continued)

Results of Hypothesas Tests
For Patient Descriptor Variables
For Four Types of Nursing Units

Variable Description	Variable Name	Type of Nursing Unit 1 Not Acute or Critical Mean	N	2 Acute Only Mean	N	3 Both Acute & Critical Mean	N	4 Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Total N	Statistically Different Pairs***
Proportion of patients with:														
Catheters	X806													
SN1		2.15	13	2.20	82	2.48	33	2.83	41	0.841	0.0010	2.40	169	(2,4)
SN2		1.56	9	2.32	94	2.34	32	2.77	35	0.799	0.0005	2.38	170	(1,2), (1,3), (1,4), (2,4)
IVs	X807													
SN1		2.69	13	3.23	82	3.64	34	4.54	42	1.060	0.0001	3.60	171	(1,3), (1,4), (2,4), (3,4)
SN2		2.11	9	3.30	93	3.85	33	4.39	36	1.048	0.0001	3.57	171	(1,2), (1,3), (1,4), (2,4)
Monitors	X808													
SN1		1.91	12	1.74	82	3.12	34	4.40	42	1.178	0.0001	2.69	170	(1,3), (1,4), (2,3), (2,4), (3,4)
SN2		1.56	9	1.70	93	3.53	32	4.47	36	1.174	0.0001	2.62	170	(1,3), (1,4), (2,3), (2,4), (3,4)
Respirators	X809													
SN1		1.33	12	1.17	82	2.21	34	2.67	42	0.716	0.0001	1.76	170	(1,3), (1,4), (2,3), (2,4), (3,4)
SN2		1.22	9	1.28	93	2.10	30	2.47	36	0.741	0.0001	1.68	168	(1,3), (1,4), (2,3), (2,4)
Total	SN1		14		84		34		42				174	
N Available'	SN2		9		94		34		37				174	

Table D.2 (Continued)

Results of Hypotheses Tests
For Patient Descriptor Variables
For Four Types of Nursing Units

		Type of Nursing Unit												
Variable Description	Variable Name	1 Not Acute or Critical Mean	N	2 Acute Only Mean	N	3 Both Acute & Critical Mean	N	4 Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Total N	Statistically Different Pairs***
Proportion of patients who need assistance in:														
Eating	X810													
SN1		2.17	12	2.26	82	2.71	31	2.74	39	1.081	0.0471	2.45	164	None
SN2		2.22	9	2.40	93	2.63	30	3.02	35	1.096	0.0269	2.56	167	(2,4)
Walking	X811													
SN1		2.08	12	2.63	82	2.48	31	2.75	40	1.123	0.3050	2.59	165	None
SN2		2.22	9	2.99	92	2.45	29	3.05	36	1.137	0.0341	2.87	166	None
Bathroom	X812													
SN1		2.33	12	2.73	82	2.66	32	2.93	41	1.110	0.4008	2.73	167	None
SN2		2.33	9	2.99	93	2.41	29	3.11	36	1.107	0.0226	2.88	167	None
Proportion of patients who are:														
Receiving Therapy from another unit	X813													
SN1		1.75	12	2.06	82	2.32	32	2.51	41	1.113	0.0832	2.20	167	None
SN2		2.25	8	2.39	94	2.33	30	2.41	34	1.124	0.9776	2.38	166	None
Total N Available'	SN1		14		84		34		42				174	
	SN2		9		94		34		37				174	

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

Table D.3
Results of Hypotheses Tests
For Mean Unit Rating Compared to Other Units
Technology and Equipment Variables
For Four Types of Nursing Units

Variable Description	Variable Name	Type of Nursing Unit 1 Not Acute or Critical Mean	N	2 Acute Only Mean	N	3 Both Acute & Critical Mean	N	4 Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Tota N	Statistically Different Pairs***
Rating of Unit Compared to Other Units in Your Hospital:														
Average Patient Acuity	X901													
SN1		3.10	10	4.52	83	5.82	33	6.00	41	1.495	0.0001	5.05	167	(1,2),(1,3),(1,4),(2,3),(2,4)
SN2		3.33	9	4.73	94	5.87	30	6.14	36	1.298	0.0001	5.16	169	(1,2),(1,3),(1,4),(2,3),(2,4)
Use of New Technology for Patient Care	X902													
SN1		3.27	11	4.09	81	5.48	33	6.19	42	1.308	0.0001	4.84	167	(1,3),(1,4),(2,3),(2,4)
SN2		4.43	7	3.95	94	5.60	30	5.72	36	1.540	0.0001	4.65	167	(2,3),(2,4)
Use of Special Equipment in Patient Care	X903													
SN1		3.40	10	4.19	81	5.85	33	6.38	42	1.368	0.0001	5.03	166	(1,3),(1,4),(2,3),(2,4)
SN2		4.71	7	4.05	93	5.77	31	5.89	36	1.607	0.0001	4.80	167	(2,3),(2,4)
Use of Computer Technology for Patient Information	X904													
SN1		3.73	11	3.64	83	4.13	32	4.81	42	1.359	0.0002	4.03	168	(2,4)
SN2		4.14	7	3.93	92	4.48	31	4.84	37	1.412	0.0093	4.25	167	(2,4)
Total Value of Equipment in your Unit	X905													
SN1		3.33	12	3.83	83	5.15	33	6.24	42	1.414	0.0001	4.72	170	(1,3),(1,4),(2,3),(2,4)
SN2		3.75	8	3.95	94	5.65	31	5.68	37	1.547	0.0001	4.62	170	(1,3),(1,4),(2,3),(2,4)
Value of Equipment Per Bed in Your Unit	X906													
SN1		3.10	10	3.82	82	5.33	33	6.15	41	1.332	0.0001	4.65	166	(1,3),(1,4),(2,3),(2,4),(3,4)
SN2		3.63	8	3.74	94	5.55	31	5.57	35	1.502	0.0001	4.45	168	(1,3),(1,4),(2,3),(2,4)
Total N Available*	SN1		14		84		34		42				174	
	SN2		9		94		34		37				174	

Table D.3 (Continued)

Results of Hypotheses Tests
For Mean Unit Rating Compared to Other Units
Technology and Equipment Variables
For Four Types of Nursing Units

Variable Description	Variable Name	Type of Nursing Unit 1 Not Acute or Critical Mean	N	2 Acute Only Mean	N	3 Both Acute & Critical Mean	N	4 Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Tota N	Statistically Different Pairs***
Rating of Unit Compared to Other Units in Your Hospital:														
Number of Nursing Staff Per Patient	X907													
SN1		2.58	12	4.18	84	5.24	33	5.66	41	1.494	0.0001	4.63	170	(1,2),(1,3),(1,4),(2,3),(2,4)
SN2		4.22	9	4.02	94	5.23	31	5.65	37	1.338	0.0001	4.60	174	(1,4),(2,3),(2,4)
Value of Equipment per Nursing Staff Memeber	X908													
SN1		3.00	11	3.69	80	5.33	33	6.02	41	1.229	0.0001	4.55	165	(1,3),(1,4),(2,3),(2,4)
SN2		3.75	8	3.76	94	5.32	31	5.30	37	1.421	0.0001	4.38	170	(1,3),(1,4),(2,3),(2,4)
Variety of Treatment from Patient to Patient	X909													
SN1		3.82	11	4.55	84	5.76	33	5.57	42	1.372	0.0001	4.99	170	(1,3),(1,4),(2,3),(2,4)
SN2		3.67	9	4.93	94	5.00	31	5.18	37	1.375	0.0019	4.64	171	(1,4),(2,4)
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

Table D.4
Results of Hypotheses Tests
For Length of Stay, Daily Admissions
And Patient Census
For Four Types of Nursing Units

		Type of Nursing Unit												
		1		2		3		4						
		Not Acute		Acute		Both Acute		Critical		ANOVA				Statistically
Variable	Variable	or Critical		Only		& Critical		Only		Root	P-value	Grand	Total	Different
Description	Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N	Pairs***
Mean Response to the Question:****														
Average Length of Stay	X1001													
SN1		3.10	10	3.80	82	3.67	30	2.34	41	1.519	0.0001	3.28	163	(2,4)
SN2		4.00	8	3.76	93	3.16	31	2.94	36	1.680	0.0458	3.49	168	*****
Longest Length of Stay	X1002													
SN1		6.22	9	6.62	82	5.56	30	5.00	41	2.336	0.0025	5.98	162	(2,4)
SN2		5.00	8	6.63	93	5.58	31	6.19	36	2.258	0.0522	6.27	168	None
Shortest Length of Stay	X1003													
SN1		1.78	9	1.52	82	1.43	30	1.20	41	1.066	0.3146	1.44	162	None
SN2		3.25	8	1.61	93	1.55	31	1.31	36	1.304	0.0028	1.61	168	(1,2),(1,3),(1,4)
Number of Beds on Unit	X1101													
SN1		4.67	9	5.34	82	4.06	32	3.88	41	1.380	0.0001	4.69	164	(2,3),(2,4)
SN2		4.00	9	5.24	94	4.45	31	3.35	37	1.450	0.0001	4.63	171	(2,4),(3,4)
Average Daily Admission	X1102													
SN1		2.44	9	2.01	84	2.78	32	2.78	41	1.752	0.0606	2.37	166	None
SN2		2.00	9	1.80	93	2.58	31	1.72	36	1.163	0.0091	1.94	169	(2,3),(3,4)
Highest Daily Admissions	X1103													
SN1		3.67	9	3.18	84	3.72	32	3.78	40	1.765	0.2431	3.45	165	None
SN2		2.56	9	2.91	92	3.74	31	2.92	36	1.321	0.0129	3.05	168	(2,3)
Lowest Daily Admissions	X1104													
SN1		1.78	9	1.12	83	2.29	31	1.57	40	1.318	0.0005	1.49	163	(2.3)
SN2		1.22	9	1.02	93	1.45	31	1.14	35	0.514	0.0013	1.14	168	(2,3)
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Table D.4 (Continued)

