UNIVERSITY OF MIAMI

AN ENGINEERING MANAGEMENT-BASED INVESTIGATION OF OWNER SATISFACTION, QUALITY AND PERFORMANCE VARIABLES IN HEALTH CARE FACILITIES CONSTRUCTION

By

Lincoln H. Forbes

A DISSERTATION

Submitted to the Faculty

of the University of Miami

in partial fulfillment of the requirements for

the degree of Doctor of Philosophy

Coral Gables, Florida

June 1999

UMI Number: 9938323

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300 North Zeeb Road
Ann Arbor, MI 48103

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FORBES, LINCOLN HARDING (Ph.D., Interdepartmental Studies)
An Engineering Management-based Investigation of Owner Satisfaction, Quality, and Performance Variables in Health Care Facilities Construction (June 1999)

Abstract of a dissertation at the University of Miami.

Dissertation supervised by Dr. Vincent K. Omachonu
No. of pages in text. (281)

The construction industry has traditionally defined performance primarily in terms of timeliness of project completion and the ability to stay within budget. Several authors have identified a low level of quality in the design and construction processes in the U.S. and immense problems with customer satisfaction and cost effectiveness when compared with manufacturing and service industries. These problems have greatly affected a health care industry already buffeted by managed care to contain costs; consequently, the construction or renovation of Health Care Facilities (HCFs) is severely challenged. This research identifies and quantifies the gaps between the expectations and perceptions of the owners of HCF construction projects and the other main parties in construction, the designer and the builder/contractor.

A preliminary survey investigated the construction environment to identify the determinants of quality, performance, and owner satisfaction. It included: 6 design firms, 6 contractors, 6 owner organizations, and a municipal code enforcement department. The information gathered was used to develop a primary survey instrument. A nation-wide survey was then conducted, targeting three groups of subjects: hospital/health care facility administrators, designers and contractors with a declared specialization in health care-related projects. This self-administered survey identified industry-based performance

measures and owner satisfaction criteria in HCF projects as well as the gaps in perceptions and expectations among the parties. The numbers of surveys issued were: owners - 2,000, designers - 2,700, contractors - 2,025. Return rates for the surveys were: owners - 280 (14%), designers - 290 (10.7%), contractors - 110 (5.43%). The numbers of usable responses to the survey were: owners, 237; designers, 241; and contractors, 82. Nonparametric analysis of variance techniques revealed notable differences in the responses by the three groups to the same questions at the .05 level of significance. These gaps (or dissonance zones) were greatest with the following variables: a) Public and private owner satisfaction criteria, b) performance evaluation criteria, c) the effectiveness of quality assurance/control methods, d) the barriers to owner satisfaction, e) design considerations, and f) the impact on owners caused by deviations in project schedules and costs. The gaps were greater between owners and designers than between owners and contractors with regard to design considerations and quality assurance/control approaches. With regard to performance evaluation criteria, the gaps between owners and designers are of the same order of magnitude as those between owners and contractors. These findings are especially meaningful as designers are expected to interpret owners' needs in the design process and also represent their interest in monitoring the construction phase of each project. The research also examined the gaps between public and private owners. Few gaps were noted, suggesting a growing convergence between the operating environments of both sectors.

In the third stage of the research a project-specific survey instrument was developed and administered to the three parties involved in each of a number of selected health care construction projects that had been completed within the preceding 5 years. The purpose of this survey was to apply a three-dimensional analysis to evaluate the interactions among the owner, designer, and contractor for the same project. The interactions are studied based on the criteria developed from the research. The variables of interest were tabulated for ten (10) participating projects. A conceptual framework is developed which may be used proactively in the future to increase the likelihood of greater owner satisfaction with HCF construction projects.

The research also provided a framework for the development of a national database to track the characteristics of designers and contractors with respect to a number of quality and performance variables. It is recommended that the data base be promoted by a "consumers' union" of health care facility owners representing their own best interests but with a government agency playing an oversight role. As data are added over time to improve the data base's utility, HCF owners can use it to make informed project and provider choices that are likely to enhance their satisfaction levels and contain costs. Designers and contractors can also use it as a self-evaluation tool to improve future performance and marketability.

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to the members of my dissertation committee who have all provided me with invaluable support and intellectual input during this arduous process. Dr. Vincent Omachonu, as chair, has been a source of inspiration throughout this scholarly journey. I cannot thank him enough for his encouragement, his guidance, his patience, and his accessibility. Dr. Shihab Asfour has been a much appreciated source of advice with regard to configuring my overall program and on the use of analytical techniques that were so important to the research. I wish to thank Dr. Tarek Khalil for his early encouragement of my research and for his ongoing counsel during my long association with the Industrial Engineering Department. Dr. Michael Milakovich has been an important influence, providing many ideas on the challenges to productivity/quality in the public sector environment from the management perspective. Dr Wimal Suaris has played an invaluable role in providing many thoughts and ideas on the construction industry, supporting the interdisciplinary approach that was essential for this research topic.

I wish to thank Dr. Norman Einspruch, the former chair of the Industrial Engineering Department, for departmental assistance that went a long way in making the research possible. Special mention must be made of The Florida Education Fund for assisting in so many ways, both tangible and intangible.

My deepest gratitude goes to my wife Laurel for her unfailing encouragement and support of my intellectual pursuits, especially this research project. Other members of my family, including my mother Ivy and son Richard, have also played an important part in making this endeavor possible, and I thank them all.

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Chapter I

INTRODUCTION

The Construction Industry has traditionally been one of the largest industries in the United States. The 1998 Statistical Abstract of the United States Reports that the value of new construction in 1997 was $618.2 billion and employed 4.67 million people, i.e. 3.6% of the non-farm working population. Over the past decade, economic trends have indicated declining activity levels in construction due to several factors:

- Higher operating costs due to increased regulation
- Reduced domestic spending
- Decreased private spending for plants, buildings, housing, etc.
- Reduced government spending
- Inflation in construction costs
- Poor quality
- Foreign competition, both in domestic and overseas construction.

The Health Care Construction Environment

Health care-related construction is a significant portion of the nation's overall construction activity. In 1997, private hospital/institutional construction was valued at $13.741 billion dollars, and public construction of hospitals at $5.042 billion. Private and public projects combined totaled $18.783 billion. Milakovich (1995) describes the medical-industrial complex as a major portion (14%) of the GDP, and points out the importance of its role in providing for the well-being of all sectors of the population. The medical delivery system has been undergoing constant change, especially during the

1990s. With the advent of managed care, privately-owned hospitals and health care facilities have faced major challenges in terms of their relationship with private insurers. Publicly (Government)-owned health care providers also face these challenges. Insurers represent by far the major source of revenue for health care organizations, yet they have gradually and consistently reduced their reimbursements for patient care. With diminishing revenues, hospitals and health care organizations have undergone radical reorganizations resulting in corporate mergers and acquisitions in order to survive. This state of affairs continues a trend that emerged with the adoption of Diagnosis Related Groups (DRGs) in the 1980's. Omachonu (1991) describes the manner in which DRGs forced the health industry to view itself as a service industry that provided approximately 490 "product lines". The industry has had to simultaneously provide an acceptable quality of care, but with a major emphasis on cost containment. According to Omachonu (1991) output-based measures of productivity were facilitated by DRGs as the products of hospital became definable in that environment. Guinn (1997) points out that the medical delivery system has had to transition from treating sickness to creating wellness. The hospital system of an earlier era, with patients confined to beds, was essentially a *sickness* system that responded to episodes of illness. In that hospital system prolonged bed stays provided a mechanism to accumulate charges, hence, each confined patient represented a steady, ongoing source of revenue. Managed care has completely changed the revenue structure in the acute care system; with capitation, reimbursement has become a fixed, finite payment instead. Guinn (1997) states that, from a revenue-generation standpoint, the inpatient environment has become the treatment center of last resort because it represents the highest overhead. Together with these changes, people have now become *customers* instead of *patients*.

Milakovich (1995) states that voluntary hospital accrediting associations and government regulators have influenced the implementation of customer-focused health care delivery based on cross-functional, team-oriented systems. In that environment the visible and hidden costs of health care delivery have become a major concern. This viewpoint underscores the importance of facilities that stress cost-effectiveness while promoting a 'healing' environment.

Government regulation has a major impact on construction decisions. Jaklevic (1997) describes a situation in which Ohio's hospital association called for a two-year moratorium on new hospital construction just months after the state phased out a Certificate-Of-Need (CON) law. This action was intended to reduce the threat to full-service hospitals by an emergence of specialty hospitals that could "cherry-pick" the most profitable services. Under the proposal, a private company that did not already own a hospital in Ohio could not build a new hospital, but an existing hospital could build a new facility and transfer its registered beds there.

Hospitals and health care facilities have become very complex, technologically. Taravella (1993) describes the state-of-the-art technology and facilities design employed in the Madigan Army Medical Center in Tacoma, Washington, a 414-bed tertiary-care referral center for a 7-state region. Said to be one of the most advanced high-technology health facilities in the United States, construction and equipment costs totaled about $350 million. The Madigan facility won the 1992 Secretary of Defense award for best health care facility and landscape design. Its special features included interstitial space that allowed the maintenance staff to make repairs without disrupting health care delivery, a cooling pond instead of a traditional cooling tower for the air conditioning and ventilating system, and bedside computer terminals allowing paperless charting. A real-time digital radiology system allowed specialists to transmit X-ray images throughout the country via telephone lines. Yundt et al. (1997) also describe how the decentralization of services has relied on technology to deliver services to the patient, rather than vice versa. Facilities have been modified to accommodate state-of-the-art material handling systems such as automated guided vehicles (AGVs), automated box conveyors (ABCs) and pneumatic tube systems (PTS). Standardized systems now include hand-held diagnostics, computerized medication dispensing, robot servers for medication or supplies that share pedestrian walkways with people, and computer-based picture archiving and communication systems (PACS).

The foregoing factors underscore the importance of health care construction. With these forces at work, and with the graying of the baby boom generation, there will be increased pressures to make health care facility design and construction as cost effective, flexible, and technologically advanced as possible in the future.

The Need for Performance and Quality Improvement in Construction

It has been recognized for at least the past 30 years that the construction industry has needed improvement in several areas. In 1968, several major U.S. corporations were concerned about rising inflation, rising construction costs and falling construction productivity. They formed the Construction Roundtable to address these problems.

Later, in 1972, the Construction Users Anti-Inflation Roundtable was formed, and became the Business Roundtable, which absorbed the Construction Roundtable. The Roundtable has been concerned with construction quality, efficiency, productivity, and effectiveness; in 1977 they formed the Construction Industry Cost Effectiveness (CICE) Project to study a number of related industry problems.

A 1982 Business Roundtable study examined industrial, commercial and utility segments of the construction industry. It proposed that formal planning and scheduling systems could reduce construction time by 10 percent and owner's costs by 3 percent. As an outgrowth of the CICE, the Construction Industry Institute (CII) was founded in 1983 as a research institute comprised of owner and engineer/contractor representatives from several major U.S. corporations, government agencies, and universities. As stated by Russell et al. (1996), "The mission of the CII is to improve the safety, quality, schedule, and cost effectiveness of the capital investment process through research and implementation for the purpose of providing a competitive advantage to North American business in the global marketplace." In response to the needs of the construction industry, the specific goals of CII are to 1) reduce total projects costs by 20%, 2) reduce total project durations by 20%, and 3) improve project safety by 25% by the year 2000.

Alfeld (1988) advances the view that construction very probably promises a greater payback for performance improvement than any other industry because of its magnitude. He proposes that a minuscule improvement in performance could translate into billions of dollars in savings but recognizes that the construction industry has been intransigent in resisting a change from seat-of-the-pants, reactive management to performance-based management systems.

Studies by Godfrey (1984) and Tucker (1986) also clearly identified a low level of quality in the design and construction process, exhibited in lower levels of customer satisfaction and cost effectiveness, when compared with manufacturing and service industries. Davis and Ledbetter (1987) state that this decline in overall performance puts the nation's construction industry at a competitive disadvantage in the international marketplace. It is also cause for concern at the domestic level, given the linkages between employment levels and economic conditions.

Studies by Nam and Tatum (1992) and Larson (1995) point to the role of adversarial relations between the parties to construction contracts as an inhibitor to the attainment of cost effective, high quality projects that satisfy owners as well as the other parties. Underlying these relations is a historical conflict of interest between owners' costs and the profits of contractors (and to some extent, designers). Partnering is proposed as a means of overcoming these conflicts. It promotes a project team with a single set of goals, instead of the zero-sum relationship described above. Research by Sanvido et al. (1992) points to the lack of a customer orientation in construction projects, and also to the lack of measuring systems to gauge customer satisfaction.

Statement of the Problem

The adoption of managed care has placed increased demands on the Health Care Industry for cost containment in all areas of activity. As described by Yundt et al.(1997)

the health care industry has encountered price competition as managed care has continued to grow; this phenomenon is not normally associated with hospitals and doctors. Yundt et al. cite the case of Worcester, Massachusetts, that has 60% of its workers covered by Health Maintenance Organizations, HMOs, one of the highest rates in the nation. A price war reduced monthly HMO premiums by almost 50%, precipitating the need for unusual sales strategies to attract customers. As this trend has grown on a national scale, health care providers have had to practice strict cost containment while trying to attract private paying consumers. This has led to strategies such as the decentralization of ambulatory patient services and the creation of focused sub-speciality centers.

Health care administrators are groping for answers on how to contain costs and increase quality. Their search has followed traditional avenues such as layoffs, re-engineering, process improvement, customer service enhancements, and the acquisition of improved technology. Expenditures for state-of-the-art radiological equipment and information systems to improve the competitiveness of health care facilities have continued to climb. Similarly, Health Care Facility construction and renovation projects have increased in the course of the last 20 years, as the industry has sought to expand and retool its services. Despite this fact, health care administrators have ignored a major area of opportunity represented by health care construction dollars. The ability to increase value and owner satisfaction in HCF construction projects represents a major source of competitive advantage in the health care industry.

When the quality of Health Care Facilities (HCFs) is not adequately managed, several negative consequences result:

- increased renovation costs
- poor utilization of existing facilities
- inadequate space for existing facilities
- inadequate work flow
- difficulty in planning future growth
- disruption in health care service by ongoing and unplanned renovation projects
- continual corrective action to existing facilities
- budget shortfalls

The foregoing problems often force health care organizations to shift their resources from the area where they have the greatest import, thereby weakening competitiveness. <u>This research strives to bring health care construction to the forefront, as an area of opportunity for improving owner satisfaction, containing costs and improving competitiveness</u>.

HCFs are very costly--per square foot costs may exceed $200 or more, as documented by R.S.Means, a national construction cost estimating service. The HCF construction work is also very complex. New construction, renovation and remodeling in the health care environment require specialized knowledge on the part of designers and builders/ contractors, as well as HCF owner representatives. There is a major emphasis on renovation projects to modify existing spaces for alternative uses, and such work poses severe challenges for the parties to construction projects. It often involves working around or within spaces that house patients on a 24-hour basis. The generation of noise, vibration, dust, odors, etc., and interruption of utilities can have dire consequences for all patients, and the health care delivery process, especially those in acute care situations. The health care construction environment, therefore, is far more challenging than most of the other situations that contractors and designers encounter. There is strong evidence that the providers of health care design and construction services are not in full agreement with their customers on the determinants of quality and performance.

This research responds to the problem by accomplishing the following:

- Identifying the determinants of owner satisfaction in HCF construction projects
- Using the knowledge of the determinants to identify the gaps in perceptions and expectations between the parties to construction
- Exploring the development of a framework for closing the gaps; the creation of a national data base for HCF construction information is proposed, as a part of this framework. A national "report card" would be a part of this system.

The research posits that the application of the framework, based on predetermined owner satisfaction variables and performance variables, can potentially reduce the time and cost incurred in HCF construction/renovation projects, and measurably improve levels of customer satisfaction in HCF owner representatives.

Contributions of This Research

The Health Care Industry needs cost containment knowledge and strategies to implement the knowledge. Construction provides an additional opportunity in this area, as projects are susceptible to huge losses because of design changes, rework, cost increases and time delays. Research in this area has been limited to construction quality and performance improvement in non-health care facilities. This research is a departure from the emphasis of those previous studies by concentrating specifically on health care facilities. Several studies (Glagola et al., 1992; Stevens et al., 1994) have addressed quality in Engineer-Procure-Construct (EPC) projects under the umbrella of the Construction Industry Institute, headquartered in The University of Texas at Austin, Texas. However, this work is not focused on health care facility construction. The American Society of Civil Engineers has also promoted research in construction quality, in EPC as well as other types of projects. A review of the literature reveals that many of these research efforts have focused on the application of Total Quality Management or its derivatives to the construction process, in general.

While there are research studies in evidence that address design approaches for health care facilities (HCFs), no dedicated studies deal specifically with the subject of HCF owner satisfaction relative to the construction process itself. The documentation of HCF owner satisfaction that has been initiated in this research may serve as a starting point for a national data base on health care facility owner satisfaction, and designer/contractor performance. In turn, the data base will have the potential to benefit all future projects and provide for continuous learning and improvement of HCF construction processes. As data are added over time to improve the data base's utility, HCF owners can use it to make informed project and provider choices that are likely to enhance their satisfaction levels; designers and contractors can use it as a self-evaluation tool, to improve future performance and marketability.

Purpose of the Research

The primary purpose of this research is to identify the variables that directly increase the likelihood of positive outcomes in health care-related construction projects, and to develop a methodology for using the knowledge of these variables to influence future projects. It is assumed for the sake of this research that positive outcomes are those that satisfy the needs of the owner's representative, with regard to the facility that is being constructed. Construction includes the creation of new facilities, i.e., new construction, as well as the renovation or remodeling of existing facilities. It generally includes three distinct parties--owners, who are represented by health care facility administrators; designers (i.e., architects and/or engineers) who prepare design and contract documents; and contractors (builders) who carry out the construction desired by the owner.

Objectives

1) To find out the determinants of owner satisfaction, quality, and performance for HCF construction and renovation projects.
2) To identify the gaps in perception and expectation of owner satisfaction and quality/performance determinants between: owners and designers, owners and contractors, and designers and contractors. (Measures to close these gaps will provide goal congruence).

) To conduct a project-specific analysis involving owners, designers, and contractors, in order to develop a conceptual framework that incorporates owner satisfaction criteria and performance guidelines for designers and contractors.

4) To identify and examine possible differences between public and private HCF environments in order to configure the framework accordingly.

Scope of the Study

This study is limited to Health Care construction activity that generally involves architects and engineers (A/E's) to execute the planning and design functions, and that is implemented by contractors. The health care facilities include hospitals and ancillary buildings. The scope includes:

- new projects of a value of $100,000 to $50 million and over.
- renovation projects of $ 50,000 to $20 million and over in value.

The requirements of these projects are:

- no restrictions on location within the U.S.
- both public sector and private sector - ownership
- both for-profit and not-for-profit status
- no limitation on square footage within the indicated dollar values
- project completion within the preceding 5 years, in order that respondents will adequately recollect their degree of satisfaction with each project

Limitations

The results generated are based on a sampling of health care organizations, design organizations, and contractors. The acquisition of data for this research is limited by certain factors which include:

- information that organizations consider to be proprietary
- the familiarity of the respondents with the specific information requested about their organizations
- the level of interest or the availability of time of the respondents
- the accuracy of interpretation by the respondents of the questions posed by the survey
- a limited sample size for the project-specific surveys

With regard to the sample size, thirty professionals participated in the project-specific survey, providing detailed information on 10 completed projects. This small number was influenced by the reasons listed above, and by the fact that the research program had few resources available to provide incentives that would attract and reward participants.

Organization of the Dissertation

Chapter I defines the problem and the respective sub-problems that are addressed in the research. The purpose of the research is defined, as are the intermediary objectives that are necessary to meet the primary objective. The scope and limitations of the research are also explained. This chapter provides background information on the health care environment and on the construction industry, both areas of interest in the research.

Chapter II comprises a literature review of the work of several researchers on quality and performance improvement in construction. It provides an understanding of the evolution of quality and productivity concepts in general building construction, and how the critical performance variables also impact against health care-related construction. The concept of service quality is explained, in the context of its relation to customer satisfaction. Gap analysis is discussed in that framework to explain how differences in expectations and perceptions between customers and suppliers may be identified and measured in order to improve customer satisfaction.

Chapter III describes the methodology utilized in the research as well as the interview procedures, questionnaire development, and sample selection. The use of non-parametric statistical methods was described with regard to their relevance to the ordinal data that were collected in the project. The detailed phases of the research were described, with particular attention to the conduct and monitoring of both the mailed survey instruments and the project-specific data collection.

Chapter IV details at length the data collected in the general survey, and presents them with the aid of charts and graphs to explain both the differences and similarities between the responses submitted by the subject groups--representatives of health care facility owners, design organizations, and construction organizations. Details of the statistical analysis of the data are provided, together with an explanation of the possible reasons for the observed results.

Chapter V describes the results of the project-specific survey and proposes the framework for using these results in a predictive fashion for future projects.

Chapter VI presents the conclusions that are formed from the analytical results of the mailed general survey, as well as the project-specific survey. This chapter also discusses the manner in which the framework proposed in Chapter III is supported by the data collected. It proposes ways in which the conclusions may be applied, especially how the gaps between owners, designers, and contractors may be reduced.

The appendices contain examples of the survey instruments and the references that were consulted or used in the research. There is also a glossary of terms related to the construction process.

Chapter II

LITERATURE REVIEW

Quality in construction appears to be a very elusive subject, with several interpretations by different parties. This was borne out by a literature search that reviewed books, dissertations, journal articles, research publications from the Construction Industry Institute, CII, and other sources, all relating to the subject of construction quality. The purpose of the search was to determine how researchers describe performance in the area of construction and to observe specific variables that describe performance. There was a special emphasis on construction quality and owner satisfaction as components of performance, much as is done in other industries.

Background on the Construction Industry

Background information on the construction industry will provide an appreciation of the standardized approaches that are also employed in the construction or renovation of health care facility (HCF)-related projects. The industry is truly diverse. The Bureau of Labor Statistics refers to three main categories: General Building Contractors (SIC Code 15), Heavy Construction (except building) (SIC Code 16), Special Trade Contractors (SIC Code 17).These are further subdivided into 11 SIC Code headings. The Construction Review, U.S. Department of Commerce, identifies 16 categories as shown in Table 2.1 below.

TABLE 2.1 Types of construction

PRIVATE OWNERS-
* Residential buildings, new or improvement
* Nonresidential-buildings, plants, etc.
* Industrial
* Office
* Other Commercial
* Other: hotels, institutions., miscellaneous
* Farm-nonresidential
* Public Utilities- privately held
* Other private construction

PUBLIC AGENCIES-
* Buildings
* Highways and streets
* Military facilities
* Conservation and development
* Sewer systems
* Water supply
* Other public construction

Ritz, 1994, subdivides construction projects into two types- process-type projects, and non-process-type projects. Examples are indicated as follows:

Process-type projects

* Liquid-gas processing plants
* Liquid/solid processing plants
* Solids processing plants
* Power plants

Non-process type projects

* Manufacturing plants
* Civil works projects
* Support facility projects
* Commercial and A&E projects
* Miscellaneous projects

Description of Commercial and Architecture & Engineering (A & E) projects

Commercial and A&E projects include the following:

* Office buildings
* High-rise buildings
* Shopping malls
* Health care facilities
* Institutions
* Schools, banks and prisons
* Multi-family housing units
* Multiple unit housing schemes
* Military facilities.

Construction projects are described as having unique characteristics. Ritz (1994) states that each project is unique and not repetitious. A project is said to work against schedules and budgets to produce a specific result. The construction team cuts across many organizational and functional lines that involve virtually every department in the company. Ritz (1994) emphasizes that projects come in various shapes, sizes, and complexities. The owner has separate contracts with the designer and the constructor in the case of design-bid-build projects. In the case of design-build projects, the owner contracts with one entity--the design builder. The design builder is comprised of a contractor organization that contains its own design professionals. In such projects, the design professionals represent the owner, and supervise (or monitor) the work done by the contractor, on the owner's behalf. The suppliers typically have a contract with the contractor, but not with the owner or designers. Government agencies oversee both the design and construction to ensure compliance with prevailing state or local construction codes.

The Parties in Construction

Oglesby et al. (1989) point out that the parties involved in construction have a major influence on productivity (and quality) as a result of their actions. These parties include the following:

1. Owners, who originate the need for projects and determine the locations and purpose of facilities. They arrange for design, financing and construction.
2. Designers. They are usually architects or engineers who interpret the owner's wishes into drawings and specifications that may be used to guide facility construction. In the design-build concept, they may be a part of the construction team.
3. Constructors. These are contractors and subcontractors who provide the work force, materials, equipment and/or tools, and provide leadership and management to implement the drawings and specifications to furnish a completed facility.
4. The Labor Force. This is comprised of foremen, craftsmen, or journeymen, and skilled or semi-skilled apprentices or helpers. Many different crafts are represented, such as masons, pipefitters, carpenters, electricians, etc.

Godwin (1979) identifies several other parties, although these are usually affiliated with the four parties: Financiers, Lawyers, Insurers, Labor Unions, Manufacturers, Suppliers, Transporters. A very important role is played by other parties that are not affiliated with any of the foregoing, such as: a) Federal and Local regulators, b) Public Services, and c) Utilities.

Project Delivery Methods

There are a number of models for the process of designing and constructing facilities. Oglesby et al. (1989) describe the following models:

1) Design-bid-build
2) Design-build
3) Engineer-procure-construct
4) Design-Construction Management (CM) contracts
5) Design-agency CM contracts

Design-Bid-Build Contracts

According to Oglesby et al. (1989) design-bid-build contracts represent the most frequently used type of project delivery system for most construction projects, and have the following characteristics:

a. The project is conceptualized by the owner.

b. Planning is carried out based on the objectives to be met, and economic and technical feasibility. Site acquisition may be implemented at any point before contract award, but is best done as early as possible, to ensure that the design will not have to be aborted.

c. Programming is carried out to identify the uses and desired sizes of various spaces, followed by schematic design to identify relationships of these spaces relative to each other. The scope of the project, preliminary budget, and schedule are derived.

d. Detailed design is usually carried out in stages, with intermediate check points for verification by the parties to the project.

e. The design culminates in the preparation of completed drawings and specific-ations, representing bid documents as well as detailed cost estimates. The bid documents are used to solicit construction bids, or are otherwise used to negotiate a construction price.

f. Bid analysis is carried out and a legally binding contract is then awarded. The drawings, specifications, and signed documents then become construction documents.

g. The contractor is given access to the site and instructed to proceed, based on legally established time frames. A contract may contain incentives for timely completion, as well as penalties for avoidable delays or cost overruns.

h. The owner, or agents of the owner, such as architects/engineers, or construction managers, monitor(s) the progress of the construction, ensuring that interim payments to the builder/contractor match construction progress.

i. At completion, there are acceptance inspections, leading to the commissioning of the facility for the owner's use.

j. The project is turned over to the owner.

Design-Build Projects

As described by Oglesby et al. (1989), project delivery is accelerated by the concurrent design and construction activities of a design-builder. As is typical of all types of projects, a design-build project is conceptualized by the owner; planning is carried out based on the objectives to be met, and on the economic and technical feasibility of the project. Site acquisition may be implemented at any point before contract award, but is best done as early as possible to ensure that the design will not have to be aborted. Planning and schematic design are carried out by the owner's design professional, and may include infrastructure and foundation details for the project. This information allows construction to start shortly after contract award, while the design builder continues the preliminary design to obtain a final design. Typically, their design professional develops a preliminary design and cost and schedule proposals for the overall project. In some design-build projects the owner may review proposals from a number of design-builders and enter into a legally binding contract with one that provides the most appropriate proposal. The design-builder is given access to the site and instructions to proceed, based on legally established time frames. This type of contract may also contain incentives for timely completion, as well as penalties for avoidable delays, or cost overruns. The design-build organization initiates construction while finalizing the detailed design. At intermediate check points verification is done by the parties to the project. The design culminates in the preparation of completed drawings and specifications that are used to complete the project. The owner or agents, such as architects/engineers, or construction managers, monitor the progress of the construction, ensuring that approvals for interim payments match the progress of the construction work. At the completion of the construction there are acceptance inspections, leading to the commissioning of the facility for the owner's use.

Engineer-Procure-Construct Projects

These are configured in a manner very similar to design-build projects. Most of the three functions are performed or managed by one organization. This model, however, is used primarily for industrial projects that emphasize engineering design, as opposed to architectural design. EPC projects typically have commissioning and maintenance phases included to allow for a plant to reach its designed operating capacity, after acceptance. As the EPC model does not usually relate to commercial and A & E projects, it is not considered in this research.

Design-Construction Management (CM) Contracts

The owner typically hires a construction management organization, for a fee, to provide professional management services. Trade contractors contract directly with the owner on an individual basis, and not through the construction manager, although the CM advises the owner on the formation and conduct of those contracts. The owner also contracts separately with a design concern, i.e., an Architectural/Engineering (A/E) firm to obtain the design documents. In some instances, the A/E firm may play the role of the CM. This form of contracting places a heavy responsibility on the owner to coordinate the work, as the trade contractors do not have contracts with each other and have no contractual obligation to cooperate.

Design-Agency CM Contracts

According to Kubal (1994), in this type of contract the owner hires a design team to prepare project construction documents, and also hires a construction manager (CM) to oversee the construction phase of the project. This is often done on the basis of a lump-sum or fixed-price contract. The CM may act as an agent of the owner, contracting directly with all the trade contractors. The CM prepares bid packages that are priced competitively by the trade contractors, and reviews these bids to select the most appropriate ones.

CM-at-Risk Contracts

Kubal (1994) describes the role of the construction manager in this type of contract as assuming the risk of pricing, and contracting directly with the respective trade contractors. In general, CM-type contracts are not as amenable to quality initiatives as design-bid-build and design-build contracts.

Fast-track Construction

Kubal (1994) states that fast-track construction is valuable in meeting accelerated schedules demanded by the owner. It allows a contractor to commence construction immediately after contract award, while a designer simultaneously completes the construction documents. It may be carried out with or without a design-builder.

Oglesby et al. (1989) and Godwin (1979) separately emphasize that the activities of all parties are necessary for projects to be successfully executed. In particular, the actions of craftsmen or crews at the work faces are absolutely essential, but failures arise most often from the actions of the other three primary parties.

Contract Compensation Formats

Kubal (1994) describes several categories of construction contract formats that cover the spectrum of available approaches, all of which may be integrated with the foregoing construction delivery methods. Some categories of contract formats may be better suited to particular delivery methods, although the number of contract formats is almost infinite, just as there are no two projects are exactly alike. The more frequently used formats are lump sum contracting, Guaranteed Maximum Price (GMP), GMP with cost savings sharing, and cost-reimbursable contracts (cost-plus). The cost-plus compensation formats may include cost-plus with guaranteed maximum price, cost-plus with guaranteed maximum and incentive, and cost-plus with guaranteed maximum price and provision for escalation.

Advantages and Disadvantages of Different Contract Compensation Formats

According to Ritz (1994), cost-plus contracts are appropriate where the scope of work does not have to be clearly defined, e.g., in major revamping of existing facilities, where technology is not well defined, or needs to be confidential. Minimum time schedules are generally obtained, but the owner/client needs to provide extensive engineering supervision and cost control. Cost-plus with guaranteed maximum price usually involves at least preliminary drawings and general specifications. Fast time schedules are possible at the expense of high contract prices, due to the contractor's risk exposure. Cost-plus with guaranteed maximum and incentive leads to fast schedules and higher prices than fixed-price contracts, but encourages the contractor to pursue savings as they are shared between both parties.

Cost-plus with guaranteed maximum and provision for escalation is generally used for long time schedules, where prices may increase substantially, and project definition is preliminary. Tight owner cost control is needed. Time and materials contracts that are based on a general scope of work assure the contractor of a reasonable profit, reduce the scope definition/proposal time needed, but require extensive client supervision. Bonus/penalty, time, and completion clauses are used when completion is highly critical to the owner. The level of project definition provided greatly affects contract prices. The involved penalties impose high risk on the contractor, and quality is often reduced to meet time schedules. Bonus/penalty, operation and performance contracts are typically used in process plant construction to guarantee successful plant operation.

Lump sum contracting is often based on definitive specifications and requires complete, detailed design. Construction efficiency and quality are maximized in direct proportion with the availability of design detail. The overall time frames required are longest, as separate design and construction contracts and phases are involved. Lump-sum based on preliminary specifications and complete general specifications, is often used for "turnkey" projects, such as plant construction. Time is saved by concurrent design and construction, and the single party responsibility inherent in this format promotes efficient project execution.

Unit-price contracts, flat rate, are best used for repetitious/homogenous tasks such as highway building, gas transmission piping. Work can proceed effectively even if the parties do not initially know the precise quantities of labor and materials required for the involved work. Unit-price contracts, sliding rate, are appropriate for the foregoing projects, but require extensive client field supervision to ensure that the involved quantities are properly monitored.

The Challenge of Measuring Performance in Construction

There are probably as many opinions on how to measure the construction process as there are practitioners in the field. Oglesby et al. (1989) observed that it is generally accepted that construction processes, and especially the level of accomplishment, are far harder to measure than manufacturing processes. There is also much disagreement on the definitions of performance, productivity, quality, and other measures of accomplishment. Alfeld (1988) equates performance (worth) to the ratio of accomplishment (value) to methods (cost). Finished work is regarded as accomplishment, and a construction technique is a method. Performance is a combination of methods and accomplishment. According to Alfeld, worthy performance occurs when the value of the accomplishment is greater than the cost of the methods used. Alfeld developed another measure of performance as Performance Ability Ratio (PAR) as the ratio of 'exemplar performance', to current performance. Exemplar performance is the historically best instance in which the value of accomplishments exceeds the cost of the methods.

Oglesby, et al. (1989) take the position that performance comprises: productivity, safety, timeliness, and quality. They describe these components as follows: Productivity measures effectiveness of use of managers, tools, workers, equipment, working space, etc., to produce a finished structure, project, etc. Safety is interpreted in terms of minimizing accidents, insurance costs. Timeliness is defined as completion on time, and adherence of job elements to schedules. Oglesby et al. visualize quality as being two dimensional: meeting owner's needs, and minimizing rework.

Kartam (1987) describes the quality characteristics of plans in terms of their ability to select the right sequence of work, select the right amount of work, and select practical work.

Baillard et al. (1994) use percentage assignments completed (PAC) as a performance measurement for field planning systems. By definition, PAC is equal to the ratio of completed assignments to planned assignments. It is considered to be a measure of the quality of plan executability.

Thomas et al. (1990) define performance in the context of their model of construction labor productivity. Performance is referred to as a multifaceted concept, consisting of seven dimensions: effectiveness, efficiency, productivity, profitability, innovation, quality of work life, and quality. Effectiveness relates to the success in meeting objectives, such as completion on time and within budget. Efficiency describes the process of converting inputs to outputs, and productivity is said to be one measure of efficiency. Profitability is the excess of revenues over costs and is the fundamental reason for the existence of a profit-making organization. Innovation is reflected in the extent to which new methods, products, and systems are introduced. Quality of work life is determined by the extent of workers' involvement in the process of production. Quality is defined by the acceptability of the work produced with respect to specification limits. In their study, Thomas et al. emphasize four of the foregoing dimensions of performance: effectiveness, efficiency, productivity, and quality. They advocate that performance is a function of the duration and intensity of effort, the crew's knowledge, skills, and abilities.

Glagola et al. (1992) conducted a study to develop a set of quantifiable, predictive performance indicators and an implementation process that could be used in the U.S. construction industry. The intent was to measure the quality of and identify improvement areas for the Engineer-Procure-Construct (EPC) process, typically used in industrial plant construction projects. Questionnaires and interviews of targeted owners, engineering firms, and construction companies, identified appropriate quality measurements for the EPC process. Glagola et al. (1992) identified that for projects, quality means conformance to established requirements. Requirements are contractually established characteristics of a product, process, or service. A Quality Measurement Matrix was developed around four TQM process elements: Customer focus, Leadership, Delivery, and Employee Empowerment. Glagola et al. identified over 600 specific measurement examples of quality performance measurement. All the involved companies employed traditional "hard" measurements such as cost, schedule, and safety, to determine quality performance. *Leading companies measured "soft" areas such as customer satisfaction*, employee involvement, and training. Planning, communication, and teamwork were perceived as major project success factors. The study also concluded that the effective use of quality performance measurements is best obtained through a logical framework such as Total Quality Management (TQM).

Hamilton and Gibson (1995) view performance in terms of financial goals that should be met or bettered, schedule performance that should be met or bettered, design capacity that should be attained in a given time frame of say, 6 months. Scheduled plant utilization to be attained is regarded as a measure of performance. The extent of preplanning effort is seen as a performance variable that is positively linked to the extent of the success of a project.

The Building Research Board (BRB), 1989, describes quality buildings as those whose characteristics create an environment where the occupant or user can accomplish his purpose effectively, efficiently, and comfortably. The BRB studied the connection between construction quality and design quality (Ledbetter et al., 1991), and found the two factors to be inextricably interconnected.

Ritz (1994) relates performance to project goals for different parties to a contract: For the construction team, it is to finish the project as specified, on schedule, within budget. For the owner/client it is to obtain the best facility for the money, on time completion, completion within budget, with a good project safety record. For the Architect/engineer it is to make a profit, finish on time, to design within budget, to furnish quality as per the contract, and to get repeat business.

Stevens (1996) describes four elements as necessary organizational attributes for construction quality: Customer focus, Leadership, Delivery, and Employee empowerment. Stevens advocates the use of the Quality Measurement Matrix to determine an organizations accomplishment of these elements. Glagola (1993, p.105) describes quality success factors as a mix of processes and results in determining quality performance. Processes are seen as an important means to an end, and the results are that end. Processes include: defined scope, communication, team work, management expertise, training, technology, and quality processes. The results achieved include: budget met, schedule met, satisfied customers, and safety.

Ledbetter et al. (1991) define quality in construction as conformance to adequately developed requirements. Emphasis is placed on the adequacy of the requirements. Davis and Ledbetter (1987) take the position that "Construction must be performed in accordance with the contract documents--doing what guarantees that the needs of the user will only be met if the design itself is adequate. In other words, customer satisfaction may be beyond the control of the contractor."

Duttenhoefer (1991) refers to construction as the area where the design professional can most easily impact costs. A misunderstanding of construction procedures by the designer can have a profound effect on feasibility and costs.

Russell et al. (1996) use the following criteria to describe performance from the Owner's perspective: Did the project meet or exceed the budgetary expectations of the owner? Was the project completed on or before the required date?. Budgetary expectations are defined as including the amount of money originally appropriated for the project plus all owner-approved changes to the budget. The required completion date is the date on which the project is expected to achieve substantial/mechanical completion. This includes any owner-approved changes to the contracted date.

From the Contractor's perspective, the level of success is determined by asking: What level of profit was earned by the prime construction contractor? Profit level is defined in percentages of an industry standard.

Health Care-related Studies

Health care-related construction has special needs. Axon (1997) states that the health care industry faces a "rapidly changing world of regulations, technology, and organization" and has to be able to continually adjust to those influences. Malkin (1997) points out that today's health care administrators have less to spend than in past eras, before managed care and before capitation; the generous expenditures of past eras placed the focus on expensive interventions and over-utilization of diagnostic technology. The decrease in expenditure could result in innovative approaches, such as the recent emphasis on the healing environment, that is not cost intensive, but requires detailed analysis and redesign. Many facilities have been undergoing modification to shift the focus of health care away from housing patients to promoting wellness. They emphasize a shift away from the institutional look to a less stressful environment in which shape, form, color, texture, sound touch and taste can influence the mind-body connection. Reportedly, the cost of this redesign is offset by faster rates of healing.

Jussaume (1996) describes the importance of good indoor air quality (IAQ) to a healing environment. As contagion rates of airborne infectious diseases rise at alarming rates, health care institutions face new pressures and increasingly stringent code requirements. New technologies and equipment also add to demand on the performance of engineering systems. Patients with suppressed immune systems must be protected from airborne bacteria, and hospital staffs must have a safe and comfortable work environment. Evaluations of each situation can result in innovative implementation such as rebalancing existing air systems, providing pressure controls for isolation rooms, retrofitting existing HVAC systems with air pressure controls, upgrading air-filtration equipment, or correcting initial design and installation flaws.

The Linkage of Programming to Design Quality

Axon (1997) describes programming of health care facilities as a most important mechanism for investigating the problems that are to be addressed by a facility design. Whereas programming is analysis, design is synthesis. Programming describes the design problems in terms of form, function, economy, and time, and should explain the user's expectations. Axon (1997) points out that programming ensures that "every square foot counts;" it costs in excess of $200. The avoidance of wasted square footage is critical as the labor costs for operating a hospital may exceed its cost in 2-1/2 years. Axon claims that it is far cheaper to program correctly in the beginning than to be forced to do corrective renovations afterwards.

Douglass (1995) researched the enhancement of the programming process, based on David Garvin's eight dimensions of quality. Quality Function Deployment (QFD), both comprehensive and structured, was modified to the health care environment in order to place the appropriate emphasis on the needs to be met by the facility design. This approach was applied with measurable success to a diagnostic and treatment facility for a small hospital.

Programming also provides a sound basis for the post occupancy evaluation of health care facilities. Osterberg (1980) conducted a post occupancy evaluation of a retirement home to evaluate the effectiveness of the building design in fulfilling users' needs. The application of design criteria was evaluated in terms of performance as measured against the program for design. The evaluation technique proved to be highly beneficial in determining how well the facility design served the users. It was determined, for example, that the architect's programmed usage of spaces was violated by changeovers in key staff members of the home, especially the home's administrator.

Public Sector Limitations

Bates, (1996) compares public and private facility owners. Despite the existence of many legal restrictions on what public agencies can do, government regulations at all levels are being made more flexible, from early programming through various design and construction options to new forms of operation, maintenance, and even ownership. Bates emphasizes that the main difference between the two groups is in the open and auditable competitive nature of the process used by the public owner/agent. Public entities are gradually adopting varying degrees of privatization, and considering the best use of human, natural and capital resources to reach their mission.

Rationale for the Selection of Customer Satisfaction as a Dependent Variable

Previous studies have yielded conflicting views of project success, according to Sanvido (1992). A number of researchers (Alfeld, 1988; Baillard, 1994) define such success in terms of hardware-oriented accomplishment. Oglesby, Parker, & Howell (1989) describe performance in terms of productivity, safety, timeliness, and quality.

Thomas et al. (1990) define performance through seven dimensions--effectiveness, efficiency, productivity, profitability, innovation, quality of work life, and quality. Quality is determined by the acceptability of the work. Hamilton et al. (1995)

view performance in terms of financial goals, schedule goals, system capability goals (such as plant capacity). Wetherington (1992) describes performance through value added (to construction) per day worked.. He applied this metric to measure the work accomplishment of four home builders in the State of Florida, in order to compare how this accomplishment was influenced by different project management methods.

While many studies have pointed to time, cost, etc. as success criteria, efforts to quantify performance have not adequately addressed the criteria identified by Parasuraman et al. relative to the dimensions of service quality. Parasuraman et al. (1985) identified ten dimensions: tangibles, reliability, responsiveness, communication, credibility, security, competence, courtesy, understanding/knowing the customer and access. They observed that the ten dimensions overlapped to a degree and that customers could best distinguish between five dimensions: tangibles, reliability, responsiveness, assurance, and empathy. Although these dimensions may not apply uniformly through all facets of the construction process, research by Ashley et al. (1987), Wilemon & Baker (1985), and Ahmed et al. (1995) points to the relevance of most of these dimensions to the construction industry. There have been a number of studies in the arena of Engineer-Procure-Construct (EPC) projects with an emphasis on the concept of customer satisfaction. There is, however, little evidence of comparable scholarly research on architect/engineer-designed projects.

Fergusson (1993) studied the EPC process to determine what constituted a high quality facility, and how to better manage the (design) development process. While a summary quality index was developed that included client satisfaction, the research was based on 17 industrial facilities in the U.S. and Canada, and studied two groups primarily, i.e. client representatives and construction staff.

Garvin (1984) proposes a positive correlation between the satisfaction of a number of product quality dimensions and a supplier's profitability. Garvin cites eight quality dimensions that are important to a supplier's strategic direction: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality. In Garvin's model, high quality as defined by improved conformance, superior aesthetics, or fitness for use, tends to cause increased market share and, subsequently, greater profits. On a parallel path, improved reliability or conformance leads to increased productivity, lower rework and scrap costs, and lower warranty and liability costs. This results in higher profits through lower production and service costs. Garvin also proposes that an organization does not need to emphasize all eight dimensions, but can strategically select those most relevant to its objectives.

Chinyio et al. (1998) state that clients' needs tend to be inadequately evaluated in project schemes, leading to insufficient contractor evaluation. Subjective decisions have prevailed in tender (bid) evaluations, and clients' needs have not been satisfied completely by the contracts awarded on that basis. Chinyio et al. state that objective contractor evaluation will be realized only when clients' needs and contractors' capabilities can be quantified and matched reliably. They propose the use of multidimensional scaling and cluster analysis techniques to accomplish these matches. Their findings also suggest that clients would best be subdivided into 5 needs-based groups.

The Importance of Supplier/Owner Relationships

In a study of marketing relationships between consulting engineering firms and construction owners, Filiatrault & Lapierre (1997) emphasize that current customers frequently offer the best growth and long-term profit opportunities, especially in the context of growing competition and market globalization. They cite research that estimates that gaining new customers costs five to six times more than keeping current ones. The observations from their study support an increase in long term profitability by shifting to ongoing relational exchanges between consultants and owners, from contractual or transactional exchanges which are short-term in nature. Customer participation (and satisfaction) are critical to relationship management. Sirkin & Stalk (1990) state that knowledge of what customers value uncovers the root causes of quality and service problems. They propose a four-step process that addresses several issues: a) critical problem-solving loops in one's organization, b) how well the organization works from the customer's perspective, c) whether the staff learns from problems and whether it corrects them proactively, and d) the degree to which underlying problems are corrected, as opposed to being allowed to recur continually.

Ahmed & Kangari (1995) cite the importance of client satisfaction factors in design and construction: client orientation, communication skills, response to complaints, quality and timeliness. Ahmed & Kangari developed a client satisfaction model based on a study of 101 client companies, involved in transportation, food, chemical, paper, utility, and miscellaneous industries. The model was based on the factors that they determined to be important to the overall satisfaction of construction clients: cost, time, quality, client orientation, communication skills, and response to complaints. Ashley et al. (1987) include satisfaction in 6 criteria of project success: budget, schedule, client satisfaction, functionality, contractor satisfaction, project mgr/team satisfaction. In the Malcolm Baldrige National Quality Award, 250 points (25%) of the 1,000 total points in the award are dedicated to the category "customer focus and satisfaction." This weighting indicates the importance of the customer in an organization's efforts to provide quality.

Understanding Quality Gaps

A number of researchers have investigated the perceptual aspects of quality, on the premise that quality is determined by the customer, i.e., the recipient of a service or a product. This is especially significant in the case of service quality. As previously stated, Parasuraman et al. (1988) define service quality in terms of five dimensions, as perceived by the service customer. These are tangibles, reliability, responsiveness, assurance, and empathy. "Gaps" in service quality describe the differences between customer expectations of service quality, as described by the quality dimensions, and the perception of the service actually received. Gaps represent long established habits that become part of an organization's culture, and create service problems. The act of correcting the gaps leads to developing a service culture. Brown (1992, 1995) defines gap analysis as *quantifying customer perceptions of a product or service, and comparing them with what management believes to be the customer's view of the product or services.* ("Management" refers to the decision-makers in the supplier organization.)

Gap analysis facilitates an evaluation of the internal barriers in meeting consumer expectations, determining whether the current standards inhibit employees' ability to give the expected service; whether the organization is communicating honestly to its customers; and if the company's vision is at odds with its capability to deliver that vision.

The difference between expected and perceived service is comprised of several components. Brown (1995) describes a 1992 study conducted by The Ontario Public Service Company. They adapted a conceptual model developed by Parasumaran et al. to improve their service quality to the residents of the province. The gaps identified in that study are as follows:

1) Service quality: the gap between customer expectations of service quality and customer perceptions of the organization's performance.

2) Understanding: the gap between customer views of service quality and the organization's view of its service quality.

3) Design: the gap between the organization's perception of customer views and of service quality and the design of the organization's service delivery system.

4) Delivery: the gap between how the organization's service delivery systems should operate, and how they actually operate.

5) Communications: the gap between the service delivered and the level of service being promised to the customer.

Brown (1995) cites a study conducted at Federal Express that applied gap analysis to the relationship between one operations function and another by posing three questions-

* What do you need from me?
* What do you do with what I give you?
* What are the gaps between what I give you and what you need?

The answers to these questions helped the company to pinpoint service problems, and to implement a strategy to close the gaps, resulting in improved service quality. The gap analysis procedure quantifies the differences between importance and performance, through a survey of both internal and external customers--the largest gaps show the elements of service (or product) quality that merit the strongest corrective action.