Results of Hypotheses Tests
For Length of Stay, Daily Admissions
And Patient Census
For Four Types of Nursing Units

		Type of Nursing Unit												
Variable Description	Variable Name	1 Not Acute or Critical Mean	N	2 Acute Only Mean	N	3 Both Acute & Critical Mean	N	4 Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Total N	Statistically Different Pairs***
Mean Response to the Question:****														
Average Patient Census	X1105													
SN1		4.90	10	4.73	83	4.47	32	3.70	40	1.736	0.0180	4.44	165	(2,4)
SN2		3.38	8	4.55	94	4.50	32	3.57	35	1.575	0.0053	4.45	169	(2,4)
Highest Patient Census	X1106													
SN1		5.60	10	5.53	83	5.25	32	4.75	40	1.687	0.1099	5.29	165	None
SN2		4.00	9	5.34	94	5.25	32	4.23	35	1.630	0.0015	5.02	170	(2,4)
Lowest Patient Census	X1107													
SN1		4.00	10	2.95	83	3.34	32	2.33	40	1.751	0.0184	2.94	165	(1,4)
SN2		2.56	9	2.88	94	2.97	32	2.49	35	1.613	0.5462	2.80	170	None
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

**** The responses to these questions were treated as continuous variables, when they really represent ordered ranges. Use of the mid-points of the responses ranges leads to very similar results.

*****None of the pairs of units tested by SAS were significantly different. However, a p-level less than .05 indicates some pairs of combinations of units are different from each other.

Table D.5

Significant Correlations (Alpha = .05)
Between Variables Representing
Length of Stay, Number of Beds on the Unit, Daily Admissions, and Patient Census

Variable		Variable	Significantly	Correlated	(Correlations	in Boldface	have p-value ≤ .01)					
Description	Sample	Name	with:	X1002	X1003	X1101	X1102	X1103	X1104	X1105	X1106	X1107
Average Length of Stay	**SN1**	**X1001**		**0.73**	**0.51**	**0.20**	**-0.57**	**-0.60**	**-0.44**		-0.16	
	SN2			**0.65**	**0.60**	**0.25**	**-0.53**	**-0.57**	**-0.36**			**0.22**
Longest Length of Stay	**SN1**	**X1002**			0.16	**0.23**	**-0.72**	**-0.66**	**-0.50**	-0.17	**-0.32**	
	SN2					**0.28**	**-0.57**	**-0.57**	**-0.40**			
Shortest Length of Stay	**SN1**	**X1003**					-0.18	**-0.24**				
	SN2						**-0.25**	**-0.30**				0.20
No. of Beds on Unit	***SN1***	***X1101***								**0.52**	**0.60**	**0.41**
	SN2									**0.74**	**0.75**	**0.53**
Average Daily Admissions	**SN1**	**X1102**						**0.91**	**0.74**	**0.46**	**0.56**	**0.45**
	SN2							**0.87**	**0.70**	**0.40**	**0.42**	**0.21**
Highest Daily Admissions	**SN1**	**X1103**							**0.62**	**0.40**	**0.55**	**0.35**
	SN2								**0.60**	**0.44**	**0.51**	**0.19**
Lowest Daily Admissions	**SN1**	**X1104**								**0.34**	**0.38**	**0.49**
	SN2									**0.32**	**0.28**	**0.36**
Average Patient Census	**SN1**	**X1105**									**0.85**	**0.82**
	SN2										**0.87**	**0.78**
Highest Patient Census	**SN1**	**X1106**										**0.71**
	SN2											**0.69**
Lowest Patient Census	**SN1**	**X1107**										
	SN2											

Table D.6
Results of Hypotheses Tests For Proportion of Time spent in Nursing Care By Different types of Nursing Staff Members For Four Types of Nursing Units

		Type of Nursing Unit												
		1 Not Acute or Critical		2 Acute Only		3 Both Acute & Critical		4 Critical Only		ANOVA				Statistically
Variable Description	Variable Name	Mean	N	Mean	N	Mean	N	Mean	N	Root MSE	P-value of F ≤	Grand Mean	Tota N	Different Pairs***
Proportion of Time Spent In Direct Patient Care By:	****													
RN Staff Members	X1301													
SN1		3.08	13	3.07	83	3.35	34	3.45	42	0.590	0.0034	3.22	172	(2,4)
SN2		3.33	9	3.13	91	3.30	33	3.46	37	0.529	0.0144	3.24	170	(2,4)
LPN Staff Members	X1302													
SN1		2.75	8	3.02	62	2.65	20	2.80	2	0.901	0.3929	2.89	110	None
SN2		3.00	3	3.01	71	3.05	18	2.55	11	0.832	0.3596	2.97	103	None
Nurse Assistants	X1303													
SN1		2.83	12	3.00	82	2.96	33	3.21	41	1.198	0.6877	3.04	168	None
SN2		3.89	9	2.97	91	3.63	32	3.56	36	1.163	0.0040	3.28	168	(2,3)
Unit Clerks	X1304													
SN1		1.30	10	1.16	75	1.45	29	1.17	34	0.458	0.0325	1.23	148	(2,3)
SN2		1.50	8	1.24	86	1.48	27	1.06	29	0.551	0.0277	1.27	150	(3,4)
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

**** The responses to these questions were treated as continuous variables, when they really represent ordered ranges.

Table D.7
Results of Hypotheses Tests
For Mean Proportion of Nursing Staff
With Various Characteristics
For Four Types of Nursing Units

		Type of Nursing Unit												
		1 Not Acute or Critical		2 Acute Only		3 Both Acute & Critical		4 Critical Only		ANOVA Root	P-value	Grand	Tota	Statistically Different
Variable Description	Variable Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N	Pairs***
Proportion of Nursing Staff on Your Unit With the given characteristic:														
RNs without BSN	X1401													
SN1		3.79	14	3.24	84	3.21	34	3.24	42	0.966	0.2380	3.28	174	None
SN2		3.88	9	3.15	94	3.15	34	3.35	37	0.944	0.1183	3.23	174	None
RNs with BSN or Higher	X1402													
SN1		1.93	14	2.27	84	1.97	34	2.14	42	0.860	0.2501	2.16	174	None
SN2		1.78	9	2.15	94	2.18	34	2.27	37	0.788	0.4144	2.16	174	None
RNs with Clinical Specia	X1403													
SN1		1.71	14	1.75	84	2.09	34	1.98	42	1.143	0.4285	1.86	174	None
SN2		2.56	9	1.77	94	2.35	34	1.62	37	1.141	0.0095	1.89	174	(3,4)
LPNs	X1404													
SN1		1.50	14	1.78	84	1.47	34	1.43	42	0.555	0.0019	1.61	174	(2,3),(2,4)
SN2		1.33	9	1.84	94	1.47	34	1.24	37	0.641	0.0001	1.61	174	(2,3),(2,4)
Nurse Assistants	X1405													
SN1		1.71	14	2.05	84	1.65	34	1.59	42	0.555	0.0001	1.83	174	(2,3),(2,4)
SN2		2.22	9	2.00	94	1.62	34	1.51	37	0.636	0.0001	1.83	174	(1,3),(1,4),(2,3),(2,4)
Permanent Full-time	X1406													
SN1		3.64	14	3.67	84	3.50	34	3.70	42	0.733	0.6715	3.64	174	None
SN2		3.33	9	3.43	94	3.65	34	3.59	37	0.845	0.4652	3.50	174	None
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Table D.7 (Continued)

Results of Hypotheses Tests
For Mean Proportion of Nursing Staff
With Various Characteristics
For Four Types of Nursing Units

		Type of Nursing Unit												
		1 Not Acute or Critical		2 Acute Only		3 Both Acute & Critical		4 Critical Only		ANOVA				Statistically
Variable Description	Variable Name	Mean	N	Mean	N	Mean	N	Mean	N	Root MSE	P-value of F ≤	Grand Mean	Tota N	Different Pairs***
Proportion of Nursing Staff on Your Unit With the given characteristic:														
Permanent Part-time	X1407													
SN1		2.54	14	2.26	84	2.15	34	2.38	42	0.658	0.0917	2.30	174	None
SN2		2.22	9	2.43	94	2.09	34	2.27	37	0.705	0.1098	2.32	174	None
Temporary Employees	X1408													
SN1		1.43	14	1.39	84	1.24	34	1.24	42	0.559	0.1288	1.70	174	None
SN2		1.11	9	1.46	94	1.26	34	1.35	37	0.570	0.1608	1.38	174	None
From Other Units or Pool	X1409													
SN1		1.50	14	1.79	84	1.62	34	1.67	42	0.502	0.3114	1.33	174	None
SN2		1.22	9	1.78	94	1.62	34	1.73	37	0.504	0.0121	1.71	174	(1,2)
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

Table D.8
Results of Hypotheses Tests
For Mean Unit Rating Compared to Other Units
For Staff Descriptor Variables
For Four Types of Nursing Unts

		Type of Nursing Unit												
Variable Description	Variable Name	1 Not Acute or Critical Mean	N	2 Acute Only Mean	N	3 Both Acute & Critical Mean	N	4 Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Total N	Statistically Different Pairs***
Rating of Your Unit Compared To Other Units in Your Hospital:														
Pay Rate for RNs	X1501													
SN1		4.31	13	4.09	84	4.33	33	4.35	42	0.694	0.1468	4.22	172	None
SN2		4.00	9	4.11	93	4.03	33	4.21	37	0.437	0.2822	4.11	172	None
Pay Rate for Other Staff	X1502													
SN1		4.00	12	4.07	84	4.31	32	4.13	37	0.538	0.1519	4.13	165	None
SN2		3.71	7	4.06	93	4.13	30	3.94	33	0.503	0.1444	4.04	163	None
Need for Unit Orientation	X1503													
SN1		5.57	14	4.72	84	5.85	33	6.00	42	1.152	0.0001	5.32	173	(2,3),(2,4)
SN2		5.00	8	4.66	92	5.70	33	5.81	37	1.164	0.0001	5.13	170	(2,3),(2,4)
Ease of Finding Enough Staff For any Given Shift	X1504													
SN1		3.77	13	4.27	84	4.47	32	4.14	42	1.476	0.5113	4.24	171	None
SN2		4.38	8	4.04	93	4.45	33	4.22	36	1.501	0.5653	4.17	170	None
Ease of Preparing Schedules	X1505													
SN1		4.00	12	4.29	84	4.22	32	4.26	42	1.309	0.9142	4.25	170	None
SN2		4.00	9	4.20	93	4.45	33	3.97	37	1.235	0.4128	4.19	172	None
Ease of Making Shift Adjustments	X1506													
SN1		3.82	11	4.28	82	4.35	31	4.43	42	1.289	0.5682	4.30	166	None
SN2		3.88	8	4.03	93	4.61	33	4.25	36	1.213	0.1125	4.18	170	None
Total N Available*	SN1		14		84		34		42				174	
	SN2		9		94		34		37				174	

Table D.8 (Continued)

Results of Hypotheses Tests
For Mean Unit Rating Compared to Other Units
For Staff Descriptor Variables
For Four Types of Nursing Units

		Type of Nursing Unit												
		1		2		3		4						
		Not Acute		Acute		Both Acute		Critical		ANOVA				Statistically
Variable	Variable	or Critical		Only		& Critical		Only		Root	P-value	Grand	Total	Different
Description	Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N	Pairs***
Rating of Your Unit Compared														
To Other Units In Your Hospital:														
Use of Pool Nurses from														
Inside Hospital	X1507													
SN1		2.82	11	3.33	81	3.00	30	3.43	40	1.682	0.5711	3.26	162	None
SN2		2.63	8	3.28	86	2.97	30	2.88	34	1.634	0.4759	3.10	158	None
Use of Pool Nurses from														
Outside Agency	X1508													
SN1		2.33	9	2.38	73	2.15	27	2.17	35	1.668	0.8948	2.28	144	None
SN2		1.66	6	2.49	75	2.11	27	2.13	32	1.600	0.4276	2.30	140	None
Turnover Rate	X1509													
SN1		2.00	13	2.94	84	3.03	32	2.78	42	1.485	0.1676	2.85	171	None
SN2		3.00	8	3.27	92	2.97	33	3.00	36	1.491	0.6748	3.14	169	None
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Footnotes:

* Hypothesis that mean is the same for all types of *nursing units is rejected for P-value of* $F \leq .05$

** *Missing Data accounts for* $N \leq$ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 *is the residual of the whole* data set, remaining after the selection of SN1.

Table D.9

Results of Hypotheses Tests
For Mean Unit Rating Compared to Other Units
For Number of Staff
For Four Types of Nursing Units

			Type of Nursing Unit												
			1		2		3		4						
Variable Description		Variable Name	Not Acute or Critical Mean	N	Acute Only Mean	N	Both Acute & Critical Mean	N	Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Total N	Statistically Different Pairs***
Rating of Your Unit Compared To Other Units in Your Hospital:															
RNs with BSN		X1601													
	SN1		2.21	14	3.73	84	4.01	34	5.64	42	4.209	0.0308	4.12	174	(1,4)
	SN2		1.72	9	3.87	94	6.19	34	4.13	37	4.157	0.0107	4.27	174	(1,3),(2,3)
RNs without BSN		X1602													
	SN1		7.85	14	6.72	84	8.26	34	9.65	42	6.333	0.1066	7.82	174	None
	SN2		4.05	9	7.43	94	7.73	34	6.98	37	4.250	0.1244	7.22	174	None
LPNs		X1603													
	SN1		2.07	14	2.55	84	1.39	34	1.22	42	2.357	0.0115	1.96	174	(2,4)
	SN2		0.44	9	2.72	94	1.19	34	0.82	37	2.246	0.0001	1.90	174	(1,2),(2,3),(2,4)
Nurse Assistants		X1604													
	SN1		2.71	14	3.54	84	2.14	34	1.66	42	2.777	0.0026	2.75	174	(2,4)
	SN2		2.77	9	3.22	94	2.35	34	1.39	37	2.738	0.0075	2.64	174	(2,4)
Unit Clerks		X1605													
	SN1		1.67	14	2.11	84	1.86	34	2.17	42	1.253	0.4519	2.04	174	None
	SN2		1.94	9	2.01	94	2.10	34	1.86	37	1.261	0.8797	1.99	174	None
Total Nursing Staff		X1606													
	SN1		12.75	10	16.31	81	17.03	33	16.8	42	7.930	0.4805	16.3	166	None
	SN2		9.11	9	15.29	91	17.32	32	12.9	35	6.840	0.0042	14.8	166	(1,3),(3,4)
Total		SN1		14		84		34		42				174	
N Available*		SN2		9		94		34		37				174	

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

Table D.10

Results of Hypotheses Tests For Differences in Mean Scores *For Scheduling Options and Procedures* For Four Types of Nursing Units

		Type of Nursing Unit												
		1		2		3		4						
		Not Acute or Critical		*Acute Only*		*Both Acute & Critical*		*Critical Only*		*ANOVA* Root				*Statistically* Different
Variable Description	**Variable Name**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**MSE**	**P-value of F ≤**	**Grand Mean**	**Total N**	**Pairs*****
Proportion of Nursing Staff in your Unit whose Schedules have These *Characteristics:*														
Fixed Start Times	**X1701**													
SN1		3.93	14	4.17	84	4.15	34	4.05	42	0.994	0.8565	4.11	174	None
SN2		4.44	9	4.36	94	4.12	34	3.92	37	1.102	0.1105	4.22	174	None
Flexible Start Times	**X1702**													
SN1		1.71	14	1.56	84	1.50	34	1.67	42	0.582	0.7011	1.59	174	None
SN2		1.33	9	1.38	94	1.41	34	1.49	37	0.756	0.8026	1.41	174	None
Rotates regularly between Day and other Shifts	**X1703**													
SN1		2.21	14	2.39	84	2.29	34	2.24	42	1.226	0.9044	2.32	174	None
SN2		1.67	9	2.55	94	2.12	34	2.59	37	1.267	0.0665	2.43	174	None
Permanent Shift Assignm	**X1704**													
SN1		3.71	14	3.27	84	3.26	34	3.57	42	1.242	0.4718	3.38	174	None
SN2		3.89	9	3.23	94	3.47	34	3.14	37	1.333	0.3149	3.29	174	None
Work A Required No. of Weekends	**X1705**													
SN1		3.64	14	4.20	84	4.15	34	4.45	42	1.026	0.2148	4.21	174	None
SN2		3.89	9	4.64	94	4.15	34	4.32	37	1.254	0.0277	4.44	174	None tested
Are Permanently Assigned to Weekends	**X1706**													
SN1		1.71	14	1.57	84	1.56	34	1.62	42	0.964	0.9535	1.59	174	None
SN2		1.33	9	1.60	94	1.59	34	1.51	37	0.969	0.8638	1.56	174	None
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Table D.10 (Continued)

Results of Hypotheses Tests
For Differences in Mean Scores
For Scheduling Options and Procedures
For Four Types of Nursing Units

Variable Description	Variable Name	Type of Nursing Unit 1 Not Acute or Critical Mean	N	2 Acute Only Mean	N	3 Both Acute & Critical Mean	N	4 Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Total N	Statistically Different Pairs***
Proportion of Nursing Staff in your Unit whose Schedules have These Characteristics:														
Permanent Unit Assignm	X1707													
SN1		4.00	14	4.14	84	4.09	34	4.29	42	0.999	0.8171	4.16	174	None
SN2		4.11	9	4.40	94	4.03	34	4.27	37	1.141	0.2827	4.28	174	None
Have a Fixed Pattern Of Days On and Off	X1708													
SN1		2.57	14	2.45	84	2.44	34	2.31	42	1.417	0.9260	2.43	174	None
SN2		3.00	9	2.50	94	2.71	34	2.49	37	1.413	0.6843	2.56	174	None
Same Days Each Week	X1709													
Each		2.57	14	2.17	84	2.35	34	2.31	42	1.243	0.6331	2.27	174	None
SN1		2.44	9	2.10	94	2.41	34	2.22	37	1.197	0.5735	2.20	174	None
SN2	X1710													
SN1		1.21	14	1.11	84	1.12	34	1.07	42	0.405	0.5789	1.11	174	None
SN2		1.00	9	1.06	94	1.00	34	1.14	37	0.331	0.5315	1.06	174	None
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

Means were computed using this scale: None = 1 A Few = 2 About Half = 3 Most = 4 All = 5

Table D.11
Results of Hypotheses Tests
For Mean Frequency of Actions Taken
When Making Staffing Adjustments
For Four Types of Nursing Unts