Definition of gaps in the research context

In the context of this research a broader scope is applied to the question of quality gaps. It is recognized that the work by Garvin and Parasuraman et al. represents service-oriented situations very well. Construction, on the other hand combines elements of both the manufacturing and service environments--the manufacturing process is protracted and involves many ongoing interactions between the parties. While a completed facility is analogous to a manufactured item the interactions involving status information, problem resolution, dispute resolution, etc., embody transactions that emulate the service environment. As illustrated in Figure 2.1, in order to provide flexibility for the research,

Figure 2.1 Health Care Facility (HCF) Construction process map with Quality Gaps

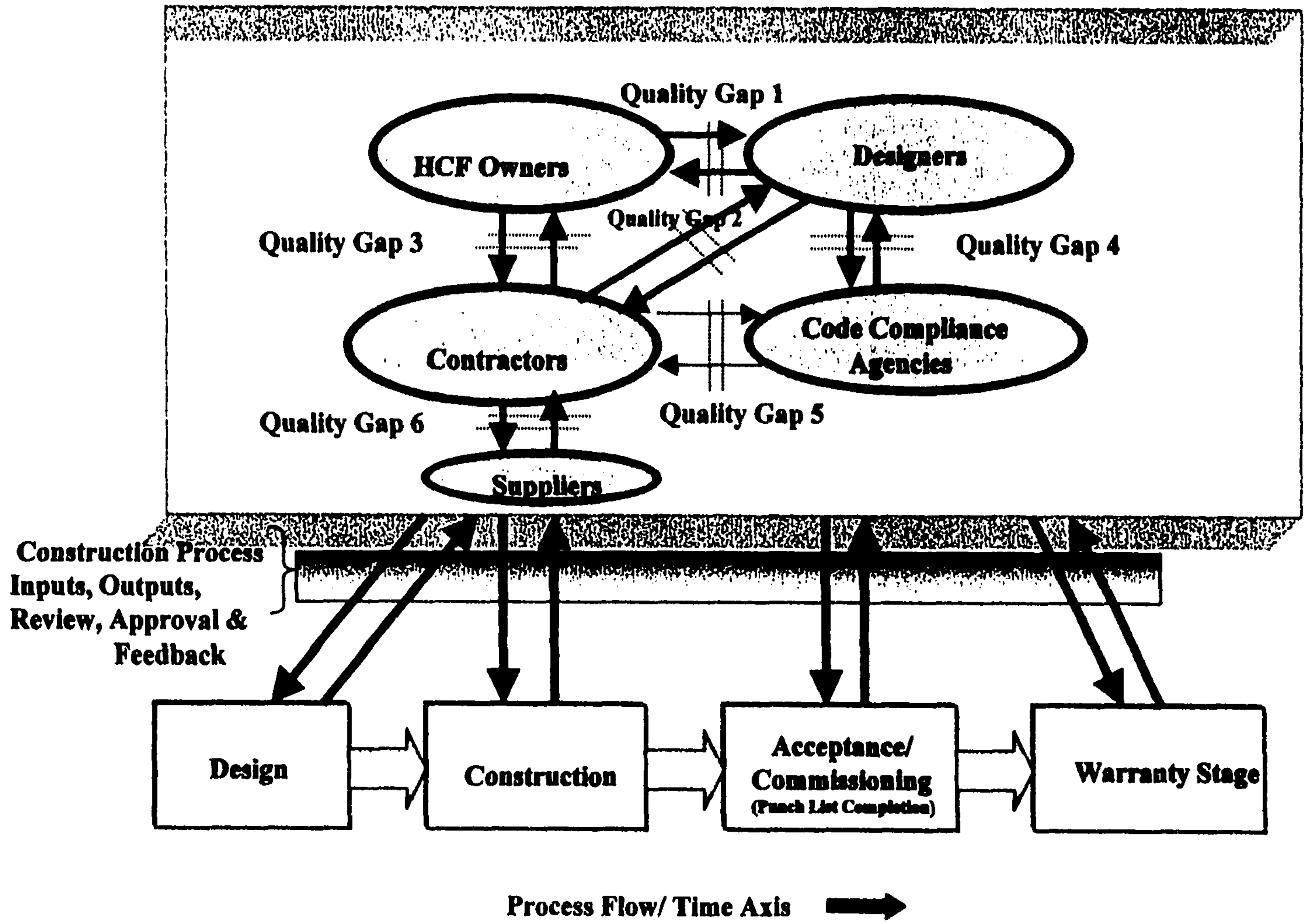


FIGURE 2.1 Health Care Facility Construction Process Map with Quality Gaps (This research addresses gaps 1, 2, & 3 only.)

gaps are treated as any area of difference in expectations and perceptions between the parties to construction. The arrows in the diagram represent the flow of information in two directions between each pair of parties; the dotted lines that intersect with the arrows symbolize the gaps in expectations/perceptions between them.

Observed construction problems

In applying gap analysis to the construction process, it is instructive to first observe the problems that may be attributable to the quality gaps. Ledbetter (1995) defines quality in construction as "Conformance to established requirements"-- requirements are contractually established characteristics of a product, process, or service. Ledbetter describes the cost of quality as the cost associated with quality management activities (prevention and appraisal) plus the cost associated with deviations.

Carr (1997) cites several major problems that are obstacles to quality in the industry: unclear description of construction processes based on drawings and words, leaving the interpretation to the skill, craftsmanship, and imagination of others. Construction information is scattered through different drawings, and is hard to integrate. This limits ability to design, estimate evaluate, control and document construction processes. Many craftsmen have trouble reading, yet are provided with 2-dimensional drawings only. There are no current standards to judge the quality of documents provided for construction projects. Despite the use of scheduling software by project managers, etc., site workers do the actual sequencing of most tasks, often with intuitive approaches only. According to Carr, the way in which projects are documented does not lend itself to analysis or learning from cost and schedule variations. Craft and supervision training are left to the industry--this often results in less qualified individuals in the industry. Construction safety is not treated at the level of priority it deserves -- zero-injury careers and zero-accident projects are not expected norms. There is very little use of ergonomics in construction, and human productivity is negatively impacted. Construction impact control is inadequate and there is much resulting disruption to people and the environment. There is very little use of execution tolerances, stresses, etc. in design drawings. Subcontractors typically execute the major portion of today's construction, yet not much attention is directed to their problems and limitations.

Stevens et al. (1994) point to a number of differences in the objectives of the parties to construction: Owners would like to have no construction or materials deficiencies. Many would like to see a team spirit fostered in the interest of a high quality project outcome, and would desire trouble-free maintenance. On the other hand, contractors are not necessarily committed to the safest work methods and often find participatory team building approaches at odds with their contractual strategy.

Puddicombe (1997) points to inadequacies in the traditional organizational structure of construction projects and identifies these as impediments to integration between designers and contractors- finalized plans are expected to define project boundaries, yet designers cannot know all the potential conflicts in their designs. Schedules and cost estimates are, in reality, only benchmarks because of this uncertainty. Sanvido (1992) notes the significance of critical success factors for construction projects and observed that the construction industry has only a marginally better understanding of these factors. Whereas knowledge of these factors would allow participants to quickly evaluate the possibility of success of a given project, lack of this information could lead to a higher probability of project failure. Sanvido observed that no single list could comprehensively define project success because of the divergence in expectations between the parties to a construction project with regard to their definition of success.

Herbsman & Ellis (1990) advance the concept of Construction Productivity Influence Factors (CPIF)-- technological factors that are deterministic, such as design data, and material properties, as contrasted with administrative factors that are stochastic, such as construction methods and procedures, training methods, and crew /supervisor relations.

Miles (1996) identifies the quality shortcomings of design-build approaches as follows:

* The process is the product. Many quality approaches focus on improving a product. Thus is workable when many widgets are being made, and product improvements in current production benefit subsequent products. In construction, this does not work as well because of the uniqueness of each product, which may well be made once only, never to be repeated in that specific form.
* Because the designer and constructor work as a team, often for a guaranteed maximum price, cost reductions are made (sometimes to the owner's detriment) both in design and materials selection and purchases, to execute the project profitably.

The gap between owners and contractors has been shown to (negatively) affect project success. Dozzi, Hartman, Tidsbury, & Ashcraft (1996) in a study of sixteen owner and contractor organizations in Alberta, found that differences between those organizations included difficulties in activities/factors necessary for project success. These activities/factors included: establishing and maintaining trust, handling construction changes fairly, sharing risks and savings, using a team approach to projects, and matching contractors' technical ability to projects.

Hartman (1993) notes that the parties to construction are usually risk averse, that inappropriate parties often had the highest risk, and contractors with the highest annual construction volume had the greatest defensiveness. This was influenced by the type of contract, the bidding process, and the extent of involvement of lawyers. Hartman (1993, 1994) also found that lump sum bids often led to higher end prices, poorer planning and scheduling, lower levels of safety and productivity; such projects involved more litigation, disputes, and claims.

Crawshaw (1979) studied the quality of new building designs and found that one in five projects suffered from poor quality of documents that resulted in contractor problems. According to Ashford (1989) the majority of construction deficiencies result from inadequacies in the management structure of the construction industry, from the lack of training, and from the commercial pressures that stem from the almost universal custom of awarding work only to the lowest bidder. Management is generally more concerned with meeting schedules (often to avoid penalties) than with building a quality workforce that will, in turn, generate construction of better quality.

Ledbetter et al. (1991) define quality (in construction) as conformance to adequately developed requirements. Emphasis is placed on the adequacy of the requirements. Davis & Ledbetter (1987) take the position that "construction must be performed in accordance with the contract documents--doing that guarantees that the needs of the user will only be met if the design itself is adequate." *In other words, customer satisfaction may be beyond the control of the contractor."*

Albanese (1993) studied owners, designers, and contractors on 41 projects that had used a project team approach. Despite the commitment that participants had made to the team process, the study identified adversarial relationships between owners, designers, and contractors that added significantly to project costs. These attitudes tended to be blamed on the contractor organization, yet the study showed that others shared the blame - poor project scope definition was cited as the root cause of poor team relations. While owner, designer, and contractor organizations were all shown to have internal conflicts, those of the owner scored worse than the other two.

Duttenhoefer (1991) refers to construction as the area where the design professional can most easily impact costs. A misunderstanding of construction procedures by the designer can have a profound effect on feasibility and costs.

Russell et al. (1966) define performance in terms of the extent to which a project meets or exceeds the budgetary expectations of the owner, as well as the expected time frames. Budgetary expectations are defined as including the amount of money originally appropriated for the project plus all owner-approved changes to the budget. The required completion date is the date on which the project is expected to achieve substantial/mechanical completion. This includes any owner-approved changes to the contracted date.

Miles (1996) notes several gaps in construction delivery systems, especially in the traditional design-bid-build method, and even in the more recent design build approach, which teams designers with contractors. The traditional method is recognized as facilitating a competitive response from the marketplace of builders, based on construction documents prepared by the designer that rigidly describe the roles and responsibilities of the parties to construction. On the other hand, however, this rigid definition leads to gaps in the goals and objectives of the respective parties. Examples of the gaps include: an information gap due to missing or unworkable design details, inequities between the parties to construction, such as exposure to differential levels of risk, communication gaps--due to uncertainty if communications with others are open and honest, a lack of trust of others, and a control gap. This latter gap relates to major imprecisions in the continuous, real-time measurement and evaluation of project milestones and goals.

The owners of construction projects have been shown to have a multiplicity of needs that are interrelated in a complex manner. Chinyio et al. (1998) investigated 60 clients' rankings of these project needs with the expectation that a knowledge of these priorities provides clients and their consultants/representatives with better tools to establish planning targets, and therefore improve project control. They posit that clients' needs cannot be assumed by others, as they are the independent variables, such as design needs, contractor selection, that influence the dependent variables; as contemporary practice typically plans the dependent variables, project outcomes often do not meet clients' needs. Chinyio et al. used a psychometric instrument to quantify clients' needs since some of these needs are personality-related. Using a paired comparison test scale values were used to represent the need scale of a typical client. Ninety-three percent (93%) of the respondents rated either quality, safety, or function as the strongest priority. Moderate priorities were applied to aesthetics, economy, and lack of surprises, while good contractual needs and timely completion of projects emerged as the lowest priority with the clients that were surveyed.

Albanese (1993) cites similar gaps as being obstacles to the effectiveness of the construction process, such as the accuracy of project scope definition, lack of agreement between the parties on project objectives, poor management of the project change process, poor communication between project participants, and divergent owner/ contractor priorities.

Sanvido (1992) cites criteria for project success that represent gaps between the parties in construction. While all parties agree on the need to meet schedules and budgets and are interested in the marketability of the finished product, owners were more interested than others in having the completed project function for its intended use (satisfying users and customers), achieve end result as envisioned, be aesthetically pleasing, provide return on investment through high marketability (image and financial), and having minimal aggravation in the construction process. Sanvido's research identified that designers seek to attain a quality architectural product that provides professional staff fulfillment while satisfying the client and meeting fee and profit goals. Contractors, in general, want to profitably meet code and design requirements (not exceed them) avoid legal claims for delays or safety violations, and have minimal surprises on each project.

Puddicombe (1997) identifies a significant gap between designers and contractors; designers traditionally want an arms-length relationship, while contractors favor integration. Designers evidently appear to lack concern for contractors' profitability, and do not differentiate between general contractors and subcontractors in this regard.

Dozzi et al. (1996) cite the price/expectation gap as the widest between owners and contractors. Owners expect lowest prices, and have traditionally favored the lowest lump sum bid to accomplish this. Dozzi et al.'s study observed that the lump sum bid denies contractors an opportunity to participate in design and construction reviews; contractors claim that their involvement in these reviews would provide savings for both owners and contractors. The study identified that contractors were awarded contracts, even when owners recognized that the contract prices were too low relative to estimates. Dozzi et al. cited the areas that most need improvements in the contracting process as: communications, dispute resolution, claims, contract interpretation, administration, and the bidding process, as well as other areas including safety.

Lean Construction Theory

According to Miles (1996) lean construction theory is a potentially effective tool for reducing several of the gaps in construction qual. Lean construction theory involves multitasking, multidisciplines, multifunctional, self-managing working groups. These groups evolve and metamorphose several times in the execution of a project to meet various needs as they arise, and revert spontaneously.

Barriers to High Quality and Productivity

Rounds and Chi (1985) state that the construction environment is very dissimilar to the manufacturing industry in a number of aspects that hinder the application of quality and productivity improvement techniques:

* Most projects are unique, single order, single production ventures
* Whereas manufacturing sites can be standardized, construction sites are unique
* The long production cycle makes construction projects more susceptible to external factors than manufacturing processes
* Due to lack of uniform standards, construction projects are evaluated subjectively
* Project participants are different for each project, therefore there is little benefit from repetition
* The roles of the various parties to a contract vary from project to project

The observations of several researchers for the Construction Industry Institute points to a lack of quality orientation in the construction industry. Although a few companies have adopted a form of productivity/quality improvement program, by far the majority see the construction process as one in which they have to achieve no more than the minimum "acceptable" standard, and to minimize their costs by pushing workers to the limit, and using the cheapest material allowed.

The Cost of Poor Quality

Davis and Ledbetter (1987) provide several reasons why quality is not readily achieved in construction--the "essence of quality" is not always defined, designers reject the responsibility for all details. Projects vary in size and scope, subcontractors often disagree, time and cost priorities may reduce the emphasis on quality. Davis and Ledbetter (1987) stress the need to minimize the cost of quality and maximize the return on investment. The costs of quality should be optimized as part of the project management systems aimed at managing cost, schedule, and quality. Quality costs in construction are described as not the cost of doing things right but rather the costs of prevention and appraisal, and the cost of deviations(which include rework, impact, litigation, and warranty costs). Symbolically, the cost of quality, $T = M + D$, where M is the cost of quality management efforts, and D is the cost of correcting deviations.

The application of the cost of quality concept is more complex in the construction industry than in the manufacturing industry. Construction projects are unique and may require in-process debugging. Deviation costs include the direct and indirect costs related to rework to correct deviations, i.e., labor, materials, and equipment.

Duttenhoeffer (1991) advocates a direct relationship between cost and quality management in the process of project delivery; costs due to rework are reduced and profits are increased by "doing it right the first time." Duttenhoeffer identifies six areas that contribute to the cost of a typical project: 1) property acquisition and location, 2) planning and engineering, 3) cost of financing, 4) utility location and services, 5) construction, 6) maintenance and operations. According to Duttenhoeffer, major problems can be traced to poor communication between the various disciplines, poor documentation, and poor or non-existent quality control and quality assurance (QC/QA) procedures. A good design allows good access to adjacent properties. Poorly defined scopes of work and poor planning lead to schedule problems and contractor claims. Duttenhoeffer describes desirable project attributes as follows: Deliverables must be well defined, committed to writing, and monitored by assigned staff. Designs should address costs holistically by considering operating and maintenance costs. Trained project staff must be available; their lack is the single biggest problem. A QA/QC plan must be set up in the first 30-60 days and the QA officer should report to the Corporate Principal.

The Importance of the Relationships Between the Parties

Many construction projects have begun to explore the partnering concept, whereby an ongoing working relationship is established between an owner, a general contractor and specific subcontractors, construction managers and design professionals. There is evidence, albeit unquantified, that the element of trust leads to better, more cost effective construction, resulting from improved communication, and a less bureaucratic structure. Larson and Gray (1995) cite the role of partnering and team-building contractual relationships that reduce or eliminate the traditional adversarial relationship between the parties to construction projects. The authors claim that partnering builds a foundation for the collaboration between potential adversaries before disputes materialize. A survey was conducted with 280 construction industry professionals, construction owner/clients, contractors and others respondents to identify the nature of the relationships in the owner/contractor dyad. Four categories were identified: a) adversarial, with each party pursuing its priorities on a win/lose basis, dominated by the threat of litigation; b) guarded adversarial, in which the parties strictly adhere to the contract and resolve disputes by strict contract interpretation; c) informal partners, a common set of goals and objectives sustains a cooperative relationship beyond the needs imposed by the contract; and d) project partners, where a strong team spirit predominates and every effort is made to avoid litigation. Adversarial approaches were fewer than 10 percent of the projects, but guarded adversarial methods were used more than twice as much. The other two methods were used to a slightly lesser extent than guarded adversarial. The study concluded that informal partners and project partners were respectively the most effective of the four categories in project management, providing higher levels of owner and contractor satisfaction. However, these methods had not been widely utilized, as implementation methods had not then been standardized by the industry.

Albanese (1993) describes the benefits of "team building" in construction projects. He describes a project team as a group of people who share goals or a reason for working together, are interdependent in effectively achieving shared goals, share a commitment to working together toward more effective problem-solving and decision-making, and are accountable as a functioning unit within a larger organizational context. Albanese distinguishes between the project-specific focus of team building and the long-term commitment required in partnering. Albanese's study included owners, designers, contractors, and construction personnel human resource executives. Research objectives included an assessment of existing team building knowledge for its relevance to the design/construction process, documentation and analysis of actual experiences using team building, and quantification of the results of applying team building to the design/construction process. There were no significant differences between the survey responses from different groups, that concurred that both tangible and intangible benefits were derived from the team building process. Tangible, or "content" benefits included proactive dispute resolution, completion on schedule, attainment of quality goals, attainment of safety goals, elevation of quality and safety expectations, and completion within budget. Intangible or "soft" benefits included reduction of adversarial relationships, development of trust and team spirit, opening of communications, improvement of cooperation and cohesiveness, and the early identification of problems. Major causes of adversarial relationships were identified as poor project scope definition, excessive project changes, poor management of project change orders, lack of agreement on project objectives, the project schedule, and the project budget.

The Importance of Interaction

Pocock et al. (1997) investigated the link between project integration and project performance, using the concept of a project's "degree of interaction" (DOI). This interaction was studied in relation to designers, builders, and project team members on 38 recently completed military construction projects. Pocock et al. utilized four measures of performance: - cost growth, schedule growth, the number of contract modifications per $million, and the percent of modifications due to design deficiencies. They used a definition of interaction as the number of staff hours spent in direct contact between designers, builders and project team members man hours, weighted by a factor representing the importance of the project phase. Regression analysis indicated a significant correlation between DOI scores and project performance; this relationship was used in a predictive model.

Post Occupancy Evaluation & Owner Satisfaction Surveys

Kartam (1996) observes that there is generally no systematic effort to harness the lessons learned from completed projects into the design and construction of subsequent projects. This project-related information could benefit the process of constructibility, in which construction knowledge is incorporated into the project planning process at an early stage. Kartam (1996) proposes an interactive knowledge-intensive system (IKIS) to harness this knowledge.

Summary of Observations from the Literature

The following observations from the literature provide direction to the research with respect to the design of survey instruments to investigate the determinants of quality, performance, and owner satisfaction.

- Most of the documented scholarly research on design and construction quality has been focused on process industries, engineer-procure-construct (EPC) contracts, transportation, utilities, and armed forces' facilities. *There is not much equivalent work in evidence on the issue of health care. This research, therefore, extends the quality-related knowledge from other types of construction to the health care industry.*

- Compensation formats have advantages and disadvantages depending on the type of construction project that is being considered. They are therefore closely linked to the perceptions of performance and owner satisfaction. This compensation, also may have an impact on the quality of materials and workmanship provided by the contractor, and consequently also influences construction quality.
- Project delivery methods offer several options for owners to obtain construction services. These options also have advantages and disadvantages, depending on the type of project. Design-build, for example, often reduces the overall time frame of a project, from the inception of design to construction completion, but eliminates the traditional interdependence between the owner and the designer.
- Performance indicators are the subject of ongoing debate between the parties to construction. Cost and schedule adherence have been used as performance indicators for many years. As opposed to other industries such as manufacturing and service, the prevailing definitions of quality limit it to "providing what was expected". Performance of systems to specifications has become the expectation. The gradual emergence of team building, partnering, and quality management in the construction environment has led to an awareness of the value of good relations between the parties to construction. The minimization of disputes is increasingly viewed as a performance indicator.
- Construction owner satisfaction has been studied in the context of industries other than health care, such as process industries, transportation, utilities, and military facilities. Those studies have emphasized the importance of communication,

communications skills, responsiveness to complaints, and features, in addition to cost and schedule adherence. Researchers such as Chase (1993), Federle et al. (1993), Hayden (1993), and Ledbetter (1994) have discussed the application of Total Quality Management (TQM) to the construction environment. These studies mention customer satisfaction as a component of TQM, but they do not discuss it in the context of health care construction.

- Design considerations are important because the role of the designer is primarily to interpret the owner's needs and design a facility (or other project) that best meets the owner's needs. The design process is critical because the decisions that are made at that stage have implications for the future of the project, during construction as well as after. Important considerations are: reliability, life cycle cost, flexibility for future adaptation, maintainability, user friendliness, and technology.
- Construction process considerations are critical to owner satisfaction. In renovation work, especially, the contractor's ability to work adjacent to occupied space is critical. The commissioning of completed projects, testing and adjusting systems to meet owners' specifications, training of owners' staff, response to warranty breakdowns is critical.
- The conduct of quality assurance activities is important for project success. This quality assurance is considered above and beyond the code-related inspections conducted by municipal agencies. Contractors typically carry out their own quality assurance and control for their own internal purposes. The way in which

the responsibility is assigned for this quality assurance may impact against owner satisfaction. Whereas the designer's services are engaged to perform the design of a project, their quality assurance support cannot be assumed to be automatically provided. Such services have to be specifically planned for, and compensated.

- It has long been accepted in the construction industry that schedule and budget adherence are key measures of project success, and are thought to have an impact on owner satisfaction. The extent of this impact may be perceived differently by owners, designers, and contractors. The degree of difference between the parties is an important gap measure.
- The frequency of interaction between the parties to construction may impact against the performance, quality, and owner satisfaction; more frequent interactions have been shown to have significant levels of correlation with higher levels of accomplishment in these areas.

AUTHOR	YEAR	HEALTH CARE FACILITY CONSTRUCTION	CONSTRUCTION QUALITY	OTHER QUALITY	CONSTRUCTION PRODUCTIVITY	OWNER/ CUSTOMER SATISFACTION
Godwin	1979				x	
Osterberg	1980	x				
Business R'table	1982		x		x	
Garvin	1984			x		
Godfrey	1984		x			
Parasuraman et al	1985			x		x
Rounds & Chi	1985				x	
Wilemon & Baker	1985		x			x
Tucker	1986		x		x	
Ashley et al	1987		x			x
Davis/Ledbetter	1987		x			x
Garvin	1987			x		x
Gilly, Touran et al	1987		x			
Kartam	1987		x			
Alfeld	1988				x	
Parasuraman et al	1988			x		x
Ashford	1989		x			
Oglesby et al	1989				x	
Walsh	1989				x	
Herbsman et al	1990				x	
Thomas et al	1990		x		x	
Duttenhoefer	1991		x			
Ledbetter	1991		x			
Stevens et al	1991		x			x
Brown	1992			x		x
Glagola et al	1992		x			x
Nam & Tatum	1992		x			
Sanvido et al	1992		x		x	x
Wetherington	1992				x	
Albanese	1993		x			x
Chase	1993		x			
Federle et al	1993		x		x	
Glagola	1993		x			x
Hartman	1993		x			
Hayden	1993		x			
Larson	1993		x			x
Low, Sui Pheng	1993		x		x	
Taravella	1993	x				
Baillard et al	1994				x	
Kubal	1994		x			x
Ledbetter	1994		x			

AUTHOR	YEAR	HEALTH CARE FACILITY CONSTRUCTION	CONSTRUCTION QUALITY	OTHER QUALITY	CONSTRUCTION PRODUCTIVITY	OWNER/ CUSTOMER SATISFACTION
Ritz	1994		x		x	x
Stevens et al	1994		x			x
Ahmed et al	1995		x			x
Douglass	1995	x (Design)				
Hamilton et al	1995		x		x	
Larson & Gray	1995		x			
Ledbetter	1995		x			
Milakovich	1995	x	x	x	x	x
Bates	1996			x		
Dozzi et al	1996					x
Kartam	1996		x			
Miles	1996		x			x
Russell et al	1996		x			x
Stevens	1996		x			x
Axon	1997	x(Design)				
Carr	1997		x			
Fliltrault et al	1997		x			x
Guinn	1997	x (Design)				
Malkin	1997	x(Design)				
Pocock et al	1997		x			x
Puddicombe	1997		x			x
Yundt et al	1997	x(Design)				
Chinyio et al	1998		x			x

Chapter III

METHODOLOGY

The purpose of the methodology applied in this study is to support the objectives that are proposed by the problem statement. As described in Chapter I, the adoption of Managed Care has placed increased demands on Health Care Facilities (HCFs) for reduced construction costs and lower maintenance costs. New construction, renovation and remodeling in the health care environment require specialized knowledge on the part of designers and builders/contractors, as well as HCF representatives. Historically, owner satisfaction goals have not been integrated into the criteria for construction project success. As in the overall construction industry, success criteria emphasize time and cost factors and there are gaps in the understanding of such criteria between owners, designers, and contractors. This research posits that the application of a framework based on predetermined owner satisfaction variables and performance variables will enable HCF owners, as the primary customers, to take into account the gaps between the parties to construction. This action can reduce the time and cost incurred in HCF construction/renovation projects, and measurably improve levels of customer satisfaction in HCF owner representatives.

Objectives

1) To find out the determinants of owner satisfaction, quality, and performance for HCF construction and renovation projects.

2) To identify the gaps in perception and expectation of owner satisfaction and quality/performance determinants between: owners and designers, owners and

contractors, and designers and contractors. (Measures to close these gaps lead to the development of a service culture.)

3) To conduct a project-specific analysis involving owners, designers, and contractors, in order to develop a conceptual framework that incorporates owner satisfaction criteria and performance guidelines for designers and contractors.

4) To identify and examine possible differences between public and private HCF environments in order to configure the framework accordingly.

Plan of the Research

As illustrated in Figure 3.1, 'Research Methodology', the objectives of the research were accomplished by a number of activities. These activities were conducted within seven distinct phases as follows:

Phase I	Preliminary survey design
Phase II	Preliminary survey interviews
Phase III	Design of the survey instruments
Phase IV	Pilot testing and refinement
Phase V	Administering of surveys
Phase VI	Compilation and analysis of survey responses
Phase VII	Administering of Project-specific surveys

Phase I - Preliminary survey design.

Following the literature review, preliminary survey instruments were developed. They included the customer satisfaction and project performance variables and quality requirements/dimensions identified from the literature. The existence of other quality variables was also investigated.

Phase II - Preliminary survey interviews

Preliminary surveys were conducted in person with selected survey subjects that belong to the respective survey groups - owners, designers, and contractors. The purpose of the interviews was to obtain specific information on the design and construction of facilities, including HCFs in order to design a valid primary survey instrument.

The preliminary surveys were administered to:

(i) HCF owners, represented by HCF administrators.

(ii) Designers, represented by architects and engineers.

(iii) Builders, represented by contractors.

Meetings were scheduled with several randomly selected subjects from each group. Through the interview process, information was gathered from the preliminary survey instruments.

Observations Based on Interviews with Personnel from Various Organizations - Owners, Designers, and Contractors

Interviews and preliminary surveys were administered in a major metropolitan area with senior executives of several organizations. These organizations included six contractors, six designers, six owners, and a municipal code compliance department. Discussions revealed several significant gaps in priorities and expectations between the parties. Owners were concerned with timely completion of projects, within their projected budgets, with the expectation that codes would be complied with and the design requirements met. However, they also expressed a need for positive interactions with the other parties to the construction, such as a need to be continually informed of project status, and to have differences of opinion or disputes promptly resolved in the most cordial way possible. Owners judged the quality of construction by the satisfaction of the end users, and were concerned with the post-construction aspects, such as responsiveness of the builder to warranty problems. Renovation projects were especially demanding of builders' flexibility and customer relations, as such projects often occur in still-occupied spaces where employees require a minimum of noise, dust, vibration, contamination, or other undesirable forms of pollution.

Designers observed that owners were often not clear on their requirements, especially on the subject of construction quality, and often had to be 'second-guessed.' Value Engineering was seen as a useful technique for cost reduction, but was typically done as a paid service and not generally volunteered by designers. Designers stated that the economics of prevailing fee structures did not provide for their provision of such services without additional compensation. Few designers, owners, or contractors seemed to use customer surveys or post occupancy analysis of completed facilities, and therefore did not obtain the invaluable quality information available through those measures.

Owners mentioned that it was important for them to feel satisfied with a project several years after its completion, but designers and contractors seemed unconcerned in this area.

Research Methodology

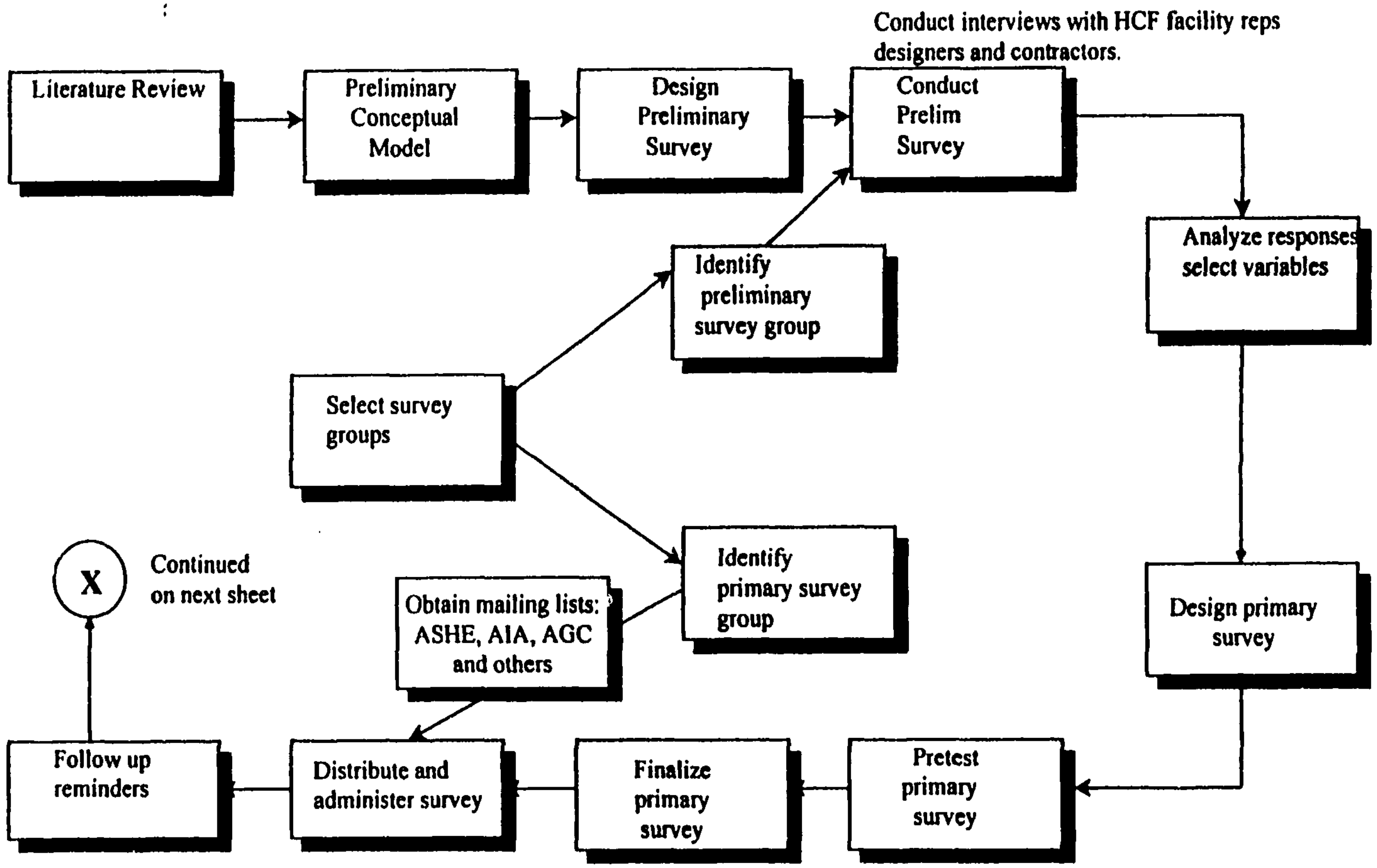


Figure 3.1 Flowchart of Research Methodology (A)

Research Methodology (cont'd)

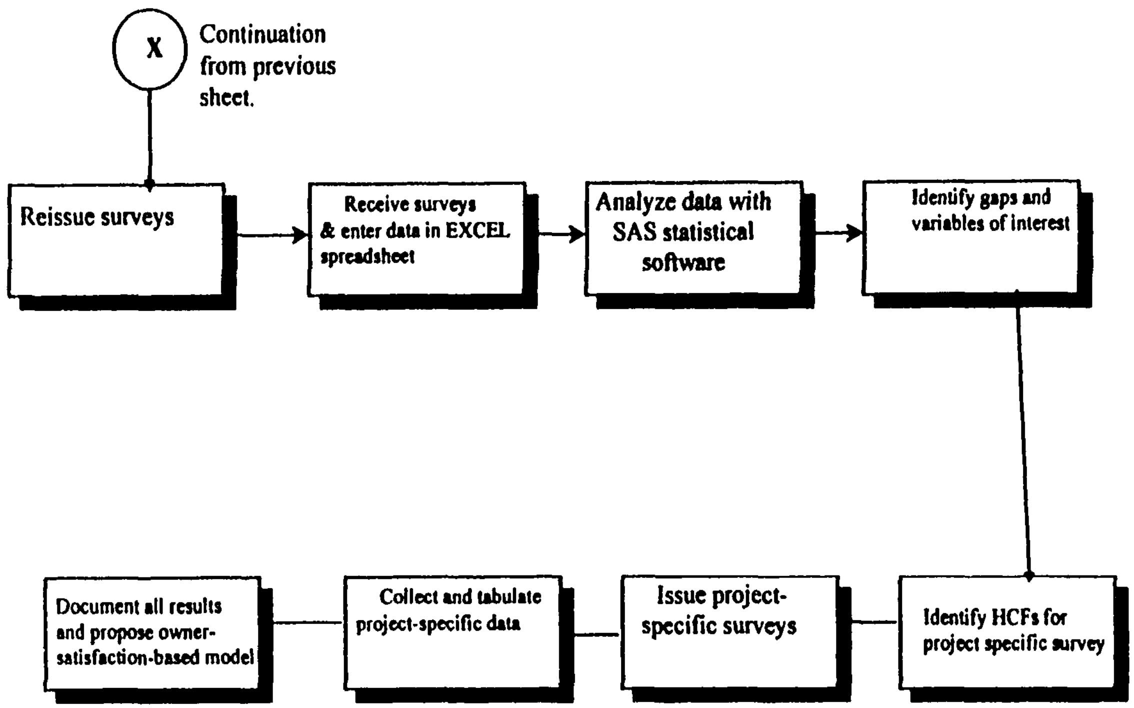


Figure 3.1 Flowchart of Research Methodology (B)

Contractors cited their fear of underbidding as a major concern--unseen conditions could destroy the profitability of a contract. They felt, however, that designers were not sensitive to such a need.

A number of specific questions were suggested through these discussions:

- Private owners should be distinguished from public owners, as the difference in their situations influences their projects, and probably their owner satisfaction criteria.
- "Building works well," etc. is a more meaningful reference than structural integrity. Structural integrity is mandated by code.
- Contractors generally assign someone to carry out quality assurance/control.
- Questions on contract compensation formats are more useful than asking about financial incentives.
- Factors that inhibit owner satisfaction include underbidding, lack of money, lateness of information, unfamiliarity with the needs of a given project, deficiencies in drawings.
- A question on quality improvement techniques should include constructibility reviews.
- Safety practices (physical obstacles) impact job quality and performance.
- Future flexibility and adaptability are important to HCF owners; these factors are influenced by both designers and contractors.
- The commissioning phase is critical, especially in equipment-based contracts.

- The responsiveness and perceived helpfulness of contractors and designers are important to HCF owners.
- The availability of representatives to discuss issues is considered by owners to be critical.
- Most of the problems in projects are "people problems".

HCF size should be referenced in square feet. The industry has moved away from using the number of beds because of the new emphasis on outpatient service. Public and private organizations have different problems and limitations--public agencies cannot exclude 'borderline' contractors without having compelling evidence to disqualify them.

In the HCF environment certain design considerations are very important, such as:

- life cycle cost
- maintainability
- reliability
- flexibility for the future
- providing for the latest technology.

The foregoing information was condensed to the following list to refine the primary survey instrument.

Satisfaction variables:

Compensation formats

Project delivery methods

Owner satisfaction criteria

Schedule delays

Cost increases

Frequency of meetings/interaction

Barriers to satisfaction

Quality/performance variables:

Performance evaluation criteria

Design considerations

Designer and contractor selection criteria

Quality assurance/control methods

Surveys (post occupancy, customer satisfaction)

Selection of the Primary Survey Population

In conjunction with the preliminary survey, questions were asked about the identification of the specific groups that would be targeted with the primary survey instrument. In this regard, it was important to find large groups of individuals that could be contacted through mailing lists, preferably those that could be obtained through professional organizations. Owners' representatives identified the American Society for Healthcare Engineering, (ASHE) as the professional organization that was most relevant in terms of its national prominence, its size, and the composition of its membership.

Designers listed the premier organization for HCF design professionals as the American Institute of Architects' Academy of Architecture for Health (AIA/AAH). It was noted that AIA/AAH members had a working relationship with those of ASHE, often participating in joint conferences on health care-related issues.

Contractors described a somewhat more fractured set of affiliations of which the premier organization was the Associated General Contractors of America (AGC).

Phase III - The Design of the Primary Survey Instruments

Primary survey instruments were designed for all three groups to elicit quantitative responses relating to the variables identified in the literature survey, the preliminary survey, as well as others that may have been identified by the subjects themselves. The surveys were targeted to:

1) Health care facility owners, represented by chief operating officers, facility directors, etc., and members of ASHE.
2) Health care facility designers, represented by architects and engineers, and including members of AIA/AAH).
3) Health care facility contractors, including members of AGC.

.Survey Design Considerations

A number of factors were taken into consideration when designing the survey instruments, in order to increase the effectiveness of the overall survey process. Fowler (1993) states that the quality of data obtained from a survey is directly influenced by money, time, or other resources; hence, the survey design requires an optimization of those resources, in order to address critical issues of:

- The choice of whether or not to use a probability sample
- The sample frame (those individuals who have a chance to be sampled)
- The sample design (the strategy for sampling individuals)
- The response rate

According to Fowler, a special purpose survey may be the only way to ensure that all the data needed for a given analysis are available, and can be related. In light of its high cost, it should only be undertaken after it is certain that the information cannot be collected by other means.

In light of the foregoing considerations, the following decisions were made:

Mailed Surveys: A mailed survey was selected because:

- Hospitals are dispersed throughout cities all over the nation, and budget limitations did not provide for travel to these disparate locations.
- Several interviewers would need to be involved, hence the probability that responses would be differentially influenced by them, unless extensive training were conducted to ensure repeatability.

Questionnaire Development

The design of the primary survey instrument emphasized the following:

1) The selection of responses from given choices.
2) The expression of the preference for the choices given by *ranking* them relative to each other in cascading order of importance.
3) The opportunity to write-in respondents' special comments, or to indicate items that were not applicable.

The purpose of the ranking of choices given was to increase the discriminability of the responses. Whereas a Likert Scale allows respondents to display equal preferences for several items, the ordinal ranking represents a "forced choice" approach. Refer to Appendix A for copies of the surveys. The instrument design is based on the use of non-parametric statistical analysis techniques.

Description of the Primary Survey Instruments

A primary survey instrument was developed initially for the audience of HCF administrators. This reference document was then modified for the other two groups, designers and contractors, resulting in three separate primary survey instruments. Relative to the owner satisfaction and quality/ performance variables, the same body of questions was directed to all three groups. The purpose of that design was to meet the objective of comparing the responses of the groups through gap analysis. In addition to those questions, others were added to obtain background information tailored to each specific audience. The following narrative describes the Owner's Survey; at the end, the specifics of the other two surveys are provided. It must be noted that different numbering systems were used for the survey instruments, even for related questions. The tables in Chapter IV that compare the responses of the three groups to similar questions have been adjusted to compensate accordingly.

Introductory Letter

Each survey instrument was prefaced by two important communication tools - one on each side of a single sheet of paper attached to the questionnaire. The Owner's Survey (Facility Owners' Construction Quality Survey) has a covering letter addressed to ASHE members, as the mailing list targets health care administrators who belong to that organization. This letter was an important factor in encouraging as high a return rate as possible, as ASHE Administration lent their organization's name to the research. Members were promised a copy of the survey results in exchange for their support. Other invitation letters without the ASHE name were sent to non-member health care administrators. The reverse side describes the procedures for completing the questionnaire.

In the case of the Designer and Contractor questionnaires, introductory letters addressed the American Institute of Architects (AIA/AAH) and the Associated General Contractors of America (AGC), respectively. Non-member versions of these letters were prepared as well.

The use of colored surveys

The initial issue of surveys was copied on pastel-colored paper, to create high visibility and promote a higher return rate.

Owner's Survey Questions

The Owner's survey is in Appendix A. Questions 1 to 11 were designed to obtain background information on each health care facility and establish that they were part of the appropriate study group.

Questions 2 and 3 determine the job title/function and length of tenure of the responding administrator.

Question 4 asks for the name of the organization.

Questions 5 and 6 address the staff size of the organization and its years in existence.

Questions 7 categorizes the facility under 4 headings--public for-profit, public non-profit, private for-profit, and private non-profit. This detail is an important factor in the analysis.

Questions 8 and 9 address the type of facility and its size in thousands of square feet.

Questions 10 and 11 categorize construction work by new facilities, remodeling/ renovation or other, and determine approximate sizes for typical projects.

Questions 12 identifies the way in which an owner organization allocates construction work, whether through a general contractor, construction manager, or design-builder.

Question 13 has two sections--it notes the method of payment used to compensate contractors by percentage of projects. It also solicits the degree of satisfaction with each method on a scale of 1 (highest) to 7 (lowest).

Question 14 uses the same response format with project delivery methods, such as design-build.

The ranking of responses

Most of the following questions utilize an ordinal ranking method, assigning a 'pecking order' number to each item. As previously stated, this 'forced choice' approach improves the discriminability of the responses. Some ranking questions also solicit a Likert scale - type rating, where indicated.

Question 15 asks for a ranking of 9 performance indicators used to judge project success.

Question 16 asks for a ranking of 9 factors that influence an owner's satisfaction with a project.

Question 17 examines owners' relationships with designers in terms of the factors that owners use as their selection criteria to engage these professionals.

Question 18 ranks a number of design factors such as life cycle cost and 'user friendliness' in order to see the relative importance of these factors in the health care environment.

Question 19 examines owners' criteria for selecting contractors.

Questions 19 and 20 rank a number of factors relating to the construction process, both the physical conditions such as noise and dust, and contractors' management practices, to see how owners perceive these factors.

Question 22 investigates quality control practices in construction projects - which party carries out the function and how often. It also asks owners to rank the effectiveness of each approach, based on their experience.

Questions 23 asks for background information on the use of various Quality Management techniques, such as TQM and ISO9000, to get an appreciation for the industry's use of them.

Question 24 determines the budget percentage and staff hours dedicated to the techniques.

Questions 25 and 26 ask about dispute avoidance and resolution in order to contrast this information with the incidence of quality assurance methods.

Question 27, parts 1 and 2, obtain a sensitivity analysis of an owner's satisfaction with varying degrees of schedule delay and cost increases on projects. This provides an important comparison between the responses of owners, designers, and contractors.

Question 28 determines how often owner satisfaction surveys and post occupancy surveys are conducted on projects, and how beneficial these surveys appear to be.

Question 29 seeks to identify the frequency of meetings that the owner deems to promote the greatest satisfaction. This is indicated at each project stage--design through start-up and warranty. The owner's perceptions will be contrasted with those of the designer and contractor.

Question 30 asks for a ranking of 11 factors to determine which aspects of the design and construction process most inhibit owner satisfaction.

Questions 31 and 32 address some owners' requirement to have public bidding and to accept the lowest bid. These requirements are suggested by the literature to be obstacles to Quality Management applications in construction projects.

Question 33 "additional comments" solicits open comments from survey respondents relative to the research

Contractor/Designer Information

In this optional section, survey participants were asked to suggest the names of design and contractor organizations that are known to do health care work.

Designer's Survey Questions

The Designer Survey is in Appendix A. This survey is very similar to the Owner's Survey. Specific background questions address the size and experience of the design organization, and how past projects were subdivided between renovations and new work, as well as the split between work for public and private health care organizations. They also consider the split between health care projects and other types.

Contractors' Survey Questions

These questions closely parallel the Owner and Designer surveys, except that different job titles and organization sizes are used.

A Discussion of Data Analysis Approaches

The survey instruments capture data reflecting categorical information such as job titles, duration of tenure, number of employees, etc. An important purpose of the analysis is to compare the perceptions of the different groups (owners, designers, and contractors) with regard to performance indicators, satisfaction variables, design considerations, construction process considerations, and so forth. These factors are ranked in order of importance, not actual magnitude.

Nonparametric Statistical Methods

In this research, hypothesis testing and estimation are used to make the comparisons between the owners, designers, and contractors. According to Dickinson (1990), classical analysis of variance tests require the assumption of mutually independent random samples drawn from normal distributions that have equal variances. This is often true. On the other hand, the nonparametric techniques require only the assumption that the samples come from any identical continuous distributions. Classical (parametric) statistical methods make inferences based on the conformity of the distributions in question with known distributions (Normal, Poisson, etc.). These restrictions are far less stringent for nonparametric tests.

Consequently, nonparametric methods are often referred to as distribution-free methods.

According to Dickinson (1993), a statistical technique is called nonparametric if it satisfies at least one of the following five types of criteria:

1) The data are enumerative, i.e., count data representing the number of observations in each category or cross-category.
2) The data are measured and/or analyzed using a nominal measurement scale.
3) The data are measured and/or analyzed using an ordinal measurement scale.
4) The inference does not involve a parameter in the population distribution
5) The probability distribution of the statistic on which the analysis is based is not dependent upon specific information or assumptions about the population(s) from which the sample(s) are drawn, but only on general assumptions, such as a continuous and/or symmetric population distribution.

Dickinson states that the most *powerful* tests are those that are based on the most stringent assumptions, as is the case with classical parametric tests. On the contrary, the most *robust* tests are by definition those that require the weakest assumptions, hence nonparametric tests are inherently robust.

The asymptotic relative efficiency (ARE) provides a measure of relative performance of two tests (with large sample sizes). With an ARE of 0.98, a nonparametric test based on 100 observations is as efficient as a parametric test with 98 observations.

Typical ARE values are:

Wilcoxon signed rank test	.955
Mann Whitney V.S. T test	.955
Siegel-Tukey	.608
Spearman	.912

In this research, the raw data from the administration of the surveys lends itself to the application of nonparametric statistical analysis. This is because the data inherently represent an empirical distribution. No transformation of the distribution is therefore necessary.

The SAS NPAR1WAY Procedure

The SAS statistical analysis software is selected for the analysis. As detailed in the SAS procedures manual, the NPAR1WAY procedure performs analysis of variance on ranks, and it computes several statistics based on the empirical distribution function (EDF) and certain rank scored of a response variable across a one way classification. NPAR1WAY is a nonparametric procedure for testing that the distribution of a variable has the same location parameter across different groups, or in the case of the EDF tests, that the distribution is the same across different groups. NPAR1WAY handles the case of independent groups, not paired data (as in the case of pre-test and post-test comparisons). NPAR1WAY calculates simple linear rank statistics based on Wilcoxon scores, median scores, Savage scores, and Van der Waerden scores. These statistics are used to test if the distribution of a variable has the same location parameter across different groups.

In order to compare the responses from two groups (say, owners and designers) ANOVA is used to test the null hypothesis that the means of these responses are equal. Sample ANOVA output:

Analysis of Variance for Variable Q16a,
Classified by Variable Group

Group	N	Mean	Among MS	Within MS
Designers	120	3.84166	21.03716	3.28723
Priv. Owners	71	3.15492	F Value	Prob < F
			6.40	.0122

In this case, the responses of Designers and Private Owners to Question Q16a. are being tested under the null hypothesis that their means are equal; the alternative hypothesis is that they are not equal, and therefore, these groups disagree. The question is treated as a dependent variable and the group as two levels of an independent variable. N indicates the number of observations in each level

Among MS is the *effect* mean square

Within MS is the *error* mean square

The F Value is the F distribution statistic

Prob < F is the significance probability

For the purpose of the research, a significance level of .05 is used for the comparison between groups. Probability values of .05 or less provide justification for the null hypothesis to be rejected, i.e., resulting in the conclusion that the responses differ. Probabilities greater than .05 indicate that the null hypothesis cannot be rejected, signifying agreement in the responses.

Phase IV - Pilot Testing and Refinement of the Primary Survey

The surveys were pilot tested with a small, select group of participants:

- Three hospital administrators
- Three designers.
- Three contractors

The purpose of the pilot test was to eliminate problems that would inhibit an adequate response rate. Comments provided from this exercise were as follows:

- The ranking method of responding should be explained more clearly.
- The response fields should be moved closer to the questions for better legibility.
- The additional information requested on the names of contractors and designers should be made optional, in order not to prolong the time needed for the survey questions.
- The use of colored paper should benefit the response rate.
- The number of pages should be reduced.
- The time needed to respond should be kept to approximately 15 minutes.

The necessary changes were made. The pages were reduced from 8 to 6. Further reduction would have created legibility problems.

Completion Time

The pilot survey subjects advised that completion was possible in 17 minutes, if respondents did not attempt to include contact information for other parties, as this would need time to consult a Rolodex, etc. Because of the importance of the contact information, those questions were kept in the primary survey instrument, nevertheless.

Phase V - Conducting/Monitoring of the Mailed Survey Process

It was recognized that as large a sample size as possible should be selected in order to provide the desired degree of confidence in the results. Industry sources such as a McGraw-Hill Construction Reporting division have historically observed very low response rates (5% or less) to self-administered, mailed surveys. Therefore, a special purpose survey may utilize 100% of the subjects available from the mailing lists. Mailing lists of owner's representatives:

Acquisition of Mailing Lists

Available mailing lists from ASHE indicated approximately 4,000 members. A random selection from that sub-population would yield a significantly smaller number, say 1000 members. In light of the historically low return on mailed surveys only 50 responses could be realistically expected. ASHE advised that not all members were appropriate subjects for the study as several were salespeople, consultants, safety managers, etc., and that approximately 2,000 members had the title of Facility Director, C.O.O., Director of Construction, etc. It was therefore decided to use a 100% 'convenience sample' by having ASHE sort and screen these individuals into the list.

Mailing Lists of Designers

Interviews with designers/architects identified that only a select number of that group specialized in health care-related construction or designed/managed such projects with regularity. By the same token, designers often specialized in a range of projects such as schools, offices, shopping malls, etc., as the owners who seek such services gravitate to professionals with established track records in distinct project types. The

American Institute of Architects, the premier national organization of professional architects/ designers was contacted, and advised that they had a Division of health care specialists termed the Academy of Architecture for Health (AAH). As was the case with the owners, they identified 2,500 members (of a total of 4,700 AAH members) who were listed as principals and/or decision makers, who would be the most appropriate subjects for the research. The 2,500 AAH members were used as a 100% 'convenience sample.' The AIA/AAH's leadership displayed interest in the research, and agreed to have the organization's name referenced in the survey documents.