		Type of Nursing Unit											
		1 Not Acute or Critical		2 Acute Only		3 Both Acute & Critical		4 Critical Only		ANOVA			
Variable Description	Variable Name	Mean	N	Mean	N	Mean	N	Mean	N	Root MSE	P-value ≤ F ≤	Grand Mean	Total N
Frequency of Actions Taken when Matching Available Staff to Number Needed:													
Voluntary Overtime	XA2101												
SN1		2.28	14	2.48	83	2.55	34	2.60	41	0.521	0.2057	2.51	172
SN2		2.33	9	2.45	93	2.64	34	2.72	37	0.522	0.0177	2.54	173
Mandated Overtime	XA2102												
SN1		1.33	12	1.24	83	1.35	34	1.40	40	0.499	0.3714	1.30	169
SN2		1.00	8	1.35	91	1.34	32	1.13	37	0.483	0.0392	1.28	168
Temporary Nurses	XA2103												
SN1		1.18	11	1.43	82	1.29	34	1.36	41	0.543	0.3515	1.37	168
SN2		1.22	9	1.36	91	1.29	34	1.44	36	0.506	0.5246	1.35	170
Hospital "Pool" Nurses	XA2104												
SN1		1.58	12	2.04	83	1.88	34	1.77	40	0.567	0.0125	1.91	169
SN2		1.66	9	2.01	93	1.79	34	2.02	37	0.641	0.1671	1.95	173
Nurses from other Unit	XA2105												
SN1		1.53	13	1.96	82	1.97	34	1.72	40	0.461	0.0018	1.87	169
SN2		1.77	9	2.03	92	1.70	34	1.94	37	0.445	0.0029	1.93	172
Decline New Admissions	XA2106												
SN1		1.00	9	1.28	82	1.14	34	1.19	41	0.410	0.1739	1.21	166
SN2		1.22	9	1.23	93	1.39	33	1.13	37	0.426	0.0922	1.24	172
Total	SN1		14		84		34		42				174
N Available*	SN2		9		94		34		37				174

Table D.11 (Continued)

Results of Hypotheses Tests
For Mean Frequency of Actions Taken
When Making Staffing Adjustments
For Four Types of Nursing Units

		Type of Nursing Unit											
		1 Not Acute or Critical		2 Acute Only		3 Both Acute & Critical		4 Critical Only		ANOVA Root	P-value	Grand	Total
Variable Description	Variable Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N
Frequency of Actions Taken when *Matching Available Staff to Number Needed:*													
Discharge Patients	XA2107												
SN1		1.33	9	1.20	82	1.17	34	1.42	38	0.487	0.1015	1.25	162
SN2		1.00	7	1.27	93	1.36	33	1.25	35	0.475	0.3201	1.27	168
Shift Patients to Other Units	XA2108												
SN1		1.50	10	1.31	82	1.33	33	1.73	38	0.532	0.0008	1.42	163
SN2		1.37	8	1.36	93	1.27	33	1.48	35	0.496	0.3697	1.37	169
Extend Hours of Part-time Nurses	XA2109												
SN1		2.25	12	2.17	82	2.29	34	2.00	41	0.473	0.0517	2.15	169
SN2		1.88	9	2.07	93	2.18	32	2.05	37	0.514	0.4353	2.08	171
Call Nurses on Assigned Day Off	XA2110												
SN1		1.85	14	1.97	83	1.97	34	2.00	41	0.398	0.7118	1.97	172
SN2		1.87	8	2.01	93	1.94	34	2.10	37	0.417	0.2879	2.01	172
Mandate Reduction in Days Off	XA2111												
SN1		1.18	11	1.03	83	1.11	34	1.12	41	0.274	0.1618	1.08	169
SN2		1.14	7	1.09	93	1.05	34	1.05	36	0.277	0.7612	1.08	170
New Permanent Staff	XA2112												
SN1		1.60	10	1.59	82	1.54	33	1.51	41	0.601	0.8905	1.56	166
SN2		1.57	7	1.67	92	1.55	34	1.63	36	0.644	0.8321	1.63	169
Total	SN1		14		84		34		42				174
N Available*	SN2		9		94		34		37				174

Table D.11 (Continued)

Results of Hypotheses Tests
For Mean Frequency of Actions Taken
When Making Staffing Adjustments
For Four Types of Nursing Units

		Type of Nursing Unit											
		1		2		3		4					
Variable Description	Variable Name	Not Acute or Critical Mean	N	Acute Only Mean	N	Both Acute & Critical Mean	N	Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Total N
Frequency of Actions Taken when Matching Available Staff to Number Needed:													
Voluntary Vacation Time	XA2113												
SN1		2.00	12	2.14	82	2.29	34	2.20	39	0.493	0.2763	2.17	167
SN2		2.00	8	2.25	91	2.18	33	2.22	36	0.483	0.5178	2.22	168
Mandated Vacation Time	XA2114												
SN1		1.50	12	1.22	81	1.18	33	1.23	39	0.478	0.2497	1.23	165
SN2		1.12	8	1.37	90	1.16	31	1.14	34	0.452	0.0191	1.27	163
Send Unneeded Nurses Home with Pay	XA2115												
SN1		1.33	12	1.35	80	1.35	34	1.25	39	0.546	0.8324	1.32	165
SN2		1.50	8	1.24	90	1.46	32	1.42	35	0.529	0.0929	1.33	165
Send Unneeded Nursing to Other Units	XA2116												
SN1		1.91	12	2.10	83	2.08	34	1.89	39	0.569	0.2218	2.04	168
SN2		2.00	8	2.17	91	1.87	33	2.08	36	0.537	0.0580	2.08	168
Assign to Other Duties within Unit	XA2117												
SN1		1.61	13	1.82	82	1.94	34	1.79	39	0.487	0.2173	1.82	168
SN2		1.87	8	1.77	92	1.87	33	1.71	35	0.439	0.4224	1.78	168
Volunteer Unpaid Time Off	XA2118												
SN1		2.08	12	1.97	82	2.00	32	1.97	39	0.509	0.9157	1.98	165
SN2		2.00	8	2.06	89	1.93	31	2.11	36	0.575	0.6216	2.04	164
Total	SN1		14		84		34		42				174
N Available*	SN2		9		94		34		37				174

Table D.11 (Continued)

Results of Hypotheses Tests
For Mean Frequency of Actions Taken
When Making Staffing Adjustments
For Four Types of Nursing Units

		Type of Nursing Unit											
Variable Description	Variable Name	1 Not Acute or Critical Mean	N	2 Acute Only Mean	N	3 Both Acute & Critical Mean	N	4 Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Total N
Frequency of Actions Taken when Matching Available Staff to Number Needed:													
Mandate Unpaid Time Off	**XA2119**												
SN1		1.25	12	1.18	81	1.30	33	1.28	39	0.469	0.5704	1.23	165
SN2		1.12	8	1.28	91	1.09	32	1.24	33	0.448	0.1905	1.23	164
Lay Off or Fire **Permanent Nursing Staff**	**XA2120**												
SN1		1.00	12	1.09	82	1.06	33	1.05	39	0.260	0.5705	1.07	166
SN2		1.00	8	1.07	91	1.06	33	1.02	34	0.264	0.7433	1.06	166
Solicit New Admissions	**XA2121**												
SN1		1.63	11	1.60	82	1.50	32	1.44	36	0.690	0.6180	1.55	161
SN2		1.25	8	1.69	88	1.51	31	1.58	34	0.696	0.2678	1.61	161
Total	SN1		14		84		34		42				174
N Available*	SN2		9		94		34		37				174

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

Table D.12
Results of Hypotheses Tests For Differences in Sources And Destinations of Patients For Four Types of Nursing Unts

		Type of Nursing Unit												
		1		2		3		4						
		Not Acute		Acute		Both Acute		Critical		ANOVA				Statistically
Variable	Variable	or Critical		Only		& Critical		Only		Root	P-value	Grand	Total	Different
Description	Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N	Pairs***
Proportion of Patients Entering Unit from:														
Current Residence	X3001													
SN1		2.83	12	2.60	83	2.47	34	1.71	42	1.010	0.0001	2.37	171	(2,4)
SN2		3.00	9	2.60	94	2.61	34	2.00	37	1.041	0.0087	2.50	174	None
Emergency Room	X3002													
SN1		2.00	12	2.24	83	2.51	31	2.48	41	0.855	0.1404	2.33	167	None
SN2		1.33	9	2.32	94	2.33	33	2.72	36	0.842	0.0003	2.36	172	None
Post-Surgical	X3003													
SN1		1.58	12	2.24	83	1.75	33	2.37	40	1.040	0.0155	2.13	168	(1,2),(1,3),(1,4)
SN2		1.00	9	2.22	94	1.81	33	2.29	37	1.040	0.0023	2.09	173	(2,3),(2,4)
Another Unit in Hospital	X3004													
SN1		2.50	12	2.18	83	2.29	34	2.57	42	0.986	0.1912	2.32	171	None
SN2		2.44	9	2.19	94	2.27	33	2.35	37	0.883	0.7166	2.25	173	None
Outside Nursing Care	X3005													
SN1		1.66	12	1.92	83	1.62	34	1.78	42	0.465	0.1714	1.85	171	None
SN2		1.55	9	1.90	94	1.88	34	1.78	37	0.543	0.2417	1.85	174	None
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Table D.12 (Continued)

Results of Hypotheses Tests
For Differences in Sources
And Destinations of Patients
For Four Types of Nursing Units