Mailing Lists of Contractors

Interviews with contractors identified that health care-related construction was treated as a speciality, and that relatively few contractors were involved in such projects, in comparison to other types of construction activity. It was also evident that contractors are not unified as a group to the extent that architects and health care facility administrators happen to be. Nationally, there are several associations relating to the construction industry; the premier organization is The Associated General Contractors of America, but there are no groups publicly documented as specializing in health care construction. It was decided to use all the names available from AGC and supplement them with names obtained from other sources. As was the case with other organizations, AGC also agreed to be identified with the research.

Owners: The American Society for Healthcare Engineering provided a list of 2,000 members, preselected as stated above, for decision-making responsibilities.

Designers: The American Institute of Architects (AIA) provided an initial list of 2,500 members, through American List Counsel, their authorized mailing list company.

Contractors: Several contractors' associations were contacted, but only one, The Associated General Contractors of America, was willing to provide the names of contractors who marketed themselves as capable of carrying out health care-related projects. Two hundred (200) names were provided. A mailing list company, Buckley and DeMent, provided a list of 475 names of contractors that claimed health care project capabilities.

In light of the low response rate previously discussed, a clear need was indicated for 1,300 or more additional names of contractor organizations. Buckley and DeMent were asked to provide additional names of general contractors, using sort techniques with S.I.C. codes for general building categories that did not necessarily pinpoint health care specialists, but that excluded most contractors that were known to specialize in totally dissimilar projects, such as roads and bridges. Thirteen hundred (1,300) names were selected accordingly.

Development/Acquisition of Mailing Lists from Various Sources

In order to augment the sample available from the mailing lists, the following approaches were used:

It was decided to issue the Owner's survey first, in order to obtain designer and contractor information. The Owner's surveys included questions requesting contact information for these groups.

The Designer's survey was issued next. The mailing list of 2,500 names was augmented by the names of designers provided by the earliest respondents to the Owners' survey. A number of designers names were also obtained from an American Hospital Association publication, the Directory of Planning and Design Professionals for Health Facilities (1997).

The Designer's survey requested contact information for contractors. The earliest responses to the Designers' survey were checked for Contractor contact information.

The survey responses from owners and designers were checked in order to identify as many contractors as possible. Fifty contractors were identified in this manner.

The Contractor's survey was subsequently issued. The mailing was based on lists compiled from the lists provided by AGC, Buckley and DeMent, Owners' and Designers' surveys, and the Directory of Planning and Design Professionals. The total mailing was 2025 surveys.

The distribution of the surveys was carefully monitored. An automatic advance numbering stamp was used to number each survey. The entire mailing lists for the owners and designers were photocopied. Each survey was stamped with a 5-digit number and, as each envelope was stuffed and the mailing label attached, the same number was stamped on the photocopy of the label, using two impressions per number. In the case of the contractors' surveys, numbers were similarly recorded for all the known health care contractors, while the copying of the labels was considered adequate for the remainder of the surveys.

The response to the surveys was monitored and followed to obtain as high a response rate as possible.

Owners' Surveys

The response to these surveys was relatively prompt, with 200 being returned within 45 days. Within 35 days of the first mailing, however, a second mailing was issued of approximately 170 owners' representatives in the State of Florida. Other names were added, using information gleaned from several hospitals, of administrators/executives who happened not to be members of ASHE. These owners were contacted in the hope that they would be supportive of a study within the state; only 19 surveys were completed and returned.

Follow up: The mailing process was repeated after 45 days, using another copy of the original mailing list minus the Florida members, for a total of 1700 surveys. Ultimately, 280 owners' surveys were received. This represented a rate of return of fourteen (14) percent. Two hundred and forty nine surveys were selected for the subsequent analysis.

Designer's Surveys

The responses were not submitted as promptly as those for the owners' surveys. Of 2,700 surveys, only 134 responses were noted after 30 days. Follow up activities included having AAH officials include a newsletter message about the study, encouraging members to participate. While additional responses arrived, a second bulk mailing was made after 40 days, followed by individual mailings to selected designers, as their names became available. Eventually, 290 surveys were submitted, representing a return rate of 10.7 percent. Two hundred and forty one (241) of these surveys were selected for analysis.

Contractors

This response was indeed significantly lower than the other two. Recognizing that the response rate was likely to be less favorable than for owners and designers, steps were taken to increase the response rate. An incentive was given; contractors were offered a free subscription to a Florida construction magazine as well as a chance to compete for free advertising of their company.

After 30 days, only 50 surveys were returned, several with errors. The mailing was repeated at 35 days - ultimately 110 surveys were returned, representing a return rate of 5.43 percent. Of these, 82 surveys proved to be usable. Several surveys (that were not used) noted that the respondents did not do health care work - some completed the surveys, nevertheless, while others did not. Many questions went unanswered, while some had similar rankings for different items.

Phase VI - Compilation and Analysis of the completed surveys

The completed surveys from the three groups, i.e., owners, designers, and contractors are compiled in a spreadsheet format and analyzed with SAS software tools.

1) The determinants of owner satisfaction and performance were examined in terms of the rankings that were assigned to questions under each heading.

2) A "gap analysis" was conducted by comparing perceptions with expectations of owner satisfaction, quality, and performance, as expressed by the three groups.

- Designers were contrasted with owners.
- Contractors were contrasted with owners.
- Contractors were contrasted with designers.

3) The responses were compared between public and private HCF owners to ascertain the degree of difference between them.

Data Handling

An EXCEL spreadsheet was designed to catalog the information obtained from the surveys. Each survey form was examined in a number of ways:

- Designers' and contractors' responses were verified for health care work. Some respondents completed the surveys even if they had not performed health care projects. These were eliminated.
- The method of responding to questions was checked for correctness. Some respondents mistakenly treated responses like a Likert scale, when a pecking order was desired instead. If this happened on a small scale, then the correctly handled responses were salvaged, and the rest discarded.. If 30% or more of the questions had been incorrectly recorded, the surveys were discarded.

The SAS software was then utilized to import the data from the EXCEL spreadsheet for the analysis. The results of the analysis are shown in Chapter IV.

Phase VII - Design and administration of the Project-specific survey

As scheduled in the research plan, a number of projects were identified in the area of South Florida for detailed analysis. The rationale for selecting that geographic region was to make it feasible to drive to the respective health care facilities and interview the involved facility administrators. The goal of the project-specific survey was to obtain written input on the conduct and the details of each project from management/administrative representatives of three distinct entities - the owner, the designer, and the contractor. These individuals needed to be at the management level in order to know the background of each project and recollect significant bits of information about how a completed project had been conducted.

It was a necessary condition of the research for the owner respondents to have participated in a project, at a high enough level to have been able to speak to the organization's level of satisfaction with a completed project. Similar conditions would apply also to the designers and contractors, so that they could accurately reflect the perceptions and perspectives of their organizations.

Design of the Project-Specific Survey Instrument

Three survey instruments were designed for the owner, designer, and contractor for each project, respectively. (See Appendix A) The questions were derived directly from the earlier general survey, which has already been explained.

Information required:

Company name

Size

Years in business

Project size

Project type - new or renovation

Compensation format

Delivery method

Design considerations

Construction process considerations

Quality assurance method

Budget and schedule performance

Frequency of meetings/interaction

Owner satisfaction (based on a scaled response).

Administration of the Project-specific Survey

Thirty health care facilities were identified in the State of Florida for possible participation in the study. To the greatest extent possible, attempts were made to schedule interviews with the responsible administrators. The process was complicated by several factors:

- In most cases, the responsible administrator was at the level of Chief Operating Officer, or Vice President of Facilities Management or Support. These individuals had schedules that made them very inaccessible, and they were disinclined to devote the time necessary
- Hospitals that belonged to a large health care organization often had their construction projects planned and managed at a Corporate headquarters in another state.

- Public sector hospitals had a similar framework, except that the respective government agencies tended to have centralized construction planning and management. Construction projects at different facilities were managed from a single location; if the staff proved to be uncooperative, as they often were, the projects at several facilities were rendered inaccessible.

- It was discovered that many health care facilities had changed ownership and had acquired new staff who recollected nothing about the projects in question.

- The determination of the contact information for the designer and contractor for each project was not possible without the willing involvement of the owner's representative. Without their willing participation, the research project could not hope to get honest feedback on their level of project satisfaction as well.

- Because of the three-way nature of the research <u>it was necessary to have all three responses</u> in order to have a candidate project suitable for analysis.

- Many survey participants made errors in the survey and had to be contacted again and persuaded to correct the surveys.

- Several construction companies, and to an extent, designers, went out of business, or moved their business to other places in other states, wherever the opportunities existed.

Of thirty sites contacted, data were collected on ten projects, representing inputs from 30 knowledgeable professionals. The responses in these surveys were compared with the results of the mailed primary survey instrument. They are documented in Chapter V.

CHAPTER IV

DATA ANALYSIS AND DISCUSSION OF RESULTS

This chapter deals with the analysis and results of the survey data submitted by the three categories of subjects - health care facility (HCF) owners, designers, and contractors. The SAS statistical package was utilized. This package has capabilities for both parametric and non-parametric analytical methods. The following approaches were used in the data management:

A) Frequencies of occurrence were determined.

B) Basic statistics were compiled.

C) Cross tabulations were performed.

D) Correlations between a number of variables were examined.

E) Non-parametric Analysis of Variance tests were applied.

The purpose of the frequencies of occurrence was to profile the experience of the subjects, such as their staff size, years of experience, project size ranges, project types, etc., as described in the survey instruments. From the basic statistics, it is possible to determine the number of responses, the mean response, standard deviation, sum, minimum and maximum. The cross tabulations listed the frequency of responses between selected pairs of questions. The correlations examined the strength of linear relationships between dependent and independent variables. The non-parametric

ANOVA was used to determine the pair-wise concurrence or disagreement between the responses from owners, designers, and contractors.

Owner Respondent's Profile Summary

A primary survey instrument was administered to the designated owners' representatives of health care facilities, as described in Chapter III preceding. This survey instrument was titled "Facility Owners' Construction Quality Survey", and is referenced in Appendix A. The data compiled for this group are presented in the tables 4-1 through 4-22. A high percentage of the respondents (40.3%) were Facilities Vice Presidents and 31.6% were at the level of Facilities or Engineering Director. The remainder were divided between a variety of facilities-related positions and "other" positions. Overall, the respondents job responsibilities reflected a knowledge base that matched the expectations of the research.

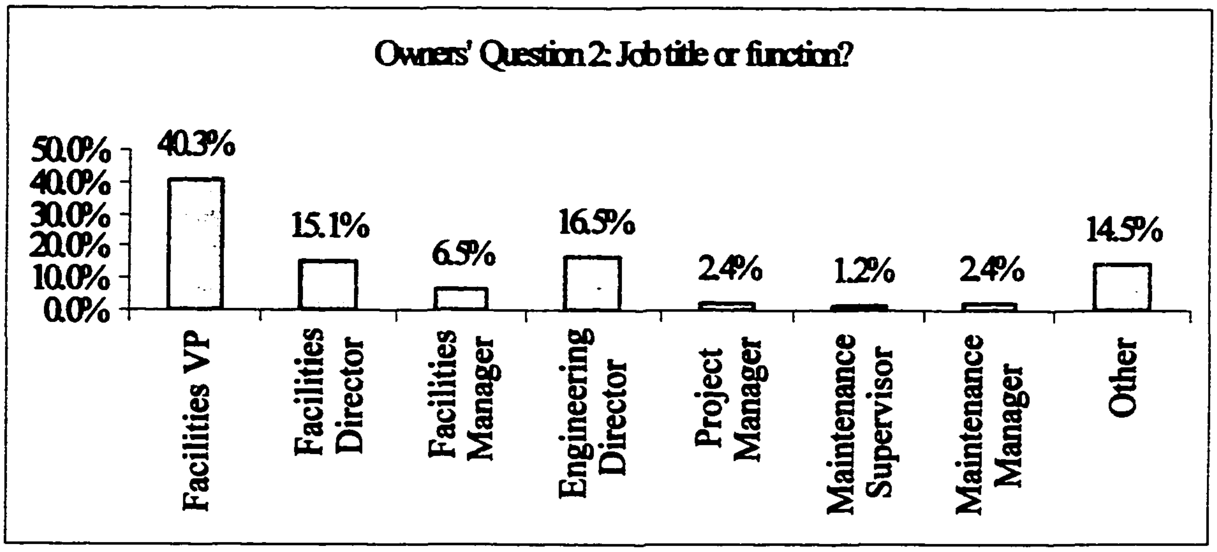


Figure 4.1 Owners' job title or function sample size, n=249

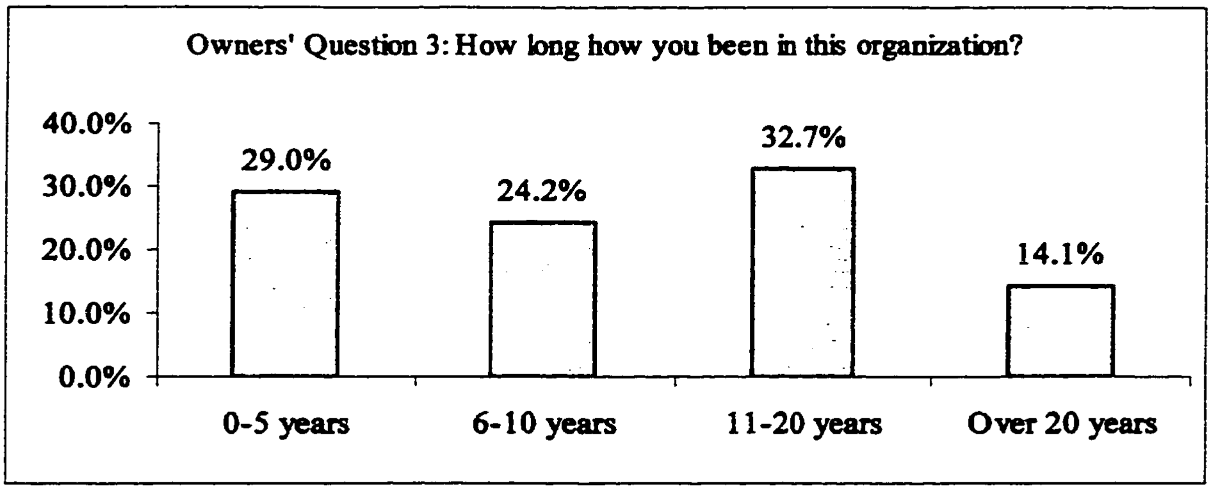


Figure 4.2 Respondent's Tenure with Organization — sample size, n=249

The percentages represented by these positions are indicated in Figure 4.1. From Figure 4.2 on the following page, it can be seen that 71 percent of the respondents had been with the respective organizations for 6 years or more; the mode was between 11-20 years for 32.7%, and 14.1% had more than 20 years' tenure. This fact suggests that the

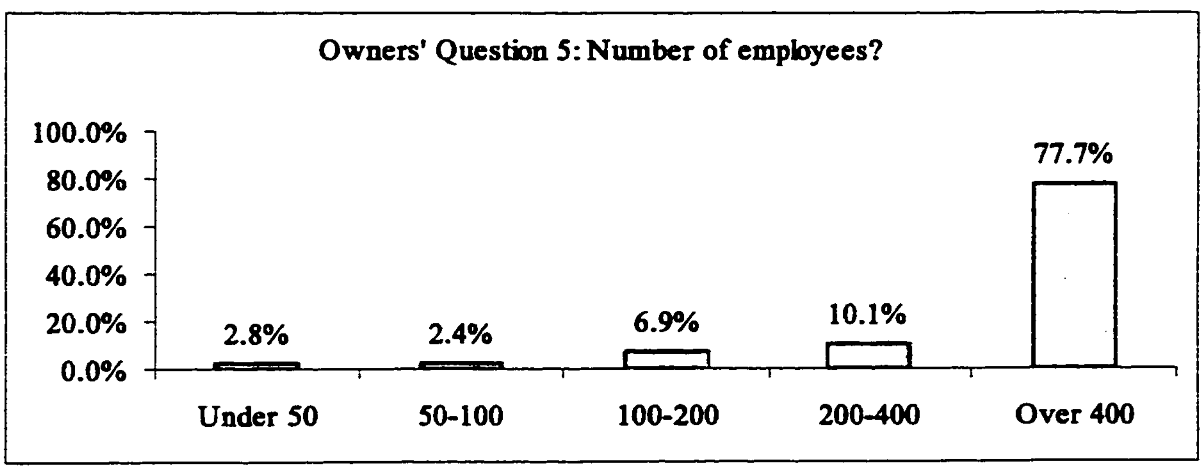


Figure 4.3 Number of Employees — sample size, n=249

majority of the respondents had a sound basis for reflecting their organization's point of view. With regard to the sizes of the health care organizations, the great majority (77.7%) had over 400 employees, and less than 6% had fewer than 100 employees.

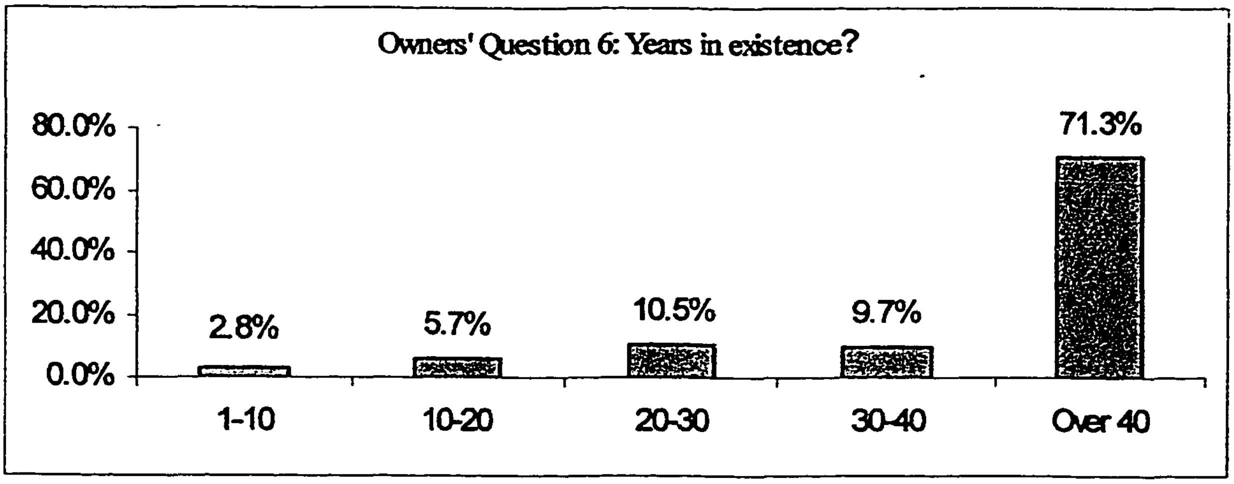


Figure 4.4 Years in Existence sample size, n=24 9

That distribution can be seen in Figure 4.3. The health care facilities (HCFs) were mostly over 40 years old (71.3%), and fewer than 9% were less than 20 years old, as shown in Figure 4.4 With regard to the number of employees, more than three out of four organizations had over 400 employees, as indicated in Figure 4.3. Overall, approximately 88% of them had more than 200 employees.

With regard to the type of ownership, approximately 93% of the survey respondents belonged to the public sector, as shown in Figure 4.5, even though the

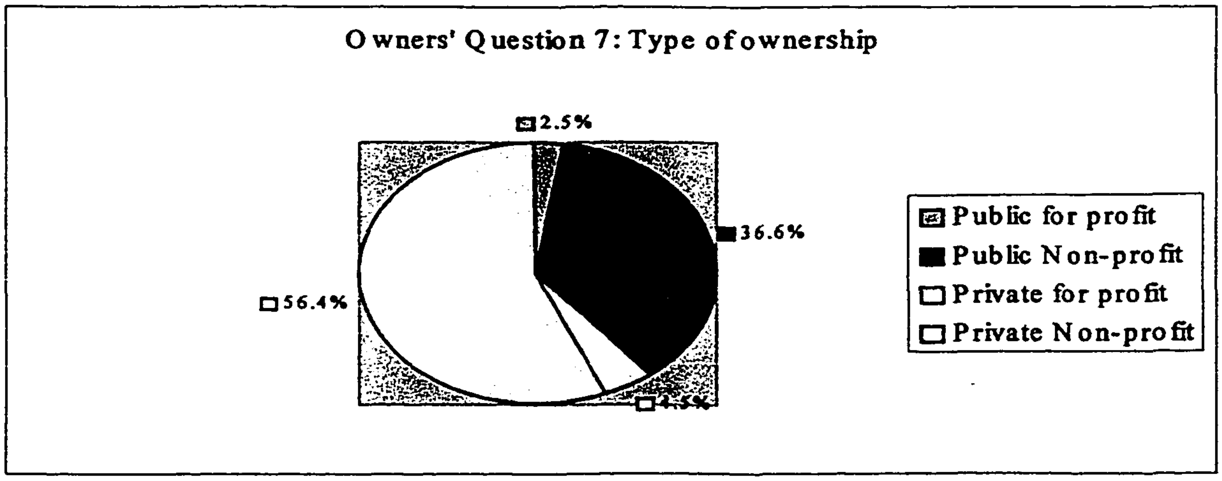


Figure 4.5 Type of Ownership sample size, n=249

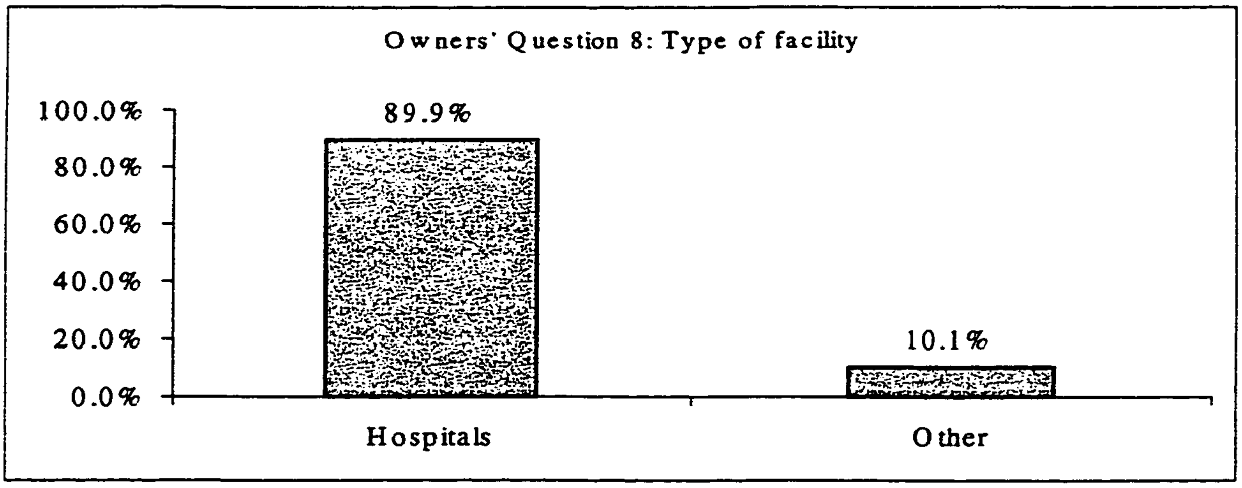


Figure 4.6 Type of Facility sample size, n=249

mailing lists did not specifically target that group. Based on the distribution of the respondents to the survey, it was decided to include in the research a comparison of private non-profit HCFs with public non-profit HCFs.

As per Question 8 (see figure 4.6) approximately 90% of the facilities responding to the survey were hospitals; the remainder were other types of health care facilities such as outpatient facilities, nursing homes, etc. With regard to size, more than 75% of the owners responding represented large facilities over 500,000 square feet in area, as

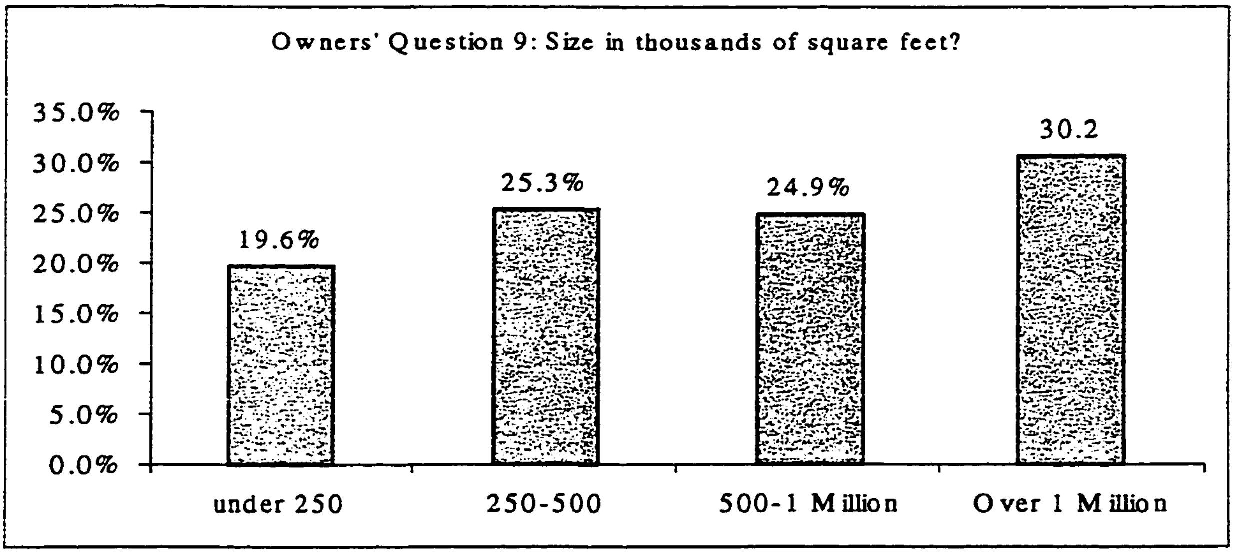


Figure 4.7 Square footage of Facility sample size, n=249

indicated in Figure 4.7.

Question 10 asked respondents to indicate the percentages of the categories of construction represented in their projects in the preceding five years. As shown in Table 4.1, both public and private owners ranked remodeling/ renovation as the major construction activity, with new construction occurring less frequently. Private owners had a greater emphasis on remodeling than did public owners.

TABLE 4.1 - Types of construction projects

		OWNERS			
Ques. 10.	Based on dollar value, over the past 5 years what percentage of your construction projects are:	Public Mean %	Public Overall Rank	Private Mean %	Private Overall Rank
10a	New facilities	46.42	2	38.36	2
10b	Remodeling/renovation	52.13	1	60.11	1
10c	Other (please specify)	1.45	3	1.53	3

Question. 11 (Price ranges - new vs. remodeling): Both groups ranked equally the ranges of prices for their remodeling/renovation projects, with the highest frequency represented by projects costing under $100,000. That would be expected, as HCFs tend to have many ongoing projects that involve minor facility modifications or additions.

TABLE 4.2 - Price range for 'average' project (new construction)

		OWNERS			
Ques. 11	Section a - New facilities. Based on the past 3-5 years, what isthe price range for the average project?	Public Mean %	Public Overall Rank	Private Mean %	Private Overall Rank
11a1	$100,000 to $1 million	29.40	2	22.133	3
11a2	$1 million to $5 million	32.77	1	35.03	1
11a3	$1 million to $20 million	23.21	3	26.02	2
11a4	$20 million to $50 million	13.17	4	13.10	4
11a5	Over $50 million	1.45	5	3.72	5

In new facilities, both groups reflected the greatest frequency of activity with projects in the range $1 million to $5 million, but private organizations listed their second category as $5 million to $20 million, as compared with $100,000 to $1 million for public owners.

TABLE 4.3 - Price range for 'average' project (renovation)

		OWNERS			
Ques. 11	Section b - Remodeling/renovation. Based on the past 3-5 years, what percentage of your projects fall in the following price ranges ?	Public Mean %	Public Overall Rank	Private Mean %	Private Overall Rank
11b1	$100,000 or less	43.26	1	39.05	1
11b2	$100,000 to $1 million	40.05	2	38.69	2
11b3	$1 million to $5 million	11.92	3	16.59	3
11b4	$5 million to $20 million	3.57	4	3.91	4
11b5	Over $20 million	1.20	5	1.76	5

Question 12 addressed the percentage of projects handled through various approaches, such as design-build and construction management. This background information is not being considered in the research.

Question 13 (Compensation formats): Compensation formats were examined for their possible impact on project outcomes, especially in terms of owner satisfaction. Private and public health care organizations reported different rankings for the methods considered. (See Table 4.4). Public organizations reported their greatest satisfaction with Guaranteed Maximum Price (GMP) with cost savings sharing, followed by Lump Sum contracting. There was a lack of a consensus among private organizations on the method that was most satisfactory. Several respondents cited methods such as time and materials as their preferred methods. As shown in Table 4.5, only 2.46 percent of private owners indicated the use of "other" compensation formats, yet this category was rated highest in

Table 4.4. It may be concluded that the high preference rating for "other" simply indicates that the small portion of the sample population that used such formats were very satisfied with them. Private owners indicated Guaranteed Maximum Price (GMP) and Cost Plus a Fee as their next preferred alternatives in order of importance. Lump Sum Contracting was the least preferred method.

TABLE 4.4 - Owner's satisfaction with compensation formats

		OWNERS			
Ques. 13	Compensation formats: During the past 5 years, what has been the level of your satisfaction with these formats? 1 = most satisfactory, 7 = least satisfactory	Public Mean Score	Public Overall Rank	Private Mean Score	Private Overall Rank
13a	Lump sum	3.1129	2	3.2551	5
13b	Cost plus a fee	3.1212	3	3.2121	3
13c	Guaranteed maximum price	3.2352	4	3.1549	2
13d	GMP with cost savings sharing	3.0500	1	3. 2211	4
13e	Other	4.3333	5	2.4615	1 *

TABLE 4.5 - Frequency of use of compensation formats

		OWNERS			
Ques. 13	Compensation formats: Based on dollar value, what % of your contracts during the past 5 years have had the following compensation formats?	Public Mean %	Public Overall Rank	Private Mean %	Private Overall Rank
13a	Lump sum	51.3	1	41.34	1
13b	Cost plus a fee	11.5	3	12.57	4
13c	Guaranteed maximum price (GMP)	20.4	2	23.47	2
13d	GMP with cost savings sharing	11.1	4	19.12	3
13e	Other	5.7	5	2.46	5

With regard to project delivery methods both public and private organizations cited "other methods" as their first choice of project delivery as shown in Table 4.6.

TABLE 4.6 - Satisfaction with delivery methods

		OWNERS			
Ques. 14	Project delivery methods: How would you score your satisfaction with the following delivery methods?	Public Mean Score	Public Overall Rank	Private Mean Score	Private Overall Rank
14a	Traditional Design-Bid-Build	3.5187	3	2.8888	2
14b	"Fast track"	2.8461	2	3.6078	5
14c	Design-Build	3.4117	4	3.3666	4
14d	Construction Management (fee paid)	3.4166	5	3.1938	3
14e	Construction Management (at risk)	4.3333	6	4.5454	6
14f	Other methods (please specify)	2.7500	1 *	2.8823	1 *

* (See explanation of anomalous scores below)

The high project delivery rating is appropriate in a limited context. A review of the source documents revealed that some Health Care Facilities (HCFs) cited a preference for methods such as "in-house" project management, "in-house" construction management, and "in-house" construction. A small number of respondents - 12% of private owners and 6% of public owners indicated satisfaction scores for that category, while the majority of the respondents did not. Those subjects that responded gave the "other" methods very high scores. From the point of view of sampling, the high scores for "other" methods would normally be considered to be representative of the population. In this instance, because the response to that category was not broad-based, we would simply conclude that the HCFs that used "other methods" were very happy with them. In the preliminary survey the conclusion was drawn that most projects were managed by outside agencies, such as architects and construction managers, in communication with an in-house liaison. It is probable that some HCFs have a preponderance of small projects that they prefer to manage, or conduct, with their own staff.

Question 15 (Performance evaluation criteria): This question revealed some differences between public and private owners with respect to job performance evaluation criteria. Public organizations gave the highest overall ranking to the item titled " building works well, meets end users' needs", and the second and third respectively were "adherence to budget agreed" and performance of all electrical/mechanical specialized systems to specifications". On the other hand, private owners ranked "adherence to budget agreed" the highest, and "building works well, etc." second. Private owners seemed more preoccupied with time concerns.

TABLE 4.7 - Performance evaluation criteria

		OWNERS			
Ques. 15	Performance evaluation criteria: What specific performance indicators do you generally use to judge the success of completed construction projects?	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
15a	Finishing within the time stipulated	3.8255	5	3.2794	3
15b	Adherence to budget agreed	3.4302	2	2.5661	1
15c	Quality of appearance (workmanship)	3.5697	4	3.3750	4
15d	Satisfactory job relations - (owners) with designers	6.6860	8	6.8676	8
15e	Satisfactory job relations - (owners) with contractors	6.5697	7	6.6985	7
15f	Building works well- meets end users' needs	3.0930	1	2.9629	2
15g	Performance of all elect./mech/specialized systems to specs.	3.5116	3	4.1555	5
15h	Minimal number and value of change orders	5.4286	6	6.1481	6
15i	Other (please specify)	7.329	9	8.142	9

In Question 16, Owner's representatives were asked how a number of factors influenced their level of satisfaction with a construction project. Both public and private owners ranked "adherence to cost estimates" highest; the remaining rankings are listed in figure 4.8. It is observed that there is congruence in the responses of both groups.

TABLE 4.8 - Owner satisfaction factors

		OWNERS			
Ques. 16	To what extent do the following factors influence an owner's (facility administrator's) level of satisfaction with a construction project? *Rank in order of importance.*	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
16a	Timeliness of the project	3.4823	2	3.2238	2
16b	Adherence to cost estimates	3.2941	1	2.4850	1
16c	Clear up-front understanding of the job scope	3.0595	5	5.1804	5
16d	Clear ongoing communication on job status	5.7176	8	5.6315	8
16e	Prompt, adequate response to owner's complaints	5.1529	6	5.4887	6
16f	Attractive design/aesthetics (architectural features)	5.5882	7	5.4887	7
16g	High quality of construction - fit and finish	4.1411	4	4.2406	4
16h	Minimal disruption to ongoing facility operations	3.7294	3	4.2045	3
16i	Other (please specify)	8.7142	9	8.6153	9

A possible explanation for this congruence is that both types of organizations are required to operate under the same regulatory requirements, and are both forced to employ competitive approaches in providing health care. This environment could result in a convergence of their owner satisfaction criteria.

Question 17 (Selection criteria): Owners were asked to rank their criteria for selecting design organizations(refer to table 4.9 below). Public owners rated track record/experience as the most important factor, followed by specialization in similar work. Private owners, on the other hand, rated specialization in similar work highest, and track record/experience second. Other rankings were similar. This might explain to some degree why they both value the same satisfaction criteria. One explanation for these rankings is that public HCFs generally negotiate contracts with designers but are often required to encourage participation from smaller organizations (sometimes to meet affirmative action goals) as tax-based public funding is generally involved.

TABLE 4.9 Designer Selection Criteria

		OWNERS			
Ques. 17	Relationships with Designers: In selecting a design organization, an owner typically relies on some of the following criteria. From the owners' perspective, rank the factors	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
17a	Specialization in similar work	2.8255	2	3.0375	1
17b	Promised design completion date	5.4418	6	5.1716	6
17c	Overall projected budget	4.8139	5	5.0300	5
17d	Track record/experience	2.7441	1	3.2761	2
17e	Recommendations by others	5.6091	7	5.6541	7
17f	Quality certification or use of techniques such as TQM	7.5862	9	7.3787	9
17g	Previous project relationship between owner and designer	3.5057	3	3.5820	3
17h	Use of innovative construction technology	6.9411	8	7.0984	8
17i	Perceived responsiveness/customer understanding	4.7142	4	4.2105	4
17j	Other (please specify)	9.740	10	8.3055	10

Smaller organizations tend to diversify to cover a wide range of projects in a relatively small office. Private HCFs, conversely, are not constrained to meet such goals and can be more selective; they have the means available to award design contracts to well known, highly specialized design firms, in order to seek a competitive advantage. This would imply that owners were more influenced by a designer's track record and declared area of specialization as well as a previous project relationship, than with quality certification and innovativeness.

Question 18 (Design considerations): When asked about their priorities for design considerations, public and private HCF owners reflected many similarities in their responses. Both agreed that meeting basic functional requirements was all important, but public owners placed system reliability ahead of maintainability, while private HCFs had these latter two items reversed. The remaining items were almost identically ranked.

TABLE 4.10 Design Considerations

		OWNERS			
Ques. 18	Design Considerations: As the Owner's representative, you have to balance a number of conflicting priorities and criteria when having construction work designed. Rank the factors	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
18a	Lowest life cycle cost	5.7159	6	5.3484	6
18b	Ease of maintenance/maintainability	3.7045	3	3.8636	2
18c	User "Friendliness"	4.0689	4	4.1503	4
18d	System reliability (failures minimized)	3.6206	2	3.8939	3
18e	Aesthetics (physical attractiveness)	6.0340	7	5.8195	7
18f	Lowest first cost (when constructed)	6.7159	9	6.5000	8
18g	Meeting basic functional requirements	3.4367	1	3.2857	1
18h	Flexibility for future adaption	5.1022	5	4.9015	5
18i	Incorporation of latest technology within the facilities	6.2325	8	6.9237	9
18j	Other (please specify)	9.750	10	8.9697	10

It is worthy of note that lowest life cycle cost ranked higher than lowest first cost for both groups, and that flexibility for future adaptation rated even higher.

Question 19 (Contractor selection criteria): As shown in Table 4.11 both public and private owners differ only slightly in these criteria. Private owners rate a previous project relationship more highly than do public owners - this is understandable, as many private owners have the freedom to maintain such a relationship, once they identify a suitable contractor. Public agencies, on the other hand, often require contracts to be awarded through public bidding. As can be seen from the table, public owners rate specialization in similar work more highly than do private owners.

Question 20 (Construction process considerations): With regard to the environmental factors involved in typical construction projects, there were a few similarities, and several differences between public and private organizations (see Table 4.12).

TABLE 4.11 Contractor Selection Criteria

		OWNERS			
Ques. 19	Relationships with Contractors: In selecting a contractor organization, an owner typically relies on some of the following. From the owner's perspective, rank the factors	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
19a	Specialization in similar work	3.4588	3	3.8345	4
19b	Promised design completion date	4.7176	6	4.5671	6
19c	Overall projected budget	4.0574	5	4.1851	5
19d	Track record/experience	3.0000	2	3.0895	2
19e	Recommendations by others	5.7529	8	6.1879	8
19f	Quality certification or use of techniques such as TQM	7.6470	10	7.5263	10
19g	Previous project relationship between owner and designer	3.7058	4	3.3111	3
19h	Use of innovative construction technology	7.1774	9	7.2045	9
19i	Perceived responsiveness/customer understanding	5.1807	7	4.7218	7
19j	Other (please specify)	9.73	10	8.83	10

Both groups agreed that the interruption of utilities was the greatest concern and that odors and vibration were least critical, ranking 6th and 7th respectively. Public HCFs were more concerned with physical barriers and debris and noise, while private HCFs ranked dust and noise next in order of importance.

TABLE 4.12 Construction Process Considerations (environmental)

		OWNERS			
Ques. 20	Construction process considerations (Environmental). Construction work that is carried out near health care facilities often calls for special considerations about external factors. Rank the Contractor's ability to manage these problems in terms of importance	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
20a	Noise	3.8372	3	3.7313	4
20b	Odors (solvents, etc.)	4.2558	6	4.3518	6
20c	Dust	4.0813	5	3.5037	2
20d	Contamination by pathogens	3.8372	4	3.7462	5
20e	Physical barriers/debris unsafe to users	3.5697	2	3.7238	3
20f	Vibration	5.6395	7	5.4812	7
20g	Interruption of utilities	2.6627	1	3.0970	1

Question 21 (Construction Process Considerations): With regard to contractors' behaviour and attitude, both categories of owners agreed uniformly. The highest importance was attached to the contractor's ability to adjust schedule to owners' operating needs, the commissioning (testing and adjusting) at startup was next. Training of owners' staff was third. It was interesting that this training was ranked higher than the response to warranty calls - it may be argued that well trained owners are better equipped to resolve problems without outside assistance.

TABLE 4.13 Construction Process Considerations

		OWNERS			
Ques. 21	Construction process considerations. Relative to contractors, rank the following 6 factors in order of importance	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
21a	Ability to adjust schedule to owner/organization's operating needs	1.4712	1	1.3382	1
21b	Training of Owner's staff on equipment installed	3.3563	3	3.3703	3
21c	Commissioning: testing/adjusting systems to meet owners' expectations	2.9310	2	3.0592	2
21d	Prompt response to Owner's warranty breakdown calls	3.4482	4	3.5074	4
21e	Prompt submission of "as built" drawings, approval certificates, etc.	3.9425	5	3.8507	5
21f	Other (please state)	5.7878	6	5.6250	6

Question 22 investigated the way in which quality control was carried out in health care construction projects. All HCF owners reported the highest frequency with a staff person serving as a quality control inspector, first, and by the designer second. Public HCFs reported an independent inspector as the third choice, followed by contracting staff and "other". Private HCFs had contracting staff as the third choice, followed by an independent inspector, and "other". Both public and private HCFs ranked the foregoing quality assurance methods equally with regard to their effectiveness.

TABLE 4.14 Frequency of Quality Control Methods

		OWNERS			
Ques. 22	How quality is controlled in the majority of your construction projects. How often are the following methods used? Always = 1 Never = 5	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
22a	By the designer as quality control inspector	2.3214	2	2.3257	2
22b	By the owner's staff person as quality control inspector	1.6823	1	1.5939	1
22c	By an independent quality control inspector	3.7407	3	3.8244	4
22d	By contracting staff	3.5000	4	3.3587	3
22e	Other	4.2000	5	4.4705	5

This concurrence can be seen in Table 4.15. Respondents rated the owner's staff person highest in effectiveness, the designer 2nd , an independent inspector 3rd, and contracting staff 4th.

TABLE 4.15 Effectiveness of Quality Control Methods

		OWNERS			
Ques. 22.	How effectively is quality controlled in the majority of your construction projects by the following?. Rate them for effectiveness.	Public Mean Score	Public Overall Rank	Private Mean Score	Private Overall Rank
22a	By the designer as quality control inspector	2.5538	2	2.3362	2
22b	By the owner's staff person as quality control inspector	1.7611	1	1.5614	1
22c	By an independent quality control inspector	2.8936	3	3.3300	3
22d	By contracting staff	3.4464	4	3.5887	4
22e	Other	4.2307	5	4.3888	5

Question 26 (Dispute resolution): Both groups gave the same ranking to various dispute resolution techniques. In descending order of importance, these were: Informal meetings, negotiation, mediation, arbitration, litigation, and "other" methods. This result was anticipated as that sequence of action is in ascending order of severity, as indicated in Table 4.16 below. Rational people can be expected to use reasonable means to resolve

TABLE 4.16 Dispute Resolution Methods

		OWNERS			
Ques. 26	Problem/dispute resolution: if you do experience problems and disputes on a project, which of the following approaches would you prefer? Rank them.	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
26a	Informal meetings	1.2948	1	1.2241	1
26b	Negotiation	1.9480	2	1.9915	2
26c	Mediation	2.9870	3	3.0796	3
26d	Arbitration	3.8961	4	3.8859	4
26e	Litigation	4.7922	5	4.8534	5
26f	Other	5.7692	6	5.5000	6

difficulties in the least complicated manner possible.

Question 27 (Impact of cost/schedules on owner satisfaction): The survey elicited information on the extent to which changes in schedule and cost would affect their satisfaction. The scale used was as follows: 1 = not at all, 2 = very little, 3 = somewhat, 4 = moderately, 5 = very much. Question 27 (1) (Schedule delay): For public HCFs, a change between 0% and 5% was rated at 2.05, i.e.,very little. The same change reflected as 2.26 for private HCFs, which is between *very little* and *somewhat*. A change of 5% to 15% reflects as 3.29 and 3.44 for the public and private HCFs respectively. This value lies between *somewhat* and *moderate*. Changes of 15% to over 50% were graded from 4.395 to 4.976, indicating impacts of significant concern, especially for changes exceeding 30%, both for public and private HCFs. One could conclude that schedule delays up to 15% are tolerable, but both public and private organizations experience great difficulty beyond those levels.

TABLE 4.17 Satisfaction with schedule delays

		OWNERS			
Ques. 27	As an owner's representative, in general, how negatively would your level of satisfaction be affected by the following increases in schedule? 1 = Not at all, 5 = Very much.	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
27a	0 - 5%	2.0459	1	2.2631	1
27b	5% - 15%	3.2873	2	3.4427	2
27c	15% - 30%	4.3953	3	4.5419	3
27d	30% - 50%	4.8588	4	4.8914	4
27e	Over 50%	4.9764	5	4.9545	5

Question 27(2) Cost increases: The responses to this question were very similar for both public and private HCFs. (See Table 4.18) Cost increases in the range 0% to 5% were rated at 2.32 to 2.33, reflecting a greater impact than *very little*. Changes of 5% to 15% were past the mid point between *somewhat* and *moderately*. Increases of 30% and over were rated at approximately 4.9, very close to the index "*very much*".

TABLE 4.18 Satisfaction with cost increases

		OWNERS			
Ques. 27	As an owner's representative, in general, how neg-atively would your level of satisfaction be affected by the following increases in cost? 1 = Not at all 5 = Very much.	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
27a	0 - 5%	2.3218	1	2.3333	1
27b	5% - 15%	3.6666	2	3.7196	2
27c	15% - 30%	4.5764	3	4.7022	3
27d	30% - 50%	4.9058	4	4.8992	4
27	Over 50%	4.0000	5	4.9469	5

Question 28 addressed the use of owner satisfaction surveys and post occupancy evaluation reviews as tools to improve the design and construction of the respective facilities. Both public and private HCFs ranked the factors similarly, as in Table 4.19, with owner satisfaction surveys first. By the same token, the benefits of the techniques were ranked in the same manner (see Table 4.20). Both types of surveys appeared to be used infrequently. However the scores indicate that these surveys are beneficial when used, ranging from 3.2 to 2.2 on a scale where 1 = maximum benefit to 7 = minimum benefit.

TABLE 4.19 Use of surveys

		OWNERS			
Ques. 28	To what extent have the following been administered on your projects? 1 = never, 5 = always	Public Mean Freq.	Public Overall Rank	Private Mean Freq.	Private Overall Rank
28a1	Owner satisfaction surveys	2.1724	1	2.3111	1
28a2	Post occupancy surveys	3.3090	2	3.6041	2

TABLE 4.20 Benefit of surveys

		OWNERS			
Ques. 28	Indicate the benefit to you of the following surveys. 1 = maximum benefit, 7 = minimum benefit.	Public Mean Score	Public Overall Rank	Private Mean Score	Private Overall Rank
28b1	Owner satisfaction surveys	2.287	1	2.340	1
28b2	Post occupancy surveys	3.285	2	3.642	2

Question 29 addressed the frequency of meetings/interaction between project decision-makers. The purpose of the question was to determine the frequency of meetings between the parties to construction that would maximize owner satisfaction. The frequencies were varied with the project stages. During the design stage 43.5% of the owners desired to meet with the other parties on a weekly basis, while 33.3% preferred two-week intervals. During construction 54.3% wanted to meet weekly, and 20.6%, on a biweekly basis. Fifteen percent of owners wanted to meet daily during this stage. During the warranty stage of the project, significant groups of HCF owners (between 19% and 19.2%) desired to meet at intervals of 1 day, 1 week, 2 weeks, 1 month, and 3 months. One in four, however, thought warranty meetings should only be held on special occasionns based on need.

TABLE 4.21 Frequency of meetings/interaction

Project Interaction		OWNERS			
Ques. 29	Frequency of meetings/interaction. How often should project representatives of the owner meet with representatives of the designer and contractor to have a completed project that best meets owner's needs?	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
29a	Daily	5.5057	5	5.5658	7
29b	Once weekly	5.6590	6	6.0230	8
29c	Once every two weeks	4.9425	4	4.6279	2
29d	Poor day-to-day project planning for construction	4.6136	2	4.6793	3
29e	Inadequate cost control	5.6666	7	5.0846	5
29f	Unfamiliarity of designers with the type of project	4.6931	3	4.8846	4
29g	Unfamiliarity of contractors with the type of project	5.7011	8	6.2538	9

Question 30 (Barriers to owner satisfaction): This question solicited opinions on the greatest barriers to the satisfaction of owner organizations. There was a fair degree of similarity between the responses of public and private owners - both agreed that lack of detail in drawings and specifications was the greatest cause. Public owners saw poor day-to-day planning for construction as the next significant factor, while the private sector viewed the underpricing of project estimates by designers equally important. Interestingly, the question of experience was seen to be more significant with designers than with contractors - public and private owners rated designer inexperience 3rd and 4th

respectively, yet they ranked contractor inexperience 8th and 9th correspondingly. In a similar vein, underbidding by contractors was ranked at a lower level than the underpricing by the designers. Interestingly, both parties observed that there was little significance to the failure of various construction codes to guarantee good workmanship and finish, ranking this factor at number 10.

TABLE 4.22 Barriers to owner satisfaction

		OWNERS			
Ques. 30	Which aspects of the design & construction process presents the greatest barriers to the satisfaction of the owner organization?	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank
30a	Underbidding by contractors	5.5057	5	5.5658	7
30b	Inadequacy of project funding by owners for features desired	5.6590	6	6.0230	8
30c	Underpricing of project estimates by designers	4.9425	4	4.6279	2
30d	Poor day-to-day project planning for construction	4.6136	2	4.6793	3
30e	Inadequate cost control	5.6666	7	5.0846	5
30f	Unfamiliarity of designers with the type of project	4.6931	3	4.8846	4
30g	Unfamiliarity of contractors with the type of project	5.7011	8	6.2538	9
30h	Lateness of information needed for a type of project	5.7931	9	5.5038	6
30i	Lack of detail in drawings and/or specifications	4.2386	1	4.4108	1
30j	Failure of codes to guarantee good workmanship and finish	7.9534	10	8.0312	10
30k	Other factors	9.4583	11	9.0789	11

Designer respondent's profile summary

The observations from the survey of the Facility Designers were as follows:

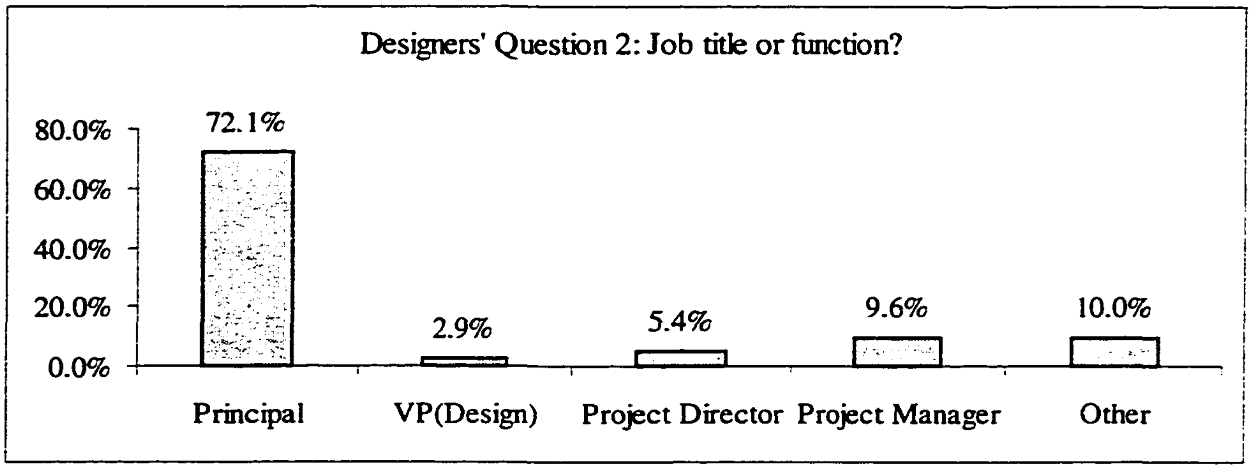


Figure 4.8 Job Title or Function sample size, n=241

As indicated in Figure 4.8, the great majority (72.1%) of the designers were principals of their organizations; respondents with other titles were as follows: VP (design), 2.9%, Project Director, 5.4%, Project Manager, 9.6%, and "Other, 10%.

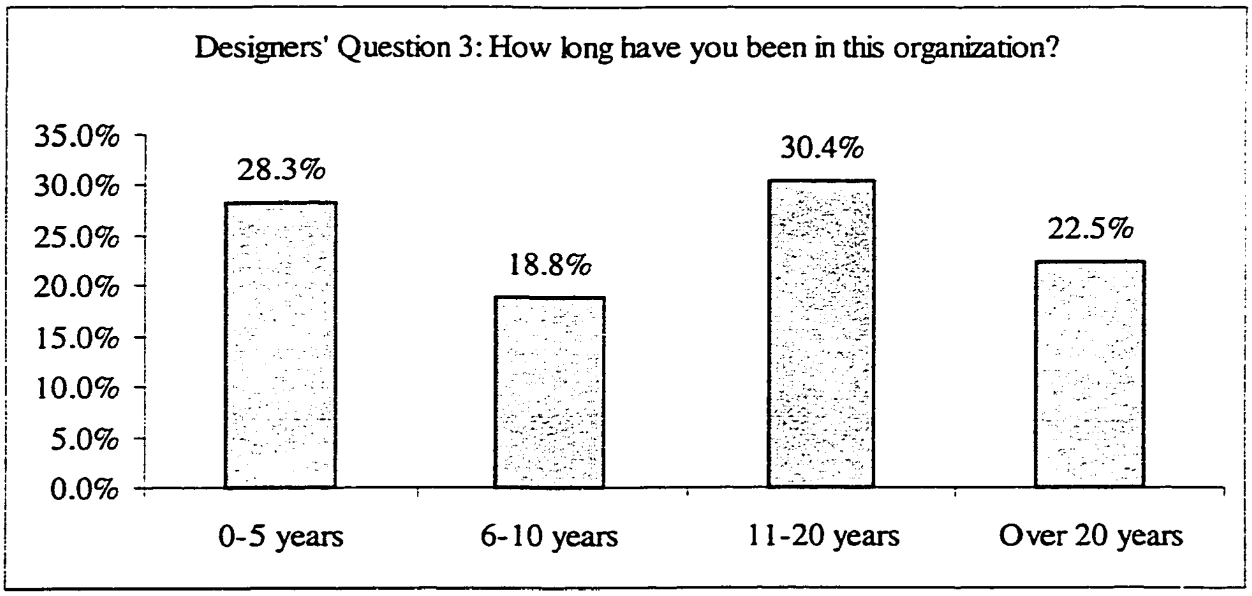


Figure 4.9 Tenure with Organization sample size, n=241

Overall, all the individuals in this survey group held titles and/or qualifications that would

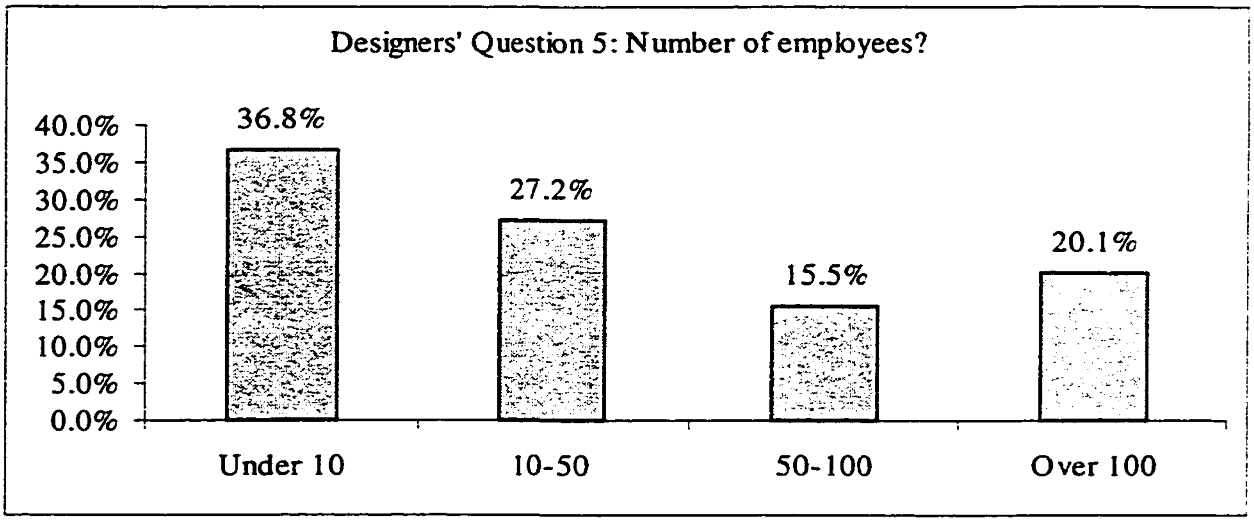


Figure 4.10 Number of Employers sample size, n=241

provide credible responses. Over 71% of the survey respondents had more than six years' experience, including 22.5% with more than 20 years' experience.

With respect to size, more than 36% had fewer than 10 employees; more than one in five were large design organizations with more than 100 employees, and 42.7 %

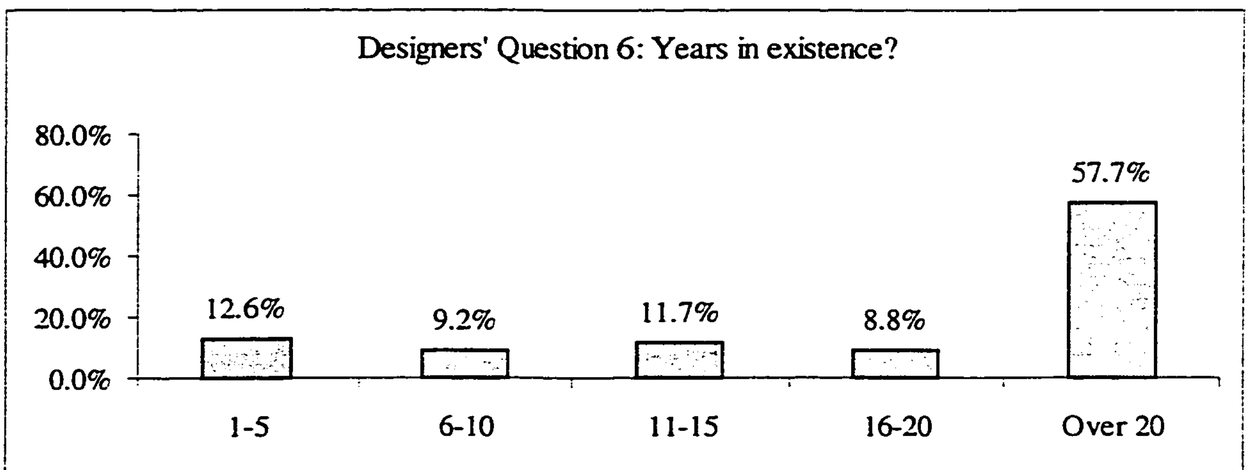


Figure 4.11 Years in Existence sample size, n=241

were in the range 10 - 100 employees (See Figure 4.10).

With respect to the ages of the firms surveyed, as shown in Figure 4.11, while one in eight design firms had existed for less than 5 years, 57.7% had been in business for more than 20 years. A total of 29.7% was noted in the range 6 to 20 years. It must be borne in mind

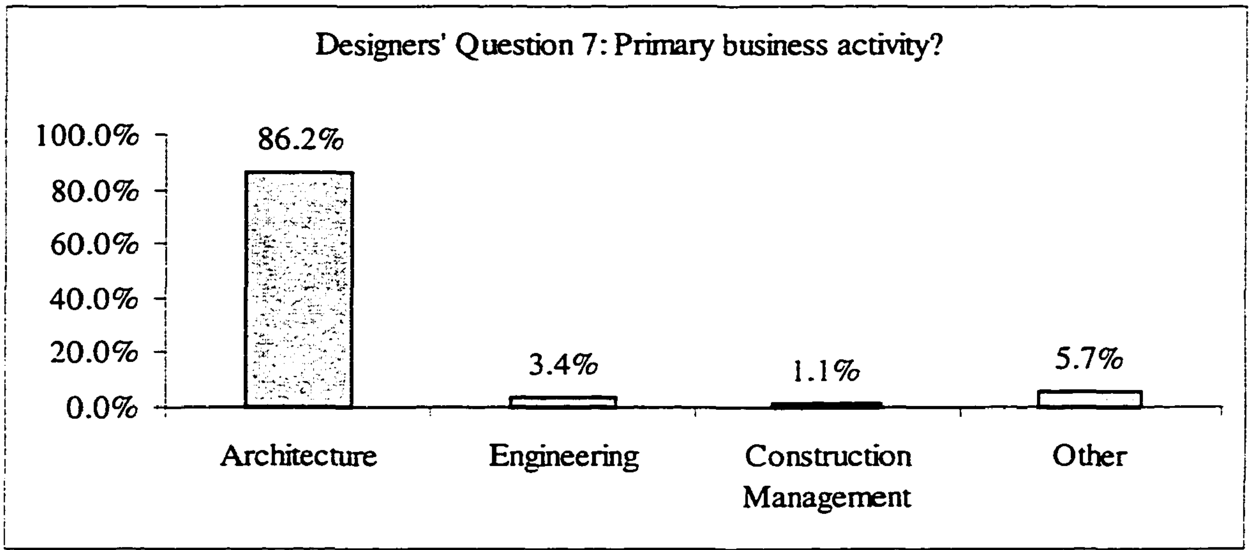


Figure 4.12 Primary Business Activity sample size, n=241

that a young company's staff may have come from another firm with far more years of experience. Aspiring design professionals often leave well established organizations to set up their own design firms.

As indicated in Figure 4.12, more than eighty six percent of the respondents were primarily architects; engineering and construction management accounted for their other business activities.

In responding to Question 9 (Project percentages) designers reported that projects were divided between different categories of projects, i.e., new facilities, remodeling/renovation and "other" projects.

These categories were represented as follows:

New facilities	37.15%
Remodeling/renovation	58.13%
Other projects	4.72%
Total	100%

As identified by question 11a, (see Table 4.23) most of the new construction projects (over 36%) were in the range $1million to $5 million; approximately one in five cost $100,000 to $1 million and a similar fraction cost $5 million to $20 million.

TABLE 4.23 Price range for 'average' project (new)

		DESIGNERS	
Ques. 11	Section a - New facilities. Based on the past 3-5 years, what per cent of your projects have been in the following price ranges? (Pro-rated)	Mean Percentage	Overall Rank
11a1	$100,000 to $1 million	21.52	3
11a2	$1 million to $5 million	36.79	1
11a3	$5 million to $20 million	23.71	2
11a4	$20 million to $50 million	10.88	4
11a5	Over $50 million	7.10	5

TABLE 4.24 Project price range

		DESIGNERS	
Ques. 11	Section b - Remodelling/renovation. Based on the past 3-5 years, what per cent of your projects have been in the following price ranges? (Pro-rated)	Mean Percentage	Overall Rank
11b1	$100,000 or less	16.95	3
11b2	$100,000 to $1 million	42.14	1
11b3	$1 million to $5 million	28.78	2
11b4	$5 million to $20 million	8.76	4
11b5	Over $20 million	3.37	5

In contrast, remodeling projects had approximately four out of ten in the range $100,000 to $1 million, 15% cost $100,000 or less, and more than one in four cost $1 million to $5 million. (See Table 4.24). As shown in Table 4.25 --Designers were asked about their involvement with a variety of well-known compensation formats. Lump sum occurred most frequently (48.9%), followed by GMP (16.77%), "Other" methods (16.47%), cost plus a fee (10.81%), and GMP with cost saving less than 5%.

TABLE 4.25 Use of compensation formats

		DESIGNERS	
Ques. 13	Compensation formats: Based on dollar value, what % of your contracts during past 5 years have had the following compensation formats?	Mean Percentage	Overall Rank
13a	Lump sum	49.94	1
13b	Cost plus a fee	11.03	4
13c	Guaranteed maximum price (GMP)	17.21	2
13d	GMP with cost savings sharing	5.02	5
13e	Other	16.80	3

TABLE 4.26 Use of compensation formats

		DESIGNERS	
Ques. 13	Compensation formats: Based on dollar value, how satisfied have you been with the following compensation formats? 1 = most satisfactory, 7 = least satisfactory.	Mean Rating	Overall Rank
13a	Lump sum	3.2562	3
13b	Cost plus a fee	3.0100	2
13c	Guaranteed maximum price (GMP)	3.8416	5
13d	GMP with cost savings sharing	3.5000	4
13e	Other	2.5263	1*

* See explanation of anomalous scores below.

Designers' satisfaction levels were not in keeping with the occurrence of the compensation formats. "Other" was rated highest, cost plus a fee was second, lump sum was third, and GMP and GMP with cost sharing fourth and fifth respectively. This situation is anomalous. Very few respondents (fewer than 20% of the survey population) addressed the questions on compensation formats. Of these respondents, a small number indicated “other” in their categories of interest, and some indicated a high rating for that category. They cited such methods as “time and materials” and “hourly” as their preference. From the standpoint of sampling techniques, it has to be recognized that these methods are highly regarded when they are used. However, in light of the low occurrence (16.6% in Table 4.25) of the category “other” techniques, it should not be concluded that they are the most appropriate ones to use. Interviews with designers have also pointed to the preponderance of smaller projects in the industry that would lend themselves to the “time and materials” and “hourly” charges. These projects tend to involve remodeling or renovation of existing facilities in which projects are difficult to define precisely, and are subject to many unforseen events. On the other hand, many large construction projects need the complex structure of the standard compensation formats.

TABLE 4.27 Use of project delivery methods

		DESIGNERS	
Ques. 14	Project delivery methods. What percentage of your projects use the following project delivery methods?	Mean Percentage	Overall Rank
14a	Traditional Design-Bid-Build	56.5	1
14b	“Fast track”	14.2	2
14c	Design-Build	9.02	4
14d	Construction Management (fee paid)	9.62	3
14	Construction Management (at risk)	4.79	6
14f	Other methods (please specify)	5.87	5

Question 14(A) (Frequency of project delivery methods): The designers reported the frequencies for the project delivery methods shown in Table 4.27. When asked about their satisfaction with various project delivery methods, designers indicated their preferences in the following declining order, as shown in Table 4.28: Traditional design-bid-build, construction management (fee paid), "Other" methods, Construction management (at risk), design-build, and lastly, fast track. These responses are understandable - designers are most used to the traditional design-bid-build. It allows time for unhurried design, bidding, and the eventual construction. Construction management (fee paid) involves a fee for professional construction management, construction management (at risk) involves risk for the designer, but also allows the potential for profit. In design-build, designers are usually employed by the contractor, supposedly working together as a team, but generally designers often find their design "freedom" limited by contractors' profitability concerns. Fast track is very demanding because of the overlapping of several activities that proves to be inconvenient for many designers.

TABLE 4.28 Satisfaction with delivery methods

		DESIGNERS	
Ques. 14	Project delivery methods. How would you score your satisfaction with the following project delivery methods? 1 = Most satisfactory, 7 = least satisfactory.	Mean Rating	Overall Rank
14a	Traditional Design-Bid-Build	2.9698	1
14b	"Fast track"	3.9236	6
14c	Design-Build	3.7540	5
14d	Construction Management (fee paid)	3.4782	2
14e	Construction Management (at risk)	3.6521	4
14f	Other methods (please specify)	3.5500	3

<u>A comparison of public and private HCF owners</u>

A number of questions solicited responses from designers relating to the respective requirements of public and private owners. The purpose of these questions was to see how these two categories affected the designers who generally work as consultants to owners.

Question 15 addressed specific performance indicators. From Table 4.29, for private owners, designers considered "building work well - meets end users' needs" as the most important category, followed by satisfactory job relations (owners with designers), 2, adherence to budgets, 3, and finishing within the time agreed, 4. For public owners, on the other hand, designers thought adherence to budget agreed was the no. 1 concern, followed by building works well, 2, satisfactory job relations (owners with designers), 3, followed by finishing within the time stipulated, 4.

TABLE 4.29 Performance evaluation criteria

		DESIGNERS			
Ques. 15	Performance evaluation criteria: what specific performance indicators do you generally use to judge the success of completed construction projects	Private Mean Rank	Private Overall Rank	Private Mean Rank	Public Overall Rank
15a	Finishing within the time stipulated	4.1404	4	3.9640	4
15b	Adherence to budget agreed	3.2595	3	2.6646	1
15c	Quality of appearance (workmanship)	4.1452	5	4.2951	5
15d	Satisfactory job relations - (owners) with designers	3.2274	2	3.7831	3
15e	Satisfactory job relations - (designers) with contractors	7.0217	8	7.2147	8
15f	Building works well - meets end users' needs	2.6936	1	3.0598	2
15g	Performance of all electrical/mech/specialized systems to specifications	5.3261	6	5.4303	6
15h	Minimal number and value of change orders	6.2777	7	5.6727	7
15i	Other (please specify)	8.3040	9	8.0312	9

The performance indicators that were ranked fourth through 9th were the same for both private and public organizations. It is worthy of note that designers rated their relations with owners as second or third in order of importance, yet their relations with contractors rated lowest.

Question 16 addressed the influence of a number of factors on the owner's level of satisfaction (see Table 4.30). Designers ranked the factors in exactly the same order for both private and public organizations. They ranked adherence to cost estimates, timeliness of the project, and prompt, adequate response to owner's complaints, as the most important factors. Question 17 addressed owners' relationships with designers, specifically the owner's criteria for selecting a design organization. Designers were asked *how they thought* the owner viewed these criteria.

TABLE 4.30 Owner satisfaction factors

		DESIGNERS			
Ques. 16	To what extent do the following factors influence an owner's (facility administrator's) level of satisfaction with a construction project? Rank the factors in order of importance	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overal l Rank
16a	Timeliness of the project	3.3008	2	3.0714	2
16b	Adherence to cost estimates	2.3559	1	2.0357	1
16c	Clear up-front understanding of the job scope	4.9529	5	4.8795	5
16d	Clear ongoing communication on job status	4.9491	4	4.5119	4
16e	Prompt, adequate response to owner's complaints	3.9406	3	4.0297	3
16f	Attractive, design/aesthetic (architectural features)	6.0211	8	6.2916	8
16g	High quality of construction - fit and finish	5.7905	7	5.9101	7
16h	Minimal disruption to ongoing facility operations	5.0296	6	5.3988	6
16I	Other (please specify)	7.5937	9	7.8125	9

As seen in Table 4.31 the rankings for both private and public organizations were fairly similar. The number 1 response was "specialization in similar work" for both categories. For private owners the number 2 response was "previous project relationship between owner and designer", and "track record and experience" was third. The order of these responses was reversed for public organizations. Designers ranked the remaining criteria equally low for both groups - "promised design completion date", 7, "quality certification or use of techniques such as TQM", 8, "use of innovative construction technology", 9, and "other", 10. Clearly, designers do not think that these factors represent a high priority.

TABLE 4.31 Designer selection criteria

		DESIGNERS			
Ques. 17	Relationships (owners) with Designers: In selecting a design organization, an owner typically relies on some of the following criteria. From the owners' perspective, rank the factors.	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overa ll Rank
17a	Specification in similar work	2.6932	1	3.0714	2
17b	Promised design completion date	5.8312	7	2.0357	1
17c	Overall project budget	5.3823	6	4.8795	5
17d	Track record/experience	2.9579	3	4.5119	4
17e	Recommendations by others	4.5147	4	4.0297	3
17f	Quality certification or use of techniques such as TQM	7.9102	8	6.2916	8
17g	Previous project relationship between owner and designer	2.7521	2	5.9101	7
17h	Use of innovative construction technology	8.0423	9	5.3988	6
17i	Perceived responsiveness/customer understanding	4.6386	5	7.8125	9
17j	Other (please specify)	9.0983	10	9.0714	10

Question 18 (Design considerations) examined the balance between conflicting factors relating to the design process. Designers were asked to assume that they had a free choice when ranking the factors; these factors were ranked relatively similarly for both groups. The number 1 concern was "meeting basic functional requirements", and the second was "user friendliness" for both groups. For private organizations, these were - Aesthetics, 3, system reliability, 4, and maintainability, 5. For public organizations, the corresponding ranks were: system reliability, maintainability, and aesthetics. The remaining items were ranked equally for both groups - notably, with the incorporation of the latest technology least important.

TABLE 4.32 Design considerations

		DESIGNERS			
Ques. 18	Design Considerations: As the Owner's representative, you have to balance a number of conflicting priorities and criteria when having construction work designed. Rank the factors.	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank
18a	Lowest life cycle cost	5.8212	7	5.7469	7
18b	Ease of maintenance/maintainability	4.9063	5	4.4819	4
18c	User "friendliness"	3.7361	2	4.0662	2
18d	System reliability (failures minimized)	4.5063	4	4.4397	3
18e	Aesthetics (physical attractiveness)	4.3234	3	4.8373	5
18f	Lowest first cost (when constructed)	7.1282	8	6.3333	8
18g	Meeting basic functional requirements	2.2042	1	2.3614	1
18h	Flexibility for future adaption	4.9957	6	5.6204	6
18i	Incorporation of latest technology within the facilities	7.2017	9	7.5151	9
18j	Other (please specify)	9.7777	10	9.9189	10

Question 19 addressed owners' relationships with contractors. Designers were asked for their perceptions of the owners' perspective. This question was considered to be important since designers typically guide the owner in selecting a contractor. The top three rankings for private organizations were: track record/experience, 1, specialization in similar work, 2, and overall project budget, 3. In contrast, the top three rankings for public organizations were: overall project budget, 1, track record/ experience, 2, and specialization in similar work, 3. For the private sector, the last four ranks were: perceived responsiveness, 7, Quality certification/TQM , 8, use of innovative construction technology, 9, and "other', 10. The corresponding items for the public sector were different: recommendations by others, 7, Other, 8, quality certification, 9, and use of innovative construction technology, 10.

Question 20 (Construction process considerations): These rankings, again , were relatively similar for both private and public organizations. The first three factors were ranked equally for both - interruption of utilities, 1, physical barriers/unsafe to users, 2, contamination by pathogens, 3.

TABLE 4.33 Construction process considerations (environmental)

		DESIGNERS			
Ques. 20	Construction process consideration (Environmental). Construction work that is carried out near health care facilities often calls for special considerations about external factors. Rank the Contractor's ability to manage these problems in terms of importance	Private mean Rank	Private overall Rank	Public Mean Rank	Public Overal l Rank
20a	Noise	4.0043	5	4.1288	4
20b	Odors (solvents, etc.)	4.4267	6	4.5214	6
20c	Dust	3.9439	4	4.1349	5
20d	Contamination by pathogens	3.6709	3	3.3950	3
20e	Physical barriers/debris unsafe to users	3.4267	2	3.2392	2
20f	Vibration	5.2629	7	5.2269	7
20g	Interruption of utilities	2.9051	1	2.9876	1

Items 4 and 5 were alternated in importance - for private organizations they were - dust, 4, and noise, 5. These factors were reversed for public organizations. One possible explanation is that both public and private HCFs have begun to converge in terms of management style because of the growing regulatory environment in which they operate. Question 21 (Construction process considerations): Designers ranked 6 factors in the same order of importance, both for private and public organizations- Ability to adjust schedules to owner's operating needs, 1, commissioning-testing/adjusting systems to meet owner's expectations, 2, prompt response to owners' warranty calls, 3, training of owner's staff, 4, prompt submission of "as-built" drawings, etc., 5, and "other",6.

TABLE 4.34 Construction process considerations

		DESIGNERS			
Ques. 21	Construction process consideration. Relative to contractors, rank the following 6 factors in terms of importance	Private mean Rank	Private Overall Rank	Public Mean Rank	Public Overal l Rank
21a	Ability to adjust schedule to owner/organization's operating needs	1.3448	1	1.3687	1
21b	Training of Owner's staff on equipment installed	3.3318	4	3.2187	4
21c	Commissioning: Testing/adjusting systems to meet owners' expectations	2.8491	2	2.8000	2
21d	Prompt response to Owner's warranty breakdown calls	3.0000	3	3.2000	3
21e	Prompt admission of "as built" drawings, approval certificates, etc.	4.6853	5	4.5562	5
21f	Other (please state)	5.3265	6	5.3142	6

Quality Control: Question 22, sections A and B elicited a response from designers on the frequency of different methods of quality control in their projects, and also asked for their belief in the effectiveness of these methods. Frequencies are displayed in Table 4.35, and levels of effectiveness are shown in Table 4.65 in combination with the responses of owners and contractors. With regard to frequency, designers responded: By the designer, 1, by the owner's staff, 2, "other", 3, by the contractor, 4, and by an independent inspector, 5. This response is as expected - in most projects, the designer prepares the design documents and is paid a fee for project administration, which includes a degree of quality control inspection services. Interestingly, the responses to Section B, (see Table 4.65) show similar ratings for perceived effectiveness. The designer considers his/her organization to be the most effective, 1, the owner's staff, 2, "other", 3, an independent inspector, 4, and least effective of all, the contractor.

TABLE 4.35 Quality control methods

		DESIGNERS	
Ques. 22	How often are the following quality control methods in the majority of your construction projects?. Always = 1, Often = 2, Sometimes = 3, Seldom= 4, Never = 5.	Mean Rating	Overall Rank
22a	By the designer as quality control inspector	1.8111	1
22b	By the owner's staff person as quality control inspector	2.6394	2
22c	By an independent quality control inspector	3.5969	5
22d	By contracting staff	3.2060	4
22e	Other	2.7027	3

Ques 26 (Problem resolution): The responses were predictable - preferences for resolution methods were: Informal meetings, 1, Negotiation, 2, Mediation, 3, Arbitration, 4, Litigation, 5, and "other", 6. This applied to both private and public organizations. All the parties to construction projects indicated the same rankings for these dispute resolution methods.

TABLE 4.36 - Dispute resolution methods

		DESIGNERS	
Ques. 26	Problem/dispute resolution: if you do experience problems and disputes on a project, which of the following approaches would you prefer? Rank them.	Public Overall Rank	Private Overall Rank
26a	Informal meetings	1	1
26b	Negotiation	2	2
26c	Mediation	3	3
26d	Arbitration	4	4
26e	Litigation	5	5
26f	Other	6	6

Ques 27 (Schedule and cost considerations): Designers were asked how they thought owners responded to certain variations in schedule and cost. The scale used was: 1 = not at all, 2 = very little, 3 = somewhat, 4 = moderately, 5 = very much. The results of the analysis follow a predictable trend - as schedule delays progress from the range 0 - 5% and above, the level of dissatisfaction increases in step. Increases in the range 15% - 30% elicit a response between 4 and 5, i.e., between *moderately* and *very much.*

TABLE 4.37 Satisfaction with schedules

		DESIGNERS	
Ques. 27	As an owner's representative, in general, how negatively would your level of satisfaction be affected by the following increases in schedule? 1 = Not at all, 5 = Very much.	Mean Rating	Overall Rank
27a	0%-5%	1.8205	1
27b	5%-15%	3.2198	2
27c	15%-30%	4.4000	3
27d	30%-50%	4.8771	4
27e	Over 50%	4.9869	5

A comparison of the responses indicated in Table 4.37 and Table 4.38 suggests that cost increases have a somewhat greater impact on owner satisfaction than schedule increases. The mean ratings for satisfaction versus cost increases can be seen to have a slightly higher value than the ratings for schedule increases.

TABLE 4.38 Satisfaction with cost increases

		DESIGNERS	
Ques. 27	As an owner's representative, in general, how negatively would your level of satisfaction be affected by the following increases in cost? 1 = Not at all, 5 = Very much	Mean Rating	Overall Rank
27a	0%-5%	1.9741	1
27b	5%-15%	3.4094	2
27c	15%-30%	4.5869	3
27d	30%-50%	4.9039	4
27	Over 50%	4.9869	5

TABLE 4.39 Use of surveys

		DESIGNERS	
Ques. 28	To what extent have the following been administered on your projects? 1 = Never, 5 = Always.	Mean Rating	Overall Rank
28a1	Owner satisfaction surveys	2.46	1
28a2	Post occupancy surveys	3.12	2

Question 28 (Conduct of surveys): The data on the conduct of owner satisfaction surveys and post occupancy surveys indicate that these were conducted only *sometimes*. However, the benefits appeared to be good when compared on a scale where 1 = maximum benefit, and 7 = minimum benefit. The construction industry does not generally include these surveys as a contract requirement. They tend to be carried out only under the auspices of the most forward-thinking organizations.

TABLE 4.40 Benefit of surveys

		DESIGNERS	
Ques. 28	Indicate their benefit to you: 1 = Maximum benefit, 7 = minimum benefit.	Mean Rating	Overall Rank
28b1	Owner satisfaction surveys	2.644	1
28b2	Post occupancy surveys	3.128	2

TABLE 4.41 Barriers to owner satisfaction

		DESIGNERS	
Ques. 30	Which aspects of the design & construction process presents the greatest barriers to the satisfaction of the owner organization?	Mean Rank	Overall Rank
30a	Underbidding by contractors	5.4824	7
30b	Inadequacy of project funding by owners for features desired	4.1163	2
30c	Underpricing of project estimates by designers	4.3478	3
30d	Poor day-to-day project planning for construction	5.1551	5
30e	Inadequate cost control	3.8956	1
30f	Unfamiliarity of designers with the type of project	5.1260	4
30g	Unfamiliarity of contractors with the type of project	6.0132	8
30h	Lateness of information needed for a type of project	5.2034	6
30i	Lack of detail in drawings and/or specifications	6.2121	9
30j	Failure of codes to guarantee good workmanship and finish	9.0398	11
30k	Other factors	8.1800	10

Question 30 (Rating of barriers to owner satisfaction): In this regard, inadequate cost control is blamed most, followed by inadequacy of owner funding and underpricing of project estimates by designers. The problem of underpricing is significant as owners rely on designers for professional guidance in this area. Interestingly, also, designers blame a lack of detail in the drawings and specifications that they prepare to only a very limited extent, ranking it ninth of eleven factors.

Contractor Respondent's Profile Summary

In this section, the results of the Health Care Facility (HCF) contractor responses are presented. Approximately 87% of the respondents had job titles at the level of Vice-President

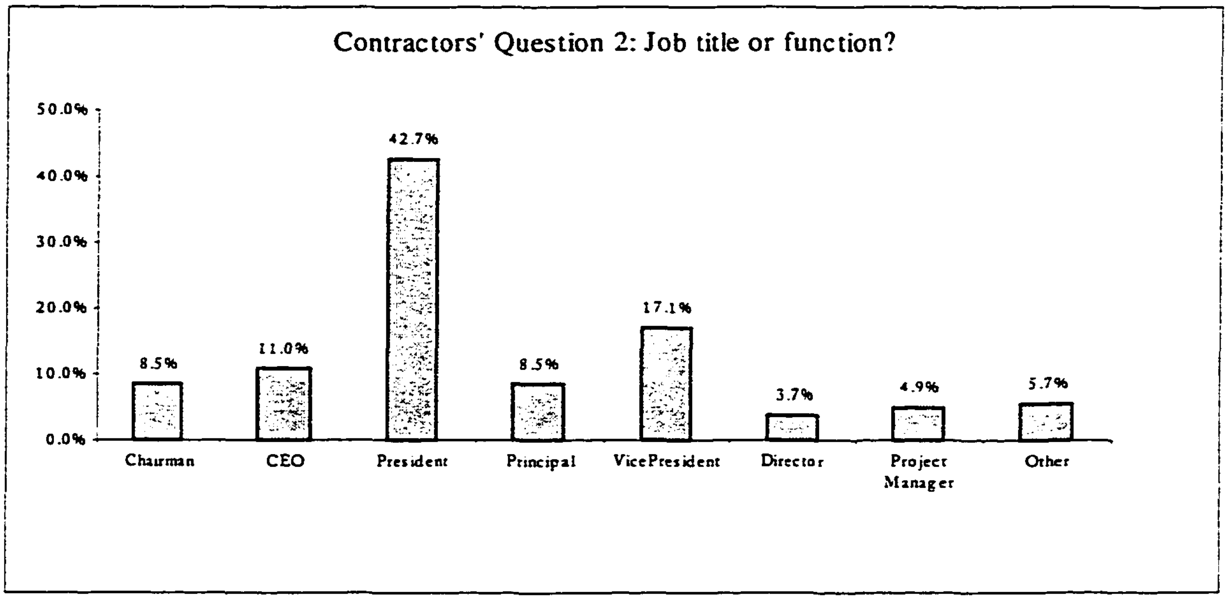


Figure 4.13 Job Title or Function sample size ,n=82

or above, lending a high level of credibility to the responses. Over 70% of the respondents had been with their organization for over eleven years, and their input was therefore considered to reflect their organizations' perceptions accurately.

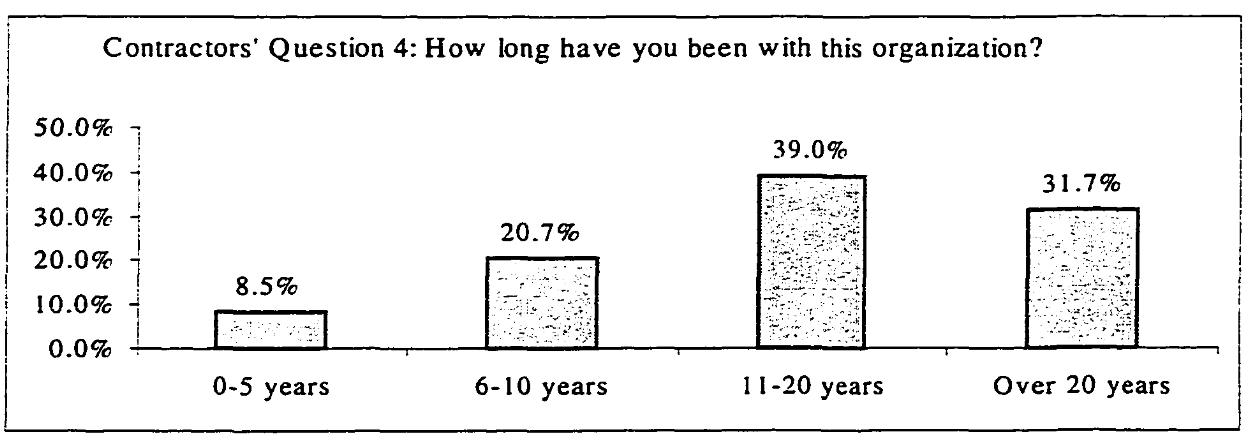


Figure 4.14 Tenure with Organization sample size, n=82

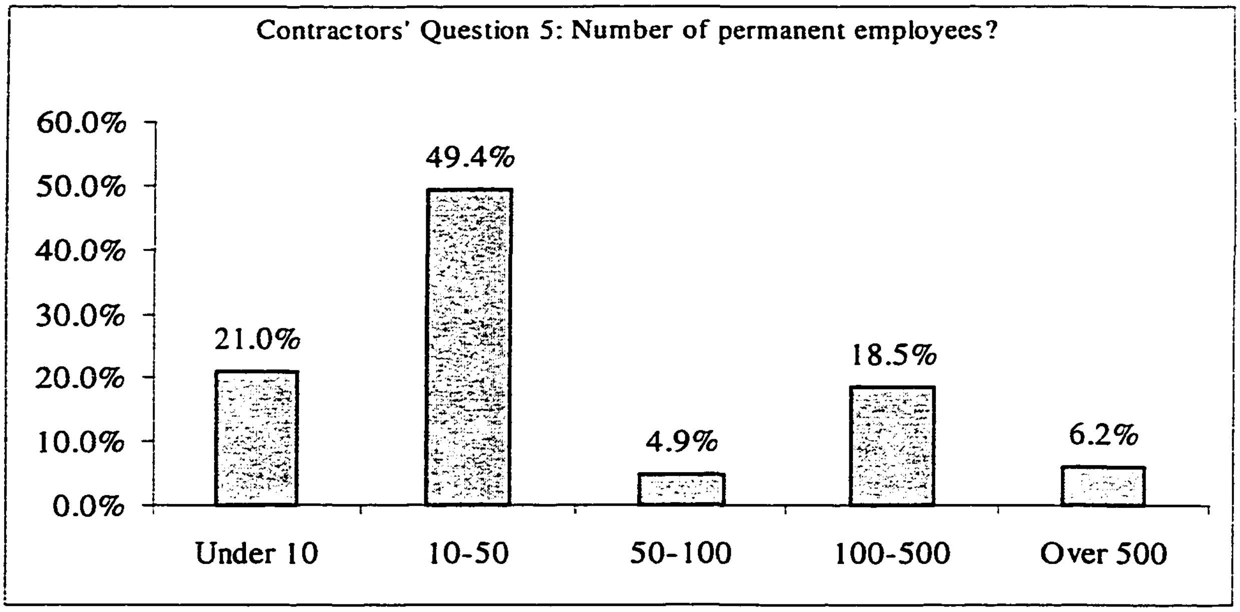


Figure 4.15 Number of Permanent Employees

sample size, n=82

In terms of size, most of the construction companies represented had between ten and fifty permanent employees. Over twenty four percent of them had more than 100 employees.

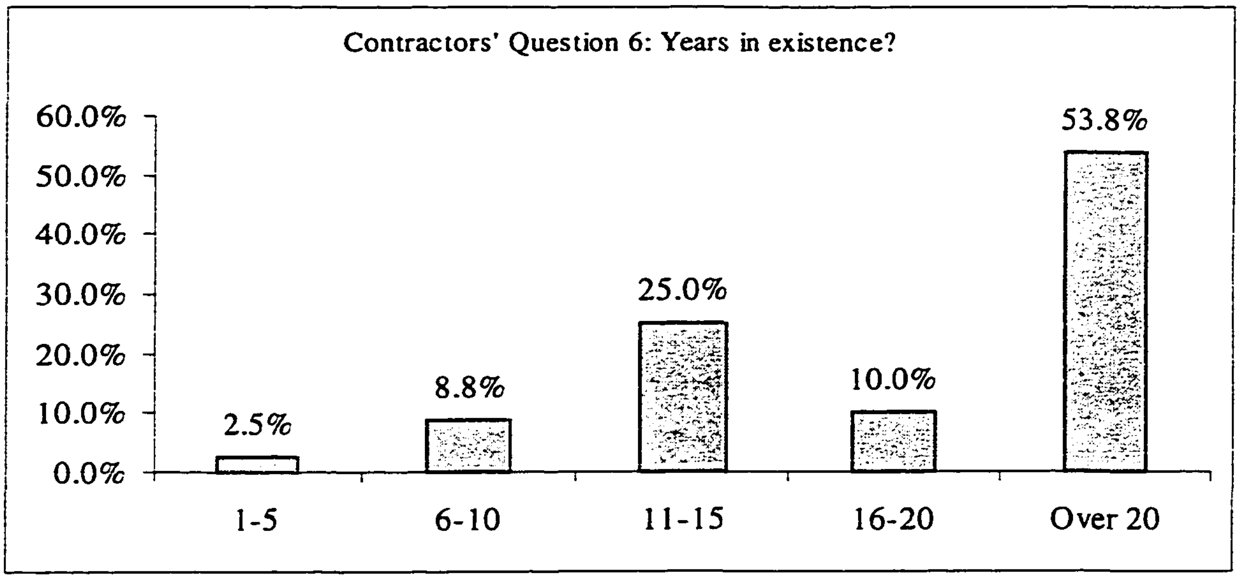


Figure 4.16 Years In Existence

sample size, n=82

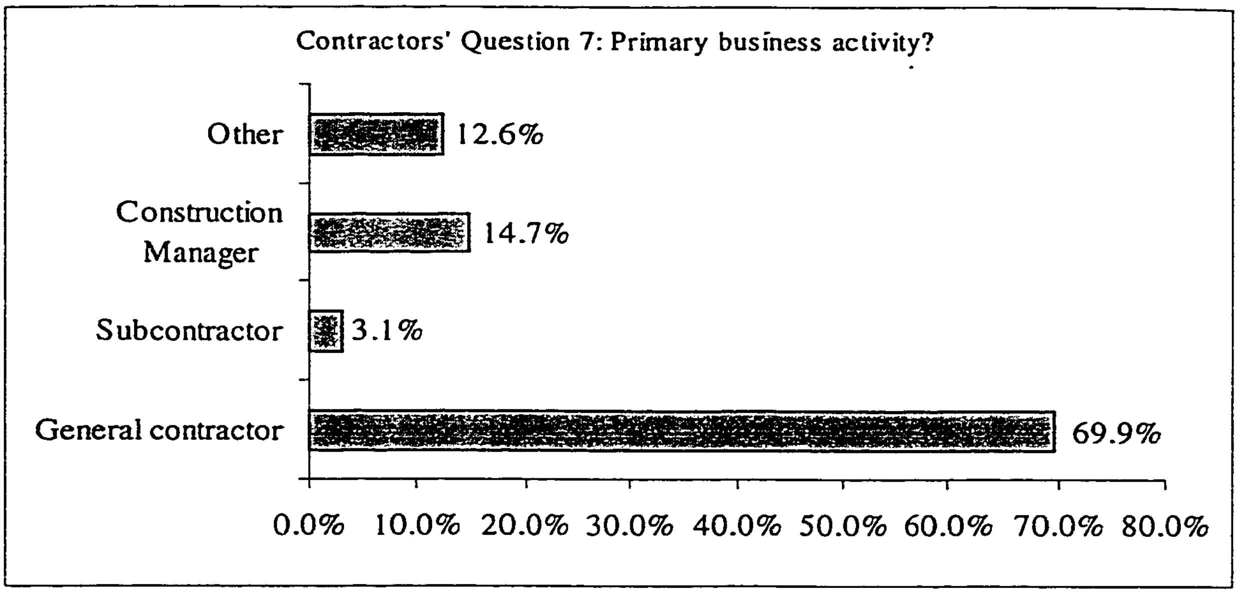


Figure 4.17 Primary Business Activity sample size, n=82

Approximately eighty one percent of the companies responding were general contractors, and over seventeen percent were subcontractors. Others represented categories such as design-builder; all these respondents were relevant to the study.

Question 10 (Table 4.42) addressed the composition of the companies' construction work - there was a greater emphasis on remodeling and renovation than on new construction, in keeping with industry experience.

TABLE 4.42 Distribution of projects

		CONTRACTORS	
Ques. 10	Based on dollar value, over the past 5 years what percentage of your construction projects are:	Mean %	Overall Rank
10a	New facilities	39.46	2
10b	Remodeling/renovation	56.10	1
10c	Other (if applicable)	3.32	3

Question 11.- part 1. (Project price ranges - new work) Projects involving new facilities ranked highest in the range $1 million to $5 million. Next in frequency were

projects in the range $100,000 to $1 million. New construction projects (see Table 4.43) are most highly represented in the range $1 million to $5 million.

TABLE 4.43 Price range for the "average" project

		CONTRACTORS	
Ques. 11	Section a - New facilities. Based on the past 3-5 years, what percentage of your projects fall in the following price ranges?	Mean %	Overall Rank
11a1	$100,000 to $1 million	30.92	2
11a2	$1 million to $5 million	39.29	1
11a3	$5 million to $20 million	22.37	3
11a4	$20 million to $50 million	5.40	4
11a5	Over $50 million	2.02	5

Question 11- part 2. (Project price ranges - renovation/remodeling) Most of the remodeling/renovation projects reported were in the range $100,000 to $1 million, followed by those in the range $100,000 or less.

TABLE 4.44 Price range for the "average" project (remodeling)

		CONTRACTORS	
Ques. 11	Section b - Renovation. Based on the past 3-5 years, what percentage of your projects fall in the following price ranges?	Mean %	Overall Rank
11b1	$100,000 or less	26.75	2
11b2	$100,000 to $1 million	40.56	1
11b3	$1 million to $5 million	20.87	3
11b4	$5 million to $20 million	2.86	4
11b5	Over $20 million	0.67	5

Question 13 (Satisfaction with various compensation programs): Contractors reported their highest satisfaction with "Cost plus a fee" with Lump sum second, followed by GMP and GMP with cost savings sharing. This is not surprising.

TABLE 4.45 Satisfaction with compensation formats

Ques. 13 Sat	Compensation formats: During the past 5 years what has been the level of your satisfaction with the following compensation formats? 1 = most satisfactory, 7 = least satis.	Mean Rank	Overall Rank
13a	Lump sum	2.8000	2
13b	Cost plus a fee	2.6097	1
13c	Guaranteed maximum price (GMP)	3.0270	3
13d	GMP with cost savings sharing	3.0277	4
13e	Other	3.5714	5

Cost plus a fee guarantees the contractor a sure profit, regardless of the costs incurred. Lump sum contracting involves contracting for an established contract price, but allowing for change orders for "extra" items that were added afterwards. Guaranteed Maximum Price (GMP) does not provide that degree of flexibility, while GMP with cost savings sharing requires the contractor to share such savings with the owner, hence these latter methods are least popular.

TABLE 4.46 Use of compensation formats

		CONTRACTORS	
Ques. 13%	Compensation formats: Based on dollar value, what percentage of your contracts during the past 5 years have the following compensation formats?	Mean Rank	Overall Rank
13a	Lump sum	58.95	1
13b	Cost plus a fee	7.89	4
13c	Guaranteed maximum price (GMP)	17.60	2
13d	GMP with cost savings sharing	12.50	3
13e	Other	0.85	5

Question 13 (Frequency of occurrence of compensation formats): As shown in Table 4.46, Lump sum experiences the highest occurrence because it is the method that owners offer most frequently. By the same token, owners offer cost plus a fee infrequently

because it does not demand highly competitive pricing by contractors. GMP with cost savings sharing is less popular than GMP only with contractors because it reduces the contractor's additional profit that can be derived from higher levels of productivity.

Question 14 (Satisfaction with Project Delivery methods): "Fast track" was rated highest by contractors. Generally, this method allows contractors to optimize the use of time, labor, and equipment, but it requires very careful scheduling by both the contractor

TABLE 4.47 Satisfaction with project delivery methods

		CONTRACTORS	
Ques. 14	How would you score your satisfaction with the following project delivery methods?	Mean Score	Overall Rank
14a	Traditional Design-Bid-Build	3.206	3
14b	"Fast track"	2.512	1
14c	Design-Build	3.065	2
14d	Construction Management (fee paid)	3.304	4
14e	Construction Management (at risk)	3.550	6
14f	Other methods (please specify)	3.400	5

the designer. In the interest of saving time, many compromises are made by the owner and designer, and these tend to favor contractors. Design-build ranks second; it involves having the contractor and designer working as one organization. This method aligns the designer with the contractor, instead of with the owner.

Question 15 (Performance evaluation criteria): It is worthy of note that contractors rate their relationship with private owners the highest, followed by adherence to budgets, finishing within the time stipulated, and workmanship.

TABLE 4.48 Performance evaluation criteria

		CONTRACTORS			
Ques. 15	Performance evaluation criteria: What specific performance indicators do you generally use to judge the success of completed construction projects?	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank
15a	Finishing within the time stipulated	3.4657	3	2.7963	1
15b	Adherence to budget agreed	3.2054	2	2.8333	2
15c	Quality of appearance (workmanship)	3.5616	4	3.8518	3
15d	Satisfactory job relations - (owners) with contractors	2.9452	1	4.0925	4
15e	Satisfactory job relations - (contractors) with designers	5.7534	6	5.7407	6
15f	Building works well- meets end users' needs	4.8767	5	5.4259	5
15g	Performance of all electrical/mech/specialized systems to specifications	6.0555	7	6.1111	7
15h	Minimal number and value of change orders	6.8767	8	6.4444	8
15i	Other (please specify)	7	9	6.4814	9

With public owners, contractors rate time as the most important factor, followed by budget adherence, workmanship, and satisfactory job relations. The remaining rankings are the same for both categories of owners - Building works well is 5th, followed by satisfactory relations with designers, performance of electrical/mechanical systems to specifications, and minimal number and value of change orders.

Question 16 (Owner satisfaction factors): Contractors' responses showed some similarity between private and public owners, but with minor differences. For public owners, timeliness and adherence to cost estimates were ranked in that order, but reversed for private owners. Prompt, adequate response to owners' complaints and minimal disruption to ongoing operations ranked 3rd and 4th for both groups.

TABLE 4.49 Owner satisfaction factors

		CONTRACTORS			
Ques. 16	To what extent do the following factors influence an owner's (facility administrator's) level of satisfaction with a construction project? Rank the factors in order of importance.	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank
16a	Timeliness of the project	3.0410	2	2.5454	1
16b	Adherence to cost estimates	2.9863	1	2.7818	2
16c	Clear up-front understanding of the job scope	5.3013	7	5.2181	7
16d	Clear on-going communication on job status	4.7671	6	4.9090	5
16e	Prompt, adequate response to owner's complaints	4.3972	3	4.4000	3
16f	Attractive design/aesthetics (architectural features)	6.4861	8	6.5454	8
16g	High quality of construction - fit and finish	4.6164	5	5.1090	6
16h	Minimal disruption to ongoing facility operations	4.5000	4	4.7090	4
16I	Other (please specify)	8.3976	9	8.2380	9

For private owners, high quality of construction, job status communication, and job scope understanding were next in importance, with aesthetics and other factors last. The last three items ranked the same for public owners, but public owners reversed the order of job status communication and construction quality.

Question 17 (Owners' relationships with contractors): Contractors thought public owners ranked overall projected budget highest when selecting a contractor, followed by promised completion date, track record, and specialization. On the other hand, private owners are thought to emphasize a previous project relation-ship, followed by track record, specialization, and budget.