		Type of Nursing Unit												
		1		2		3		4						
Variable Description	Variable Name	Not Acute or Critical Mean	N	Acute Only Mean	N	Both Acute & Critical Mean	N	Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Total N	Statistically Different Pairs***
Proportion of Patients Entering Unit from:														
Current Residence	X3101													
SN1		3.33	12	3.55	83	2.94	34	1.95	42	0.931	0.0001	3.02	171	(1,4),(2,3),(2,4),(3,4)
SN2		3.88	9	3.55	94	2.67	34	2.18	37	0.991	0.0001	3.10	174	(1,3),(1,4),(2,3),(2,4)
Other Unit in Hospital	X3102													
SN1		1.91	12	2.01	83	2.44	34	3.40	42	0.783	0.0001	2.43	171	(1,4),(2,3),(2,4),(3,4)
SN2		1.77	9	2.05	94	2.79	34	3.54	37	0.836	0.0001	2.50	174	(1,3),(1,4),(1,2),(2,4),(3,4)
Outside Nursing Care	X3103													
SN1		1.66	12	1.97	83	1.91	34	1.78	42	0.440	0.0374	1.89	171	None
SN2		1.88	9	1.98	94	1.76	34	1.78	37	0.543	0.1008	1.89	174	None
Death	X3104													
SN1		1.50	12	1.75	83	1.88	34	1.85	42	0.469	0.0726	1.78	171	None
SN2		1.33	9	1.68	94	1.82	34	1.81	37	0.466	0.0217	1.71	174	(1,3),(1,4)
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

Table D.13

Results of Hypotheses Tests

For Differences in Control and Variability

For Four Types of Nursing Unts

		Type of Nursing Unit												
		1 Not Acute or Critical		2 Acute Only		3 Both Acute & Critical		4 Critical Only		ANOVA Root	P-value	Grand	Total	Statistically Different
Variable Description	Variable Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N	Pairs***
Rating Control Over:														
Demand Predictability for Nursing Services	X32													
SN1		4.15	13	4.09	83	5.45	33	4.73	41	1.867	0.0045	4.51	170	(2,3)
SN2		4.11	9	4.81	93	4.38	34	5.08	37	1.736	0.2420	4.75	173	None
Complexity of Scheduling	X33													
SN1		5.07	14	4.67	83	5.42	33	5.29	41	1.294	0.0140	5.00	171	(2,3)
SN2		4.66	9	4.76	93	4.47	34	5.21	37	1.392	0.1518	4.79	173	None
Complexity of Shift Adjustments	X34													
SN1		4.69	13	4.53	83	5.09	33	5.00	41	1.197	0.0679	4.76	170	None
SN2		4.25	8	4.86	93	4.42	33	4.83	37	1.267	0.2073	4.75	171	None
Timing of Admissions	X3501													
SN1		2.45	11	2.32	84	1.96	33	1.74	39	1.455	0.1659	2.12	167	None
SN2		3.33	9	2.64	93	255	34	1.94	36	1.727	0.0941	2.51	172	None
Timing of Discharges	X3502													
SN1		2.90	10	2.76	84	2.54	33	3.12	39	1.697	0.5205	2.81	166	None
SN2		4.00	9	2.67	92	3.61	33	3.02	36	1.765	0.0347	2.98	170	None
Timing of Peak Demand	X3503													
SN1		3.45	11	2.96	83	3.00	33	2.51	39	1.485	0.2178	2.89	166	None
SN2		3.33	9	3.11	93	3.47	34	2.74	35	1.721	0.3608	3.12	171	None
Timing of Personnel from Non-nursing units	X3504													
SN1		2.50	10	3.06	81	3.227	33	3.73	39	2.194	0.3091	3.22	162	None
SN2		3.50	6	3.11	93	4.37	29	3.88	35	2.153	0.0343	3.52	163	(2,3)
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Table D.13 (Continued)

Results of Hypotheses Tests
For Differences in Control and Variability
For Four Types of Nursing Units

		Type of Nursing Unit												
Variable	Variable	1 Not Acute or Critical		2 Acute Only		3 Both Acute & Critical		4 Critical Only		ANOVA Root	P-value	Grand	Total	Statistically Different
Description	Name	Mean	N	Mean	N	Mean	N	Mnan	N	MSE	of F ≤	Mean	N	Pairs***
Rating of Control Over Number of Patients	X3505													
SN1		2.41	12	2.51	84	2.12	32	2.33	39	1.601	0.7025	2.38	167	None
SN2		3.55	9	2.45	93	3.35	34	2.16	36	1.792	0.0122	2.62	172	(3,4)
Number of Nursing Staff	X3506													
SN1		5.16	12	4.95	84	4.96	33	5.66	39	1.629	0.0694	5.13	168	None
SN2		4.77	9	5.06	93	5.70	34	5.55	36	1.284	0.0309	5.33	172	None
Number of Personnel from Non-nursing Units	X3507													
SN1		3.20	10	3.08	82	3.12	33	4.28	38	2.250	0.0474	3.38	163	(2,4)
SN2		3.50	6	3.02	92	3.71	28	3.82	35	2.150	0.1995	3.33	161	None
Determination of Short term Needs	X3508													
SN1		5.00	12	5.03	84	4.68	32	5.48	39	1.581	0.2036	5.07	167	None
SN2		5.66	9	4.93	93	5.45	33	5.41	36	1.481	0.1398	5.17	171	None
Determination of Long term Needs	X3509													
SN1		4.91	12	4.65	84	4.75	32	5.05	39	1.670	0.6661	4.78	167	None
SN2		4.77	9	4.79	93	5.11	34	5.19	36	1.595	0.5355	4.94	172	None
Matching of Needed Staff with Actual on Duty	X3510													
SN1		5.16	12	4.61	84	4.69	33	5.18	38	1.465	0.1910	4.80	167	None
SN2		4.33	9	4.61	91	5.23	34	4.86	36	0.216	1.6010	4.77	170	None
Total	SN1		14		84		34		42				174	
N Available*	SN2		9		94		34		37				174	

Table D.13 (Continued)

Results of Hypotheses Tests
For Differences in Control and Variability
For Four Types of Nursing Units

		Type of Nursing Unit												
		1		2		3		4						
Variable Description	Variable Name	Not Acute or Critical Mean	N	Acute Only Mean	N	Both Acute & Critical Mean	N	Critical Only Mean	N	ANOVA Root MSE	P-value of F *	Grand Mean	Total N	Statistically Different Pairs***
Rating of Control Over: Matching Budgeted Staff to Actual Number on Duty	X3511													
SN1		4.66	12	4.10	84	4.42	33	4.58	39	1.667	0.3890	4.32	168	None
SN2		4.55	9	4.39	91	4.91	34	5.08	36	1.619	0.1294	4.65	170	None
Total N Available*	SN1		14		84		34		42				174	
	SN2		9		94		34		37				174	

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** *Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences*

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

Table D.14
Results of Hypotheses Tests
For Rating Importance of Objectives to Nurse Managers
For Four Types of Nursing Units

		Type of Nursing Unit											
		1		2		3		4					
		Not Acute		Acute		Both Acute		Critical		ANOVA			
Variable	Variable	or Critical		Only		& Critical		Only		*Root*	*P-value*	*Grand*	*Total*
Description	Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N
Rating of Importance of:													
Containing Costs	XA3801												
SN1		2.84	13	2.57	82	2.73	34	2.60	40	0.492	0.1557	2.63	169
SN2		2.77	9	2.63	94	2.63	33	2.69	36	0.478	0.8020	2.65	172
Staying Within Budget	XA3802												
SN1		2.69	13	2.51	82	2.55	34	2.50	40	0.537	0.6840	2.53	169
SN2		2.44	9	2.61	94	2.51	33	2.63	36	0.517	0.5789	2.59	172
Ability to Quickly Reduce Staff Levels	XA3803												
SN1		2.30	13	2.02	81	2.18	33	2.07	40	0.736	0.5138	2.08	167
SN2		2.12	8	2.03	92	2.06	33	2.08	36	0.715	0.9735	2.05	169
Ability to Quickly Increase Staff Levels	XA3804												
SN1		2.69	13	2.62	82	2.82	34	2.69	39	0.463	0.2114	2.68	168
SN2		2.62	8	2.71	92	2.63	33	2.75	36	0.533	0.7934	2.70	169
Wide Variety of Nurses	XA3805												
SN1		2.53	13	2.39	82	2.50	34	2.41	39	0.606	0.7828	2.42	168
SN2		2.62	8	2.54	94	2.57	33	2.61	36	0.598	0.9329	2.56	171
Productivity Level	XA3806												
SN1		2.76	13	2.70	82	2.94	34	2.77	40	0.427	0.0698	2.77	169
SN2		3.00	9	2.76	94	2.87	33	2.85	35	0.384	0.1811	2.81	171
Increasing Productivity	XA3807												
SN1		2.69	13	2.71	82	2.82	34	2.62	40	0.451	0.3122	2.71	169
SN2		2.77	9	2.77	94	2.84	33	2.69	36	0.434	0.5378	2.77	172
Total	SN1		14		84		34		42				174
N Available*	SN2		9		94		34		37				174

Table D.14 (Continued)

Results of Hypotheses Tests
For Rating Importance of Objectives to Nurse Managers
For Four Types of Nursing Units