TABLE 4.50 Contractor selection criteria

		CONTRACTORS			
Ques.	Relationships (owners) with Contractors: In selecting a construction organization, an owner typically relies on some of the following criteria. From the owners' perspective, rank the factors	Private Mean Rank	Private Overal lRank	Public Mean Rank	Public Over-all Rank
17a	Specification in similar work	3.8266	3	4.0000	4
17b	Promised design completion date	4.7763	6	3.4385	2
17c	Overall project budget	4.0000	2	2.7719	1
17d	Track record/experience	3.5921	2	3.6071	3
17e	Recommendations by others	4.6184	5	6.1428	6
17f	Quality certification or use of techniques such as TQM	7.5789	8	6.6785	8
17g	Previous project relationship between owner and designer	3.3866	1	4.8214	5
17h	Use of innovative construction technology	8.0000	9	7.7142	9
17i	Perceived responsiveness/customer understanding	5.6000	7	6.2407	7
17j	Other (please specify)	8.9200	10	8.6500	10

The last four items are ranked equally - perceived responsiveness, 7th, quality certification, 8th, innovative construction technology, 9th, and other factors, 10th.

Questions 18 and 19 are not addressed here, as they relate to design issues, which are not usually within the contractor's control, except in special situations, such as design-build contracts.

Question 20 (Construction process considerations): Contractors rated the interruption of utilities as being of maximum criticality with private owners, followed by noise, while these were reversed for public owners. Physical barriers were ranked equally at 3rd, as were odors and vibration at 6th and 7th respectively. Dust and contamination by pathogens are also oppositely ranked.

TABLE 4.51 Construction process considerations (environmental)

		CONTRACTORS			
Ques. 20	Construction process consideration (Environmental). Construction work that is carried out near health care facilities often calls for special considerations about external factors. Rank the Contractor's ability to manage these problems in terms of importance	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank
20a	Noise	3.3200	2	3.1754	1
20b	Odors (solvents, etc.)	4.4666	6	4.4210	6
20c	Dust	3.9600	5	3.9473	4
20d	Contamination by pathogens	3.9466	4	4.1052	5
20e	Physical barriers/debris unsafe to users	3.7600	3	3.7017	3
20f	Vibration	5.4133	7	5.3750	7
20g	Interruption of utilities	3.0270	1	3.2456	2

TABLE 4.52 Construction process considerations

		CONTRACTORS			
Ques. 21	Construction process consideration. Relative to contractors, rank the following 6 factors in terms of importance	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank
21a	Ability to adjust schedule to owner/organization's operating needs	1.2820	1	1.7500	1
21b	Training of Owner's staff on equipment installed	3.4743	4	3.1785	2
21c	Commissioning: Testing/adjusting systems to meet owners' expectations	3.1153	3	3.1785	3
21d	Prompt response to Owner's warranty breakdown calls	2.4743	2	3.8750	4
21e	Prompt submission of "as built" drawings, approval certificates, etc.	4.7435	5	4.1428	5
21f	Other (please state)	5.9166	6	5.7647	6

Question 21 (Construction process considerations) The contractor's ability to adjust to the owner's needs was paramount to both public and private organizations, but private owners were more concerned about prompt responses to breakdowns than

public owners, who considered training of staff next in importance. Both groups were thought to care equally about the commissioning process as well as the provision of "as-built" drawings. Private owners rated training of staff 4th, whereas public owners rated prompt breakdown responses 4th as well.

TABLE 4.53 Quality control methods

		CONTRACTORS		
Ques. 22	With respect to quality control in the majority of your construction projects, how effective are the following methods?: Most effective = 1, least effective = 5	Mean Rating	Private Overall Rank	Public Mean Rank
22a	By the designer as quality control inspector	2.3506	2	
22b	By the owner's staff person as quality control inspector	2.6447	3	
22c	By an independent quality control inspector	3.3947	4	
22d	By contracting staff	2.0526	1	
22e	Other	3.7333	5	

Question 22 (Rating of quality control effectiveness): As shown in table 4.53, contractors rated their ability to effect quality control higher than any other entity; the designer was rated 2nd, and the owner 3rd. They rated an independent inspector as the least effective.

Questions 23 to 26 are not included in this research. They requested basic background information on the occurrence of productivity/quality efforts, and the use of various dispute resolution methods.

Question 27 - part 1 (Satisfaction with deviations in schedule) Contractors were asked how negatively both private and public parties would respond to certain deviations, on a scale of 1 to 5. Predictably, dissatisfaction increases directly with increases in the schedule beyond the planned time frames.

TABLE 4.54 Satisfaction with schedules

		CONTRACTORS	
Ques. 27	As an owner's representative, in general, how negatively would your level of satisfaction be affected by the following increases in schedule? 1 = Not at all, 5 = Very much.	Mean Rating	Overall Rank
27a	0-5%	2.0909	1
27b	5%-15%	3.2179	2
27c	15%-30%	4.3376	3
27d	30%-50%	4.8125	4
27e	Over 50%	4.95	5

TABLE 4.55 Satisfaction with costs

		CONTRACTORS	
Ques. 27	As an owner's representative, in general, how negatively would your level of satisfaction be affected by the following increases in cost? 1 = Not at all, 5 = Very much.	Mean Rank	Overall Rank
27a	0-5%	2.2597	1
27b	5%-15%	3.3670	2
27c	15%-30%	4.3076	3
27d	30%-50%	4.7974	4
27e	Over 50%	4.9012	5

Schedule delays in the range 0 to 5 percent are noted as having 'very little impact'. Increases of 15 to 30 percent are rated as influencing satisfaction "somewhat", and those over 30 percent are thought to impact against owner satisfaction 'moderately' to 'very much'.

Question 27 - part 2 (Satisfaction with deviations in cost) Contractors expressed the opinion that cost increases influence owner satisfaction more than schedule delays, for the same degree of deviation. The mean values shown for deviations from 0% to 15% are larger in table 4.55 than in table 4.54, suggesting that cost changes in this range have more impact on the customer than schedule changes.

Question 28 relates to post occupancy and owner satisfaction surveys, and is excluded. Question 29 addresses the desired frequency of meetings and/or interaction that would best meet the owner's needs. Comparisons are made in the later section - (Discussion of the "gaps" between owners, designers, and contractors)

Question 30 (Barriers to owner satisfaction): Contractors placed the responsibility for low owner satisfaction with designers who underestimate project costs.

TABLE 4.56 Barriers to owner satisfaction

		CONTRACTORS	
Ques. 30	Which aspects of the design & construction process present the greatest barriers to the satisfaction of the owner organization?	Mean Rank	Overall Rank
30a	Underbidding by contractors	4.8024	4
30b	Inadequacy of project funding by owners for features desired	4.4320	2
30c	Underpricing of project estimates by designers	3.6875	1
30d	Poor day-to-day project planning for construction	5.4230	6
30e	Inadequate cost control	5.6962	8
30f	Unfamiliarity of designers with the type of project	4.4625	3
30g	Unfamiliarity of contractors with the type of project	6.2820	9
30h	Lateness of information needed for a type of project	5.4625	7
30i	Lack of detail in drawings and/or specifications	5.3375	5
30j	Failure of codes to guarantee good workmanship and finish	9.1265	10
30k	Other factors	10.5217	11

Inadequate owner funding was next, followed by designers' unfamiliarity with projects. Contractors blamed their own underbidding (4th) but blamed designers for lack of design detail. Lateness of information and inadequate cost control were diminished in importance. Interestingly, contractors ranked their unfamiliarity with project types as even less of a problem.

Discussion of the "gaps" between owners, designers, and contractors.

The data collected and described in the previous sections clearly point to gaps in the expectations and perceptions of health care facility (HCF) owners and the designers and contractors who carry out their construction projects. The gaps in understanding can be considered by making the following comparisons:

a) Owners versus designers

b) Owners versus contractors

C) Designers versus contractors

Variables of interest:

The variables of interest in this comparison are based on the survey items, and are as follows::

- Compensation formats
- Project delivery methods
- Performance evaluation criteria
- Owner satisfaction factors
- Designer selection criteria
- Contractor selection criteria
- Design considerations

- Construction process considerations
- Quality control effectiveness
- Satisfaction/schedule impacts
- Owner satisfaction inhibitors

In this section, the responses are compared in tabular fashion. The strength of association between the variables is further tested with regard to owners and designers; owners and contractors; and designers and contractors; through the application of Non-parametric Analysis of Variance.

Compensation formats:

No two parties ranked the factors in the same order. Whereas public owners ranked satisfaction with GMP with cost saving/sharing highest (see Table 4.57) private owners preferred other methods such as "time and materials", as did designers. Contractors ranked "cost plus a fee" highest; in fact that method is similar to time and materials.

TABLE 4.57 Satisfaction with compensation formats

		OWNERS				DESIGNERS		CONTRACTORS	
Ques. 13 Satis-faction	Compensation formats: Based on dollar value, how satisfied have you been with the following compensation formats? 1 = Most satisfactory, 7 = least.	Public Mean Score	Public Overall Rank	Private Mean Score	Private Overall Rank	Mean Score	Overall Rank	Mean Score	Overall Rank
13a	Lump sum	3.1129	2	3.2551	5	3.2562	3	2.8000	2
13b	Cost plus a fee	3.1212	3	3.2121	3	3.0100	2	2.6097	1
13c	Guaranteed maximum price	3.2352	4	3.1549	2	3.8416	5	3.0270	3
13d	GMP with cost savings	3.0500	1	3.2211	4	3.5000	4	3.0277	4
13e	Other	4.3333	5	2.4615	1	2.5263	1	3.5714	5

The ANOVA results are not in perfect agreement with these observations, as displayed in Figure 4.18. They indicate differences between public owners and designers, but show agreement between public and private owners. They also indicate agreement between public owners and contractors, between private owners and designers. Private owners are shown to agree closely with designers, but differ slightly with contractors, while designers and contractors also differed slightly.

The analysis of variance results in Table 7.1 in Appendix B indicate that the responses of private owners appear to agree with those of the designers except for the category "Guaranteed Maximum Price" (GMP). Despite the difference in ordinal ranking, the ANOVA does not indicate a statistically significant difference in responses between these two groups. Designers, when compared with contractors, do show a difference in the GMP category. The responses of public owners are similar to those of the designers for all categories except "other" methods of compensation. As was the case with private owners, public owners' responses agreed with those of the contractors. The responses of both public and private owners agreed on all four types of compensation cited, with the exception of "other".

TABLE 4.58 Satisfaction with project delivery methods.

		OWNERS				DESIGNERS		CONTRACTORS	
Ques. 14	Project delivery methods: How would you score your satisfaction with the following? 1 = Most satisfactory, 7 = least satisfactory.	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Mean Rank	Overall Rank	Mean Rank	Overall Rank
14a	Traditional Design-Bid-Build	3.159	3	2.889	2	2.970	1	3.206	3
14b	"Fast track"	2.846	2	3.608	5	3.924	6	2.512	1
14c	Design-Build	3.412	4	3.367	4	3.754	5	3.065	2
14d	Construction Management (fee paid)	3.417	5	3.194	3	3.478	2	3.304	4
14e	Construction Management (at risk)	4.333	6	4.545	6	3.652	4	3.550	6
14f	Other methods (please specify)	2.750	1	2.882	1	3.550	3	3.400	5

Project delivery methods:

As seen in Table 4.58, the parties differed greatly - owners cited other methods highest and construction management at risk lowest. Designers liked the traditional design-bid-build method best, and fast-track least, while contractors favored the latter method most. The analysis of variance provides a number of findings. The extent of similarities and differences is shown in Figure 4.18, IIA and IIB: Public owners appear to agree with designers on all project delivery methods except "fast track".

TABLE 4.59 Performance evaluation criteria

		OWNERS				DESIGNERS				CONTRACTORS			
Ques. 15	Performance evaluation criteria: what specific performance indicators do you generally use to judge the success of completed construction projects	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank
15a	Finishing within the time stipulated	3.826	5	3.279	3	4.140	4	3.964	4	3.466	3	2.796	1
15b	Adherence to budget agreed	3.43	2	2.566	1	3.259	3	2.665	1	3.205	2	2.833	2
15c	Quality of appearance (workmanship)	3.57	4	3.375	4	4.145	5	4.295	5	3.562	4	3.852	3
15d	Satisfactory job relations -(owners) with designers	6.686	8	6.867	8	3.227	2	3.783	3				
	Satisfactory job relations - owners with contractors									2.945	1	4.093	4
15e	Satisfactory job relations - (owners) with contractors	6.57	7	6.698	7	7.022	8	7.215	8				
	Satisfactory job relations - contractors with designers									5.753	6	5.741	6
15f	Building works well - meets end users' needs	3.093	1	2.962	2	2.694	1	3.060	2	4.877	5	5.426	5
15g	Performance of all electrical/mech/ specialized systems to specifications	3.512	3	4.155	5	5.326	6	5.430	6	6.056	7	6.111	7
15h	Minimal number and value of change orders	5.429	6	6.148	6	6.278	7	5.673	7	6.877	8	6.444	8
15i	Other (please specify)	7.329	9	8.142	9	8.304	9	8.031	9	7.000	9	6.481	9

Private owners agreed with designers on all categories. In the case of comparison with contractors, public owners agreed with them on all categories except traditional design -bid-build.

Private owners agreed with these contractors on all categories except "Fast track".

Performance indicators:

Designers and contractors were asked to rank the criteria separately for public and private projects. The gaps between the perspectives are clear - both owners rated satisfactory relations with designers lowest, while designers placed those relationships at the second or third level. Similarly, contractors ranked relations with owners higher than the owners did. The differences were narrower with regard to time and budget adherence. The analysis of variance (ANOVA) indicated significant differences in the rankings of the performance evaluation criteria between all the parties. These differences were evident in most of the criteria under the heading of performance to a greater extent than in several of the other factors that were compared in the research. The ANOVA summaries (Tables 7.19, 20, & 21) are located in Appendix B. The Dissonance Zone Analysis (Figure 4.23) is located at the end of this chapter. The areas of dissonance are discussed as follows:

Owners versus designers

Of eight (8) indicators that were compared, public Health Care Facility (HCF) owners agreed with designers on only three, as shown on Table 7.21 in Appendix B.. These were: Finishing within the time stipulated, Building works well, and Minimal number and value of change orders. Private owners disagreed on two items - Building works well, and "other" criteria.

Owners versus contractors

Public owners agreed with contractors on only one item - quality of appearance, Private contractors agreed with owners on two items - Finishing within the time stipulated, and minimal number and value of change orders.

Public owners versus private owners

Of nine criteria, there was dissonance between public and private owners on four of them. These were - Finishing within the time stipulated, Adherence to the budget agreed, Performance of electrical/mechanical systems to specifications, and minimal value and number of change orders. However, both groups appear to agree on performance criteria such as Qaulity of appearance, satisfactory job relations with designers and contractors, Building works well - meets end users' needs, and "other" issues. Overall, public and private owners may be said to agree on performance criteria to a far greater extent than they do with designers and contractors.

Owner satisfaction factors:

Owner satisfaction concerns are central to the research as they are treated as a proxy for project success. Table 4.60 showed that all the parties agreed in ranking cost adherence and project timeliness as 1st and 2ndrespectively. However, both designers and contractors ranked minimal disruption to operations and performance to specifications lower than the owners did. Interviews with facility managers identified these two factors as areas of significant concern. The ANOVA results indicate major differences between all the parties at the .05 level of significance, as shown by the dissonance zones in Figure 4.18, IIIA and IIIB, as well as Tables 7.5 and 7.6.in Appendix B.

TABLE 4.60 Owner satisfaction factors

		OWNERS				DESIGNERS				CONTRACTORS			
Ques. 16	To what extent do the following factors influence an owner's (facility administrator's) level of satisfaction with a construction project? Rank the factors in order of importance.	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank
16a	Timeliness of the project	3.482	2	3.224	2	3.301	2	3.071	2	3.041	2	2.545	1
16b	Adherence to cost estimates	3.294	1	2.485	1	2.356	1	2.036	1	2.986	1	2.782	2
16c	Clear up-front understanding of the job scope	5.06	5	5.180	5	4.953	5	4.876	5	5.301	7	5.218	7
16d	Clear ongoing communication on job status	5.718	8	5.632	8	4.949	4	4.512	4	4.767	6	4.909	5
16e	Prompt, adequate response to owner's complaints	5.153	6	5.489	6	3.941	3	4.029	3	4.397	3	4.400	3
16f	Attractive design/aesthetics (architectural features)	5.588	7	5.489	7	6.021	8	6.292	8	6.486	8	6.545	8
16g	High quality of construction - fit and finish	4.141	4	4.241	4	5.796	7	5.910	7	4.616	5	5.109	6
16h	Minimal disruption to ongoing facility operations	3.729	3	4.205	3	5.029	6	5.399	6	4.500	4	4.709	4
16i	Other (please specify)	8.714	9	8.615	9	7.594	9	7.8125	9	8.308	9	8.238	9

In private projects, designers and contractors differed on 3 of 9 criteria, including the importance of budget adherence and on fit and finish, with respect to construction quality. Private owners differed from designers on four of nine issues, including response to owners' complaints, aesthetics, fit and finish, and minimal disruption to ongoing facility operations. Public owners differed from designers and contractors to an even greater extent. Owners differed from contractors on six of nine issues, i.e., all except adherence to cost estimates, and the importance of a clear, up-front understanding of job scope. Owners differed from designers on all except two items, the up-front understanding of the job scope, and 'other' factors. Designers differed from contractors on three of nine items - adherence to cost estimates, fit and finish, and "other" factors.

TABLE 4.61 Designer selection criteria

		OWNERS				DESIGNERS				CONTRACTORS			
Ques. 17	Relationships (owners) with Designers: In selecting a design (or construction) organization, an owner typically relies on some of the following criteria. Rank the factors	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank
17a	Specialization in similar work	2.826	2	3.038	1	2.693	1	2.168	1	3.827	3	4.000	4
17b	Promised completion date	5.44	6	5.172	6	5.831	7	5.329	7	4.776	6	3.439	2
17c	Overall projected budget	4.81	5	5.030	5	5.382	6	4.586	4	4.000	4	2.772	1
17d	Track record/experience	2.74	1	3.276	2	2.958	3	2.707	2	3.591	2	3.607	3
17e	Recommendations by others	5.610	7	5.654	7	4.515	4	5.182	5	4.618	5	6.143	6
17f	Quality certification or use of techniqes such as TQM	7.587	9	7.379	9	7.910	8	7.366	8	7.579	8	6.678	8
17g	Previous project relationship between owner and designer	3.506	3	3.582	4	2.752	2	4.234	3	3.387	1	4.821	5
17h	Use of innovative construction technology	6.941	8	7.098	8	8.042	9	8.133	9	8.000	9	7.714	9
17i	Perceived responsiveness/customer understanding	4.714	4	4.211	4	4.639	5	5.287	6	5.600	7	6.241	7
17j	Other (please specify)	9.74	10	8.310	10	9.098	10	9.071	10	8.920	10	8.650	10

With regard to selecting a design organization, designers seemed to understand owners from a marketing point of view, although owners relied more on 'track record' than designers thought they did. Both private and public owners cited their top four concerns as track record and experience, specialization in similar work, previous project relationship, and perceived responsiveness to the customer.

Design considerations:

As shown in Table 4.62, all owners and designers concur that meeting basic functional requirements is the most important design consideration. System reliability and ease of maintenance and flexibility for future adaptation appear to be more important to HCF representatives than to designers. The ANOVA results on Table 7.8 (Appendix) and Figure 4.21, XIII, indicate major differences between designers and both public and private owners, at the .05 level of significance. They disagree on important design considerations, such as: maintainability, system reliability, aesthetics, the importance of meeting basic functional requirements, and the incorporation of the latest technology. This finding is most important, as the owner-designer relationship is central to the development of designs that best meet the owner's needs.

TABLE 4.62. Design considerations

		OWNERS				DESIGNERS			
Ques. 18	Design Considerations: As the Owner's representative, you have to balance a number of conflicting priorities and criteria when having construction work designed. Rank the factors.	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank
18a	Lowest life cycle cost	5.716	6	5.3484	6	5.8212	7	5.7469	7
18b	Ease of maintenance/maintainablity	3.705	3	3.8636	2	4.9063	5	4.4819	4
18c	User "Friendliness"	4.069	4	4.1503	4	3.7361	2	4.0662	2
18d	System reliability (failures minimized)	3.621	2	3.8939	3	4.5063	4	4.4397	3
18e	Aesthetics (physical attractiveness)	6.0340	7	5.8195	7	4.3234	3	4.8373	5
18f	Lowest first cost (when constructed)	6.716	9	6.5000	8	7.1282	8	6.3333	8
18g	Meeting basic functional requirements	3.437	1	3.2857	1	2.2042	1	2.3614	1
18h	Flexibility for future adaptation	5.102	5	4.9015	5	4.9957	6	5.6204	6
18i	Incorporation of latest technology within the facilities	6.233	8	6.8549	9	7.2017	9	7.5151	9
18j	Other (please state)	9.75	10	8.9697	10	9.7777	10	9.9189	10

It was observed that private and public owners disagreed on only one item - the incorporation of the latest technology.

<u>Construction process considerations (environmental):</u>

With regard to environmental construction process considerations, owners, designers, and contractors seem to understand the working environment - except for contractors' ranking of public projects, all considered the interruption of utilities to be the most critical, and vibration and noise the least. Figures 4.19, IVA, and IVB, illustrate the findings from the ANOVA tabulation on Tables 7.9 and 7.10 in Appendix B.

Owners differed less from contractors than from designers; private owners disagreed with designers on the roles of noise, dust, and physical obstacles. They differed from contractors only on the issue of dust. Public owners differed from designers on the significance of pathogens and vibration, and from contractors only on the role of noise.

TABLE 4.63 Construction process considerations (environmental)

		OWNERS				DESIGNERS				CONTRACTORS			
Ques. 20	(Environmental). Rank the Contractor's ability to manage these problems in terms of importance	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank
20a	Noise	3.837	3	3.731	4	4.004	5	4.129	4	3.320	2	3.175	1
20b	Odors (solvents, etc.)	4.256	6	4.452	6	4.427	6	4.521	6	4.467	6	4.421	6
20c	Dust	4.081	5	3.504	2	3.944	4	4.135	5	3.960	5	3.947	4
20d	Contamination by pathogens	3.837	4	3.746	5	3.671	3	3.395	3	3.947	4	4.105	5
20e	Physical barriers/debris unsafe to users	3.57	2	3.724	3	3.427	2	3.239	2	3.760	3	3.702	3
20f	Vibration	5.64	7	5.481	7	5.263	7	5.227	7	5.413	7	5.375	7
20g	Interruption of utilities	2.663	1	3.097	1	2.905	1	2.988	1	3.027	1	3.246	2

<u>Construction process considerations</u>:

There was a close agreement between the responses of public and private owners, but significant differences existed between the other parties, as seen on the ANOVA Tables 7.11, 7.12, and Figure 4.19, VA and VB. All the parties thought that schedule flexibility was most critical, and submission of "as built" drawings the least. However, owners ranked contractors' training of staff higher than did designers or contractors. Designers and contractors differed at the .05 level of significance on several items - In public projects, they agreed only on the importance of training of the owner's staff and warranty responsiveness.

TABLE 4.64 Construction process considerations

		OWNERS				DESIGNERS				CONTRACTORS			
Ques. 21	Relative to contractors, rank the following 6 factors in order of importance	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Public Mean Rank	Public Overall Rank
21a	Ability to adjust schedule to owner/ organization's operating needs	1.471	1	1.338	1	1.345	1	1.369	1	1.282	1	1.750	1
21b	Training of Owner's staff on equipment installed	3.356	3	3.370	3	3.332	4	3.219	4	3.474	4	3.179	2
21c	Commissioning: Testing, adjusting systems to meet owners' expectations	2.931	2	3.059	2	2.849	2	2.800	2	3.115	3	3.179	3
21d	Prompt response to Owner's warranty calls	3.448	4	3.507	4	3.000	3	3.200	3	2.474	2	3.875	4
21e	Prompt submission of "as built" drawings, approval certificates, etc.	3.943	5	3.851	5	4.685	5	4.556	5	4.744	5	4.143	5
21f	Other (please state)	5.788	6	5.625	6	5.327	6	5.314	6	5.917	6	5.765	6

In private projects, they agreed only on the training issues. Designers and owners had a lesser degree of divergence - with private projects, they disagreed on all items except the importance of training the owner's staff on equipment installed. With public projects, they agreed on this latter item, and the appropriate response to warranty breakdown calls. Private owners differed from contractors on the importance of warranty responsiveness and the submission of completed 'as built' drawings. Public owners differed from contractors on warranty responsiveness only.

Effectiveness of quality assurance methods:

As displayed in table 4.65, the parties diverged significantly on this item - both public and private owners thought they could best assure quality through their own

TABLE 4.65 - Quality control effectiveness

		OWNERS				DESIGNERS		CONTRACT-ORS	
Ques. 22	How effectively is quality controlled in the majority of your construction projects by the following?. Rank them for effectiveness 1 = Most effective, 5 = Least effective.	Public Mean Rank	Public Overal l Rank	Private Mean Rank	Private Overall Rank	Mean Rank	Overall Rank	Mean Rank	Contractor's Overall Rank
22a	By the designer as quality control inspector	2.5538	2	2.3362	2	1.7244	1	2.4838	2
22b	By the owner's staff person as quality control inspector	5.6590	1	1.5614	1	2.6923	2	2.7098	3
22c	By an independent quality control inspector	4.9425	3	3.3300	3	2.7597	4	2.9166	4
22d	By contracting staff	4.6136	4	3.5887	4	3.3131	5	2.1451	1
22e	Other	5.6666	5	4.3888	5	2.5428	3	4.3571	5

staff person, and somewhat less effectively through the designer or by an independent quality control inspector. Designers, on the other hand, considered themselves best at quality assurance, with the contractor last. Contractors thought they were best at doing their own quality control, and rated the designers more highly than the owners in this regard. The differences observed on this topic are among the greatest in the study; the quality of the completed facilities has the greatest impact on owner satisfaction. Tables, 7.13, 7.14, (See Appendix B) and Figure 4.19, VIA &VIB indicate the extent of these differences. Private owners disagreed with designers on the effectiveness of all five proposed methods of quality control. They disagreed with contractors on three alternatives, the relative effectiveness of the owner's inspector, an independent inspector, and the contractor's inspector. Not surprisingly, the contractor and designer agreed on the owner's inspector and an independent inspector - those two categories did not include them. Public owners agreed with designers on only three of five alternatives - the independent inspector, and contracting staff. Notably, these categories excluded them both. Public owners disagreed with contractors on the owner's inspector, and the contractor's inspector.

Reaction to schedule increases:

As shown in Table 4.66, the general trend in responses to schedule increases(delays) was for all parties to directly relate this to lowering of owner satisfaction. Private owners assigned a greater degree of impact to incremental changes in schedule than did public owners. Private owners differ equally from designers and contractors on the impact of schedule delays in three increments - 0 to 5%, 5% to 15%, and 15% to 30%. A lower level of dissonance was indicated with public owners' projects - these owners agreed fully with contractors and disagreed with designers on only the first increment of delay.

TABLE 4.66 - Satisfaction with schedule increases

		OWNERS				DESIGNERS		CONTRACTORS	
Ques. 27	As an owner's representative, in general, how negatively would your level of satisfaction be affected by the following increases in schedule? 1 = Not at all, 5 = very much.	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Mean Rank	Overall Rank	Mean Rank	Overall Rank
27a	0 - 5%	2.0459	1	2.2631	1	1.8205	1	2.0909	1
27b	5% - 15%	3.2873	2	3.4427	2	3.2198	2	3.2179	2
27c	15% - 30%	4.3953	3	4.5419	3	4.4000	3	4.3376	3
27d	30% - 50%	4.8588	4	4.8914	4	4.8771	4	4.8125	4
27e	Over 50%	4.9764	5	4.9545	5	4.9869	5	4.9500	5

Reaction to cost increases:

As was the case with schedule delays, differences were observed between the parties with respect to cost increases in HCF construction projects. Designers and contractors differed greatly, on four of five cost increments. Private owners differed from designers on the first two cost ranges, and from contractors on the second and third ranges. Public owners experienced the very same differences with designers and contractors. Public and private owners were shown by the ANOVA to have no differences at the .05 level of significance.

Desired Frequency of Interaction (Owner's Survey Question #29)

Figures 4.24 (a, b, & c) indicate the respective frequency of meetings that owners, designers, and contractors collectively desired. The question was posed as needing to identify the meeting frequency that would best meet the *owner's* needs.

Three distinct construction phases were identified - the design stage, the construction stage, and the warranty stage (after completion). No distinction was made between private and public owners when the question was posed to the sample populations.

Design stage

The modal response occurred at the 'once weekly' increment. Designers represented the greatest response at 44.6%, followed by owners at 43.5%., and contractors at 29.8%. The next highest set of responses occurred at biweekly intervals; both designers and contractors reflected a higher percentage than owners - 33.3%, 36.5%, and 36.4%.

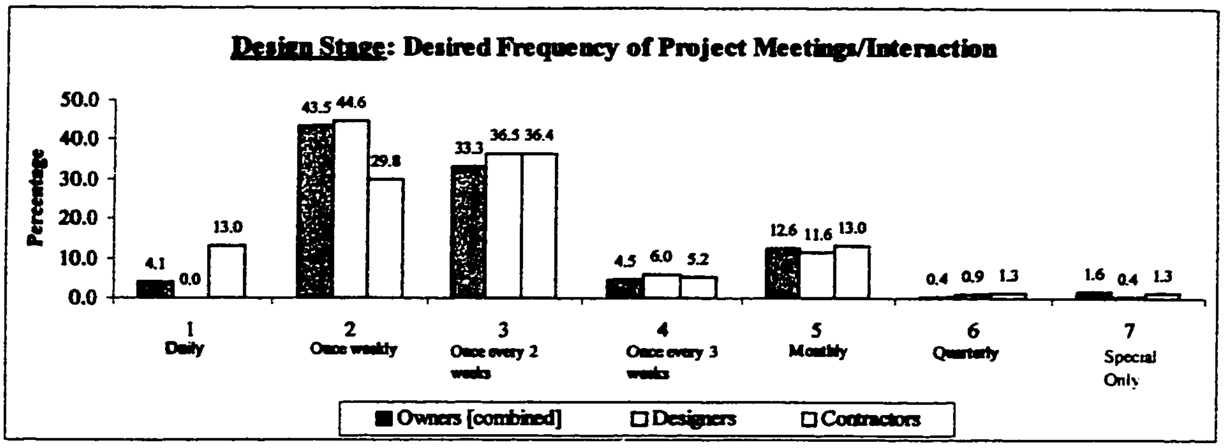


Figure 4.24a Design Stage-Frequency of Meetings/Interaction

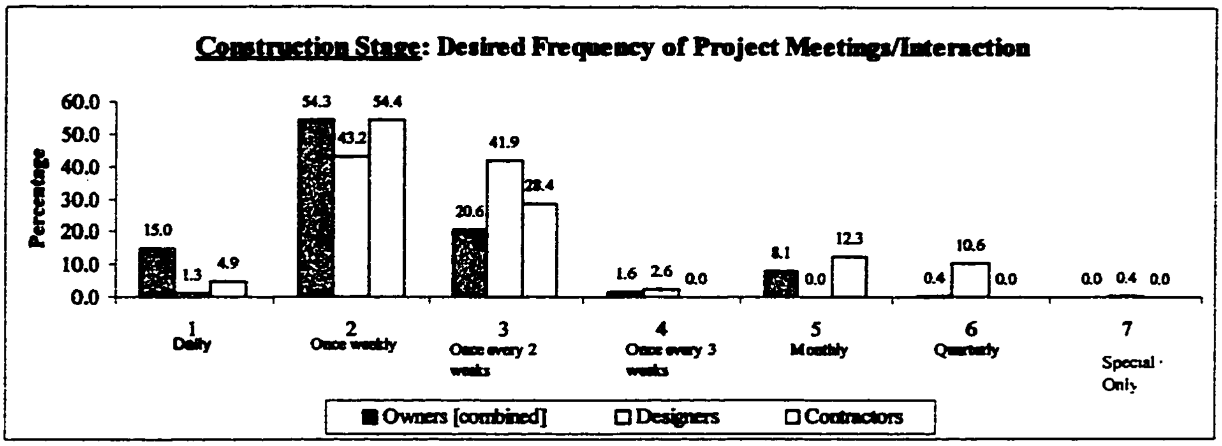


Figure 4.24b Construction Stage-Frequency of Meetings/ Interaction

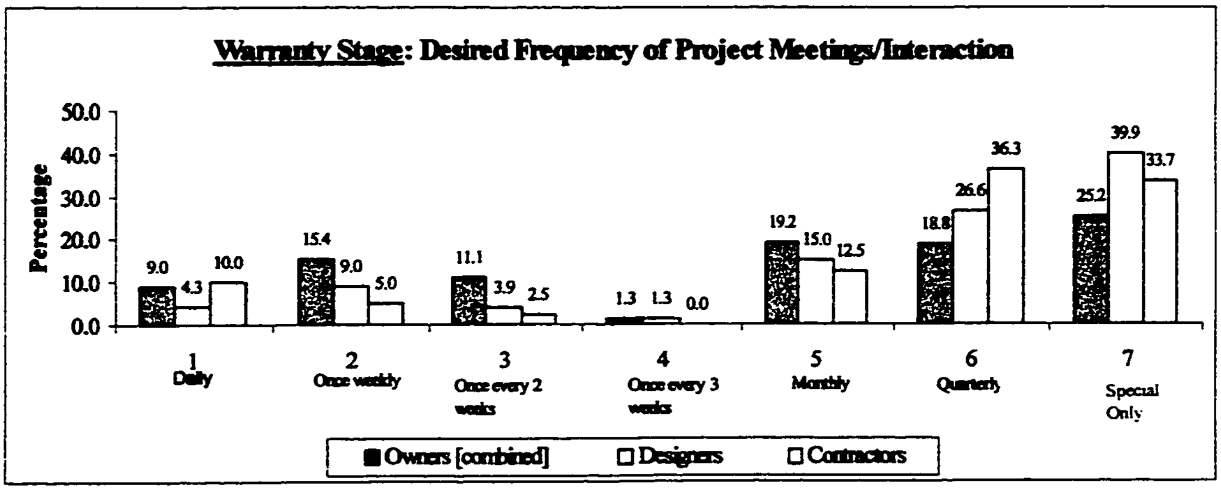


Figure 4.24c Warranty Stage-Frequency of Meetings/ Interaction

Construction stage

The modal response occurred at the 'once weekly' increment; both the contractors and owners desired to meet at that interval at a greater frequency than did the designers. The next highest set of responses occurred at biweekly intervals, but designers were the group that expressed the highest interest in that frequency, at 41.9% vs 20.6% and 28.4% for owners and contractors, respectively. It must be noted that a fair-sized constituency of owners (15%) expressed a desire to meet on a *daily basis* during the construction stage.

Warranty stage

The modal response at this stage occurred at the 'special occasions only' interval, followed by 'quarterly' intervals. Both contractors and designers showed a greater interest than did owners, with respect to meeting at these intervals. A small constituency of owners and contractors 9% and 10% respectively, desired to interact daily, and that is worthy of note.

Obstacles to owner satisfaction in the construction process:

Owners, designers, and builders differed greatly in their opinions of the obstacles to owner satisfaction in the construction process. Both public and private owners saw lack of detail in drawings and specifications as the primary cause, followed by poor estimating by designers, and poor day-by-day construction planning. Designers placed the highest blame on poor cost control (by contractors) followed by inadequate project funding by owners. Contractors ranked inadequate designer estimates highest, followed by inadequate project funding. Overall, the role of codes in promoting good workmanship was placed at the lowest level of priority by all parties.

Table 4.67 Barriers to owner satisfaction

		OWNERS				DESIGNERS		CONTRACTORS	
Ques. 30	Which aspects of the design & construction process presents the greatest barriers to the satisfaction of the owner organization?	Public Mean Rank	Public Overall Rank	Private Mean Rank	Private Overall Rank	Mean Rank	Overall Rank	Mean Rank	Overall Rank
30a	Underbidding by contractors	5.507	5	5.566	7	5.482	7	4.802	4
30b	Inadequacy of project funding by owners for features desired	5.659	6	6.023	8	4.116	2	4.432	2
30c	Underpricing of project estimates by designers	4.944	4	4.628	2	4.348	3	3.688	1
30d	Poor day-to-day project planning for construction	4.614	2	4.679	3	5.155	5	5.423	6
30e	Inadequate cost control	5.667	7	5.085	5	3.896	1	5.696	8
30f	Unfamiliarity of designers with the type of project	4.693	3	4.885	4	5.126	4	4.463	3
30g	Unfamiliarity of contractors with the type of project	5.701	8	6.254	9	6.013	8	6.282	9
30h	Lateness of information needed for a type of project	5.793	9	5.504	6	5.203	6	5.463	7
30i	Lack of detail in drawings and/or specifications	4.239	1	4.411	1	6.212	9	5.338	5
30j	Failure of codes to guarantee good workmanship and finish	7.953	10	8.031	10	9.040	11	9.127	10
30k	Other factors	9.458	11	9.079	11	8.180	10	10.520	11

The results of the ANOVA are indicated in Figure 4.20, IXA and IXB, as well as Tables 7.17 and 7.18. At the .05 level of significance, the greatest differences are observed between owners and contractors. Public HCF owners agree with contractors on only three of eleven possible barriers to owner satisfaction - inadequate cost control, unfamiliarity of designers, and the lateness of construction-related information. Private owners agree with contractors on only two factors - unfamiliarity of contractors, and lateness of information. Designers agree with contractors on all except four of eleven items - underpricing of estimates by designers, inadequate cost control (by contractors), lack of detail in drawings, and 'other' causes. Owners, both public and private, disagree with designers on only four of eleven items - inadequacy of project funding, inadequate cost control, lack of detail in drawings and specifications, and the failure of codes to guarantee good workmanship and finish.

A Comparison of Public and Private owners.

The survey responses of both public and private health care facility (HCF) owners were compared in order to determine the degree of difference between their needs, if any. The motivation for ascertaining that difference is to incorporate compensatory adjustments to a proposed model that will optimize owner satisfaction and project performance. As previously discussed, a statistical analysis was carried out to compare the manner in which both parties ranked a number of performance and satisfaction-related criteria. This information was further subjected to a non-parametric analysis of variance (using SAS software) in order to determine the degree of difference (or dissonance) between them. The following discussion is based on the specific variables with which both sample populations were tested. Reference should be made to Figures 4.21 and 4.22, the Dissonance Zone Analysis for the two survey populations. The comparisons were made on the basis of the following factors.

1) Question 13. Satisfaction with project compensation formats.

No differences were noted between both sample populations at the .05 level of significance. There were differences in the ordinal rankings, although the variability of the data could account for the ANOVA interpretation of no significant difference. Public owners listed a higher preference for lump sum and GMP with cost savings sharing than did private owners. Private owners rated "other methods" highest, followed by GMP, whereas public owners rated those methods lowest.

2) Question 14. Satisfaction with project delivery methods.

The dissonance zone diagram indicates two areas of difference, of the five factors noted. The ANOVA indicated those items of dissonance to be "fast track" and design-build. Although both groups cited "other methods" as the preferred project delivery method, the second, third and fourth rankings were different. Public owners preferred "fast track" followed by the traditional design-bid-build method, and Design-build. Private owners' next three preferences were design-bid-build, followed by construction management (fee paid) and design-build.

3). Question 15. Performance evaluation criteria.

Public and private owners have a fair number of differences noted at the .05 level of significance as noted in a preceding discussion. Four items of performance evaluation criteria, of a total of nine, exhibited the great extent of these differences.

4) Question 16. Owner satisfaction indicators.

The ANOVA indicated a single dissonance, i.e., adherence to cost estimates. The tabulated mean rank for this item shows a lower value for private owners - 2.48 as compared with 3.29 for public owners. Although the assigned ranking was first for both sample populations, the dispersion in the data could result in the statistically significant difference.

5) Question 18. Design considerations.

The single dissonance item observed under this heading was "incorporation of latest technology". Although both groups assigned low rankings to this item, public owners' ranking of 8th place was higher than private owners'9th place ranking. At the same time both groups were equally, and more concerned about flexibility for future adaptation by listing it in 5th place. Two factors come to mind in this context; a) Public owners have a sense of permanence and are more willing to extend their budgets with the latest technology, whereas private owners are wary of the ongoing changes in the industry, b) the latest trend towards "healing environments" does not emphasize high technology. Both sample populations disagreed significantly with the respective designers with whom they interact on projects, on half or more of the ten factors of comparison: maintainability, system reliability, aesthetics, meeting basic functional requirements, and the incorporation of the latest technology. In addition, private owners disagreed on "other factors".

6) Question 20. Construction process considerations (environmental).

A single dissonance item was indicated - the production of dust in construction or renovation projects. Private owners ranked this item 2nd as compared with 5th place for public owners.

7) Question 21. Construction process considerations.

No differences were registered under this category. Both groups registered the same rankings, with the top three concerns being 1) The contractor's ability to adjust schedules to meet the owner's operating needs, 2) The commissioning of new systems to meet the owner's needs, and 3) The training of the owner's staff on the equipment installed.

8) Question 22. Quality control effectiveness

No statistically significant differences were registered under this category. Both groups of owners rated their quality control efforts to be more effective than all other alternatives, followed by having the designer assigned this function. Both groups agreed that the contractor's quality control efforts were not the most effective in meeting the owner's needs.

9) Question 27 (A) Satisfaction with schedule delays.

No statistically significant differences were noted between public and private owners' responses. Both groups expressed progressive decreases in satisfaction as schedules were delayed. The mean ranks suggested that private owners assigned a greater degree of impact to these incremental changes than did public owners.

10) Question 27 (B) Satisfaction with cost overruns.

No statistically significant differences were noted between public and private owners' responses. Both groups were only slightly impacted by cost increases of 5%, but expressed close to moderate concern with changes between 5% and 15%. Both were very dissatisfied with increases over 30%.

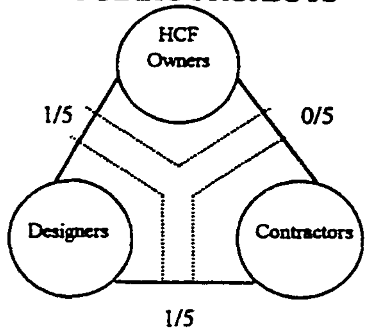
11) Question 30. Barriers to owners' satisfaction.

Both public and private owners had close agreement on the barriers to their satisfaction. The one area of difference was on the impact of the lack of detail in drawings and specifications prepared by designers. It is noteworthy that both sample populations listed that item as their number 1 concern, but the variability in data could provide differential ANOVA results. When comparisons were made between owners and designers, both groups differed on the basis of four factors out of eleven. In both cases, these factors were: the lack of design detail, the inadequacy of project funding, the inadequacy of cost control, and the failure of codes to guarantee workmanship.

Fig. 4.18 **Dissonance Zone Analysis**

IA PUBLIC PROJECTS

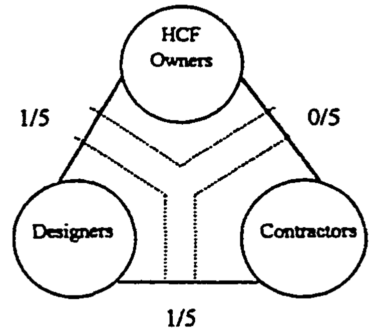
Ques. 13



Compensation formats

IB PRIVATE PROJECTS

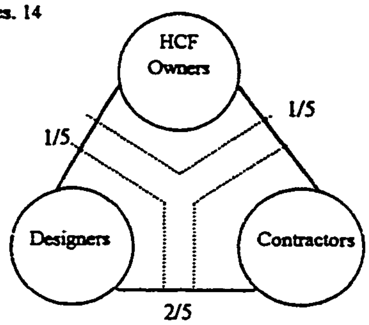
Ques. 13



Compensation formats

IIA

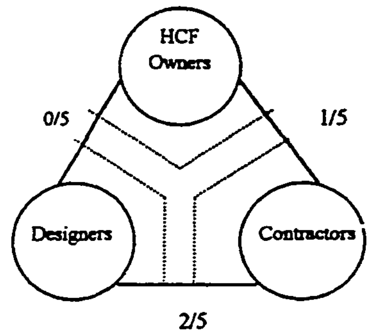
Ques. 14



Project delivery methods

IIB

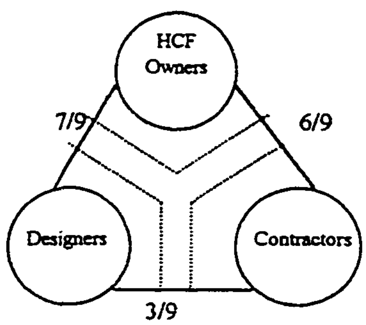
Ques. 14



Project delivery methods

IIIA

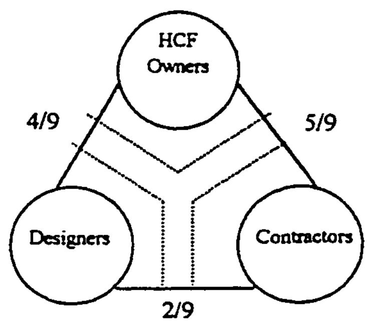
Ques. 16



Owner satisfaction criteria

IIIB

Ques. 16



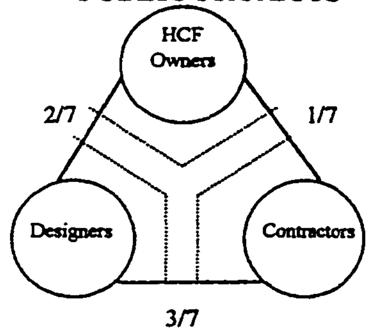
Owner satisfaction criteria

NOTES:
The dissonance zones are labeled to represent the degree of disagreement between dyads, based on the Nonparametric Analysis of Variance calculations.

Fig. 4.19 **Dissonance Zone Analysis**

IVA PUBLIC PROJECTS

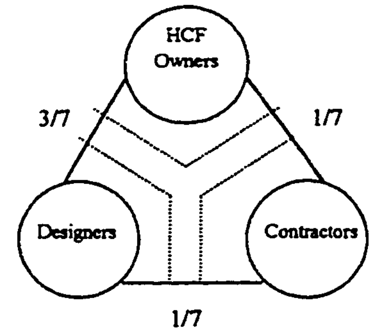
Ques. 20



Construction process considerations (environmental)

IVB PRIVATE PROJECTS

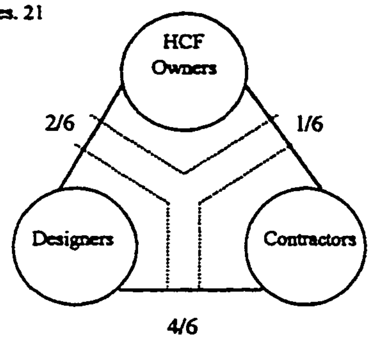
Ques. 20



Construction process considerations (environmental)

VA

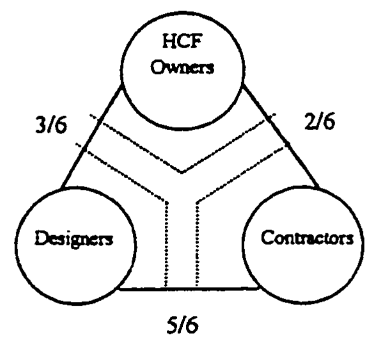
Ques. 21



Construction Process considerations

VB

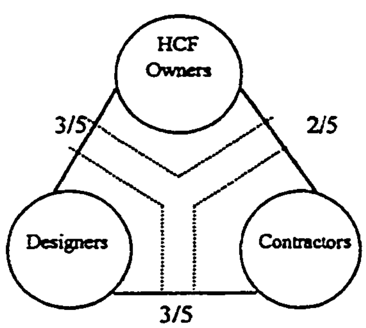
Ques. 21



Construction Process considerations

VIA

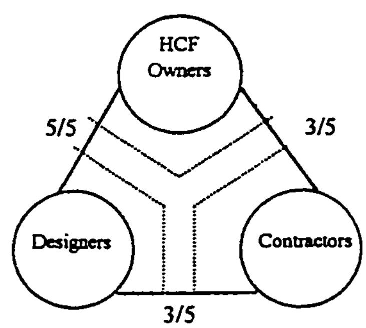
Ques. 22



Quality Control methods
(Effectiveness)

VIB

Ques. 22



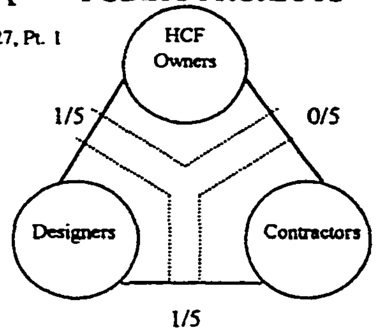
Quality Control methods
(Effectiveness)

NOTES:
The dissonance zones are labeled to represent the degree of disagreement between dyads, based on the Nonparametric Analysis of Variance calculations.

Fig. 4.20 **Dissonance Zone Analysis**

VIIA PUBLIC PROJECTS

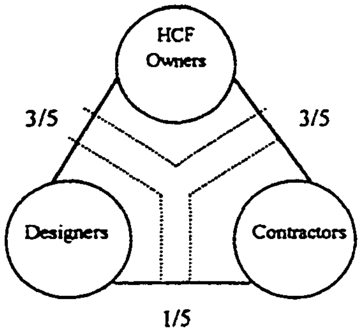
Ques. 27, Pt. 1



Owner's satisfaction with schedule delays

VIIB PRIVATE PROJECTS

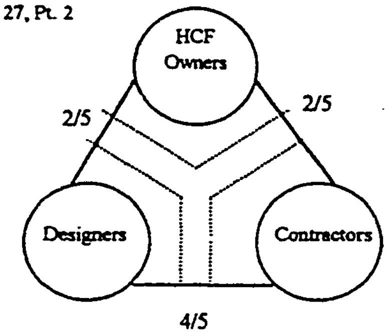
Ques. 27, Pt. 1



Owner's satisfaction with schedule delays

VIIIA

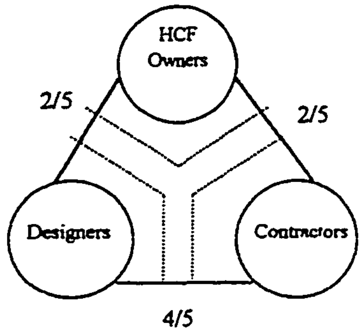
Ques. 27, Pt. 2



Owner's satisfaction with cost overruns

VIIIB

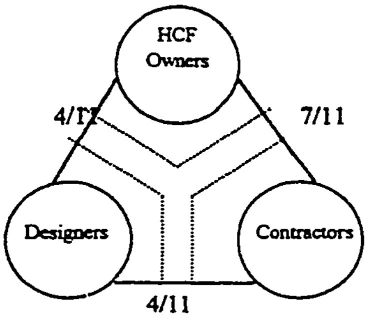
Ques. 27, Pt. 2



Owner's satisfaction with cost overruns

IXA

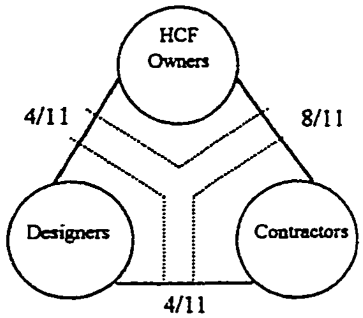
Ques. 30



Barriers to owner satisfaction

IXB

Ques. 30



Barriers to owner satisfaction

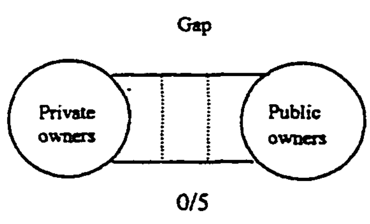
NOTES:
The dissonance zones are labeled to represent the degree of disagreement between dyads, based on the Nonparametric Analysis of Variance calculations.

Fig. 4.21 **Dissonance Zone Analysis**

Comparison of Public and Private Owners' Responses

X

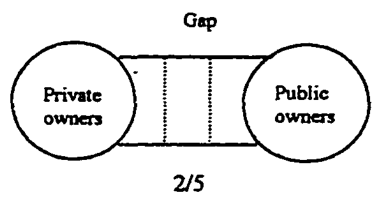
Ques. 13



Satisfaction with compensation formats

XI

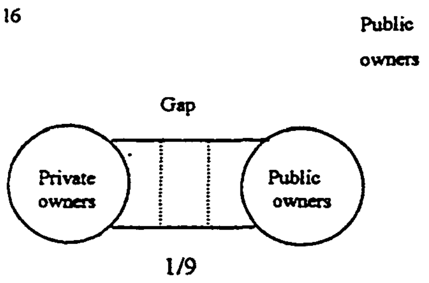
Ques. 14



Satisfaction with project delivery methods

XII

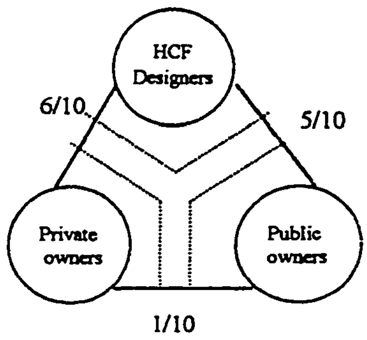
Ques. 16



Owner satisfaction indicators

XIII

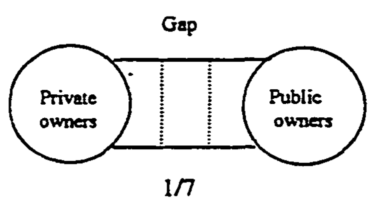
Ques. 18



Design considerations

XIV

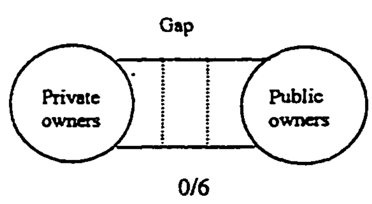
Ques. 20



Construction process considerations (environmental)

XV

Ques.21



Construction process considerations

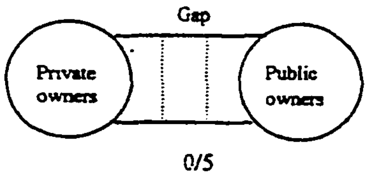
NOTES:
The dissonance zones are labeled to represent the degree of disagreement between dyads, based on the Nonparametric Analysis of Variance calculations.

Fig. 4.22 **Dissonance Zone Analysis**

Comparison of Public and Private Owners' Responses

XVI

Ques. 22

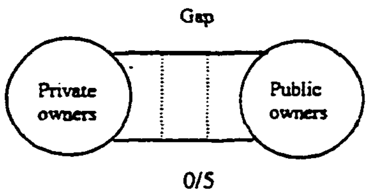


Quality control methods (effectiveness)

XVI

Ques. 27

Part 1



Satisfaction with schedule delays

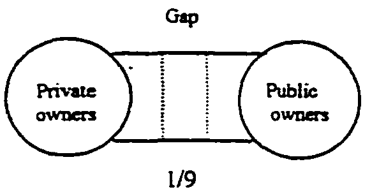
XVII

Ques. 27

Part 2

Public

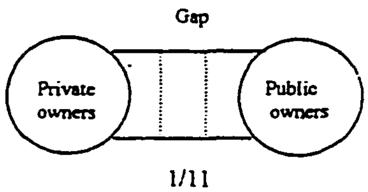
owners



Satisfaction with cost overruns

XVIII

Ques. 30



Barriers to owner's satisfaction

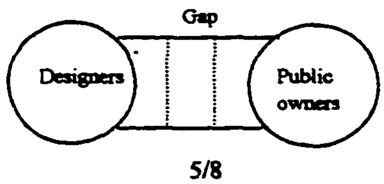
NOTES:
The dissonance zones are labeled to represent the degree of disagreement between dyads, based on the Nonparametric Analysis of Variance calculations.

Fig. 4.23 **Dissonance Zone Analysis**

Performance Evaluation Criteria

XIX

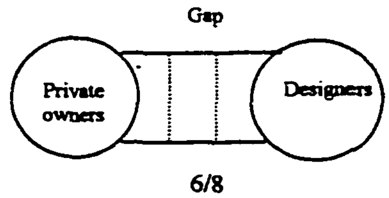
Ques. 15



Gaps between Public Owners and Designers

XX

Ques. 15

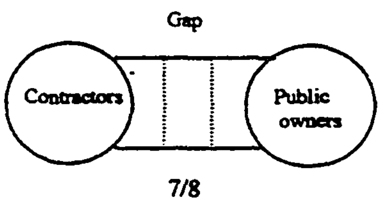


Gaps between Private Owners and Designers

XXI

Ques. 15

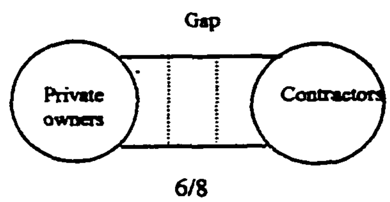
Public owners



Gaps between Public Owners and Contractors

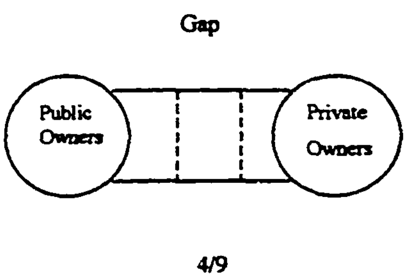
XXII

Ques. 15



Gap between Private Owners and Contractors

XXIII



Gaps between Public and Private Owners

NOTES:
The dissonance zones are labeled to represent the degree of disagreement between dyads, based on the Non-parametric Analysis of Variance calculations.

Chapter V

RESULTS OF THE PROJECT-SPECIFIC SURVEY

As described in Chapter III (Methodology), Phase VII of the research involves a survey of specific completed hospital/HCF construction projects. The purpose of the project-specific analysis is to develop a three-dimensional project-specific database involving Health Care Facility (HCF) owners, designers, and contractors. Through this process it would be possible to examine for a given project with its owner, designer, and contractor. The project-specific data will be based on the information compiled in the primary survey. This information is to be used to develop a conceptual framework for a National Database that incorporates owner satisfaction criteria as well as performance guidelines for designers and contractors. As previously stated, the research posits that the application of such a framework can reduce the time and cost incurred in HCF construction/renovation projects, and measurably improve levels of quality and customer satisfaction in HCF owner representatives.

Review of the Survey Process

a) Project Identification

Thirty sites were visited in the State of Florida, and the responsible administrators were asked to support the research. These administrators typically held titles such as: Chief Operating Officer (COO), Vice President of Facilities, Director of Facilities, Director of Construction, Corporate Project Manager, Project Manager, and Maintenance Manager. The criteria given to these individuals for eligible projects were:

- New construction or the renovation or remodeling of existing facilities.
- Completion within the previous 5 years, in order to facilitate recollection of the conduct of the project.
- A value of $50,000 or more.

Contact information was acquired for the designer and contractor for each respective project, in order to have the required three-way response. Some of the administrators represented both municipal and corporate health care systems that each consisted of several hospitals.

A total of fifteen (15) projects were indicated for the purpose of the project-specific evaluation.

b) Data Collection

For each of the fifteen projects, the designers and contractors were contacted for their corresponding input and documentation. They were contacted by telephone, fax, letter, and personal visits where the locations made it practical to do so. It was discovered that, as is often the trend in the construction industry, contractors tend to move from one city to the next in order to carry out their projects. Once a project is completed, they shift all their attention to the next one; mid-level and lower-level staff also tend to move from one company to the next, often in order to remain employed. To a lesser extent, the foregoing observations also apply to design firms.

Consequently, many of the contractors and designers who participated responded from locations that were geographically removed from the respective projects in the research.

Of the fifteen projects that were previously identified, it was possible to obtain full documentation for ten (10) of them. This documentation represented all three respondents for each project - owners, designers, and contractors. The responses were compiled on a spreadsheet (See Table 5.2) in order to facilitate review.

Explanation of Health Care Facility (HCF) Construction Data Base

It is anticipated that the documentation of the data for the specific projects can be developed in the future as a national database, essential towards creating a HCF construction report card system. Table 5.1 describes the concept with a small amount of data, and Table 5.2 further explains the documentation and conclusions from the ten (10) projects that were investigated.

The purpose of the spreadsheet (Table 5.2) is to display the characteristics of each project in a manner that will allow conclusions to be drawn readily. The gaps in expectations and perceptions of HCF owners, designers, and contractors are considered to have a major impact on the outcome of each project, with respect to the satisfaction of the owner. Comparisons are made between the priorities of the three parties, in order to observe the existence and effects of these gaps. A number of factors are used for comparison purposes, based on the project-specific responses of owners, designers, and contractors, respectively.

<u>Explanation of Table 5.2 "SUMMARY OF PROJECT CHARACTERISTICS FROM THE PROJECT-SPECIFIC SURVEY"</u>

Table 5.1 below is used to explain table 5.2 which reflects the projects that were used for the collection of project-specific data. This table merely illustrates a few of the types of data recorded in table 5.2. It is a typical representation of the above mentioned database for only a portion of the criteria that are considered in a typical project. Only some of the columns in the data base are indicated for purposes of illustration. ***The example is derived from the summary table for Project Number 1, a medical office building and parking garage.*** The fields in the table are explained in the narrative below the table, with respect to the numbered columns. It is important to note that columns 10, 11, and 12 are used to record the 'top three' rankings for each of several criteria that are used in the survey process.

<u>Table 5.1 Partial Summary of HCF Project-specific Observations</u>

(Column numbers)

C1	C2	C 6	C7	C 8	C10	C11	C12	x	C32	C33
					"Top three" performance evaluation criteria			Other criteria		
Proj no.	Project Descript.	Compen-sation format/ Award method	Project delivery method	Respond-ent: O =owner D = designer. C =contr-actor	1	2	3		Inter-action frequ-ency desired	Compos-ite owner satisfact-ion score
1	Medical office building and parking garage	GMP/S Low bid	Design, bid, build (DBB)	O	f	c	b		1 per month	3.1
				D	f	b	a		1 per week	
				C	e	b	c		1 per 2 wks	

In table 5.1, only the category 'performance evaluation criteria' is indicated, by way of an example. The 'top three' criteria are deliberately selected for visual review purposes, but a computer-based system would be able to manipulate all the variables that are identified as being important.

Column number	Description of field
C1	Project number
C2	Project description
C6	Compensation format/Award method (In this case Guaranteed Maximum Price with cost saving sharing - GMP/S was utilized. Award was based on the lowest bid).
C7	Project delivery method - the method used was design-bid-build (DBB).
C8	Three respondents are indicated--the owner, designer, and contractor.
C10, C11, C12	Columns 10, 11, and 12 represent the performance evaluation criteria that are applied to the specific project, using the letter codes below:

Letter code	Individual questions corresponding to letter codes
a)	Finishing on time
b)	Adherence to budget
c)	Quality of appearance
d)	Satisfactory job relations--owner with designer
e)	Satisfactory job relations--owner with contractor
f)	Building works well
g)	Performance of systems to specifications
h)	Minimum number and value of change orders
i)	Other

10) The 'number 1' choice of performance criteria is 'f' for owners and designers. That item represents 'performance to specifications; the contractor's choice was 'e', satisfactory relations--owner with contractor.

11) Owners choose 'c', quality of appearance, as a number 2 priority. Designers and contractors choose 'b', adherence to budget, as a number 2 priority.

12) The third priority is 'b', 'a', and 'c'--adherence to budget, finishing on time and quality of appearance, for owners, designers, and contractors, respectively.

X) This column symbolizes several other criteria that may be applied in the same manner.

32) Interaction frequency: Owners expressed a desire to meet once monthly, Designers, once weekly; and contractors, once every two weeks.

33) Composite owner satisfaction score: This overall score represents the owner's level of satisfaction, based on several aspects of the conduct of the completed project. The range used is 1 = 'best' to 5 = 'worst', with 3 = neutral. In this instance, a score of 3.1 represents an experience that was slightly worse than neutral.

An explanation of the owner satisfaction scores

The Owner's project specific survey is used to calculate an overall score that represents the level of satisfaction with the overall construction process. Section 'D' of the Owner's Survey (see Appendix A) addresses several questions to factors that are a combination of both service quality metrics and product quality metrics. A 5 - point Likert scale is used to test the Owners' level of agreement with a statement of performance, over a continuum from 'strongly agree'= 1(best) to 'strongly disagree' = 5(worst). 'Neutral' is assigned a mid-range score of 3.

The composite Owner Satisfaction score is computed as the simple mean of the raw scores for each project. It is regarded as the dependent variable in the conceptual framework. *In project # 1*, the score is calculated as follows:

	Description of factor	Score
Availability of support:		
1 a)	Whenever our organization needed to discuss a project, a designated representative could be easily contacted	2
1b)	Meetings were held at times my organization found convenient	3
Responsiveness:		
2a)	Whenever a construction problem was identified to the designated representatives, someone responded within a reasonable time	4
2b)	Warranty problems were fixed within a reasonable time with minimal inconvenience to occupants	2
Communication/pleasantness of support:		
3a)	Problems were always identified and explained in a clear, concise manner	1
3b)	If a dispute arose it was addressed quickly and amicably	2
Product Quality:		
4a)	The fit and finish of the final product conveyed an impression of good quality	3
4b)	The materials used in the project appeared to be durable and trouble-free	2
Process Quality		
	Our organization was satisfied with the overall process of carrying out this project with the organizations below:	
5a)	The Designer	2
5b)	The Contractor	3
	Mean score:	3.1

This score is in the 'neutral' range, i.e., Neither agree nor disagree.

<u>Description of Table 5.2</u>

Table 5.2 extends the principle used in Table 5.1 by including a greater number of variables. Columns 1 to 33 describe the attributes and variables involved in each project. The following column designations are described:

1: Project Number

2: Project Description

3: Project type--New or renovation

4: Facility size in (1000s) of sq. ft

5: Cost in $millions

6: Compensation format, method of contract award

7: Project delivery method

8: Survey Respondent: Owner, Designer, Contractor

9. Used before by owner? This field indicates whether or not the owner engaged the services of the designer or contractor previously.

10: On time? (Was the project on time?)

11: Late? (Was the project late?)

12: Ahead of schedule? (Was the project ahead of schedule?)

13: Within budget? (Was the project within budget?)

14: Over budget?

15: Under budget?

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
									Proj.sched.status			Proj.cost status			Top 3 Perf. Eval.		
Proj No.	Proj. descrip	Proj. type N=new, R = renov.	Project size X 1000 sq. ft.	Project cost x $million	Compensation format/Award method	Project deliv. method	Respond. O=owner D=design, C=contract	Used before by Owner?	On time?	Late?	Ahead of sched.?	Within budget?	Over budget?	Under budget?	1	2	3
1	Medical office & parking garage	N	80	25	GMP/S Low bid	DBB	O	-	x			x			f	c	b
							D	Y	x			x			f	b	a
							C	Y	x			x			e	b	c
2	Renov pharm spine clin. misc. pat. Rms	R	25	6.3	GMP Negot.	CM (f)	O	-		x		x			f	g	a
							D	N	x			x			b	a	c
							C	Y	x			x			a	c	g
3	Conv. Simul rm to CAT Scan room	R	0.4	0.12	L. sum Low bid	DBB	O	-	x			x			f	g	a
							D	Y	x				x		f	c	g
							C	Y	x			x			c	a	e
4	Rad ther. Cntr Lin acc sim rm exam rms	N	6.3	1.7	GMP Low bid	CM (f)	O	-			x	x			b	a	f
							D	Y	x			x			f	g	e
							C	Y	x			x			a	b	g
5	Psychiatric renov	R	22	1.3	GMP Negot.	DBB	O	-	x			x			a	b	f
							D	Y	x			x			b	a	f
							C	Y			x			x	b	c	a
6	Kitchen, cafet & powerhouse new & renov	N / R	30	10	L. sum Low bid	CM (f)	O	-	x			x			b	a	g
							D	Y		x			x		h	e	g
							C	Y	x					x	f	g	c
7	GRECC LAB	N	2.4	0.868	L. sum Low bid	DBB	O	-		x			x		f	g	c
							D	N	x			x			f	g	e
							C	N	x			x			a	e	c
8	Constr. AIDS Inpat clinic & Dialysis unit	R	17	2.463	Prg pay Low bid	DBB	O	-		x			x		f	c	g
							D	Y		x		x			f	c	g
							C	Y		x			x		e	g	c
9	Syrgery renov	R		3.4	GMP Negot.	DBB	O	-	x			x			a	b	f
							D	Y	x			x			b	a	f
							C	Y	x			x			b	a	c
10	Fiscal services fin. Offices	R		0.085	L. sum Negot.	DBB	O	-							c	f	b
							D	Y							e	c	f
							C	Y							a	c	e

Table 5.2 Summary of project characteristics from the project-specific survey

18	19	20	21	22	23	24	25	26	27	28		29	30	31	32	33
Eval.	Top 3	Design Consid.		Top 3 Construc. Process			Quality Assurance Effectiveness					Nature of relationship				
3	1	2	3	1	2	3	Designer	Owner	Indep.	Contract.	Other	Owner-Designer	Owner-Contractor	Designer-Contractor	Interact freq?	Comp owner satis. score
b	g	c	e	a	e	c			4			2	4	4	1 month	
a	c	e	g				1	2		2		2	3	2	1 wk	3.1
c				g	f	a	2	2		2		2	2	2	2 wks	
a	g	h	d	h	d	e	3	3				1	2	2	1 wk	
c	g	d	e				2	5				2	2	2	2 wk	1.9
g				c	d	b	4	3		2		3	2	2	2wk	
a	g	h	d	g	d	e	1	1				1	1	2	1 wk	
g	g	I	c				1	2	4	3		1	2	3	2 wk	1.3
e				e	g	c	3	2		1		3	2	4	1 wk	
f	g	h	I	c	d	e	5	1	5	3		1	1	2	Daily	
e	g	c	h				1	2				1	1	2	1 wk	2.0
g				c	g	e				1		3	1	.2	1 wk	
f	g	a	f	g	d	e	2	2				2	2	2	2 wks	
f	f	g	d				3	1	*S(2)	4		2	2	3	2 wks	1.1
a				c	b	a	1	1		1		1	1	1	Daily	
g	d	c	b	g	a	f				3		2	2	3	1 month	
g	i	g	d				1	3		2		2	3	2	Spec'l	2.2
c				g	d	e	3	4	2	1		1	1	1	1 month	
c	g	b	h	g	e	d		1				2	1	3	Spec'l	
e	g	e	I				1					2	3	3	2 wks	1.0
c							5	1				4	1	4	1 month	
g	g	I	d	g	d	e		1				4	3	4	1 wk	
g	g	c	d				1	3	2	4		5	5	5	1 month	1.7
c				g	d	c	1	1		1		3	2	4	1 wk	
f	g	a	f				3	3				3	3	3	3 wks	
f	f	g	d				3	1	*S 2	4		2	2	3	2 wks	1.4
c							1	1		1		2	1	2	Daily	
b	c	h	g	b	c	a	1	3				1	1	2	1 wk	
f	e	g	d				2	2				1	2	2	1 wk	1.6
e				e	g	c		2		1		3	2	3	1 wk	

EXPLANATION OF QUESTIONS (for columns 16-24)

15	Performance eval criteria
a	Finishing on time
b	Adherence to budget
c	Qual. Of appearance
d	Sat. job rel., owner w. design.
e	Sat. job rel., owner w. contract.
f	Building works well
g	Perform of systems to spec.
h	Min no. & val. Of change orders
I	Other

18	Design considerations
a	Lowest life cycle cost
b	Ease of maintenance
c	User friendliness
d	System reliability
e	Aesthetics
f	Lowest first cost
g	Meeting basic funct. reqs.
h	Flexibility for future adapt
I	Incorp of latest technology
j	Other

20	Construction process consider.
a	Noise
b	Odors
c	Dust
d	Contamination by pathogens
e	Physical obstacles/safety
f	Vibration
g	Interruption of utilities

16 - 18: The three most highly ranked performance evaluation factors, i.e., the 'top three' performance evaluation criteria. These are indicated by placing the letter that represents each appropriate criterion in the chart columns labeled 1,2, and 3 respectively.

19 - 21: The 'top three' design considerations.

22 - 24: The 'top three' construction process considerations.

25 - 28: A comparison of the effectiveness of construction quality control activities. The parties were requested to rate the effectiveness of having quality control carried out by different entities. A number grade is assigned to each column that represents an entity. The scoring used for this purpose ranges from (1) = most effective to (5) = least effective.

29 - 31 The nature of the relationship between the parties. This relationship ranges from a score of (1) = full partnership, to (5) = adversarial.

32: The frequency of meetings/interaction desired by the parties.

32: <u>Description of the dependent variable - owner satisfaction</u>

Column 33 reflects a composite 'owner satisfaction' score. This score is regarded as the dependent variable in this analysis; it is considered to be influenced by a number of independent variables, such as compensation format, delivery method, design considerations, construction process considerations, quality assurance methods, etc.

Analysis of Survey Results

Several observations are evident from the summary spreadsheet, Table 5.2:

1) Project Costs: The projects reflect a wide cross section of typical Health Care Facility (HCF) projects, from a major $25 million new addition (project #1) to a small office renovation costing $85,000 (project #10). Project #1 reflects the trend away from serving in-patients to treating out-patients instead; beds are replaced by parking spaces.

2) Project Size: The projects varied widely in physical size, from 400 sq. ft. to 80,000 sq. ft.

3) Utilization of Designers and Contractors: The 10 projects that were reported involved the re-utilization of both designers and contractors in 8 cases, and the re-use of a contractor in the 9th project.

4) Project Type: Six (6) projects were renovations, three (3) were new construction, and the tenth was a combination of new and renovation work.

5) Compensation Formats: The compensation formats utilized were mostly Guaranteed Maximum Price (GMP), followed by Lump Sum. GMP was used in 4 projects, and with cost saving/sharing in a 5th project. Sump Sum was used in 4 projects, while the owner reported 'progress payments' on the 10th project.

6) Contractor selection: The method of contractor selection was 'lowest bid' in 6 projects, and 'negotiated' in 4 projects.

7) Project Delivery: With regard to the project delivery method, the traditional design-bid-build (DBB) method predominated; it was used on 7 projects, while Construction Management for a fee (CM (f)) was used on the remaining three.

8) Cost & Schedule Adherence: Responses on cost and schedule adherence were mixed. In 6 instances, all three parties claimed to be either on time or ahead of schedule. In three cases the owner reported lateness of the project, but the designer and contractor did not report it. In 4 cases, all three parties agreed projects within budget, but there was disagreement on the others.

In only two cases was there a reporting of a project being completed under budget, and that information was reported by the contractor; the other two parties reported 'within budget.' That situation could be a matter of semantics--people tend to be more concerned about cost overruns, and could treat an 'under budget' situation as being 'within budget.'

9) Design Considerations: With regard to 'design considerations' there was disagreement between most owners and designers. In no instance, of the 10 projects, did both owners and designers report the same sequence in the top three design considerations. Although the passage of time could affect recollections, this fact is noteworthy especially since the designer is expected to understand the owner's wishes and priorities and include them in the design concept. However, an important observation is that 9 of 10 owners listed item 'g'--meeting basic functional requirements--as an important design consideration, and 7 of these listed it as their number 1 ranked priority. Also, both owners and designers rated

this item equally 50% of the time. Designers did cite this item in every case, although at a lower priority 30% of the time.

Item 'h'--Flexibility for future adaptation--was also repeatedly cited by owners, but only once by designers, again pointing to an area of difference.

Owners included item 'e'--Aesthetics--only once, but designers listed it 4 times.

10. Construction Process Considerations: Responses were compared between owners and contractors on the subject of construction process considerations. Owners cited item 'g'--Interruption of utilities as a number 1 concern on 5 occasions, while contractors cited it less often. Owners cited items 'd' and 'e' in that order 50% of the time. These refer to contamination by pathogens and the safety concern of physical obstacles that affect building users during the construction process. These items were mentioned in 4 renovation projects, understandably. They were also mentioned in a new construction project, but that project was on the same property as the existing hospital. The primary survey instrument had also indicated the foregoing items as being considered a top priority, by owners and contractors alike. Item 'c'--dust--was listed as a concern by both owners and contractors, although slightly more so by contractors.

11. Quality Assurance Methods: There was a wide divergence in these scores. Owners generally reported their quality assurance effectiveness scores to be as high as, or higher than the performance of the other parties. Designers, on the other hand, consistently rated owners' scores lower than their own, and

contractors' scores even lower. Whenever contractors reported their own scores, they ranked themselves highest, followed by owners, and then by designers.

12. Relationships between the parties: There was a significant divergence in this area. Owners reported that their relationship with designers was better than that with contractors. In many cases, owners reflected a rating of 2, slightly less than full partnership. The owner-contractor relationship was slightly higher, approaching a rating of 3. However, owners clearly perceived a poorer relationship between designers and contractors, than between the owners and contractors, and owners and designers. This relationship is understandable. Most projects involved GMP and were awarded to the lowest bidder, putting the contractor and owner in an inherently adversarial relationship. On the positive side, most projects involved a re-use of the contractors, indicating an ongoing relationship that would lessen the degree of adversity.
In all the cases involved, designers were hired through a negotiation process that is less confrontational than a bidding situation.

Designers typically reported their relationship with contractors as being worse than the relations between owner and designer and owner and contractor. Contractors typically thought that their relationship with the owner was better than the designers' relations with the owner. They also reported poorer designer-contractor relations.

.13. Performance Evaluation Criteria: There was a closer similarity between the scores of owners and designers than there was between owners and contractors.

Owners cited item 'f'--Building works well--as their number 1 concern 50% of the time, and as a second or third priority in all except 1 of 10 projects. Items 'a' and 'b'-- Finishing on time, and adherence to budget--are frequently listed among the top three, but were listed among the top two in only 4 of 10 projects.

In only 1 project did the performance evaluation criteria match for both owners and designers, i.e., project number 8. Designers, however also reported item 'f'--Building works well--as their number 1 concern. Item 'c'--Quality of appearance--was cited frequently as a second or third priority.

Contractors listed item 'a'--Finishing on time as one of the top 3 priorities in 8 of 10 projects. Quality of appearance 'c' was frequently listed as well, as was 'b'--adherence to budget. These results are not markedly different from the observations with the primary survey instrument.

14. <u>Interaction frequency</u> In most cases, owners desired to meet more frequently than contractors and designers did. It was noticeable that designers, in several cases, wanted to meet less frequently than owners and contractors indicated.

15. <u>Composite Owner Satisfaction scores</u> Owner satisfaction scores were computed as the sample means of responses to questions on the conduct of each project with regard to availability of support, responsiveness, communication/pleasantness of support, product quality, and process quality. A 5-point Likert scale evaluated these conditions over a range from strong agreement to strong disagreement.

In this survey, scores ranged from a high of 1.0 (the highest) to 3.1, slightly worse than neutral.

The proposal of an owner satisfaction/project performance model

As observed from both the general survey and the project-specific survey, owner satisfaction appears to be influenced by several independent variables, including: Project type, project size, project cost, compensation format, project delivery method, design priorities, construction priorities, relationship scores, interaction scores etc. The nature of this relationship would best be quantified by analysis using multiple regression techniques. *The financial limitations of this research resulted in a smaller sample size than would be desirable for the use of these techniques.*

Description of the model

The model assumes that the dependent variable, the owner's satisfaction, will be influenced by a number of independent variables. The emphasis is on the *owner's satisfaction*, as the primary customer. Some of these variables are selected by the owner by virtue of the characteristics of the project, and the methods to be used to deliver the project. These are considered to be 'controllable'.

	Description of owner selected variables	Symbol
a)	Project type (new or renovation)	T
b)	Project size (square feet/cost)	SC
c)	Project category (use, complexity)	C
d)	Compensation formats	CF
e)	Project delivery method	M
f)	Design considerations	D
g)	Construction process considerations	CP
h)	Quality assurance method	Q
i)	Intended relationship (adversarial to full partners)	R
j)	Planned frequency of interaction/meetings	I

Other factors are influenced by random events, such as cost growth and schedule growth, although the parties to construction are expected to make every conscious effort to minimize this randomness. Other variables outside of the owner's control are:

Designer performance index	(DI)
Contractor performance index	(CI)
Cost growth	(CG)
Schedule growth	(SG)

Owner satisfaction, the dependent variable is represented as (OSI_i).

Equation 5.1 $OSIi = f\,(DI, CI, CG, SG, CF, M, D, CP, Q, R, I)$

The designer and contractor performance indices are influenced by project type, size, category (e.g.,labs vs. waiting rooms)

Equation 5.2 $DI = \sum(W_{nD(i)} \cdot S_{n(j)})_{T,S,C,CF}$

Equation 5.3 $CI = \sum\,(W_{nC(i)} \cdot S_{n(k)})_{T,S,C,CF}$

Where W = weighting factor, n = 1, 2, 3, ... S = historical score of designer or contractor, for Owner (i), Designer (j), Contractor (k), Project (p), time period (t):

Equation 5.4

$$\text{Then, } OSI\ i\ (t) = a + a1 \cdot \sum(W_{nD(i)} \cdot S_{n(j)})_{T,S,C,CF} - a2 \cdot \sum(W_{nCP(i)} \cdot S_{n(k)})_{T,S,C,CF} + a3 \cdot CG_{p(t)} +$$

$$a4 \cdot SG_{p(t)} + a5 \cdot M_{p(t)} + a6 \cdot Q_{p(t)} + a7 \cdot R_{p(t)} + a8 \cdot I_{p(t)} + \epsilon.$$

Regression analysis would determine the value of constant a and coefficients a1 to a8. The regression equation could be maintained as an interactive computer model. As described in figures 5.1 and 5.2, the owner would decide on the weights to apply on each project, with respect to design considerations and construction process considerations, for example. The computer program would apply the weights to the historical scores for designers and contractors, to preliminarily pinpoint the appropriate candidates to be selected. Induction of this information in the program would allow the optimal owner satisfaction index to be determined.

Development of the conceptual framework

Figure 5.1 illustrates the conceptual framework that may be used to configure health care facility (HCF) construction/renovation projects for optimum performance and owner satisfaction. It is based on the underlying assumption that a national data base will be developed from the prototype that was created in this research. This data base should be supported through Federal, State, and Local government health care departments that set or monitor policy on health care issues. These organizations already maintain information on hospitals and other care-givers. Government-funded care-gives, for example, have to have capital improvements in excess of a legislated dollar value reviewed at the state level.

It would, therefore, be in the interest of the oversight organization to utilize performance-based information about contractors (and designers) when contemplating construction or renovation work. Since many contractors and designers carry out HCF-related work with both the private and public sectors, it would benefit the health care industry as a whole to monitor the performance of those suppliers on an ongoing basis. The health care industry has already begun to maintain 'report cards' on physicians and hospitals; by the same token, they should maintain report cards on HCF contractors and designers. Construction decisions that are based on these report cards have an increased likelihood of reducing the gaps that have historically divided HCF owners, designers, and contractors. The completed facilities that result are also more likely to meet the needs of the owners (and users); the facilities are more likely to be more cost effective, and more adaptable to future changes in usage.

Utilization of the framework

Figure 5.1 illustrates the conceptual framework. Figure 5.2 refers to the use of the data base itself. Typically, the framework will be used by owner organizations at the inception of each project to incorporate the factors that will maximize owner satisfaction. These factors may vary by the choice of project and may be addressed to reduce quality gaps between the parties with contract language and project administration procedures. The factors may include: Compensation formats (how contractors are paid), project delivery methods (design-build, etc.), time and schedule incentives, communication requirements, design priorities, construction process considerations/criteria, quality control methods, dispute resolution procedures, and meeting/interaction frequencies. As previously explained, the OWNER SATISFACTION INDEX (OSI) is the dependent variable that represents the project initiator's degree of satisfaction with the outcomes of a given project. The emphasis is on the owner's satisfaction, as the primary customer. (See Equation 5.4).

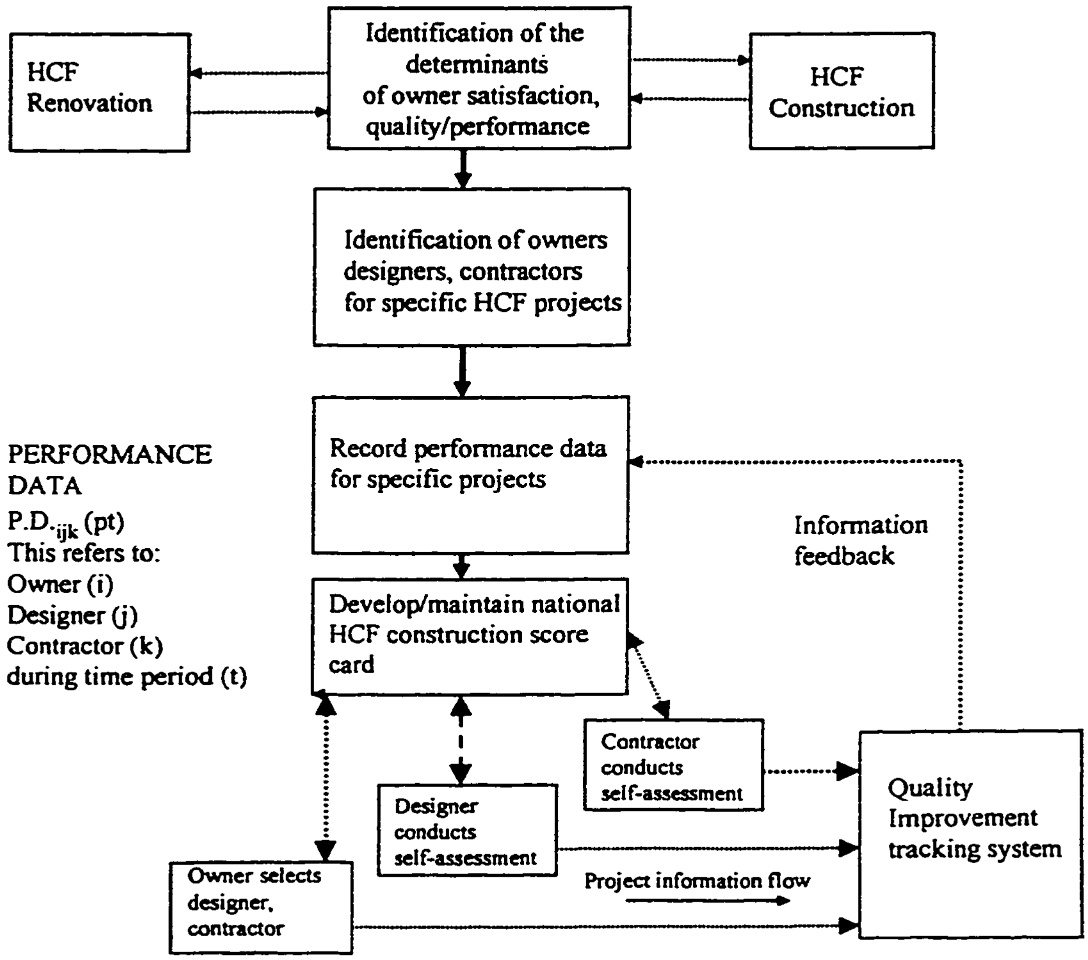
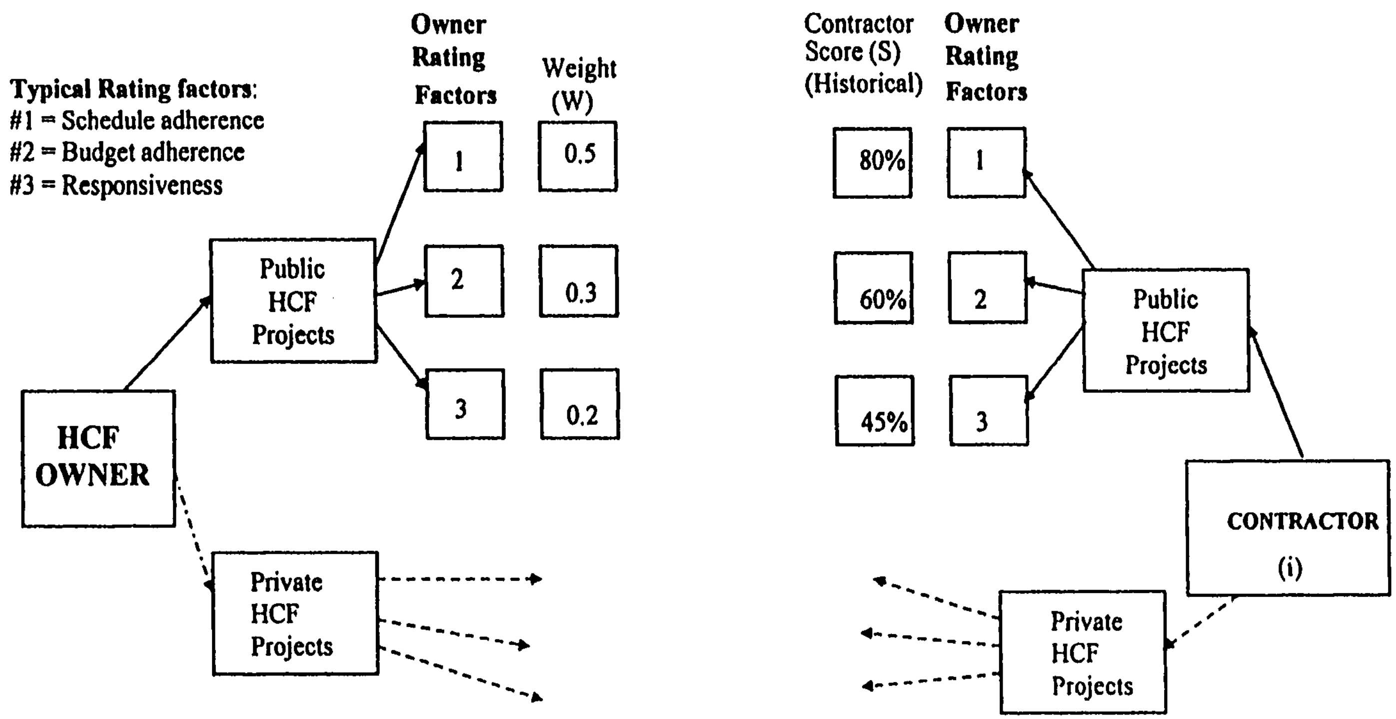


Figure 5.1 Development of a conceptual framework for project performance

The framework may also be used by designers and contractors as a self-assessment tool to identify the degree to which they meet the criteria. This research takes the position that an understanding of the determinants of owner satisfaction for HCF construction and the gaps in perceptions and expectations will empower designers and builders to attain higher levels of customer satisfaction in their projects. This framework provides the metrics that are essential for 'continuous improvement' efforts to be implemented. The metrics may, in time, be used as benchmarks that allow organizations to compare each other and adopt the 'best practices' of industry leaders. These actions have proven, in other industries, to be a precursor of repeat business, and financial prosperity, by extension.

At the top of figure 5.1 the owner identifies the type of project to be undertaken - new or renovation - and decides which of the foregoing factors are most critical. The owner could identify the 'top three' rating factors, such as schedule adherence, budget adherence, and responsiveness, when selecting a contractor. The owner would also select the appropriate weights (W) that best represent the project under consideration.

Proposing a Report Card Database for Contractors



DESCRIPTION OF PROCEDURE:

Based on the needs of the specific project, the owner selects the appropriate rating factors and the weights to be applied to them. In choosing a contractor, or in selecting between finalists for a contract, the owner would search the database with contractor performance information. Composite contractor scores are computed and compared : contractor performance index = Σ Wi . Si. The contractor with the highest index would be selected. In the illustration, the scores are used for a public health care facility (HCF) project. For a private HCF project, contractor "private sector" scores would be used.

Figure 5.2 Proposing a report card data base for contractors

In choosing a contractor, or in selecting between finalists for a contract, the owner would search the data base with contractor performance information. The owner would obtain the contractor's historical score (S) for each rating factor, and compute composite contractor scores by summing the products of the scores and the project weights. Contractor performance index = $\sum(Wi \times Si)$. The contractor with the highest performance index for a specific project could be selected based on this score - all other factors being equal.

At the completion of the project, information on the outcome would be recorded in the data base, using the variables that have been identified, such as project delivery methods, compensation formats, design considerations, construction process considerations, etc. Very importantly, *owner satisfaction data* relating to the outcome of the project would be recorded.

National Data Base for health care construction information

Benefits/purpose of the data base

The national data base for health care-related construction projects will benefit owners, designers, and contractors. Owners will be the greatest beneficiaries of the information in the data base. They bear the ultimate costs of all design and construction work, and experience the long-term benefits (or deficiencies) of each completed project. It is hereby proposed that the development of the conceptual model and the national data base will best succeed as the product of a "consumers' movement" that represents their own best interests. This action would parallel the success of organizations such as The

Consumers' Union or The American Association of Retired Persons (AARP). Both have produced ongoing reports on a wide variety of consumer products and services, such as multi-media electronic equipment, refrigerators, and automobiles. These reports inform members (consumers) of the performance, reliability, and durability etc. of the products or services in the marketplace, and have the ability to influence purchasing decisions. The past successes of the above mentioned organizations have been largely attributable to the competitive pressures imposed on the providers of goods and services by consumers' preferences for products and services of demonstrably or certifiably better quality. The following are lists of organizations that could meet these requirements in the context of health care construction:

k) The American Society for Healthcare Engineering (ASHE)

l) The American Medical Association

m) The American Hospital Association

<u>Issues related to the development of the data base</u>

There are several issues to be considered with regard to developing the data base. These issues include:

- Start-up Cost
- Operating Cost
- Privacy (Encoding of information and anti-piracy activities)
- Protection against viruses
- Legal implications
- System Maintenance (Y2K compliance, updating/information backup)

- Verification of information
- Internet access
- Regulatory compliance
- Dispute resolution
- Scope of information captured and maintained
- Government oversight
- Marketing activities

The cost of the system can be funded through user fees levied on users of the data base. Through aggressive marketing, prospective users could be persuaded to deposit a retainer for future services. The initial cost could be minimized by establishing the data base as a pilot system run on an existing mainframe computer that already has the hardware and infrastructure to perform data capture and data recording activities. A fee structure should be developed to a level that the market will bear - essentially, owner representatives should recognize the value of designer/contractor historical information in helping to make informed choices prior to initiating multi-million dollar projects.

While the cost of the national data base may be borne by users, the sensitivity of the information it contains would justify the involvement of a neutral body that could impartially collect and record the project-related data. There would also have to be a means of ensuring that project information is submitted for inclusion in the data base. A federal government agency would be the most appropriate third party to manage the information, as it would have the administrative power to enforce the submission of project-related information, and, very probably, have the power to address the legal issues that may arise in such an undertaking . The Department of Human Health & Services could perform that role. Another possibility would be JCAHO (The Joint Commission on Accreditation of Health Care Organizations). Already, they collect information on health care-related construction projects. At the state level, there are agencies that oversee health care-related activities of every description, including construction. In the case of Florida, the Department of Health and Human Services oversees construction and reviews applications for Certificates of Need. Owners submit justification information for the respective projects, etc.

Data capture/management economies

In order to effect economies in the establishment and management of the data base, an emphasis will be placed on the factors that have been identified as exhibiting the greatest dissonance between the parties to construction projects. These factors can be observed in the Dissonance Zone Analysis charts (Figures 4.18 to 4.23). They are shown below with the areas of dissonance between the parties shown in parentheses:

- Owner satisfaction criteria (Owners and Designers 4/9 to 7/9)
  (Owners and Contractors 5/9 to 6/9), (Designers and Contractors 2/9 to 3/9)
- Construction process consideration (Owners and Designers 2/6 to 3/6)
  (Owners and Contractors 1/6 to 2/6), (Designers and Contractors 4/6 to 5/6)
- Quality control measures (Owners and Designers 3/5 to 5/5)
  (Owners and Contractors 2/5 to 3/5), (Designers and Contractors 3/5)

- Owner's satisfaction with schedule delays - Private projects (Owners and Designers 3/5) (Owners and Contractors 3/5)
- Owner's satisfaction with cost overruns (Owners and Designers 2/5) (Owners and Contractors 2/5), (Designers and Contractors 4/5)
- Barriers to owner satisfaction (Owners and Designers 4/11) (Owners and Contractors 7/11 to 8/11), (Designers and Contractors 4/11)
- Design considerations (Owners and Designers 5/10 to 6/10)
- Performance evaluation criteria (Owners and Designers 5/8 to 6/8) (Owners and Contractors 6/8 to 7/8)
- Satisfaction metrics - Availability of support, responsiveness, communication/pleasantness of support, product quality, and process quality.

The foregoing data could be captured through entry and exit questionnaires. These questionnaires would be concise instruments that capture the needed data in the shortest time possible. The entry questionnaire could be a shortened version of the primary survey instrument that was used in the research. It would seek input on the above mentioned factors at the start of a project, as well as specific project information such as cost, type, size, type of compensation, project delivery, etc. The exit questionnaire would determine how well the factors were addressed, and would derive an owner satisfaction score for the completed project.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

The general survey and the project-specific survey have both provided valuable information with respect to Health Care Facility (HCF) construction and renovation projects. The objectives of the research were met within the defined scope and limitations.

1) The determinants of owner satisfaction, quality, and performance were defined.
2) The gaps between owners, designers, and contractors were identified.
3) A project-specific analysis was used to promote a conceptual framework for improving owner satisfaction and project performance.
4) The public and private HCF environments were investigated in order to allow for differences between them in the conceptual framework.

The determinants of owner satisfaction were found to be influenced by a combination of many factors that varied from one project to the next, and differed based on whether owners were private or public. Public owners preferred Guaranteed Maximum Price compensation (with cost savings sharing) followed by Lump sum and cost-plus methods. Private owners were most satisfied with the flexibility of other compensation methods, such as time and materials, followed by GMP and cost-plus. At the .05 level of significance, public owners disagreed with designers on only one of five categories of compensation; these owners appeared to agree with contractors on all categories, yet designers disagreed with contractors on one category of compensation. Private owners responded similarly.

HCF owner satisfaction was influenced most by a number of factors in the following order:

- Adherence to cost estimates
- Timeliness of the project
- Minimal disruption to ongoing facility operations
- High quality of construction with regard to fit and finish
- Clear up-front understanding of the job scope.

Owners placed a lower priority on issues such as response to complaints, aesthetics, and clear, ongoing communication on job status.

With regard to performance evaluation criteria, it was noteworthy that public owners cited 'building works well', followed by adherence to budget agreed, and performance of specialized systems to specifications. Of nine (9) performance evaluation criteria, private owners cited budget adherence first, followed by 'building works well', and finishing within the time stipulated. Both public and private owners ranked quality of appearance/workmanship in 4th place, and the minimization of change orders in 6th place. The analysis of variance identified extensive gaps between the parties on this subject, suggesting possible explanations for the adversarial nature of many construction projects. Essentially, they do not evaluate performance in a consistent manner. Of eight areas of comparison, designers and owners disagree on between 5 and 6 of them. Owners and contractors differ on between 6 and 7 of the performance evaluation criteria. This observation also may also help to explain the adversarial nature of many construction projects. It may be argued that such large zones of dissonance in understanding and expectations predispose the parties to a perception that their needs are not being met in the construction process.

Designers and contractors seemed to place a high value on having satisfactory relations with owners - designers listed 2nd and 3rd places for these relations with private and public owners, in contrast with an 8th place ranking by the owners. Contractors listed 1st and 4th places for private and public owners respectively, while owners indicated 7th place for these job relations. The designers' and contractors' priorities are understandable -- they are in a competitive environment. The higher priorities placed on private owners are logical - public sector work is more openly competitive, while private sector work is more influenced by personal contacts and relationships. This apparent ambivalence by owners may be symptomatic of the major gaps that were observed, especially in categories such as owner satisfaction criteria, performance evaluation criteria, construction process considerations, quality control effectiveness, and cost and schedule overruns.

In owner satisfaction criteria, the major areas of dissonance between owners and designers were fit and finish, aesthetics, response to complaints, budget adherence, and schedule adherence. Owners and contractors disagreed to an even greater extent on this issue, especially public owners. The areas of dissonance included timeliness, communications, responsiveness, aesthetics, fit and finish, and disruption to operations (caused by the construction process).

Design considerations were also a source of major dissonance - evidently, designers were not in accord with owners in the way that traditional suppliers strive to understand and meet their clients' needs. This dissonance focused on maintainability, system reliability, aesthetics, the incorporation of the latest technology, and meeting basic functional requirements.

On the question of construction process considerations, designers did not seem to pay sufficient attention to the impact of noise, dust, physical obstacles, cross contamination and vibration. In fact, contractors seemed to understand these factors better, as they had fewer areas of dissonance with owners.

Quality control effectiveness proved to be highly controversial. Owners, designers and contractors held strongly opposing views. Each party claimed to offer the most effective quality control.

On the question of the barriers to owner satisfaction, the areas of dissonance between owners and designers centered on project funding, cost control, and lack of design detail, recognizing that codes cannot guarantee good workmanship.

Overall, the significant gaps observed between designers and contractors are in keeping with the observations of Puddicombe (1997). The author concluded that adversarial relationships between designers and contractors had negative impacts on project outcomes.

Public/private owner differences

In summary, there were few differences between these groups. They ranked their preferences for contract compensation formats somewhat differently, and the public sector evidently is limited by having to have mostly open bidding. This limits their ability to be selective, as they have to accept the lowest bid in most instances. There were different preferences for project delivery methods, but the only limitations observed are that an adequate number of suitably experienced designers and contractors would have to be available for the successful application of 'fast track' and design-build. These techniques are more demanding than the typical design-bid-build method.

There was close agreement between public and private owners on issues such as owner satisfaction indicators, quality control effectiveness, and cost and schedule overruns. Both groups shared a high degree of dissonance with designers on very much the same design considerations. With respect to owner satisfaction criteria, both groups shared almost the same dissonance with designers and contractors. On the other hand, public and private HCF representatives were less unified on the question of performance evaluation - they differed on 4 of 9 criteria.

Overall, beyond the issue of procurement limitations, the need to deliver health care makes both public and private owners relatively similar to each other. The conceptual framework that is being proposed could be used in entirely the same manner by both groups.