		Type of Nursing Unit											
		1		2		3		4					
		Not Acute or Critical		Acute Only		Both Acute & Critical		Critical Only		ANOVA Root	P-value	Grand	Total
Variable Description	Variable Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N
Rating of Importance of:													
Utilizing Equipment	XA3808												
SN1		2.07	13	2.05	79	2.52	34	2.38	39	0.679	0.0027	2.23	165
SN2		2.25	8	2.13	92	2.63	33	2.47	36	0.698	0.0021	2.30	169
Matching Actual to Number Needed	XA3809												
SN1		2.84	13	2.89	82	2.91	34	2.85	40	0.326	0.8306	2.88	169
SN2		2.77	9	2.87	93	2.93	33	2.88	36	0.323	0.5533	2.88	171
Assigning Equitable Work Loads	XA3810												
SN1		2.84	13	2.90	82	2.94	34	2.82	40	0.316	0.4044	2.88	169
SN2		2.77	9	2.93	92	2.87	33	2.88	35	0.293	0.3867	2.90	169
Conformance to JCAHO	XA3811												
SN1		2.92	13	2.74	82	2.88	34	2.62	40	0.436	0.0415	2.75	169
SN2		3.00	9	2.70	93	2.90	33	2.75	36	0.428	0.0496	2.77	171
Zero-error rate in Dispensing of Medicine	XA3812												
SN1		3.00	12	2.64	82	2.85	34	2.67	40	0.492	0.0396	2.72	168
SN2		2.75	8	2.73	94	2.75	33	2.94	36	0.449	0.1211	2.78	171
Level of Quality Care	XA3813												
SN1		3.00	13	2.98	82	3.00	34	2.97	40	0.109	0.7682	2.98	169
SN2		2.88	9	2.86	94	2.67	33	3.00	36	0.107	0.6790	2.98	172
Improving Quality of Care	XA3814												
SN1		3.00	13	2.97	82	3.00	34	2.97	40	0.133	0.7634	2.98	169
SN2		3.00	9	2.97	93	2.96	33	2.94	36	0.169	0.7234	2.97	171
Total	SN1		14		84		34		42				174
N Available*	SN2		9		94		34		37				174

Table D.14 (Continued)

Results of Hypotheses Tests
For Rating Importance of Objectives to Nurse Managers
For Four Types of Nursing Units

		Type of Nursing Unit											
		1 Not Acute or Critical		2 Acute Only		3 Both Acute & Critical		4 Critical Only		ANOVA Root	P-value	Grand	Total
Variable Description	Variable Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N
Rating of Importance of:													
Response to Requests In Certain Time Period	XA3815												
SN1		3.00	13	2.86	82	2.91	34	2.74	39	0.346	0.0671	2.85	168
SN2		2.88	9	2.86	94	2.87	33	2.91	36	0.348	0.8826	2.87	172
Correction of Errors In Certain Time Period	XA3816												
SN1		2.92	13	2.76	82	2.94	34	2.74	39	0.389	0.0748	2.80	168
SN2		2.77	9	2.85	94	2.81	32	2.88	36	0.362	0.7744	2.84	171
Quickly offer new Nursing Services	XA3817												
SN1		2.41	12	2.28	81	2.38	34	2.22	40	0.647	0.6771	2.29	167
SN2		2.12	8	2.29	93	2.42	33	2.41	36	0.605	0.4193	2.33	170
Satisfied Staff	XA3818												
SN1		3.00	13	3.00	82	3.00	33	2.95	40	0.107	0.0910	2.98	168
SN2		2.88	9	2.94	93	2.9	33	2.94	36	0.247	0.8214	2.93	171
Low Turnover Rate	XA3819												
SN1		3.00	13	2.93	81	2.94	34	2.82	40	0.295	0.1408	2.91	168
SN2		3.00	8	2.88	94	2.87	33	2.94	36	0.300	0.5466	2.90	171
Considering Preferences For Certain Schedules	XA3820												
SN1		3.00	13	2.78	82	2.88	34	2.70	40	0.396	0.0612	2.79	169
SN2		2.62	8	2.71	94	2.66	33	2.80	36	0.464	0.5716	2.71	171
Total N Available*	SN1		14		84		34		42				174
	SN2		9		94		34		37				174

Table D.14 (Continued)

For Rating Importance of Objectives to Nurse Managers
For Rating Performance on Objectives
For Four Types of Nursing Units

		Type of Nursing Unit											
		1 Not Acute or Critical		2 Acute Only		3 Both Acute & Critical		4 Critical Only		ANOVA Root	P-value	Grand	Total
Variable Description	Variable Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N
Rating of Importance of:													
Considering Preferences													
for Specific Days off	XA3821												
SN1		3.00	13	2.71	82	2.88	34	2.72	40	0.412	0.0445	2.77	169
SN2		2.75	8	2.65	94	2.69	33	2.80	36	0.459	0.4384	2.70	171
Total	SN1		14		84		34		42				174
N Available*	SN2		9		94		34		37				174

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

Table D.15
Results of Hypotheses Tests
For Rating Performance on Objectives
For Four Types of Nursing Units

		Type of Nursing Unit											
		1 Not Acute or Critical		2 Acute Only		3 Both Acute & Critical		4 Critical Only		ANOVA			
Variable Description	Variable Name	Mean	N	Mean	N	Mean	N	Mean	N	Root MSE	P-value of F ≤	Grand Mean	Total N
Rating of Your Performance In:													
Containing Costs	X4001												
SN1		3.61	13	3.54	82	3.50	34	3.53	39	0.881	0.9818	3.54	168
SN2		3.11	9	3.41	91	3.62	32	3.71	35	0.749	0.0679	3.50	167
Staying Within Budget	X4002												
SN1		3.66	12	3.60	80	3.48	33	3.30	39	0.874	0.3448	3.51	164
SN2		3.33	9	3.53	89	3.40	32	3.85	34	0.806	0.0980	3.56	164
Ability to Quickly Reduce Staff Levels	X4003												
SN1		3.77	9	3.52	74	[illegible]	28	3.40	35	0.946	0.3370	3.45	146
SN2		3.00	6	3.35	79	3.67	[illegible]	3.66	33	0.839	0.0742	3.47	149
Ability to Quickly Increase Staff Levels	X4004												
SN1		3.25	12	3.00	81	3.12	33	3.00	39	1.020	0.8253	3.04	165
SN2		2.75	8	3.01	84	3.21	33	3.40	35	0.914	0.1116	3.12	160
Offer Variety of Svcs.	X4005												
SN1		3.41	12	3.40	76	3.33	33	3.16	36	0.906	0.6093	3.33	157
SN2		3.00	7	3.04	82	3.60	28	3.42	35	0.809	0.0063	3.23	152
Productivity Level	X4006												
SN1		3.58	12	3.74	83	3.50	34	3.56	39	0.798	0.4033	3.64	168
SN2		3.55	9	3.50	91	3.67	34	4.05	36	0.721	0.0022	3.65	170
Increasing Productivity	X4007												
SN1		3.38	13	3.49	81	3.41	34	3.54	37	0.814	0.8860	3.47	165
SN2		3.25	8	3.41	90	3.38	34	3.86	39	0.705	0.0062	3.40	168
Total	SN1		14		84		34		42				174
N Available*	SN2		9		94		34		37				174

Table D.15 (Continued)

Results of Hypotheses Tests
For Rating Performance on Objectives
For Four Types of Nursing Units

		Type of Nursing Unit											
		1		2		3		4					
		Not Acute		Acute		Both Acute		Critical		ANOVA			
Variable	Variable	or Critical		Only		& Critical		Only		Root	P-value	Grand	Total
Description	Name	Mean	N	Mean	N	Mean	N	Mean	N	MSE	of F ≤	Mean	N
Rating of Your Performance In:													
Utilizing Equipment	X4008												
SN1		3.45	11	3.27	68	3.79	29	3.81	38	0.851	0.0058	3.53	146
SN2		3.15	7	3.06	77	3.65	32	3.81	33	0.786	0.0001	3.36	149
Matching Actual to Number Needed	X4009												
SN1		3.33	12	3.37	82	3.41	34	3.51	39	0.932	0.9924	3.38	167
SN2		3.12	8	3.17	89	3.52	34	3.66	36	0.845	0.0151	3.35	167
Assigning Equitable Work Loads	X4010												
SN1		3.58	12	3.80	82	3.52	34	3.84	39	0.273	0.8110	3.74	167
SN2		3.25	8	3.56	90	3.75	33	4.13	36	0.775	0.0010	3.71	167
Conformance to JCAHO	X4011												
SN1		3.91	12	3.67	82	3.81	33	3.76	38	0.783	0.6571	3.73	165
SN2		3.77	9	3.56	91	3.75	33	3.83	36	0.766	0.2550	3.66	169
Zero-error rate In Dispensing of Medicine	X4012												
SN1		3.63	11	3.18	80	3.54	33	3.23	39	0.823	0.0927	3.30	163
SN2		3.85	7	3.12	88	3.09	32	3.55	36	0.761	0.0038	3.24	163
Level of Quality Care	X4013												
SN1		3.84	13	3.93	83	3.82	34	4.07	38	0.690	0.4343	3.94	168
SN2		4.00	9	3.81	91	3.85	34	4.05	35	0.704	0.3456	3.88	169
Total	SN1		14		84		34		42				174
N Available*	SN2		9		94		34		37				174

Table D.15 (Continued)

Results of Hypotheses Tests
For Rating Performance on Objectives
For Four Types of Nursing Units