Proposals to close the gaps between the parties

A number of techniques are proposed to close the dissonance zones or construction quality gaps, based on the literature, as well as on surveys and interviews of owners, designers, and contractors:

1) There should be a well organized, cohesive team to plan, design, construct, and operate facilities. The HCF owner, i.e, a responsible HCF administrator, should take the lead in developing this team approach when contracts are being initiated. Common team goals should be identified and contracts should promote teamwork without conflict of interest, allocating risk and reward fairly. Risk apportionment should be improved through partnering or other methods in order to foster trust and cooperation.

2) Communication is cited as a major factor in reducing quality gaps. Timely information from owner, designer, and contractor should be instituted at the very , beginning of the planning and design of facilities. This communication is so important that the construction industry should invest in improving the communications skills of those who interface with others on construction sites.

3) A greater level of understanding between the HCF owner and the designer would reduce the significant zones of dissonance that were revealed by the survey analysis. Evidently, the communication tools that are used in the design profession have room for improvement in this area. Quality Function Deployment should be considered as a vehicle for harnessing information on the large number of diverse factors that are involved in HCF projects.

4) By the same token designers and contractors should focus on service quality dimensions in order to understand and meet the owner's needs.

5) Owners should take the initiative to promote a positive relationship between the parties to construction, in order to improve project execution. The "customer

concept" should be ingrained in the construction process, in keeping with quality management principles. The research identified that both designers and contractors were more concerned about their relations with owners than the owners' interest in reciprocating. Owners should address this failure.

6) Designers should give urgent attention to a number of issues that impact owner satisfaction. Lack of detail in drawings and/or specifications was identified as a major area of concern by owners, and to some extent by contractors. In the HCF environment more extensive design detail is justified, as compared with other types of projects.

7) Designers should also address a reported tendency toward the underpricing of project estimates. At the same time, designers perceive owners as not having adequate funding for the features desired. It should be in the owner's best interest to utilize professional cost estimators especially on larger projects. Owners should also ask for ongoing evidence that projects are on track both in terms of schedule and cost.

8) Owners should strongly consider team-building or partnering in order to improve the success rate of construction projects, especially with regard to disputes and aggravation. Although the construction industry has not widely instituted enforceable contracts based on these methods, HCF owners should provide impetus for their development.

9) HCF owners should assign the quality assurance function to a specific entity in order to ensure that the completed construction meets their requirements. The

research suggests that the best results may be obtained by having suitably trained staff perform that function. It should not be assumed that the designer will perform that function. With time, the quality assurance activity could be expanded to include other quality management techniques.

10) Consideration should be given to modifying the form of contract used in HCF construction projects. These changes would beneficially include provisions for:

- The frequency of meetings to be held at different project stages. This could be refined to clarify the type of information the owner (and the other parties) would require at these meetings on as practical a level as possible. This should be customized to meet the needs of each project.
- Making Post Occupancy Evaluations and Customer satisfaction surveys an optional feature. If the option is exercised, it should be legally enforceable.
- Describing the impact/importance to the owner of construction process considerations such as noise, vibration, interruption of utilities, etc.
- Stating the precise requirements of the owner with regard to the commissioning of new or renovated facilities/equipment in order to optimize the owner's use at the completion of the project.
- Instituting a ***"Report Card"*** for designers and contractors. There should be a contractual expectation that the outcome of each completed project would be referred to a data base for evaluation purposes.

11) Discussions should be brought to the public domain in settings such as open forums to have owners, designers, and contractors discuss the owner satisfaction, quality, and performance issues in HCF design and construction. These discussions would also promote the need for mechanisms to improve accountability in the design and construction process.

The concept of developing a ***National Data base*** is offered as a way to close the gaps between owners, designers, and contractors. The use of the data base would empower the users of health care facility design and construction services to make more informed purchasing decisions. As described in Chapter V, the data base would provide the infrastructure for a "report card" for designers and contractors. That "report card" would parallel a system that has already been developed to evaluate the delivery of health care services. The development of the National Data base would require the resolution of several issues such as: Start-up Cost, operating cost, privacy, regulatory/legal issues, system maintenance, verification of information, Internet access, dispute resolution, and government oversight. The complexity and gravity of these issues would suggest that the data base be under the purview of a government agency, such as The Department of Health & Human Services, or the JCAHO (The Joint Commission on Accreditation of Health Care Organizations). These agencies represent a possible 'fit' as they already collect some information on health care-related construction. Given the high value of the data base/report card information, there is the potential to collect sizeable fees from users who initiate construction or renovation projects. At the same time, the success of the data base may best be promoted through a consumer-based movement such as The American Association of Retired Persons (AARP).

Benefits of the research

There are several benefits to this research with regard to health care facility construction:

- An understanding was derived of the determinants of owner satisfaction, project performance, and quality. This understanding empowers the parties to HCF projects to better understand that environment, and to increase their likelihood of improving the attainment of these determinants in their projects.
- The gaps in expectations and perceptions between owners and contractors, owners and designers, and designers and contractors were clearly identified. Based on the knowledge of these gaps, all the parties may make informed decisions on narrowing the gaps. In particular, the HCF owner's representative should use this knowledge in configuring each construction/renovation project for increased success.
- The project-specific survey has facilitated the development of a conceptual framework for project performance. This framework is designed to record and maintain performance data for specific projects, noting the characteristics of the project, but also tracking contractor and designer performance. Indispensable to the concept of construction owner satisfaction is the recording of the owner's *substantiated perceptions*, based on the conduct of the project. With the

appropriate support, this framework may be upgraded to form a National database. This support could begin with State-level Health Care Administration agencies. Such agencies already track a degree of construction information, and could easily request and maintain the type of information proposed in this framework.

Several other benefits may be derived by the parties to HCF construction projects:

- Communication between the parties may be improved.
- The parties can pinpoint the sources of satisfaction and dissatisfaction.
- The probability of negative outcomes is lessened.
- Conflicts between the parties may be minimized.
- Legal costs can be reduced.
- It is possible for the 3 parties to achieve their goals, both similar and disparate.
- Delays in project completion may be reduced.
- Cost overruns may be avoided.
- Safety problems may be reduced for trades staff, as well as for the owner's staff on occupied renovation sites.
- A database has been initiated that may be expanded nationally to gauge satisfaction and performance in objective measures that will provide ongoing evaluation and review.
- Owners will benefit by being able to make better project hiring decisions.
- Better hiring decisions will lead to more successful construction contracts.
- Designers will benefit by using the conceptual framework as a self- assessment

tool.

- Contractors will also be provided with a self-assessment tool.
- Owners will know up-front which quality assurance approach works in their best interest.
- Reductions in construction costs may result from the application of the conceptual framework and will ultimately allow health care costs to decrease.
- Customer satisfaction surveys and post occupancy surveys should be conducted as much as possible. They provide specific information that will influence choices on future work; the results can go into a national database to be accessible to others.
- The conceptual framework may be adaptable to other types of construction projects. These may include airports, schools, and other institutional projects that share the complexity of health care facilities. In those projects, administrators face some of the problems that are experienced in public sector health care design and construction.

Limitations of the Research

The limitations that have been observed are:

- The majority of the owner survey responses for the general survey were provided by not-for-profit health care organizations, both public and private. Very few responses were provided by for-profit organizations.

- The response rate to the general survey was low, with respect to contractors, in particular. This pattern was evident with both the general survey and the project-specific survey, despite persistent reminders to the contractors.
- Because of the limited funding available for the research, it was not possible to provide significant financial incentives that may have increased the rate of response.
- The selection of owner satisfaction as a dependent variable placed reliance on the self-reporting by health care facility owner representatives. The information on the independent variables was also self reported. While a relationship between the variables could be observed, it was difficult to confirm correlations between both sets of variables.

Areas for future research

- The creation of a National Database should be pursued in order to collect and maintain the amount and quality of information that will make it feasible to "fine-tune" Equation 5.4 that is proposed in Chapter V. The availability of a greater number of data points, from a larger sample of projects will make the use of regression analysis feasible. Such analysis will determine the values of coefficients and identify the significant variables in a regression equation.
- Additional funding and other resources should be sought to extend the scope of the research beyond the limitations that were encountered in this project. The support of regulatory and other agencies may be needed to solicit input from for-

profit health care organizations.

- Further research should examine the differences between renovation projects and new construction. While the construction process is similar in many respects for both types of projects, renovation is more fraught with unexpected events. In many instances, existing construction plans are often outdated, and are often unreliable.

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GLOSSARY OF CONSTRUCTION-RELATED TERMS

ASHE — The American Society for Healthcare Engineering

AIA/AAH — The American Institute of Architects - Academy of Architecture for Health Division

AGC — The Associated General Contractors of America

Acceleration: A necessary means of correcting construction schedules that are behind those originally planned. Acceleration can include double shifts, overtime, or hiring additional contractors.

Award fee contract: A method of contracting that establishes several standards of process quality that must be met by team members, to receive their full-fee payment. Standards that are reviewed include safety, contract management, quality programs, schedules, and cost controls.

Change request: A request by a member of the construction team for a change in the contract documents to incorporate deviations from the original plans and specifications. This usually results in cost additions to, or deletions from, the contract.

Conceptual drawings: The initial drawings completed by an architect or program manager that begin to document the design and intent parameters of a project.

Constructibility: The extent to which the construction documents are constructible, based on the means and methods available in the local construction market where a project is to be built.

Construction Industry Institute (CII): The CII is a partnership of owner, contractor, and academic leadership whose mission is to improve total quality and cost effectiveness of the construction industry through research initiatives and implement-ation support. The CII is headquartered at the University of Texas at Austin.

Construction management at risk: A contract format that requires the construction manager to assume all the risk for the total cost of construction. This is usually based on a guaranteed maximum price form of contract.

Construction management for fee: A contract format in which the construction manager acts only as an agent for the owner, providing professional management services for a fee, with no risk.

Construction master plan: The master plan describes the planning, organizing, and control of the major activities needed to meet the goals of completing a project on time, within budget, and as specified.

Contingency: This is a factor to cover two major unknowns present in all estimates - errors due to inaccurate or incomplete design data, and errors of omission and commission in project cost estimating.

Cost-reimbursible contracts: The owner contracts with construction professionals for their services, with all costs associated with the project reimbursed by the owner. Overheads may be reimbursed as a lump sum or on an as-used basis.

Critical path method CPM: A scheduling system that identifies the constructio activities that take the longest time to complete.

Design-bid-build: A traditional project delivery system involving discrete stages of design, bidding by general contractors, and subsequent construction.

Design-build: A method of construction contracting in which an owner uses a single organization to design and construct a project.

Design documents: The plans and specification that describe an owner's needs through written and drawn instructions. These documents reflect the minimum quality standards of a completed construction project.

General contractor: A construction organization whose own employees complete all field construction activities. This organization may use subcontractors to carry out the work.

Guaranteed maximum price (GMP): The maximum price that a contractor guarantees that a project will cost

Lost time: Delay time spent on unproductive activity.

Lump-sum-bids: A method of contracting based on a fixed price or lump-sum.

Partnering: A quality management process to improve communication between the parties to a construction contract, promoting trust and openness. Partnering generally requires a long-term commitment between the partners.

Partnering agreement: A summary of goals agreed upon; it is not a legally binding contract, but an expression of the wishes and needs of each of the partner organizations.

Performance guarantee: This is a written commitment by the contractor that a facility will perform in a prescribed manner with regard to products, quality, on-stream time, etc.

Preplans (construction): Pre-established detailed proposals for carrying out particular tasks , setting procedures on what, why, how, when and where

Program manager: A construction-related firm that acts in a professional capacity for an owner in several ways, including preparing conceptual drawings and preparing bid documents. The program manager may also select architectural/engineering firms, as well as contractors.

Punch list: A list of defects compiled after a construction project is said to be substantially complete. By contract, these items are required to be completed before final completion is granted. Punch lists actually reflect quality problems in the contractor's work.

Requests for information (RFIs): Information requests from the construction team, during construction, for clarification of any portion of the documentation that is unclear.

Schematic drawings: Construction documents that are completed for owner review and approval before actual work on construction drawings is begun. Schematic drawings define the initial scope of a project.

Subcontractor: A contractor who carries out the installation of a particular field-construction process, such as electrical work. This term is interchangeable with the term trade contractor.

Substantial completion: The point in field construction when a project is fit for its intended use, but it does not mean final completion. The period between substantial and final completion is the time allowed a contractor to complete the punch list.

Team building: It is a project-focused process that builds and develops shared goals, interdependence, trust and commitment, and accountability, among the different organizations that constitute a project team. It enhances the problem-solving skills of the team members.

Trade contractors: Contractors (subcontractors) who carry out the installation of a particular field-construction process, such as electrical work.

APPENDIX A

UNIVERSITY OF Miami

DEPARTMENT OF INDUSTRIAL ENGINEERING

MEMORANDUM

May 10, 1998

TO: ASHE MEMBERS

RE: RESEARCH ON CONSTRUCTION/RENOVATION QUALITY IN HEALTH CARE FACILITIES

The University of Miami's Department of Industrial Engineering is currently conducting research on construction quality and customer satisfaction in the health care environment. This research is in response to the needs of the health care community to adequately maintain and upgrade their facilities while meeting the requirements of quality, cost, and government and insurance industry regulations. It is hoped that the findings will benefit the parties involved in the construction process - the owners and Health Care Facilities Planning administrators, the designers of new construction or renovation work, and the contractors who build these facilities.

We have limited the participants in the survey to acknowledged professionals, such as yourself, in order to obtain credible information, and are sending this survey to you with the consent and support of the American Society for Healthcare Engineering. By participating, you will be sharing your considerable experience in the management of construction projects. <u>If you are not involved in construction projects, please forward this survey to the appropriate person at your facility.</u>

<u>With regard to confidentiality, all information provided will be kept in the strictest confidence. No specific information related to your organization shall be disseminated without your express written permission</u>

<u>As members of ASHE, we would like to provide you with a copy of the survey results and resulting recommendations for improving health care construction management, at the end of the study. Based on the caliber of the survey participants, we expect this information to be most valuable to anyone involved in the management and construction of hospitals and health care facilities.</u>

We have attached a survey form and a self addressed envelope with prepaid postage for your convenience. Please return the completed form at the earliest possible opportunity. Should you have any questions or require further information, please contact Dr. Vincent Omachonu at (305) 284-2372.

Thank you for your participation!

cc: Ms. S. MiHalo, ASHE

Department of Industrial Engineering
P.O. Box 248294
Coral Gables, Florida 33124-0623
Fax: 305-284-4040 • Phone: 305-284-2344 • Email: ien@eng.miami.edu

FACILITY OWNERS' CONSTRUCTION QUALITY SURVEY

Please provide the following information: Survey No. ________

SECTION A. ORGANIZATION INFORMATION

1) YourName:________________________________ Tel/Fax(Optional)______________

2) Which best describes your job title or function? (Please check only one box below)

a) Facilities VP ☐ b) Facilities Director ☐ c) Facilities Manager ☐
d) Engineering Director ☐ e) Project Manager ☐ f) Maintenance Supervisor ☐
g) Maintenance Manager ☐ h) Other (Specify) ______________________________.

3) How long have you been with this organization?
a) 0-5 years ☐ b) 6-10 years ☐ c) 11-20 years ☐ d) Over 20 yrs. ☐

4) Name of Organization: ____

5) Number of employees? a)Under 50 ☐ b) 50-100 ☐ c) 100 - 200 ☐ d) 200 - 400 ☐ e) Over 400 ☐

6) Years in existence? a) 1-10 ☐ b) 10-20 ☐ c) 20-30 ☐ d) 30-40 ☐ e) Over 40 ☐ .

7) Type of ownership: a) Public For Profit ☐ b) Public Non-Profit ☐
c) Private For Profit ☐ d) Private Non-Profit ☐

8) Type of facility: a) Hospital ☐ b) Other health care facilities ☐ (Describe)____________

9) Approximate size in <u>thousands of square feet</u> ? a) Under 10 ☐ b) 10 - 30 ☐ c) 30- 60 ☐
d) 60-100 ☐ e) 100-300 ☐ f) Over 300 ☐

10) Based on dollar value, over the past 5 years what percentage of your construction projects are:

a) New facilities ______%
b) Remodeling/renovation ______%
c) Other (if applicable) ______%
100%

11) Based on the past 3-5 years, what is the price range for the "average" project? Please write in rough percentages of your projects (based on dollar value) that fall in the ranges below:

a) New facilities:

$100,000 to $1 million ______%
$1 million to $5 million ______%
$5 million to $20 million ______%
$20 million to $50 million ______%
Over $50 million ______%
100%

b) Remodeling/renovation:

$100,000 or less ______%
$100,000 to $1 million ______%
$1 million to $5 million ______%
$5 million to $20 million ______%
Over $20 million ______%
100%

12) Based on dollar value, what percentage of your construction contracts are established directly with:
a) a design build organization ______%
b) a Construction Management organization ______%
c) a general contractor ______%
d) Other ______%
100%

13) **COMPENSATION FORMATS**: Based on dollar value, what percentage of your contracts during the past 5 years have used the following construction compensation formats? Also, how satisfactory have these formats been for your organization? Please rank the formats in the right hand column using the number 1 for most satisfactory, 2 less satisfactory, and so forth.

		RANKING
a) Lump sum	______%	______
b) Cost plus a fee	______%	______
c) Guaranteed maximum price (G.M.P.)	______%	______
d) G.M.P. with cost saving/sharing	______%	______
d) Other compensation format: (please specify)	______%	______
	100%	

14) **PROJECT DELIVERY METHODS**: As above, what percentage of your projects used the following delivery methods, and how would you rank their effectiveness?

		RANKING
a) Traditional Design-Bid-Build	______%	______
b) "Fast-track"	______%	______
c) Design-Build	______%	______
d) Other methods (please specify)__________	______%	______
	100%	

SECTION B - PERFORMANCE/EVALUATION CRITERIA

15) What specific **performance indicators** do you generally use to judge the success of completed construction projects? Rank the following 9 factors in order of importance from most to least with 1 as the most important, and 9 the least. USE EACH RANK NUMBER ONLY ONCE.

	RANKING
a) Finishing within the time stipulated	______
b) Adherence to budget agreed	______
c) Quality of appearance (workmanship)	______
d) Satisfactory job relations with designer	______
e) Satisfactory job relations with contractors	______
f) Building works well - meets end users' needs	______
g) Performance of all electrical/mechanical/ specialized systems to specifications	______
h) Minimal number and value of change orders	______
i) Other (please specify)	______

16) To what extent do you think the following factors influence an owner's (facility administrator's) **level of satisfaction** with a construction project? Please respond by ranking the following 9 factors in order of importance from most to least with 1 as the most important, and 9 the least. (Use each number only once).

	RANKING
a) Timeliness of the project	______
b) Adherence to cost estimates	______
c) Clear up-front understanding of the job scope	______
d) Clear ongoing communication on job status	______
e) Prompt, adequate response to owner's complaints	______
f) Attractive design/aesthetics (architectural features)	______
g) High quality of construction - fit & finish	______
h) Minimal disruption to ongoing facility operations	______
i) Other (please specify)________________________	______

17) **RELATIONSHIPS WITH DESIGNERS.**

In selecting a design organization, an owner typically relies on some of the following criteria. From the owner's perspective, please respond by ranking the following 10 factors in order of importance from most to least with 1 as the most important, and 10 the least.

	RANKING
a) Specialization in similar work	______
b) Promised design completion date	______
c) Overall project budget	______
d) Track record/experience	______
e) Recommendations by others	______
f) Quality certification or use of techniques such as TQM	______
g) Previous project relationship between owner and designer	______
h) Use of innovative construction technology	______
i) Perceived responsiveness/customer understanding	______
k) Other (please specify)	______

18) **DESIGN CONSIDERATIONS.**

As the owner's representative, you have to balance a number of conflicting priorities and criteria when having construction work designed. **Using each number only once, please rank** the following from most critical = 1 to least critical = 10.

	RANKING
a) Lowest life cycle cost	______
b) Ease of maintenance/maintainability	______
c) User "friendliness"	______
d) System reliability (failures minimized)	______
e) Aesthetics (physical attractiveness)	______
f) Lowest first cost (when constructed)	______
g) Meeting basic functional requirements	______
h) Flexibility for future adaptation	______
i) Incorporation of latest technology within the facilities	______
j) Other (please state)	______

19) **RELATIONSHIPS WITH CONTRACTORS.**

This question addresses the criteria used to select contractors. **Using each number only once,** please rank the following from most critical = 1 to least critical = 10.

	RANKING
a) Specialization in similar work	______
b) Promised construction completion date	______
c) Overall project budget	______
d) Track record/experience	______
e) Recommendations by others	______
f) Quality certification or use of techniques such as TQM	______
g) Previous project relations	______
i) Use of innovative construction technology	______
j) Perceived responsiveness/customer understanding	______
k) Other (please specify)________________________	______

20) **CONSTRUCTION PROCESS CONSIDERATIONS (Environmental).**
Construction work that is carried out in or near health care facilities often calls for special considerations about external factors. Please rank the Contractor's ability to manage these problems (in terms of importance to you organization). Using each number only once, rank the following 6 factors in order of importance from most to least with 1 as the most important and 6 the least.

	RANKING
a) Noise	______
b) Odors (solvents, etc.)	______
c) Dust	______
e) Contamination by pathogens	______
f) Physical obstacles/debris unsafe to users	______
g) Vibration	______

21) **CONSTRUCTION PROCESS CONSIDERATIONS.**

Using each number only once. rank the following 6 factors (relative to contractors) in order of importance from most to least with 1 as the most important and 6 the least.

	RANKING
a) Ability to adjust schedule to owner/organization's operating needs	______
b) Training of owner's staff on equipment installed	______
c) Commissioning - testing/adjusting systems to meet owner's expectations	______
d) Prompt response to owner's warranty breakdown calls	______
e) Prompt submission of "as built" drawings, approval certificates, etc.	______
f) Other (please state)	______

22) This question has to do with how quality is controlled in the majority of your construction projects. The following approaches are commonly used.

(A) Please indicate how often they are used in <u>your</u> projects using a scale that looks like this: Always = 1, Often = 2, Sometimes = 3, Seldom = 4, Never = 5
(B) **Please rank these methods for effectiveness in the right hand column, using the following scale**: (Most effective = 1, Least effective = 5
Use each number only once.

	1	2	3	4	5	Effectiveness
a) By the designer as quality control inspector	☐	☐	☐	☐	☐	________
b) By the owner's staff person as quality control inspector	☐	☐	☐	☐	☐	________
c) By an independent quality control inspector	☐	☐	☐	☐	☐	________
d) By contracting staff	☐	☐	☐	☐	☐	________
e) Other (please specify)	☐	☐	☐	☐	☐	________

23) There are a number of techniques that have been used to improve productivity and quality in construction projects. Do you recognize any of the techniques listed below as having been used in your projects? Please check all that apply.

a) Partnering ☐ b) (Project) Team Building ☐ c) Total Quality Management ☐
d) ISO 9000 ☐ e) Value Engineering ☐ f) Constructibility reviews ☐
g) Other: (Please specify) ☐

24) If any of the foregoing techniques were utilized, please provide the average weekly hours <u>of your organization's staff</u> typically devoted to the items in the previous question:
_______ staff hours/week (Example: Two (2) staff members for 3 hours each per week = 6 staff hours/week).

25) Disputes among the parties to a contract are a common feature of construction projects. During the past 5 years, what percent of your projects have experienced disputes that resulted in litigation, mediation, or arbitration?

a) 0-10%	☐	b) 11-20%	☐	c) 21-30%	☐
d) 31-40%	☐	e) 41-50%	☐	f) Over 50%	☐

26) If you do experience problems and disputes on a project, which of the following approaches would you prefer? Rank the following 6 factors in order of importance from most to least with 1 as the most important and 6 the least.

<u>Definitions</u>:
Arbitration is a dispute resolution process involving certified arbitrators, that is quicker and less formal than court proceedings. Decisions are usually binding. Mediation is a less formal dispute resolution procedure, based on the principle of voluntary acceptance. Unlike an arbitrator, the mediator has no conclusive powers in a dispute. Litigation involves aggressive legal action of one party against another in a court of law.

	RANKING
a) Informal meetings	_______
b) Negotiation	_______
c) Mediation	_______
d) Arbitration	_______
e) Litigation	_______
f) Other	_______

27) As an owner's representative, in general, how negatively would your level of satisfaction be affected by the following **increases in schedule and cost?**

<u>Part 1</u>

<u>Schedule delay</u>	Not at all	very little	somewhat	moderately	very much
0-5%	☐	☐	☐	☐	☐
5%-15%	☐	☐	☐	☐	☐
15-30%	☐	☐	☐	☐	☐
30-50%	☐	☐	☐	☐	☐
Over 50%	☐	☐	☐	☐	☐

<u>Part 2</u>

<u>Cost Increase</u>	Not at all	very little	somewhat	moderately	very much
0-5%	☐	☐	☐	☐	☐
5%-15%	☐	☐	☐	☐	☐
15-30%	☐	☐	☐	☐	☐
30-50%	☐	☐	☐	☐	☐
Over 50%	☐	☐	☐	☐	☐

28) To what extent have the following been administered on your projects? Check the most appropriate answers. Also, indicate their benefit to you, the own, with a numerical score on a scale ranging from 1 (maximum benefit) to 5 (minimum benefit).

	NEVER	SELDOM	SOMETIMES	OFTEN	ALWAYS	BENEFIT SCORE (1 TO 5)
Owner Satisfaction Surveys	☐	☐	☐	☐	☐	____
Post Occupancy Surveys	☐	☐	☐	☐	☐	____

29) Frequency of meetings/interaction (OF PROJECT DECISION-MAKERS SUCH AS PROJECT MANAGERS OR PRINCIPALS WITH DESIGNERS/CONTRACTORS). In your experience, for a project lasting up to one (1) year, with a typical 1-year warranty, how often should project representatives of the owner meet with project representatives of the designer and the contractor, in order to have a completed project that best satisfies the owner's needs? The meetings may be for the purpose of reviewing drawings, project scope, project status, and problem avoidance and resolution. Check the most appropriate responses.

OWNER WITH DESIGNER AND CONTRACTOR	DESIGN STAGE	CONSTRUCTION	START-UP & 1-YR. WARRANTY
a) Daily	☐	☐	☐
b) Once Weekly	☐	☐	☐
c) Once every 2 weeks	☐	☐	☐
d) Once every 3 weeks	☐	☐	☐
e) Monthly	☐	☐	☐
f) Once per quarter	☐	☐	☐
g) Special occasions only	☐	☐	☐

30) In your estimation, which aspects of the design and construction process present the greatest barriers to the satisfaction of the owner organization (the primary customer)? Rank the following 11 factors with 1 as the most important and 11 the least.

___ Underbidding by contractors
___ Inadequacy of project funding by owners for features desired
___ Underpricing of project estimates by designers
___ Poor day-to-day project planning for construction
___ Inadequate cost control
___ Unfamiliarity of designers with the type of project
___ Unfamiliarity of contractors with the type of project
___ Lateness of information needed for a type of project
___ Lack of detail in drawings and/or specifications
___ Failure of codes to guarantee good workmanship and finish
___ Other factors(Please state)________________________________

31) ADDITIONAL COMMENTS: Please feel free to add any comments on the construction process that you think may contribute to the research or help to improve the delivery of high quality construction.________________________________

____

____

____

CONTRACTOR/DESIGNER INFORMATION

If you can, please assist our research by providing names of contractors and designers who do health care related construction and design. Please try to give as much contact information as you may have readily available.

GENERAL CONTRACTORS:

Name of Company: ____________________

Contact Person (Project Manager, etc.) ____________________

Telephone or Fax____________ City____________________ State ________

Street address (if available)____________________

Name of Company: ____________________

Contact Person (Project Manager, etc.) ____________________

Telephone or Fax ____________ City____________________ State ________

Street address (if available)____________________

DESIGN FIRMS:

Name of Company: ____________________

Contact Person (Project Manager, etc.) ____________________

Telephone or Fax ____________ City____________________ State________

Street address (if available)____________________

THANK YOU

UNIVERSITY OF MIAMI

DEPARTMENT OF INDUSTRIAL ENGINEERING

MEMORANDUM June 10, 1998

TO: AIA - ACADEMY OF ARCHITECTURE FOR HEALTH (AIA/AAH) AND AIA MEMBERS

RE: RESEARCH ON DESIGN AND CONSTRUCTION/RENOVATION QUALITY IN HEALTH CARE FACILITIES

The University of Miami's Department of Industrial Engineering is currently conducting research on design and construction quality and customer satisfaction in the health care environment, with the participation of the American Institute of Architects/Academy of Architecture for Health (AIA/AAH). This research is in response to the needs of the health care community to adequately maintain and upgrade their facilities while meeting the requirements of quality, cost, and government and insurance industry regulations. The findings are expected to benefit the parties involved in the health care facilities construction process - the owners and facilities managers, the designers of new construction or renovation work, and the contractors who build these facilities.

We have limited the research participants to acknowledged professionals, such as yourself, in order to obtain credible information, and are sending this survey to you with the consent and support of the AIA/Academy of Architecture for Health. By participating, you will be sharing your considerable experience in the design and management of construction projects. If you are not involved in health care-related projects, kindly forward this survey to the appropriate person at your office.

With regard to confidentiality, all information provided will be kept in the strictest confidence. No specific information related to your organization shall be disseminated without your express written permission

As survey team members, we would like to provide you with a copy of the survey results and resulting recommendations for improving health care design and construction management, at the end of the study. Based on the caliber of the survey participants, we expect this information to be most valuable to anyone involved with projects of this type.

We have attached a survey form and a self addressed envelope with prepaid postage for your convenience. Please return the completed form at the earliest possible opportunity. Should you have any questions or require further information, please contact Dr. Vincent Omachonu at (305) 284-2372, or research staff by e-mail at: **conqualrsh@aol.com**.

Thank you for your participation!

cc: Mr. Donald McKahan, AIA, President, AIA/AAH
Mr. Kirk Hamilton, FAIA, President-Elect, AIA/AAH

Department of Industrial Engineering
P.O. Box 248294
Coral Gables, Florida 33124-0623
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FACILITY DESIGNERS' CONSTRUCTION QUALITY SURVEY

Please provide the following information: Survey No. __________

Section A. Organization Information

1) Your Name: ____

2) Which best describes your job title or function?: (Please check 1 box below or otherwise describe)
   a) Principal ☐ b) VP (Design) ☐ c) Project Director ☐ d) Project Manager ☐
   e) Other ☐ (Specify)______________________________

3) How long have you been with this organization?
   a) 0-5 years ☐ b) 6-10 years ☐ c) 11-20 years ☐ d) Over 20 years ☐

4) Name of Organization: ____

5) Number of employees? a) Under 10 ☐ b) 10-50 ☐ c) 50 - 100 ☐ d) Over 100 ☐

6) Years in existence? a) 1-5 ☐ b) 6-10 ☐ c) 11-15 ☐ d) 16-20 ☐ e) Over 20 ☐

7) Primary business activity?: a) Architecture ☐ b) Engineering ☐ c) Construction management ☐
   d) Other ☐ (Please state)______________________________

8) Based on dollar value, over the past 5 years approximately what percentage of your projects belong to the categories below?
   a) Hospitals/health care facilities(HCFs) ______%
   b) Projects other than hospitals/HCFs ______%
   100%

9) With respect to hospitals/HCFs and based on dollar value, what percentage of your projects are:
   a) New facilities ______%
   b) Remodeling/renovation ______%
   c) Other (if applicable) ______%
   100%

10) Based on dollar value, what percentage of your hospital/health care facility projects are:
   a) Public sector facilities ______%
   b) Private sector facilities ______%
   c) Other (Specify)________________ ______%
   100%

11) Based on the past 3-5 years, what is the price range for the "average" project? Please write in rough percentages of your projects (based on dollar value) that fall in the ranges below:

a) New facilities:

$100,000 to $1 million	______%
$1 million to $5 million	______%
$5 million to $20 million	______%
$20 million to $50 million	______%
Over $50 million	______%
	100%

b) Remodeling/renovation:

$100,000 or less	______%
$100,000 to $1 million	______%
$1 million to $5 million	______%
$5 million to $20 million	______%
Over $20 million	______%
	100%

12) In what range is the annual value of construction work designed, supervised, or monitored by your firm?

a)	$100,000 to $1 million	_____%	b)	$0.5 to $5 million	_______%
c)	$5 to $10 million	_____%	d)	$10 to $25 million	_______%
e)	$25 to $50 million	_____%	f)	Over $50 million	_______%

13) Based on dollar value, what percentage of your contracts are established directly with:

a)	an owner	_______%
b)	a design build organization	_______%
c)	a Construction Management organization	_______%
d)	an architect/engineer (as a design subcontractor)	_______%
e)	Other	_______%
		100%

14) **COMPENSATION FORMATS**: Based on dollar value, what percentage of your contracts during the past 5 years have used the following construction compensation formats? Also, please score your satisfaction level for each on a scale of 1 (most satisfactory) to 7 (least satisfactory).

SATISFACTION SCORE (1-7)		
_______	a) Lump sum	_______%
_______	b) Cost plus a fee	_______%
_______	c) Guaranteed maximum price (G.M.P.)	_______%
_______	d) G.M.P. with cost saving/sharing	_______%
_______	e) Other compensation format: (please specify)	_______%
	________________________________	100%

15) **PROJECT DELIVERY METHODS**: As above, what percentage of your projects used the following delivery methods, and how would you score your satisfaction with them?

SATISFACTION SCORE (1-7)		
_______	a) Traditional Design-Bid-Build	_______%
_______	b) "Fast-track"	_______%
_______	c) Design-Build	_______%
_______	d) Construction Management (fee paid)	_______%
_______	e) Construction Management (at risk)	_______%
_______	f) Other methods (please specify)	_______%
	________________________________	100%

SECTION B - PERFORMANCE/EVALUATION CRITERIA

PRIVATE/PUBLIC SECTOR FACILITIES: The following questions relate to new construction and renovation/remodeling projects in privately-owned facilities and publicly owned facilities:

16) What specific **performance indicators** do you generally use to judge the success of completed construction projects? Rank the following 9 factors in order of importance from most to least with 1 as the most important, and 9 the least. Consider private sector facilities and public sector facilities separately. **USE EACH RANK NUMBER ONLY ONCE.**

	PRIVATE SECTOR	PUBLIC SECTOR
a) Finishing within the time stipulated	____	____
b) Adherence to budget agreed	____	____
c) Quality of appearance (workmanship)	____	____
d) Satisfactory job relations with owner	____	____
e) Satisfactory job relations with contractors	____	____
f) Building works well - meets end users needs	____	____
g) Performance of all electrical/mechanical/ specialized systems to specifications	____	____
h) Minimal number and value of change orders	____	____
i) Other (please specify)	____	____

17) To what extent do you think the following factors influence an owners's (facility administrator's) **level of satisfaction** with a construction project? Please respond by ranking the following 9 factors in order of importance from most to least with 1 as the most important, and 9 the least. **(USE EACH RANK NUMBER ONLY ONCE)**

	PRIVATE SECTOR	PUBLIC SECTOR
a) Timeliness of the project	____	____
b) Adherence to cost estimates	____	____
c) Clear up-front understanding of the job scope	____	____
d) Clear ongoing communication on job status	____	____
e) Prompt, adequate response to owner's complaints	____	____
f) Attractive design/aesthetics (architectural features)	____	____
g) High quality of construction - fit & finish	____	____
h) Minimal disruption to ongoing facility operations	____	____
i) Other (please specify)	____	____

18) **RELATIONSHIPS WITH OWNERS.**

When owners select a design organization, how do you think they use the following criteria? Please respond by ranking the following 10 factors in order of importance from most to least with 1 as the most important, and 10 the least. Rank them separately for private sector and public sector projects.

	PRIVATE SECTOR	PUBLIC SECTOR
a) Specialization in similar work	____	____
b) Promised completion date	____	____
c) Overall project budget	____	____
d) Track record/experience	____	____
e) Recommendations by others	____	____
f) Quality certification or use of techniques such as TQM	____	____
g) Previous project relationship between owner and designer	____	____
h) Use of innovative construction technology	____	____
i) Perceived responsiveness/customer understanding	____	____
j) Other (please specify)	____	____

19) **DESIGN CONSIDERATIONS.**
As designer, you have to balance a number of conflicting priorities and criteria when designing a project for construction. **Given a free choice** how would you rank these factors? Please respond by ranking the following from most critical = 1 to least critical = 10 (**using each number only once**). Rank them separately for private sector and public sector projects.

	PRIVATE SECTOR	PUBLIC SECTOR
a) Lowest life cycle cost	____	____
b) Ease of maintenance/maintainability	____	____
c) User "friendliness"	____	____
d) System reliability (failures minimized)	____	____
e) Aesthetics (physical attractiveness)	____	____
f) Lowest first cost (when constructed)	____	____
g) Meeting basic functional requirements	____	____
h) Flexibility for future adaptation	____	____
i) Incorporation of latest technology in the facilities	____	____
j) Other (please state)	____	____

20) **OWNERS' RELATIONSHIPS WITH CONTRACTORS.**
When owners select a contractor, how do you think they use the following criteria? **Using each number only once**, please respond by ranking the following from most critical = 1 to least critical = 10. Rank them separately for private sector and public sector projects.

	PRIVATE SECTOR	PUBLIC SECTOR
a) Specialization in similar work	____	____
b) Promised completion date	____	____
c) Overall project budget	____	____
d) Track record/experience	____	____
e) Recommendations by others	____	____
f) Quality certification or use of technique such as TQM	____	____
g) Previous project relations	____	____
i) Use of innovative construction technology	____	____
j) Perceived responsiveness/customer understanding	____	____
k) Other (please specify)	____	____

21) **CONSTRUCTION PROCESS CONSIDERATIONS (Environmental).**
Construction work that is carried out in or near health care facilities often calls for special considerations about external factors. Please rank the Contractor's ability to manage these problems (in terms of importance to your organization). Using each number only once, rank the following 7 factors in order of importance from most to least with 1 as the most important and 7 the least. Rank them separately for private sector and public sector projects.

	PRIVATE SECTOR	PUBLIC SECTOR
a) Noise	____	____
b) Odors (solvents, etc.)	____	____
c) Dust	____	____
e) Contamination by pathogens	____	____
f) Physical obstacles/debris unsafe to users	____	____
g) Vibration	____	____
h) Interruption of utilities	____	____

22) **CONSTRUCTION PROCESS CONSIDERATIONS.**

Using each number only once. rank the following 6 factors (relative to contractors) in order of importance from most to least with 1 as the most important and 6 the least. Rank them separately for private sector and public sector projects.

	PRIVATE SECTOR	PUBLIC SECTOR
a) Ability to adjust schedule to owner/organization's operating needs	_____	_____
b) Training of owner's staff on equipment installed	_____	_____
c) Commissioning - testing/adjusting systems to meet owner's expectations	_____	_____
d) Prompt response to owner's warranty breakdown calls	_____	_____
e) Prompt submission of "as built" drawings approval certificates, etc.	_____	_____
f) Other (please state) ____________________	_____	_____

23) This question has to do with how quality is controlled in the majority of your construction projects. The following approaches are commonly used.

(A) Please indicate how often they are used in your projects using a scale that looks like this: Always = 1, Often = 2, Sometimes = 3, Seldom = 4, Never = 5

(B) **Please rank these methods for effectiveness in the right hand column, using the following scale:** (Most effective = 1, Least effective = 5). **Use each number only once.**

	1	2	3	4	5	Effectiveness
a) By the designer as quality control inspector	☐	☐	☐	☐	☐	____________
b) By the owners' staff person as quality control inspector	☐	☐	☐	☐	☐	____________
c) By an independent quality control inspector	☐	☐	☐	☐	☐	____________
d) By contracting staff	☐	☐	☐	☐	☐	____________
e) Other (please specify)	☐	☐	☐	☐	☐	____________

24) There are a number of techniques that have been used to improve productivity and quality in construction projects. Do you recognize any of the techniques listed below as having been used in your projects? Please check all that apply.

a) Partnering ☐ b) (Project) Team Building ☐ c) Total Quality Management ☐
d) ISO 9000 ☐ e) Value Engineering ☐ f) Constructibility reviews ☐
g) Other: (Please specify) ☐____________________

25) If any of these techniques were utilized, please provide the average weekly hours typically devoted by your organization's staff to the items in the previous question: (Example: Two (2) staff members for 3 hours each per week = 6 staff hours/week).

a) Staff hours =______ hrs. per week.

b) Staff cost as approx % of construction cost?:
(Less than 0.5%___) (0.5 to 1%____) (1% to 3%____) (3% to 5%____) (over 5%____)

26) Disputes among the parties to a contract are a common feature of construction projects. During the past 5 years. what percent of your projects have experienced disputes that resulted in litigation. mediation. or arbitration?

a) 0% ☐ b) 1-10% ☐ c) 11-20% ☐ d) 21-30% ☐
e) 31-40% ☐ f) 41-50% ☐ g) Over 50% ☐

27) If you do experience problems and disputes on a project, which of the following approaches would you prefer? Rank the following 6 factors in order of importance from most to least with 1 as the most important and 6 the least. Consider privately owned facilities and public sections facilities separately.

Definitions:
Arbitration is a dispute resolution process involving certified arbitrators. that is quicker and less formal than court proceedings. Decisions are usually binding. Mediation is a less formal dispute resolution procedure. based on the principle of voluntary acceptance. Unlike an arbitrator. the mediator has no conclusive powers in a dispute. Litigation involves aggressive legal action of one party against another in a court of law.

	PRIVATE SECTOR	PUBLIC SECTOR
a) Informal meetings	_____	_____
b) Negotiation	_____	_____
c) Mediation	_____	_____
d) Arbitration	_____	_____
e) Litigation	_____	_____
f) Other	_____	_____

28) In general, how negatively do you think an owner's level of satisfaction would be affected by the following **increases in schedule and cost**?

PART 1

Schedule Delay	Not at all	very little	somewhat	moderately	very much
0-5%	☐	☐	☐	☐	☐
5%-15%	☐	☐	☐	☐	☐
15-30%	☐	☐	☐	☐	☐
30-50%	☐	☐	☐	☐	☐
Over 50%	☐	☐	☐	☐	☐

PART 2

Cost Increase	Not at all	very little	somewhat	moderately	very much
0-5%	☐	☐	☐	☐	☐
5%-15%	☐	☐	☐	☐	☐
15-30%	☐	☐	☐	☐	☐
30-50%	☐	☐	☐	☐	☐
Over 50%	☐	☐	☐	☐	☐

29) To what extent have the following been administered on your projects? Check the most appropriate answers. Also, indicate their benefit to you, the owner, with a numerical score on a scale ranging from 1 (maximum benefit) to 7 (minimum benefit).

	NEVER	SELDOM	SOMETIMES	OFTEN	ALWAYS	BENEFIT SCORE (1 TO 7)
Owner Satisfaction Surveys	☐	☐	☐	☐	☐	____
Post Occupancy Surveys	☐	☐	☐	☐	☐	____

30) Frequency of meetings/interaction (OF PROJECT DECISION-MAKERS SUCH AS PROJECT MANAGERS OR PRINCIPALS WITH DESIGNERS/CONTRACTORS): In your experience, for a project lasting up to one (1) year, with a typical 1-year warranty, how often should project representatives of the owner meet with project representatives of the designer and the contractor, in order to have a completed project that best satisfies the owner's needs? The meetings may be for the purpose of reviewing drawings, project scope, project status, and problem avoidance and resolution. Check the most appropriate responses.

OWNER WITH DESIGNER AND CONTRACTOR	DESIGN STAGE	CONSTRUCTION	COMMISSIONING (START-UP) & 1YR. WARRANTY
a) Daily	☐	☐	☐
b) Once Weekly	☐	☐	☐
c) Once every 2 weeks	☐	☐	☐
d) Once every 3 weeks	☐	☐	☐
e) Monthly	☐	☐	☐
f) Once per quarter	☐	☐	☐
g) Special occasions only	☐	☐	☐

31) In your estimation, which aspects of the design and construction process present the greatest barriers to the satisfaction of the owner organization (the primary customer)? **Using each number only once**, rank the following 11factors in order of importance from most to least with 1 as the most important and 11 the least.

___ Underbidding by contractors
___ Inadequacy of project funding by owners for features desired
___ Underpricing of project estimates by designers
___ Poor day-to-day project planning for construction
___ Inadequate cost control
___ Unfamiliarity of designers with the type of project
___ Unfamiliarity of contractors with the type of project
___ Lateness of information needed for a type of project
___ Lack of detail in drawings and/or specifications
___ Failure of codes to guarantee good workmanship and finish
___ Other factors (Please state)________________________________

32) ADDITIONAL COMMENTS: Please feel free to add any comments on the construction process that you think may contribute to the research or help to improve the delivery of high quality construction.

____

____

____

<u>SECTION C: CONTRACTOR INFORMATION</u> **<u>(Based on readily available information only)</u>**

If you can, please assist our research by providing names of <u>general contractors</u> who do health care related construction:

Name of Company (#1):____

Contact Person (VP, Project Manager, etc.) ______________________________

Telephone/Fax____________________**City**_____________**State**______________

Street address (if available)____

Name of Company (#2):____

Contact Person (VP, Project Manager, etc.) ______________________________

Telephone/Fax____________________**City**_____________**State**______________

Street address (if available)____

THANK YOU!

UNIVERSITY OF Miami

DEPARTMENT OF INDUSTRIAL ENGINEERING

MEMORANDUM July, 1998

TO: Contractors/Construction Professionals

RE: RESEARCH PROJECT ON CONSTRUCTION/RENOVATION QUALITY IN HEALTH CARE FACILITIES

The University of Miami's Department of Industrial Engineering, with the support of several professional organizations, is currently conducting research on construction quality and customer satisfaction in the health care environment. The organizations include The Associated General Contractors of America (AGC), The American Institute of Architects, and members of The American Hospital Association, as well as others. We expect the findings to benefit the parties involved in the construction process - building owners, designers, and contractors. We have limited the participants in the survey to acknowledged professionals such as yourself, in order to obtain reliable information.

FREE GIFT!
In return for your support, we have special free gifts: a) Companies that respond will receive a complimentary 12-month subscription to the Florida Construction News (FCN), a monthly publication featuring construction projects and issues in Florida, Latin America and the Caribbean, and b) Each company will be entered in a Grand Prize Drawing to award three free 1/3-page company advertisements in FCN. c) We will also share with you (if you participate) the results of the survey, with specific facts on how to serve customers better and make your company more competitive. (See the back of the questionnaire for FCN information).

With regard to confidentiality, all information provided will be kept in the strictest confidence. No specific information related to your organization shall be disseminated without your express written permission.

We have attached a survey form and a self-addressed envelope with prepaid postage for your convenience. Please return the completed form at the earliest possible opportunity. If you are not involved in health care-related projects, kindly forward this survey to the appropriate person in your company.

Should you have any questions or require further information, please contact Dr. Vincent Omachonu at (305) 284-2372, or research staff by e-mail at: conqualrsh@aol.com

Thank you for your participation!

Department of Industrial Engineering
P.O. Box 248294
Coral Gables, Florida 33124-0623
Fax: 305-284-4040 • Phone: 305-284-2344 • Email: ien@eng.miami.edu

RESEARCH PROJECT - HOSPITALS/HEALTH CARE FACILITIES

FACILITY CONTRACTORS' CONSTRUCTION QUALITY SURVEY

Please provide the following information: Survey No. __________

Section A. Organization Information

1) Your Name: ____Tel.______________

2) Which best describes your job title or function?: (Please check 1 box below or otherwise describe)

a) Chairman ☐ b) CEO ☐ c) President ☐ d) Principal ☐ e) Vice President ☐ f) Director ☐
g) Project Manager ☐ h) Other ☐ (Please specify)______________________________

3) Name of Organization: ____

4) How long have you been with this organization?
a) 0-5 years ☐ b) 6-10 years ☐ c) 11-20 years ☐ d) Over 20 yrs. ☐

5) Number of permanent employees? a) Under 10 ☐ b) 10-50 ☐ c) 50 - 100 ☐ d) 100 - 500 ☐ e) Over 500 ☐

6) Years in existence? a) 1-5 ☐ b) 6-10 ☐ c) 11-15 ☐ d) 16-20 ☐ e) Over 20 ☐

7) Primary business activity?: a) General Contractor ☐ b) Subcontractor ☐ c) Construction manager ☐
d) Other ☐ (Please state)______________________________

8) Based on dollar value, over the past 5 years approximately what percentage of your projects belong to the categories below?

a)	Hospitals/health care facilities(HCFs)	______%
b)	Projects other than hospitals/HCFs	______%
		100%

9) With respect to hospitals/HCFs and based on dollar value, what percentage of your projects are:

a)	New facilities	______%
b)	Remodeling/renovation	______%
c)	Other (if applicable)	______%
		100%

10) Based on dollar value, what percentage of your hospital/health care facility projects are:

a)	Public sector facilities	______%
b)	Private sector facilities	______%
	Other (Specify)______________	______%
		100%

11) Based on the past 3-5 years, what is the price range for the "average" project? Please write in rough percentages of your projects (based on dollar value) that fall in the ranges below:

a) New facilities:

$100,000 to $1 million	______%
$1 million to $5 million	______%
$5 million to $20 million	______%
$20 million to $50 million	______%
Over $50 million	______%
	100%

b) Remodeling/renovation:

$100,000 or less	______%
$100,000 to $1 million	______%
$1 million to $5 million	______%
$5 million to $20 million	______%
Over $20 million	______%
	100%

12) In what range is the annual value of construction work certified, managed, or executed by your firm?

a) $100,000 to $1 million ______% b) $0.5 to $5 million ______%
c) $5 to $10 million ______% d) $10 to $25 million ______%
e) $25 to $50 million ______% f) Over $50 million ______%

13) Based on dollar value, what percentage of your contracts are established directly with:

a) an owner ______%
b) a design build organization ______% ____________________
c) a Construction Management organization ______%
d) a general contractor (as a subcontractor) ______%
e) Other ______%
100%

14) In general, when you serve as a General Contractor, what percentage of your work is done by subcontractors?________%

15) COMPENSATION FORMATS: Based on dollar value, what percentage of your contracts during the past 5 years have used the following construction compensation formats? Also, please score your satisfaction level for each on a scale of 1 (most satisfactory) to 7 (least satisfactory).

SATISFACTION
SCORE (1-7)
______ a) Lump sum ______%
______ b) Cost plus a fee ______%
______ c) Guaranteed maximum price (G.M.P.) ______%
______ d) G.M.P. with cost saving/sharing ______%
______ e) Other compensation format: (please specify) ______%
____________________ 100%

16) PROJECT DELIVERY METHODS: As above, what percentage of your projects used the following delivery methods, and how would you score your satisfaction with them?

SATISFACTION
SCORE (1-7)
______ a) Traditional Design-Bid-Build ______%
______ b) "Fast-track" ______%
______ c) Design-Build ______%
______ d) Construction Management (fee paid) ______%
______ e) Construction Management (at risk) ______%
______ f) Other methods (please specify) ______%
____________________ 100%

SECTION B - PERFORMANCE/EVALUATION CRITERIA

PRIVATE/PUBLIC SECTOR FACILITIES: The following questions relate to new construction and renovation/remodeling projects in privately-owned facilities and publicly owned facilities.