		Type of Nursing Unit											
		1 Not Acute or Critical		2 Acute Only		3 Both Acute & Critical		4 Critical Only		ANOVA			
Variable Description	Variable Name	Mean	N	Mean	N	Mean	N	Mean	N	Root MSE	P-value of F ≤	Grand Mean	Total N
Rating of Your Performance In:													
Improving Quality of Care	X4014												
SN1		3.66	12	3.86	83	3.67	34	3.94	39	0.802	0.4301	3.83	168
SN2		4.00	9	3.75	91	3.82	34	3.97	36	0.696	0.3939	3.82	170
Respose to Requests In Certain Time Period	X4015												
SN1		3.66	12	4.00	82	3.61	34	3.89	38	0.77	0.0812	3.87	166
SN2		4.11	9	3.80	90	3.84	32	4.11	36	0.713	0.1220	3.89	167
Correction of Errors In Certain Time Period	X4016												
SN1		3.84	13	3.69	83	3.41	34	3.78	38	0.747	0.1227	3.67	168
SN2		3.77	9	3.62	91	3.58	34	3.91	36	0.775	0.2267	3.68	179
Quickly offer new Nursing Services	X4017												
SN1		3.18	11	3.13	75	2.88	34	2.83	37	0.917	0.2998	3.01	157
SN2		2.50	8	3.01	81	3.25	28	3.09	33	0.823	0.1454	3.04	150
Satisfied Staff	X4018												
SN1		3.53	13	3.60	82	3.61	34	3.56	39	0.849	0.9840	3.59	168
SN2		3.44	9	3.57	92	3.44	34	3.58	36	0.773	0.8007	3.54	171
Total N Available'	SN1		14		84		34		42				174
	SN2		9		94		34		37				174

Table D.15 (Continued)

Results of Hypotheses Tests
For Rating Performance on Objectives
For Four Types of Nursing Units

Variable Description	Variable Name	Type of Nursing Unit 1 Not Acute or Critical Mean	N	2 Acute Only Mean	N	3 Both Acute & Critical Mean	N	4 Critical Only Mean	N	ANOVA Root MSE	P-value of F ≤	Grand Mean	Total N
Rating of Your Performance In:													
Low Turnover Rate	X4019												
SN1		3.75	12	3.59	83	3.76	34	3.66	39	0.972	0.8207	3.65	168
SN2		3.33	9	3.46	86	3.41	34	3.50	34	0.971	0.9617	3.45	163
Considering Preferences For Certain Schedules	X4020												
SN1		4.25	12	4.01	80	4.08	34	4.13	38	0.309	0.8071	4.07	164
SN2		3.55	9	3.83	89	4.00	32	4.20	35	0.853	0.1886	3.98	165
Considering Preferences for Specific Days off	X4021												
SN1		4.33	12	4.13	82	4.11	34	4.18	38	0.872	0.8843	4.15	166
SN2		4.11	9	3.91	89	4.09	32	4.17	35	0.840	0.3957	4.01	165
Total	SN1		14		84		34		42				174
N Available*	SN2		9		94		34		37				174

Footnotes:

* Hypothesis that mean is the same for all types of nursing units is rejected for P-value of F ≤ .05

** Missing Data accounts for N ≤ Available Total. Missing data treated as random occurences

*** Differences between Pairs of means tested for difference from zero by Gabriel's,GT2, Bonferroni's,Scheffe's tests. Alpha = .05

SN1 is a randomly selected subset of the whole date set

SN2 is the residual of the whole data set, remaining after the selection of SN1.

Table D.16
T-Test of Mean Differences Between Nurse Managers' Rating of Importance of Objectives and Their Perceived Rating of Importance to Top Managers

Variable Description	Arbitrary Objective Number	Diff. SN1	Standard Deviation	P-Value of t	N	Diff. SN2	Standard Deviation	P-Value of t	N
Cost									
Containing Costs	1	-0.337	0.4842	0.0001	169	-0.302	0.5010	0.0001	172
Staying Within Budget	2	-0.405	0.5311	0.0001	168	-0.351	0.5240	0.0001	171
Productivity Level	6	-0.065	0.4754	0.0781	169	-0.065	0.4289	0.0553	170
Increasing Productivity	7	-0.107	0.5262	0.0090	169	-0.030	0.5675	0.5018	168
Utilizing Equipment	8	0.018	0.6773	0.7336	165	0.000	0.5619	1.0000	169
Flexibility									
Reduce Staff	3	-0.515	0.6470	0.0001	167	-0.500	0.6955	0.0001	168
Increase Staff	4	0.449	0.7385	0.0001	167	0.542	0.7061	0.0001	168
Variety of Services	5	-0.023	0.8572	0.7184	168	0.036	0.6806	0.4985	169
Needed vs. Actual	9	0.562	0.7102	0.0001	169	0.538	0.6463	0.0001	169
New Services	17	0.006	0.8117	0.9233	166	-0.006	0.7844	0.9219	167
Quality									
JCAHO Conformance	11	-0.179	0.4587	0.0001	168	-0.158	0.4390	0.0001	171
Zero-error rate	12	0.174	0.6137	0.0004	167	0.129	0.4932	0.0038	171
Quality Level	13	0.296	0.5664	0.0001	169	0.285	0.5075	0.0001	172
Improving Quality	14	0.385	0.6124	0.0001	169	0.322	0.5699	0.0001	171
Response to Patients	15	0.327	0.6265	0.0001	168	0.227	0.5675	0.0001	172
Correction of Errors	16	0.241	0.6248	0.0001	166	0.167	0.4790	0.0001	168
Work Force Satisfaction									
Equitable Workload	10	0.799	0.7153	0.0001	169	0.757	0.6725	0.0001	169
Satisfied Staff	18	0.690	0.6695	0.0001	168	0.626	0.6230	0.0001	171
Low Turnover Rate	19	0.506	0.6843	0.0001	166	0.474	0.6739	0.0001	171
Scheduling Preferences	20	0.964	0.6815	0.0001	169	0.865	0.7282	0.0001	171
Days off Preferences	21	1.024	0.6832	0.0001	169	0.888	0.7354	0.0001	170

TABLE D.17

STAFFING AND SCHEDULING FLEXIBILITY VARIABLES
Determined A Priori
For Five Types of Flexibility

VOLUME FLEXIBILITY

Name	Direction for High Flexibility	Variable Description
X401	High	Number of times in a year for hiring new nursing staff
X402	High	Number of times in a year for terminating nursing staff
X403	High	Number of times in a year for adding nursing positions
X404	High	Number of times in a year for deleting nursing positions
X406	High	Number of times in a year for authorizing temporary nursing staff
X410	High	Number of times in a year for making shift adjustments to schedule
X1406	Low	Proportion of nursing staff who are permanent full time employees of hospital
X1407	High	Proportion of nursing staff who are permanent part time employees of hospital
X1408	High	Proportion of nursing staff who are temporary employees from outside agency
X1507	High	Rating of Use of inhouse pool nurses
X1508	High	Rating of Use of pool nurses from outside agency
X2102	Low	Frequency of use of mandated overtime when matching needed to actual
X2103	High	Frequency of hiring temporary nursing staff from outside when matching needed to actual
X2106	Low	Frequency with which new admissions are declined in order to match needed to actual
X2107	Low	Frequency with which patients are discharged in order to match needed to actual
X2108	Low	Frequency with which patients are shifted to other units in order to match needed to actual
X2111	Low	Frequency of mandating a reduction in days off when matching needed to actual
X2112	High	Frequency of hiring new permanent nursing staff when matching needed to actual
X2114	Low	Frequency of use mandated vacation time when matching needed to actual
X2115	High	Frequency of sending unneeded nursing staff home with pay for matching needed to actual
X2119	Low	Frequency of use of mandated unpaid time off for matching needed to actual
X2120	High	Frequency of laying off or firing permanent nursing staff for matching needed to actual
X2121	Low	Frequency with which new admissions are solicited in order to match needed to actual

REASSIGNMENT FLEXIBILITY

Name	Direction for High Flexibility	Variable Description
X407	High	Number of times in a year for making patient care assignments
X408	High	No. of times in a year for determining exact staff working in your unit
X2117	High	Freq. of assigning staff to other duties within unit when matching needed to actual

TABLE D.17 (Continued)

STAFFING AND SCHEDULING FLEXIBILITY VARIABLES
Determined A Priori
For Five Types of Flexibility

TIME FLEXIBILITY

Name	Direction for High Flexibility	Variable Description
X405	High	Number of times in a year for Authorizing nursing overtime
X409	High	Number of times in a year for Scheduling nursing staff in your unit
X410	High	Number of times in a year for making shift adjustments to schedule
X1701	Low	Proportion of Staff whose schedules have Fixed Start Times
X1702	High	Proportion of Staff whose schedules have Flexible Start Times
X1703	High	Proportion of Staff who regularly rotate between day and other shifts
X1704	Low	Proportion of Staff who have a Permanent Shift Assignment
X1705	High	Proportion of Staff who are required to work a certain number of weekends
X1706	Low	Proportion of Staff permanently assigned to weekends
X1708	Low	Proportion of Staff whose schedules have Fixed Pattern of days on and off
X1709	Low	Proportion of Staff who Work the same days every week
X1710	High	Proportion of Staff who Work split shifts (4 hour son, a few off, 4 more on)
X1801&06	High	No. of regular shift lengths for RNs without overtime (weekdays, weekends)
X1802&07	High	No. of regular shift lengths for LPNs without overtime
X1803&08	High	No. of regular shift lengths for nurse assistants without overtime
X1804-05	High	Difference between Longest and Shortest periods likely to be worked [Weekdays]
X1809-10	High	Difference between Longest and Shortest periods likely to be worked [Weekends]
X1901	High	Number of shift start times on weekdays
X1902	High	Number of shift start times on weekends
X2101	High	Frequency of use voluntary overtime when matching needed to actual
X2109	High	Frequency of extending hours of part-time nurses when matching needed to actual
X2110	High	Frequency of calling in nurses on assigned day off when matching needed to actual
X2113	High	Frequency of use of voluntary vacation time for for matching needed to actual
X2118	High	Frequency of use of volunteer unpaid time off for matching needed to actual

TABLE D.17 (Continued)

STAFFING AND SCHEDULING FLEXIBILITY VARIABLES
Determined A Priori
For Five Types of Flexibility

JOB FLEXIBILITY

Name	Direction for High Flexibility	Variable Description
X909	High	Rating of Variety of Treatment from Patient to Patient
X12	High	Model for Nursing Staff Assignment Practices
X1401	High	Proportion of nursing staff who are RNs without BSN
X1402	High	Proportion of nursing staff who are RNs with BSN
X1404	Low	Proportion of nursing staff who are LPNs
X1405	Low	Proportion of nursing staff who are Nurse assistants

PLACE FLEXIBILITY

Name	Direction for High Flexibility	Variable Description
X1409	High	Proportion of nursing staff who are from other units or inhouse pool
X1707	Low	Proportion of Staff whose schedules have permanent assignment to your unit
X2104	High	Frequency of use hospital "pool" nurses when matching needed to actual
X2105	High	Frequency of use nurses from another unit when matching needed to actual
X2116	High	Freq. of sending unneeded staff to other units when matching needed to actual
X22	Low	Degree of centralization of the nursing staff scheduling process

TABLE D.18

SUMMARY OF VARIABLES FOR FLEXIBILITY MEASURES A PRIORI VERSUS A POSTERIORI ANALYSES

Name	A priori Type of Flexibility	Disposition	A posteriori Type of Flexibility	Variable Description
X401	Volume	Rescaled	Volume	No. of times in a year for hiring new staff
X402	Volume	Rescaled	Volume	No.of times in a year for terminating staff
X403	Volume	Rescaled	Volume	No. of times in a year for adding positions
X404	Volume	Rescaled	Volume	No. of times in a year for deleting positions
X405	Time	Discarded		No. of times in a year for authorizing overtime
X406	Volume	Discarded		No. of times in a year for authorizing temps
X407	Reassign	Discarded		No. of times in a year for making patient care assignments
X408	Reassign	Rescaled	Reassign	No. of times in a year for determining exact staff working in your unit
X409	Time	Rescaled Reclassified	Reassign	No. of times in a year for Scheduling nursing staff in your unit
X410	Time	Rescaled Reclassified	Reassign	No. of times in a year for making shift adjustments to schedule
X909	Job	Discarded*		Rating of variety of treatment from pt. to pt.
X12	Job	Discarded*		Model for Nursing Staff Assignment. Practices
X1401	Job	Discarded*		Proportion of nursing staff who are RNs without BSN
X1402	Job	Discarded*		Proportion of nursing staff who are RNs with BSN
X1404	Job	Discarded*		Proportion of nursing staff who are LPNs
X1405	Job	Discarded*		Proportion of nursing staff who are Nurse assistants
X1406	Volume	Discarded*		Proportion of nursing staff who are permanent full time employees of hospital
X1407	Volume	Discarded*		Proportion of nursing staff who are permanent part time employees of hospital
X1408	Volume	Discarded*		Proportion of nursing staff who are temporary employees from outside agency
X1409	Place	Discarded*		Proportion of nursing staff who are from other units or in-house pool units
X1507	Volume	Discarded*		Rating of Use of inhouse pool nurses
X1508	Volume	Discarded*		Rating of Use of pool nurses from outside agency

TABLE D.18 (Continued)

SUMMARY OF VARIABLES FOR FLEXIBILITY MEASURES A PRIORI VERSUS A POSTERIORI ANALYSES

Name	A priori Type of Flexibility	Disposition	A posteriori Type of Flexibility	Variable Description
X1701	Time	Discarded*		Proportion of Staff whose schedules have Fixed Start Times
X1702	Time	Discarded*		Proportion of Staff whose schedules have Flexible Start Times
X1703	Time	Discarded*		Proportion of Staff who regularly rotate between day and other shifts
X1704	Time	Discarded*		Proportion of Staff who have a Permanent Shift Assignment
X1705	Time	Discarded*		Proportion of Staff who are required to work a certain number of weekends
X1706	Time	Discarded*		Proportion of Staff permanently assigned to weekends
X1707	Place	Discarded*		Proportion of Staff whose schedules have permanent assignment to your unit
X1708	Time	Discarded*		Proportion of Staff whose schedules have Fixed Pattern of days on and off
X1709	Time	Discarded*		Proportion of Staff who Work the same days every week
X1710	Time	Discarded*		Proportion of Staff who Work split shifts (4 hours on, a few off, 4 more on)
X1801&06	Time	Recoded	Time	One or more than one regular shift length for RNs without overtime (weekdays, weekends)
X1802&07	Time	Discarded		No. of regular shift lengths for LPNs without overtime
X1803&08	Time	Discarded		No. of regular shift lengths for nurse assistants without overtime
X1804-05	Time	Recoded	Time	Difference between Longest and Shortest periods likely to be worked
X1809-10	Time	Recoded	Time	Difference between Longest and Shortest periods likely to be worked [Weekends]
X1901	Time		Time	Number of shift start times on weekdays
X1902	Time		Time	Number of shift start times on weekends
X2101	Time	Discarded		Frequency of use voluntary overtime when matching needed to actual
X2102	Volume	Discarded		Frequency of use of mandated overtime when matching needed to actual
X2103	Volume		Volume	Frequency of hiring temporary nursing staff from outside when matching needed to actual
X2104	Place	Reclassified	Volume	Frequency of use hospital "pool" nurses when matching needed to actual
X2105	Place		Place	Frequency of use nurses from another unit when matching needed to actual

TABLE D.18 (Continued)

SUMMARY OF VARIABLES FOR FLEXIBILITY MEASURES A PRIORI VERSUS A POSTERIORI ANALYSES

Name	A priori Type of Flexibility	Disposition	A posteriori Type of Flexibility	Variable Description
X2106	Volume	Discarded		Frequency with which new admissions are declined when matching needed to actual
X2107	Volume		Volume	Frequency with which patients are discharged when matching needed to actual
X2108	Volume		Volume	Frequency with which patients are shifted to other units when matching needed to actual
X2109	Time	Reclassified Discarded	Volume	Frequency of extending hours of part-time nurses (if available) when matching needed to actual
X2110	Time	Reclassified Discarded	Volume	Frequency of calling in nurses on assigned day off when matching needed to actual
X2111	Volume	Discarded		Frequency of mandating a reduction in days off when matching needed to actual
X2112	Volume	Discarded		Frequency of hiring new permanent nursing staff when matching needed to actual
X2113	Time	Reclassified	Volume	Frequency of use of voluntary vacation time for for matching needed to actual
X2114	Volume		Volume	Frequency of use mandated vacation time when matching needed to actual
X2115	Volume	Discarded		Frequency of sending unneeded nursing staff home with pay for matching needed to actual
X2116	Place		Place	Frequency of sending unneeded nursing staff to other units when matching needed to actual
X2117	Reassign	Discarded		Frequency of assigning nursing staff to other duties within unit when matching needed to actual
X2118	Time	Reclassified	Volume	Frequency of use of volunteer unpaid time off for matching needed to actual
X2119	Volume		Volume	Frequency of use of mandated unpaid time off for matching needed to actual
X2120	Volume	Discarded		Frequency of laying off or firing permanent nursing staff for matching needed to actual
X2121	Volume	Discarded		Frequency with which new admissions are solicited in order to match needed to actual
X22	Place	Discarded*		Degree of centralization of the nursing staff scheduling process

* Discarded variables from questions 9, 12,14, 15, 17, and 22 later were analyzed for correlations with the resulting flexibility measures.

TABLE D.19

STATISTICAL TABLES AVAILABLE ON REQUEST

E.3	Pearson Correlations of the Place Flexibility Measure with Final and Initial Variables For Sample Number One and Sample Number Two
E.4	Pearson Correlations of the Reassignment Flexibility Measure with Final and Initial Variables For Sample Number One and Sample Number Two
E.5	Pearson Correlations of the Time Flexibility Measures with Final and Initial Variables For Sample Number One and Sample Number Two
E.6	Pearson Correlations of the Volume Flexibility Measure with Final and Initial Variables For Sample Number One and Sample Number Two
E.7	Pearson Correlations of Potential Job Flexibility Variables For Sample Number One and Sample Number Two
E.8	One-factor ULS Factor Analysis for Final Place Flexibility Measure For Sample Number One and Sample Number Two
E.9	One-Factor ML Factor Analysis with Final Reassignment Flexibility Measure For Sample Number One and Sample Number Two
E.10	Two-Factor ML Factor Analysis with Final Time Flexibility Measures For Sample Number One and Sample Number Two
E.11	Four-Factor ML Factor Analysis with Final Volume Flexibility Measures For Sample Number One and Sample Number Two
E.12	Three-factor ULS Factor Analyses with Final Flexibility Measures For Sample Number One and Sample Number Two
E.13	Descriptive Statistics for the Final Flexibility Measures for Sample Number One and Sample Number Two
E.14	Four-Factor ULS Factor Analysis with Environmental Variables from Questions 8 and 9 for For Sample Number One and Sample Number Two
E.15	Pearson Correlations of Flexibility Measures with Variables of Interest for For Sample Number One and Sample Number Two
E.16	Spearman Correlations of Flexibility Measures with Ranked Variables of Interest for For Sample Number One and Sample Number Two
E.17	Pearson and Spearman Correlations of Miscellaneous Variables for Hypothesis Tests in Chapter IV, for Sample Number One and Sample Number Two.

Request Tables from Dr. Sue Perrott Siferd
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