17) What specific **performance indicators** do you generally use to judge the success of completed construction projects? Rank the following 9 factors in order of importance from most to least with 1 as the most important, and 9 the least. Consider private sector facilities and public sector facilities separately. **USE EACH RANK NUMBER ONLY ONCE FOR EACH SECTOR.**

	PRIVATE SECTOR	PUBLIC SECTOR
a) Finishing within the time stipulated	____	____
b) Adherence to budget agreed	____	____
c) Quality of appearance (workmanship)	____	____
d) Satisfactory job relations with owner	____	____
e) Satisfactory job relations with designers	____	____
f) Building works well - meets end users needs	____	____
g) Performance of all electrical/mechanical/ specialized systems to specifications	____	____
h) Minimal number and value of change orders	____	____
i) Other (please specify)	____	____

18) To what extent do you think the following factors influence an owners's (facility administrator's) **level of satisfaction** with a construction project? Please respond by ranking the following 9 factors in order of importance from most to least with 1 as the most important, and 9 the least. **(USE EACH RANK NUMBER ONLY ONCE FOR EACH SECTOR)**

	PRIVATE SECTOR	PUBLIC SECTOR
a) Timeliness of the project	____	____
b) Adherence to cost estimates	____	____
c) Clear up-front understanding of the job scope	____	____
d) Clear ongoing communication on job status	____	____
e) Prompt, adequate response to owner's complaints	____	____
f) Attractive design/aesthetics (architectural features)	____	____
g) High quality of construction - fit & finish	____	____
h) Minimal disruption to ongoing facility operations	____	____
i) Other (please specify)	____	____

19) **RELATIONSHIPS WITH OWNERS.**

When owners select a construction organization, how do you think they use the following criteria? Please respond by ranking the following 10 factors in order of importance from most to least with 1 as the most important, and 10 the least. Rank them separately for private sector and public sector projects.

	PRIVATE SECTOR	PUBLIC SECTOR
a) Specialization in similar work	____	____
b) Promised completion date	____	____
c) Overall project budget	____	____
d) Track record/experience	____	____
e) Recommendations by others	____	____
f) Quality certification or use of techniques such as TQM	____	____
g) Previous project relationship between owner and contractor	____	____
h) Use of innovative construction technology	____	____
i) Perceived responsiveness/customer understanding	____	____
j) Other (please specify)	____	____

20) **DESIGN CONSIDERATIONS.**
The owner and designer of a project have to balance a number of conflicting priorities and factors. **Given a free choice** how would you rank these factors? Please respond by ranking the following from most critical = 1 to least critical = 10 (**using each number only once for each sector**). Rank them separately for private sector and public sector projects.

	PRIVATE SECTOR	PUBLIC SECTOR
a) Lowest life cycle cost	_____	_____
b) Ease of maintenance/maintainability	_____	_____
c) User "friendliness"	_____	_____
d) System reliability (failures minimized)	_____	_____
e) Aesthetics (physical attractiveness)	_____	_____
f) Lowest first cost (when constructed)	_____	_____
g) Meeting basic functional requirements	_____	_____
h) Flexibility for future adaptation	_____	_____
i) Incorporation of latest technology in the facilities	_____	_____
j) Other (please state)	_____	_____

21) **CONSTRUCTION PROCESS CONSIDERATIONS (Environmental).**
Construction work that is carried out in or near health care facilities often calls for special considerations about external factors. How do you think the owner ranks the Contractor's ability to manage these factors? Using each number only once, rank the following 7 factors in order of importance from most to least with 1 as the most important and 7 the least. Rank them separately for private sector and public sector projects.

	PRIVATE SECTOR	PUBLIC SECTOR
a) Noise	_____	_____
b) Odors (solvents, etc.)	_____	_____
c) Dust	_____	_____
e) Contamination by pathogens	_____	_____
f) Physical obstacles/debris unsafe to users	_____	_____
g) Vibration	_____	_____
h) Interruption of utilities	_____	_____

22) CONSTRUCTION PROCESS CONSIDERATIONS.

Using each number only once, show how you think owners rank the following 6 factors (that relate to contractors) in order of importance from most to least with 1 as the most important and 6 the least. Rank them separately for private sector and public sector projects.

	PRIVATE SECTOR	PUBLIC SECTOR
a) Contractor's ability to adjust schedule to owner's or organization's operating needs	_____	_____
b) Training of owner's staff on equipment installed	_____	_____
c) Commissioning - testing/adjusting systems to meet owner's expectations	_____	_____
d) Prompt response to owner's warranty breakdown calls	_____	_____
e) Prompt submission of "as built" drawings approval certificates, etc.	_____	_____
f) Other (please state)____________________	_____	_____

23) This question has to do with how quality is controlled in the majority of your health care facility (HCF)construction projects. The methods listed below are commonly used.

(A) Please indicate how often they are used in <u>your HCF projects</u> using a scale that looks like this: Always = 1, Often = 2, Sometimes = 3, Seldom = 4, Never = 5

(B) **Please show how effective you think these methods are by ranking in the right hand column, using the following scale:** (Most effective = 1, Least effective = 5) . **Use each number only once.**

	How often used? 1	2	3	4	5	Effectiveness
a) By the designer as quality control inspector	☐	☐	☐	☐	☐	______
b) By the owners' staff person as quality control inspector	☐	☐	☐	☐	☐	______
c) By an independent quality control inspector	☐	☐	☐	☐	☐	______
d) By contracting staff	☐	☐	☐	☐	☐	______
e) Other (please specify)	☐	☐	☐	☐	☐	______

24) There are a number of techniques that have been used to improve productivity and quality in construction projects. Do you recognize any of the techniques listed below as having been used in your projects? Please check all that apply.

a) Partnering ☐ b) (Project) Team Building ☐ c) Total Quality Management ☐
d) ISO 9000 ☐ e) Value Engineering ☐ f) Constructibility reviews ☐
g) Other: (Please specify) ☐__________________

25) If any of these techniques were utilized, please provide the average weekly hours typically devoted by your organization's staff to the items in the previous question: (Example: Two (2) staff members for 3 hours each per week = 6 staff hours/week).

a) Staff hours =______ hrs. per week. b) Staff cost as approx % of construction cost:
(Less than 0.5%___) (0.5 to 1%____) (1% to 3%____) (3% to 5%____) (over 5%____)

26) Disputes among the parties to a contract are a common feature of construction projects. During the past 5 years, what percent of your projects have experienced disputes that resulted in litigation, mediation, or arbitration?

a) 0% ☐ b) 1-10% ☐ c) 11-20% ☐ d) 21-30% ☐
e) 31-40% ☐ f) 41-50% ☐ g) Over 50% ☐

27) If you do experience problems and disputes on a project, which of the following approaches would you prefer? Rank the following 6 factors in order of importance from most to least with 1 as the most important and 6 the least. Consider privately owned facilities and public sections facilities separately.
Definitions:
Arbitration is a dispute resolution process involving certified arbitrators, that is quicker and less formal than court proceedings. Decisions are usually binding. Mediation is a less formal dispute resolution procedure, based on the principle of voluntary acceptance. Unlike an arbitrator, the mediator has no conclusive powers in a dispute. Litigation involves aggressive legal action of one party against another in a court of law.

	PRIVATE SECTOR	PUBLIC SECTOR
a) Informal meetings	____	____
b) Negotiation	____	____
c) Mediation	____	____
d) Arbitration	____	____
e) Litigation	____	____
f) Other	____	____

28) In general, how negatively do you think an owner's level of satisfaction would be affected by the following **increases in schedule and cost?**

PART 1

Schedule Delay	Not at all	very little	somewhat	moderately	very much
0-5%	☐	☐	☐	☐	☐
5%-15%	☐	☐	☐	☐	☐
15-30%	☐	☐	☐	☐	☐
30-50%	☐	☐	☐	☐	☐
Over 50%	☐	☐	☐	☐	☐

PART 2

Cost Increase	Not at all	very little	somewhat	moderately	very much
0-5%	☐	☐	☐	☐	☐
5%-15%	☐	☐	☐	☐	☐
15-30%	☐	☐	☐	☐	☐
30-50%	☐	☐	☐	☐	☐
Over 50%	☐	☐	☐	☐	☐

29) To what extent have the following been administered on your projects? Check the most appropriate answers. Also, indicate their benefit to you, the owner, with a numerical score on a scale ranging from 1 (maximum benefit) to 7 (minimum benefit).

	NEVER	SELDOM	SOMETIMES	OFTEN	ALWAYS	BENEFIT SCORE (1 TO 7)
Owner Satisfaction Surveys	☐	☐	☐	☐	☐	____
Post Occupancy Surveys	☐	☐	☐	☐	☐	____

30) Frequency of meetings/interaction (OF PROJECT DECISION-MAKERS SUCH AS PROJECT MANAGERS OR PRINCIPALS WITH DESIGNERS/CONTRACTORS). In your experience, for a project lasting up to one (1) year, with a typical 1-year warranty, how often should project representatives of the owner meet with project representatives of the designer and the contractor, in order to have a completed project that best satisfies the owner's needs? The meetings may be for the purpose of reviewing drawings, project scope, project status, and problem avoidance and resolution. Check the most appropriate responses.

OWNER WITH DESIGNER AND CONTRACTOR	DESIGN STAGE	CONSTRUCTION	COMMISSIONING (START-UP) & 1-YR. WARRANTY
a) Daily	☐	☐	☐
b) Once Weekly	☐	☐	☐
c) Once every 2 weeks	☐	☐	☐
d) Once every 3 weeks	☐	☐	☐
e) Monthly	☐	☐	☐
f) Once per quarter	☐	☐	☐
g) Special occasions only	☐	☐	☐

31) In your estimation, which aspects of the design and construction process present the greatest barriers to the satisfaction of the owner organization (the primary customer)? **Using each number only once**, rank the following 11 factors in order of importance from most to least with 1 as the most important and 11 the least.

a) ___ Underbidding by contractors
b) ___ Inadequacy of project funding by owners for features desired
c) ___ Underpricing of project estimates by designers
d) ___ Poor day-to-day project planning for construction
e) ___ Inadequate cost control
f) ___ Unfamiliarity of designers with the type of project
g) ___ Unfamiliarity of contractors with the type of project
h) ___ Lateness of information needed for a type of project
i) ___ Lack of detail in drawings and/or specifications
j) ___ Failure of codes to guarantee good workmanship and finish
k) ___ Other factors (Please state)________________________________

32) ADDITIONAL COMMENTS: Please feel free to add any comments on the construction process that you think may contribute to the research or help to improve the delivery of high quality construction.

____

____

____

____

UNIVERSITY OF MIAMI
HEALTH CARE FACILITY CONSTRUCTION QUALITY RESEARCH PROJECT
PROJECT-SPECIFIC SURVEY
FACILITY OWNER REPRESENTATIVES

SURVEY NUMBER________

Purpose of the survey:
To obtain specific information about the conduct and outcome of ***completed*** renovation or new construction projects. This information will provide supportable facts on which to base a model for the success of future projects. Your contribution will be highly appreciated.

SECTION A. ORGANIZATION INFORMATION Date______________

1) Completed by:____Tel.________________

2) Job title or function? (Please check below)

a) C.O.O ☐ b) Facilities VP ☐ c) Facilities Director ☐
d) Engineering Director ☐ e) Project Manager ☐ f) Maintenance Supervisor ☐
g) Maintenance Manager ☐ h) Other (Please specify)________________________

3) Health Care Organization:____

4) Address:______________________________________State:_________Zip Code______

5) Type of facility: a) Hospital ☐ b) Other health care facilities ☐

(Describe)_________________________________

SECTION B - PROJECT-SPECIFIC INFORMATION:

PLEASE PROVIDE US WITH ABBREVIATED INFORMATION ABOUT 1 OR MORE OF YOUR CONSTRUCTION PROJECTS THAT HAVE BEEN COMPLETED WITHIN THE PAST 5 YEARS. EACH PROJECT SHOULD PREFERABLY INVOLVE NEW CONSTRUCTION OR RENOVATION COSTING $50,000 OR MORE, AND SHOULD BE BASED ON OCCUPIED SPACE PRIMARILY.

Please use one survey form for each project.

1) PROJECT NO:(temporary)__________________

2) Short Description____

____

3) Category: New___/Renovation____ Square footage____________

4) Which organization did the design?____

5) Designer's Project Manager___________________________Phone_________Fax_________

6) Who was the Contractor?____

7) Project Manager/Superintendent_________________Phone_____________Fax_________

8) **COMPENSATION FORMATS**:

Which compensation method was used for this project? (Please check below).

a) Lump sum
b) Cost plus a fee ______
c) Guaranteed maximum price (G.M.P.) ______
d) G.M.P. with cost saving/sharing ______
e) Other compensation format: (please specify) ______

____

9) **PROJECT DELIVERY METHODS**:

What project delivery method was used? (Please check below).

a) Traditional Design-Bid-Build ______
b) "Fast-track" ______
c) Design-Build ______
d) Construction Management (fee paid) ______
e) Construction Management (at risk) ______
f) Other methods (please specify) ______

____

10) How was the project awarded to the contractor? (Check as appropriate)
Lowest bid__________Negotiated price___________

11) Did you use this contractor before? (YES_____) (NO_____)

12) How was the project awarded to the designer? (Check below)
Competitive/open negotiations__________ Private/closed negotiations_________

13) Did you use this designer before (YES____) (NO_____)

14) Were any of the techniques listed below used in this project? (Please check all that apply).

a) Partnering ☐ b) (Project) Team Building ☐ c) Total Quality Management ☐
d) ISO 9000 ☐ e) Value Engineering ☐ f) Constructibility reviews ☐

g) Other: (Please specify) ☐______________________________

h) Not sure____________________

SCHEDULE PERFORMANCE:

15) Was the project: (late?____) (on time?______) (ahead of schedule?_____)

16) Design start date______Projected end date_____ Actual design end date________

17) If there was a design delay, what caused it? a) Changes by owner_______

b) Unforseen conditions________ c) Other (please state)____________________

18) Construction start date______Projected end date_______ Actual end date___________

19) If there was a construction delay, what caused it? a) Changes by owner_____
b) Unforseen conditions______ c) Other (please state)____________________

20) If there were schedule delays on this project, how negatively was your organization's level of satisfaction affected?

			Part I		
Schedule delay	Not at all	very little	somewhat	moderately	very much
	☐	☐	☐	☐	☐

COST PERFORMANCE:

21) Was the project: (over budget?___) (within budget?___) (significantly under budget?____)

22) (a) Contract price $_________ Final cost$_________ Difference$___________

23) If there was a cost increase, what caused it? a) Changes by owner_______ b) Unforseen conditions________ c) Other (please state)____________________

24) If there were cost increases on this project, how negatively was your organization's level of satisfaction affected?

Cost Increase	Not at all	very little	somewhat	moderately	very much
	☐	☐	☐	☐	☐

SECTION C - PERFORMANCE/EVALUATION CRITERIA

The following ***three*** questions ask for a ranking of certain factors that were considered in this project. **There are no other ranking questions**.

1) For this project, please ***rank*** the following 9 factors in terms of their importance by the following scale:

1 = most important, 9 = least important.

RANKING (1 to 9)

_______ a) Finishing within the time stipulated
_______ b) Adherence to budget agreed
_______ c) Quality of appearance (workmanship)
_______ d) Satisfactory job relations with designer
_______ e) Satisfactory job relations with contractors
_______ f) Building works well - meets end users' needs
_______ g) Performance of all electrical/mechanical/specialized systems to specifications
_______ h) Minimal number and value of change orders
_______ i) Other (please state)_________________________________

2) **DESIGN CONSIDERATIONS.**

For this project, please ***rank*** the following 10 factors in terms of their importance by the following scale:
1 = most important, 10 = least important.

RANKING (1 to 10)

_______ a) Lowest life cycle cost
_______ b) Ease of maintenance/maintainability
_______ c) User "friendliness"
_______ d) System reliability (failures minimized)
_______ e) Aesthetics (physical attractiveness)
_______ f) Lowest first cost (when constructed
_______ g) Meeting basic functional requirements
_______ h) Flexibility for future adaptation
_______ i) Incorporation of latest technology within the facilities

_______ j) Other (please state)
____

3) **CONSTRUCTION PROCESS CONSIDERATIONS (Environmental).**

For this project, please rank the following factors in terms of their importance by the following scale: 1 = most important, 7 = least important.

RANKING (1 to 7)
a) Noise
_______ b) Odors (solvents, etc.)
_______ c) Dust
_______ e) Contamination by pathogens
_______ f) Physical obstacles/debris unsafe to users
_______ g) Vibration
_______ h) Interruption of utilities

4) QUALITY ASSURANCE METHODS:.

(A) Please check to indicate if any of the methods listed below were used in this project.

(B) **Please rate the effectiveness of the method(s) that were used in the right hand column, using the following scale**: (Most effective = 1, Least effective = 5

	(Check method(s) used)	Effectiveness Score (1 to 5)
a) By the designer as quality control inspector	☐	_______
b) By the owner's staff person as quality control inspector	☐	_______
c) By an independent quality control inspector	☐	_______
d) By contracting staff	☐	_______
e) Other (please specify)	☐	_______

5) If any of the foregoing techniques were utilized, please provide the average weekly hours of your organization's staff typically devoted to the items in the previous question:
(Example: Two (2) staff members for 3 hours each per week = 6 staff hours/week).

a) Staff hours = ______ hrs. b) Staff cost as percentage of construction cost = _____%

6) Please indicate if any of the following problem resolution approaches were this project.

Definitions:
Arbitration involves certified arbitrators, and is quicker and less formal than court proceedings. Mediation is a less formal dispute resolution procedure. Litigation involves aggressive legal action of one party against another in a court of law.

(Check methods used)

(Check methods used)	
______	a) Informal meetings
______	b) Negotiation
______	c) Mediation
______	d) Arbitration
______	e) Litigation
______	f) Other (Please state)

---

7) How would you describe the nature of the relationship between the parties: Use a scale of 1= full partnership to 5 = adversarial (Please circle the appropriate number)

	Full partnership		Neutral		Adversarial
a) Owner with Designer:	1	2	3	4	5
b) Owner with Contractor	1	2	3	4	5
c) Designer with Contractor	1	2	3	4	5

8) Were the following administered on this project?

	YES	NO	BENEFIT SCORE (1 greatest to 7 least)
Owner Satisfaction Surveys	☐	☐	____
Post Occupancy Surveys	☐	☐	____

9) Frequency of meetings/interaction (OF PROJECT DECISION-MAKERS SUCH AS PROJECT MANAGERS OR PRINCIPALS WITH DESIGNERS/CONTRACTORS). How often did project representatives of the owner meet with project representatives of the designer and the contractor?. The meetings may have been for the purpose of reviewing drawings, project scope, project status, and problem avoidance and resolution. Check the most appropriate responses.

OWNER WITH DESIGNER and CONTRACTOR	DESIGN STAGE	CONSTRUCTION	(START-UP) & - WARRANTY
a) Daily	☐	☐	☐
b) Once Weekly	☐	☐	☐
c) Once every 2 weeks	☐	☐	☐
d) Once every 3 weeks	☐	☐	☐
e) Monthly	☐	☐	☐
f) Once per quarter	☐	☐	☐
g) Special occasions only	☐	☐	☐

Section D Satisfaction metrics

SCORING SCALE : (Strongly agree =SA Agree = A, Neither agree nor disagree = NAND Disagree = D, Strongly disagree = SD

Availability of support:

a) Whcnever cur organization needed to discuss the project, a designated representative could be easily contacted:

SA	A	NAND	D	SD
☐	☐	☐	☐	☐

b) Meetings were held at times that my organization found convenient

SA	A	NAND	D	SD
☐	☐	☐	☐	☐

Responsiveness

c) Whenever a construction problem was identified to the designated representatives, someone responded within a reasonable time

SA	A	NAND	D	SD
☐	☐	☐	☐	☐

d) Warranty problems were fixed within a reasonable time with minimal inconvenience to occupants

SA	A	NAND	D	SD
☐	☐	☐	☐	☐

Communication/pleasantness of support

e) Problems were always identified and explained in a clear concise manner

SA	A	NAND	D	SD
☐	☐	☐	☐	☐

f) If a dispute arose it was addressed quickly and amicably .

SA	A	NAND	D	SD
☐	☐	☐	☐	☐

Product quality:

a) The fit and finish of the final product conveyed an impression of good quality

SA	A	NAND	D	SD
☐	☐	☐	☐	☐

b) The materials used in the project appeared to be durable and trouble free.

SA	A	NAND	D	SD
☐	☐	☐	☐	☐

Process quality:

c) Our organization was satisfied with the overall process of carrying out the project with the organizations below:

	SA	A	NAND	D	SD
The Designer	☐	☐	☐	☐	☐

	SA	A	NAND	D	SD
The Contractor	☐	☐	☐	☐	☐

UNIVERSITY OF MIAMI (DESIGN ORGANIZATION SURVEY)
HEALTH CARE FACILITY CONSTRUCTION QUALITY RESEARCH PROJECT

Contact: Dr. V. Omachonu (305) 284-2372 , L. Forbes (Beep 305-881-9028)
Department of Industrial Engineering - Fax number: (305) 284-4040

Research study information:
The University of Miami is collaborating with a number of hospitals/health care facilities to determine the factors that make construction projects successful. Staff at the facility noted below referred us to you with the hope that you would assist us with specific information on a construction/renovation project that you conducted for them. Your contribution will be highly appreciated.

SECTION A: HEALTH CARE FACILITY ORGANIZATION INFORMATION

1) Name of Health Care Organization(HCF):____________________
1) Address____________________ State:______ Zip Code:_________
2) Name of contact person:____________________ Tel__________

4) BRIEF DESCRIPTION OF PROJECT____________________

____

5) Project No. (optional)_________ Designer's project manager____________________

SECTION B: DESIGN ORGANIZATION INFORMATION

1) Name of survey respondent:____________________ Title____________
2) Name of your organization:____________________ Tel:__________
3) Address:____________________ State:_____ Zip Code:______

4) Years in existence? a) 1-5☐ b) 6-10☐ c) 11-15☐ d) 16-20☐ e) Over 20☐

SECTION C: SCHEDULE / COST PERFORMANCE:

1) Was the project: Late? ☐ On time? ☐ Ahead of schedule? ☐

2) Was the project: Over budget? ☐ Within budget? ☐ Significantly under budget? ☐

SECTION D: PERFORMANCE/EVALUATION CRITERIA

1) For this project, please ***rank*** the following 8 factors in order of their importance from 1 to 8 by the following scale: 1 = most important, 8 = least important.

RANK ORDER (1 to 8) Please use each number only once.

______ a) Finishing within the time stipulated
______ b) Adherence to budget agreed
______ c) Quality of appearance (workmanship)
______ d) Satisfactory job relations with contractors
______ e) Satisfactory job relations with owners
______ f) Building works well - meets end users' needs
______ g) Performance of all elect/mech/specialized systems to specifications
______ h) Minimal number and value of change orders

2) **DESIGN CONSIDERATIONS.**
For this project, please ***rank order*** the following factors in order of their importance from 1 to 9 by the following scale: 1 = most important, 9 = least important.

RANK ORDER (1 to 9) Please use each number only once.

_________a) Lowest life cycle cost
_________b) Ease of maintenance/maintainability
_________c) User "friendliness"
_________d) System reliability (failures minimized)
_________e) Aesthetics (physical attractiveness)
_________f) Lowest first cost (when constructed)
_________g) Meeting basic functional requirements
_________h) Flexibility for future adaptation
_________i) Incorporation of latest technology in the facilities

3) **QUALITY ASSURANCE METHODS:.**

(A) Please check to indicate if any of the methods listed below were used in this project.

(B) **Please rate the effectiveness of the method(s) that were used in the right hand column, using the following scale:** (Most effective = 1, Least effective = 5

	(Check method(s) used)	Effectiveness Score: 1 = most to 5 = least
a) By the designer as quality control inspector	☐	____
b) By the owner's staff person as quality control inspector	☐	____
c) By an independent quality control inspector	☐	____
d) By contracting staff	☐	____
e) Other (please specify)	☐	____

4) How would you describe the nature of the relationship between the parties: Use a scale of 1= full partnership to 5 = adversarial (Please circle the appropriate number)

	Full partnership		Neutral		Adversarial
a) Owner with Designer:	1	2	3	4	5
b) Owner with Contractor	1	2	3	4	5
c) Designer with Contractor	1	2	3	4	5

6) ***On the average***, how often did representatives of the owner meet with representatives of the designer and the contractor?. (for reviewing drawings, project scope, project status, and problem avoidance and resolution, etc.) Check the *single most appropriate* response:

OWNER WITH DESIGNER AND/OR CONTRACTOR

a) Daily ☐ b) Once Weekly ☐ c) Once every 2 weeks ☐
d) Once every 3 weeks ☐ e) Monthly ☐ f) Once per quarter ☐
g) Special occasions only ☐

THANK YOU!

UNIVERSITY OF MIAMI (CONTRACTOR'S SURVEY)
HEALTH CARE FACILITY CONSTRUCTION QUALITY RESEARCH PROJECT

Contact: Dr. V. Omachonu (305) 284-2372, L. Forbes (Beep 305-881-9028)
Department of Industrial Engineering - Fax number (305) 284-4040

Research study information:
The University of Miami is collaborating with a number of hospitals/health care facilities to determine the factors that make construction projects successful. Staff at the facility noted below referred us to you with the hope that you would assist us with specific information on a construction/renovation project that you conducted for them. Your contribution will be highly appreciated.

SECTION A: HEALTH CARE FACILITY ORGANIZATION INFORMATION

1) Name of Health Care Organization(HCF):______________________
1) Address______________________State:______Zip Code:________
2) Name of contact person:______________________Tel__________

4) BRIEF DESCRIPTION OF PROJECT______________________
____

5) Project No. (optional)________Contractor's project manager______________

SECTION B: CONTRACTOR ORGANIZATION INFORMATION

1) Name of survey respondent:______________________Title__________
2) Name of your organization:______________________Tel:________
3) Address:______________________State:_____Zip Code:______

4) Years in existence? a) 1-5☐ b) 6-10☐ c) 11-15☐ d) 16-20☐ e) Over 20☐

SECTION C: SCHEDULE / COST PERFORMANCE:

1) Was the project: Late? ☐ On time? ☐ Ahead of schedule? ☐

2) Was the project: Over budget? ☐ Within budget? ☐ Significantly under budget? ☐

SECTION D: PERFORMANCE/EVALUATION CRITERIA

1) For this project, please ***rank*** the following 8 factors in order of their importance from 1 to 8 by the following scale: 1 = most important, 8 = least important.

RANK ORDER (1 to 8) Please use each number only once.

______ a) Finishing within the time stipulated
______ b) Adherence to budget agreed
______ c) Quality of appearance (workmanship)
______ d) Satisfactory job relations with contractors
______ e) Satisfactory job relations with owners
______ f) Building works well - meets end users' needs
______ g) Performance of all elect/mech/specialized systems to specifications
______ h) Minimal number and value of change orders

2) **CONSTRUCTION PROCESS CONSIDERATIONS (Environmental).**
For this project, please *rank order* the following factors in order of their importance from 1 to 7 by the following scale: 1 = most important, 7 = least important.

RANK ORDER (1 to 7) Please use each number only once.

_______ a) Noise
_______ b) Odors (solvents, etc.)
_______ c) Dust
_______ d) Contamination by pathogens
_______ e) Physical obstacles/debris unsafe to users
_______ f) Vibration
_______ g) Interruption of utilities

3) **QUALITY ASSURANCE METHODS:.**

(A) Please check to indicate if any of the methods listed below were used in this project.

(B) **Please rate the effectiveness of the method(s) that were used in the right hand column, using the following scale:** (Most effective = 1, Least effective = 5

	(Check method(s) used)	Effectiveness Score: 1 = most to 5 = least
a) By the designer as quality control inspector	☐	___
b) By the owner's staff person as quality control inspector	☐	___
c) By an independent quality control inspector	☐	___
d) By contracting staff	☐	___
e) Other (please specify)	☐	___

4) How would you describe the nature of the relationship between the parties: Use a scale of 1= full partnership to 5 = adversarial (Please circle the appropriate number)

	Full partnership		Neutral		Adversarial
a) Owner with Designer:	1	2	3	4	5
b) Owner with Contractor	1	2	3	4	5
c) Designer with Contractor	1	2	3	4	5

6) ***On the average***, how often did representatives of the owner meet with representatives of the designer and the contractor?. (for reviewing drawings, project scope, project status, and problem avoidance and resolution, etc.) Check the *single most appropriate* response:

OWNER WITH DESIGNER AND/OR CONTRACTOR

a) Daily ☐ b) Once Weekly ☐ c) Once every 2 weeks ☐
d) Once every 3 weeks ☐ e) Monthly ☐ f) Once per quarter ☐
g) Special occasions only ☐

THANK YOU!

APPENDIX B

Table 7.1 NON-PARAMETRIC ANOVA SUMMARY (COMPENSATION FORMATS)

Hypothesis testing of gaps in perception between the parties to construction.

CONDITIONS: **PRIVATE OWNER'S PROJECTS**

COMPENSATION FORMATS: State your level of satisfaction with the following construction compensation formats		PRIVATE OWNER VS. DESIGNER				PRIVATE OWNER VS. CONTRACTOR				DESIGNER VS CONTRACTOR. (Public and private projects combined)			
ques. no.	COMPENSATION FORMATS: Question description	F value	prob. (p)	Sig.	A/D?	F value	prob. (p)	Sig.	A/D ?	F value	prob. (p)	Sig.	A/D ?
13a	Lump sum	.000	.9959	NS	A	2.601	.1088	NS	A	2.777	.0968	NS	A
13b	Cost plus a fee	.520	.4718	NS	A	2.671	.1052	NS	A	1.193	.2766	NS	A
13c	Guaranteed maximum price (GMP)	6.40	.0122	S	D	0.150	.6988	NS	A	5.738	.0178	S	D
13d	GMP with cost saving/sharing	.552	.4590	NS	A	.190	.6638	NS	A	1.249	.2664	NS	A
13e	Other (methods)	0.013	.9093	NS	A	1.422	.2485	NS	A	1.874	.1748	NS	A

LEGEND: S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval) D - the responses of the groups being compared disagree A - the responses of the groups being compared are assumed to agree.	Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

PRI_13/14

Table 7.2 NON-PARAMETRIC ANOVA SUMMARY (COMPENSATION FORMATS)

Hypothesis testing of gaps in perception between the parties to construction.

CONDITIONS: **PUBLIC OWNER'S PROJECTS**

COMPENSATION FORMATS: State your level of satisfaction with the following construction compensation formats.		PUBLIC OWNER VS. DESIGNER				PUBLIC OWNER VS. CONTRACTOR				PUBLIC OWNERS VS. PRIVATE OWNERS			
Ques. no.	Question description	F value	prob. (p)	Sig.	A/D?	F value	prob. (p)	Sig.	A/D ?	F value	prob. (p)	Sig.	A/D ?
13a	Lump sum	.269	.6045	NS	A	.902	.3441	NS	A	.256	.6139	NS	A
13b	Cost plus a fee	.091	.7636	NS	A	1.182	.2805	NS	A	.068	.7953	NS	A
13c	Guaranteed maximum price (GMP)	2.741	.0998	NS	A	0.266	.6074	NS	A	.049	.8256	NS	A
13d	GMP with cost saving/sharing	.765	.3845	NS	A	.001	.9693	NS	A	.103	.7493	NS	A
13e	Other (methods)	4.838	.0307	S	D	.338	.5727	NS	A	3.566	.0762	NS	A

LEGEND:	
S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval) D - the responses of the groups being compared disagree A - the responses of the groups being compared are assumed to agree.	Null hypothesis: H0 : The variable of interest is ranked equally by both samplepopulations Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

Table 7.3 NON-PARAMETRIC ANOVA SUMMARY (PROJECT DELIVERY METHODS)

Hypothesis testing of gaps in perception between the parties to construction.

CONDITIONS: **PRIVATE OWNER'S PROJECTS**

PROJECT DELIVERY METHODS: How would you score your satisfaction with the following methods?		PRIVATE OWNER VS. DESIGNER				PRIVATE OWNER VS. CONTRACTOR				DESIGNER VS CONTRACTOR. (Public and private projects combined)			
ques. no.	PROJECT DELIVERY METHODS: Question description	F value	prob. (p)	Sig.	A/D?	F value	prob. (p)	Sig.	A/D ?	F value	prob. (p)	Sig.	A/D ?
14a	Traditional design-bid-build	.119	.7308	NS	A	1.198	.2753	NS	A	.679	.4105	NS	A
14b	Fast track	1.266	.2618	NS	A	13.462	.0004	S	D	22.794	.0001	S	D
14c	Construction Management (fee paid)	1.780	.1839	NS	A	0.579	.4483	NS	A	4.168	.0428	S	D
14d	Construction Management (at risk)	.754	.3866	NS	A	.045	.8324	NS	A	.139	.7104	NS	A
14e	Other methods	3.439	.0681	NS	A	2.093	.1558	NS	A	.039	.8443	NS	A

LEGEND:	
S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval) D - the responses of the groups being compared disagree A - the responses of the groups being compared are assumed to agree.	Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PRI_14-15

Table 7.4 NON-PARAMETRIC ANOVA SUMMARY (PROJECT DELIVERY METHODS)

Hypothesis testing of gaps in perception between the parties to construction (dyads)

CONDITIONS: PUBLIC OWNER'S PROJECTS

PROJECT DELIVERY METHODS: How would you score your satisfaction with the following methods?		PUBLIC OWNER VS. DESIGNER				PUBLIC OWNER VS. CONTRACTOR				PUBLIC VS PRIVATE OWNERS			
Ques. no.	PROJECT DELIVERY METHODS: Question description	F value	prob. (p)	Sig.	A/D?	F value	prob. (p)	Sig.	A/D ?	F value	prob. (p)	Sig.	A/D ?
14a	Traditional design-bid-build	..426	.5146	NS	A	.019	.892	S	D	.837	.362	NS	A
14b	Fast track	.463	.0041	S	D	.981	.3257	NS	A	4.174	.045	S	D
14c	Design build	.901	.3441	NS	A	.528	.4697	NS	A	.012	.911	S	D
14d	Construction Management (fee paid)	..020	.8857	NS	A	.029	.8658	NS	A	.224	.637	NS	A
14e	Construction Management (at risk)	1.462	.2316	NS	A	.989	.3280	NS	A	.087	.770	NS	A

LEGEND: S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval) D - the responses of the groups being compared disagree A - the responses of the groups being compared are assumed to agree.	Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PUB_14-15

Table 7.5 NON-PARAMETRIC ANOVA SUMMARY (OWNER SATISFACTION)

Hypothesis testing of gaps in perception between the parties to construction.

CONDITIONS: **PUBLIC OWNER'S PROJECTS**

OWNER SATISFACTION: To what extent do the following factors influence an owner's level of satisfaction with a construction project?		PUBLIC OWNER VS. DESIGNER				PUBLIC OWNER VS. CONTRACTOR				DESIGNER VS CONTRACTOR. (PUBLIC PROJECTS)			
Ques. no:	Question description	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D?
16a	Timeliness of the project	3.848	.05	S	D	16.306	.0001	S	D	3.429	.0654	NS	A
16b	Adherence to cost estimates	54.32	.0001	S	D	3.401	.0659	NS	A	8.025	.005	S	D
16c	Clear, up front understanding of job scope	0.636	.4254	NS	A	0.415	.5197	NS	A	0.984	.3224	NS	A
16d	Clear, ongoing communication on job status	13.876	.0002	S	D	13.539	,0003	S	D	1.735	.1891	NS	A
16e	Prompt, adequate response to owner's complaints	35.758	.0001	S	D	13.909	.0002	S	D	2.005	.1582	NS	A
16f	Attractive design/aesthetics	12.682	,0004	S	D	20.161	.0001	S	D	0.842	.3598	NS	A
16g	High quality of construction - fit and finish	73.195	.0001	S	D	13.812	.0002	S	D	7.557	.0065	S	D
16h	Minimal disruption to ongoing facility operations	42.167	.0001	S	D	13.012	.0003	S	D	3.877	.0502	NS	A
16i	Other factors	3.396	.0662	NS	A	1.172	.2807	NS	A	0.431	.5136	S	D

LEGEND:	
S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the 95% level of significance D - the responses of the groups being compared disagree A - the responses of the groups being compared do agree.	Null hypothesis: H0 : The variable of interest is ranked equally by both samplepopulations Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PUB_16-17

Table 7.6 NON-PARAMETRIC ANOVA SUMMARY (OWNER SATISFACTION)

Hypothesis testing of gaps in perception between the parties to construction.

CONDITIONS: **PRIVATE OWNER'S PROJECTS**

OWNER SATISFACTION: To what extent do the following factors influence an owner's level of satisfaction with a construction project?		PRIVATE OWNER VS. DESIGNER				PRIVATE OWNER VS. CONTRACTOR				DESIGNER VS CONTRACTOR. (PRIVATE PROJECTS)			
Ques. no.	OWNER SATISFACTION INDICATORS: Question description	F value	prob. (p)	Sig	A/D?	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?
16a	Timeliness of the project	.061	.8055	NS	A	2.138	.1442	NS	A	.992	.3201	NS	A
16b	Adherence to cost estimates	3.305	.0692	NS	A	5.968	.0149	S	D	6.257	.0129	S	D
16c	Clear, up front understanding of job scope	2,507	.1135	NS	A	1.265	.2611	NS	A	1.247	.265	NS	A
16d	Clear, ongoing communication on job status	3.176	.0749	NS	A	17.309	.0001	S	D	0.103	.7485	NS	A
16e	Prompt, adequate response to owner's complaints	98.19	.0001	S	D	48.619	.0001	S	D	3.587	.0592	NS	A
16f	Attractive design/aesthetics	23.325	.0001	S	D	27.701	.0001	S	D	3.751	.0537	NS	A
16g	High quality of construction - fit and finish	97.68	.0001	S	D	9.111	.0027	S	D	21.193	.0001	S	D
16h	Minimal disruption to ongoing facility operations	17.983	.0001	S	D	0.230	.6318	NS	A	2.785	.0962	NS	A
16i	Other	3.723	.0543	NS	A	1.864	.1738	NS	A	1.408	.2386	NS	A

LEGEND:
S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval)
D - the responses of the groups being compared disagree
A - the responses of the groups being compared do agree.

Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations
Alternative hypothesis . H1 : The variable of interest is NOT ranked equally by both sample populations.

Table 7.7 NON-PARAMETRIC ANOVA SUMMARY (OWNER SATISFACTION)

Hypothesis testing of gaps in perception between the parties to construction (dyads)

CONDITIONS: **PUBLIC OWNER'S PROJECTS**

OWNER SATISFACTION: To what extent do the following factors influence an owner's level of satisfaction with a construction project?		PUBLIC OWNERS VS. PRIVATE OWNERS			
Ques.no.	OWNER SATISFACTION INDICATORS: Question description	F value	prob. (p)	Sig	A/D?
16a	Timeliness of the project	.904	.3429	NS	A
16b	Adherence to cost estimates	8.888	.0032	S	D
16c	Clear, up front understanding of job scope	.142	.707	NS	A
16d	Clear, ongoing communication on job status	.099	.7539	NS	A
16e	Prompt, adequate response to owner's complaints	1.674	.1970	NS	A
16f	Attractive design/aesthetics	.121	.7287	NS	A
16g	High quality of construction - fit and finish	.102	.7492	NS	A
16h	Minimal disruption to ongoing facility operations	2.426	.1208	NS	A
16i	Other	.083	.7743	NS	A

LEGEND:	
S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval) D - the responses of the groups being compared disagree A - the responses of the groups being compared do agree.	Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PUB-PRI_16-17

Table 7.8 NON-PARAMETRIC ANOVA SUMMARY (DESIGN CONSIDERATIONS)

Hypothesis testing of gaps in perception between the parties to construction (dyads)

CONDITIONS: **PUBLIC & PRIVATE OWNERS' PROJECTS**

DESIGN CONSIDERATIONS: As the owner's representative, the designer has to balance conflicting priorities and criteria, etc. Rank the following in order of importance:		PRIVATE OWNERS VS. PUBLIC OWNERS				PRIVATE OWNERS VS. DESIGNERS				PUBLIC OWNERS VS. DESIGNERS			
Ques no.	Question description	F value	prob. (p)	Sig	A/D?	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?
18a	Lowest life cycle cost	1.299	.2556	NS	A	1.467	.2660	NS	A	.002	.9621	NS	A
18b	Ease of maintenance/maintainability	.421	.5171	NS	A	18.521	.0001	S	D	14.797	.0001	S	D
18c	User friendliness	.075	.7846	NS	A	1.168	.280	NS	A	.031	.8612	NS	A
18d	System reliability (failures minimized)	.877	.3501	NS	A	9.186	.0025	S	D	11.505	.0007	S	D
18e	Aesthetics (physical attractiveness)	.490	.4845	NS	A	31.977	.0001	S	D	22.412	.0001	S	D
18f	Lowest first cost	.056	.8124	NS	A	0.103	.7479	NS	A	1.562	.2118	NS	A
18g	Meeting basic functional requirements	.182	.6702	NS	A	25.117	.0001	S	D	16.027	.0001	S	D
18h	Flexibility for future adaptation	.338	.5615	NS	A	3.189	.0744	NS	A	2.776	.096	NS	A
18i	Incorporation of latest technology	4.196	.0417	S	D	5.313	.0213	S	D	31.600	.0001	S	D
18j	Other (methods)	1.896	.1742	NS	A	8.367	.0041	S	D	1.418	..2352	NS	A

LEGEND: S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval) D - the responses of the groups being compared disagree A - the responses of the groups being compared do agree.	Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PUB-PRI_18-19

Table 7.9 NON-PARAMETRIC ANOVA SUMMARY (CONSTRUCTION PROCESS CONSIDERATION - Environmental)

Hypothesis testing of gaps in perception between the parties to construction.

CONDITIONS: **PRIVATE OWNER'S PROJECTS**

CONSTRUCTION PROCESS CONSIDER-ATIONS (Environmental) Rank the following in terms of their importance, from 1(most) to 7(least):		PRIVATE OWNER VS. DESIGNER				PRIVATE OWNER VS. CONTRACTOR				DESIGNER VS CONTRACTOR.			
ques. no.	Question description	F value	prob. (p)	Sig	A/D?	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?
20a	Noise	5.73	.0168	S	D	3.141	.0772	NS	A	7.514	.0065	S	D
20b	Odors (solvents, etc.)	.001	.9709	NS	A	.014	.9063	NS	A	.037	.8484	NS	A
20c	Dust	21.942	.0001	S	D	6.150	.0136	S	D	.005	.941	NS	A
20d	Contamination by pathogens	.343	.5579	NS	A	.435	.5098	NS	A	.872	.3513	NS	A
20e	Physical obstacles	6.93	.0086	S	D	.004	.9528	NS	A	1.624	.2035	NS	A
20f	Vibration	3.291	.0699	NS	A	.010	.9186	NS	A	.423	.5161	NS	A
20g	Interruption of Utilities Other (methods)	2.684	.1017	NS	A	.028	.8666	NS	A	.185	.6673	NS	A

LEGEND: S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval) D - the responses of the groups being compared disagree A - the responses of the groups being compared are assumed to agree.	Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PRI_20-21

Table 7.10 NON-PARAMETRIC ANOVA SUMMARY (CONSTRUCTION PROCESS CONSIDERATION - Environmental)

Hypothesis testing of gaps in perception between the parties to construction.

CONDITIONS: **PUBLIC/PRIVATE OWNER'S PROJECTS**

CONSTRUCTION PROCESS CONSIDERATIONS: (Environmental) Rank the following in terms of their importance, from 1 (most) to 7 (least)		PUBLIC OWNER VS. DESIGNER				PUBLIC OWNER VS. CONTRACTOR				DESIGNER VS. CONTRACTOR				PUBLIC VS. PRIVATE OWNER			
Ques. no.	Question description	F value	prob. (p)	Sig.	A/ D?	F value	prob. (p)	Sig.	A/ D?	F value	prob (p)	Sig.	A/ D	F value	prob. (p)	Sig.	A/ D?
20a	Noise	3.583	.0588	NS	A	7.125	.0081	S	D	11.30	.0009	S	D	.181	.6711	NS	A
20b	Odors (solvents, etc.)	3.238	.0724	NS	A	.551	.4586	NS	A	.180	.6720	NS	A	.804	.3708	NS	A
20c	Dust	.072	.7887	NS	A	.304	.5816	NS	A	.506	.4775	NS	A	7.188	.0079	S	D
20d	Contamination by pathogens	4.609	.0322	S	D	.590	.4432	NS	A	4.671	.0318	S	D	.089	.7662	NS	A
20e	Physical obstacles	3.736	.0537	NS	A	.364	.5470	NS	A	2.397	.1230	NS	A	.304	.5819	NS	A
20f	Vibration	6.828	.0092	S	D	1.223	.2699	NS	A	.285	.5941	NS	A	.543	.4619	NS	A
20g	Interruption of Utilities	2.317	.1285	NS	A	3.276	.0715	NS	A	.593	.4421	NS	A	2.093	1495	NS	A

LEGEND:
S - SIGNIFICANCE OF F VALUE: Probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance, (95% confidence interval)
D - the responses of the groups being compared disagree
A - the responses of the groups being compared do agree.

Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations

Alternative : H1 : The variable of interest is NOT ranked equally hypothesis by both sample populations.

F_PUB_20-21

Table 7.11 NON-PARAMETRIC ANOVA SUMMARY (CONSTRUCTION PROCESS CONSIDERATIONS)

Hypothesis testing of gaps in perception between the parties to construction (dyads)

CONDITIONS: PRIVATE OWNERS' PROJECTS

CONSTRUCTION PROCESS CONSIDERATIONS: Rank the following 6 factors (relative to contractors) in order of importance:		PRIVATE OWNER VS. DESIGNER				PRIVATE OWNER VS. CONTRACTOR				DESIGNER VS. CONTRACTOR (PRIVATE PROJECTS)				PRIVATE OWNER VS. PUBLIC OWNER			
Ques. no.	Question description	F value	prob. (p)	Sig.	A/D?	F value	prob. (p)	Sig.	A/D?	F value	prob (p)	Sig.	A/D	F value	prob. (p)	Sig.	A/D?
21a	Ability to adjust schedule to owner's operating needs	.028	.8672	NS	A	1.208	.2726	NS	A	12.186	.0005	S	D	1.139	.869	NS	A
21b	Training of owner's staff on equipment installed	1.172	.2793	NS	A	.195	.6589	NS	A	.871	.3509	NS	A	.009	.9251	NS	A
21c	Commissioning - testing/adj. Systems to meet owner's expectations	10.091	.0015	S	D	.261	.6101	NS	A	24.04	.0001	S	D	.627	.4292	NS	A
21d	Prompt response to owner's warranty breakdown calls	30.873	.0001	S	D	49.699	.0001	S	D	33.321	.0001	S	D	.137	.7115	NS	A
21e	Prompt submission of "as built" drawings, approval certificates, etc.	103.62	.0001	S	D	21.899	.0001	S	D	14.255	.0002	S	D	.236	.6273	NS	A
21f	Other (please state)	2.842	.0933	NS	A	3.502	.0649	NS	A	8.134	.0047	S	D	.432	.5173	NS	A

LEGEND:
S - SIGNIFICANCE OF F VALUE: Probability (p) values .05 or less allow the null hypothesis to be rejected at the 95% level of significance
D - the responses of the groups being compared disagree
A - the responses of the groups being compared do agree.

Null hypothesis: H0 ; The variable of interest is ranked equally by both populations
Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both populations.

F_PRI_21-22

Table 7.12 NON-PARAMETRIC ANOVA SUMMARY (CONSTRUCTION PROCESS CONSIDERATIONS)

Hypothesis testing of gaps in perception between the parties to construction (dyads)

CONDITIONS: PUBLIC OWNERS' PROJECTS

CONSTRUCTION PROCESS CONSIDERATIONS: Rank the following 6 factors (relative to contractors) in order of importance:		PUBLIC OWNER VS. DESIGNER				PUBLIC OWNER VS. CONTRACTOR				DESIGNER VS. CONTRACTOR (PUBLIC PROJECTS)			
Ques. no.	Question description	F value	prob. (p)	Sig.	A/ D?	F value	prob. (p)	Sig.	A/ D?	F value	prob (p)	Sig.	A/ D
21a	Ability to adjust schedule to owner's operating needs	2.253	.134	NS	A	2.92	.0891	NS	A	12.186	.0005	S	D
21b	Training of owner's staff on equipment installed	1.667	.1972	NS	A	.829	.3637	NS	A	.871	.3509	NS	A
21c	Commissioning - testing/adj. Systems to meet owner's expectations	2.208	.138	NS	A	2.80	.0959	NS	A	24.04	.0001	S	D
21d	Prompt response to owner's warranty breakdown calls	5.57	.0187	S	D	12.405	.0005	S	D	13.329	.0950	NS	A
21e	Prompt submission of "as built" drawings, approval certificates, etc.	32.136	.0001	S	D	.994	.3199	NS	A	14.255	.0002	S	D
21f	Other (please state)	3.681	.0572	NS	A	.017	.8971	NS	A	8.134	.0047	S	D

LEGEND:

S - SIGNIFICANCE OF F VALUE: Probability (p) values .05 or less allow the null hypothesis to be rejected at the 95% level of significance

D - the responses of the groups being compared disagree

A - the responses of the groups being compared do agree.

Null hypothesis: H0 : The variable of interest is ranked equally by both populations

Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both populations.

F_PUB_21-22

Table 7.13 NON-PARAMETRIC ANOVA SUMMARY (QUALITY CONTROL METHODS)

Hypothesis testing of gaps in perception between the parties to construction (dyads)

CONDITIONS: PUBLIC OWNER'S PROJECTS

Rank the following methods for construction quality control with regard to their effectiveness (1=most to 5 = least)		PUBLIC OWNER VS. DESIGNER				PUBLIC OWNER VS. CONTRACTOR				PUBLIC VS. PRIVATE OWNERS			
Ques. no.	Question description	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?
22a	By the designer as Q.C. inspector	45.224	.0001	S	D	.066	.7966	NS	A	2.055	.1535	NS	A
22b	By the owner's staff person as Q.C. inspector	54.843	.0001	S	D	55.721	.0001	S	D	1.980	.1611	NS	A
22c	By An independent Q.C. inspector	.656	.4179	NS	A	.034	.8544	NS	A	3.764	.0543	NS	A
22d	By contracting staff	.460	.4978	NS	A	55.134	.0001	S	D	.660	.4178	NS	A
22e	Other (methods)	13.371	.0003	S	D	.191	.6623	NS	A	.117	.7343	NS	A

LEGEND:

S - SIGNIFICANCE OF F VALUE: Probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance. (95% confidence interval)
D - the responses of the groups being compared disagree
A - the responses of the groups being compared do agree.

Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations

Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PUB_22-23

Table 7.14 NON-PARAMETRIC ANOVA SUMMARY (QUALITY CONTROL METHODS)

Hypothesis testing of gaps in perception between the parties to construction (dyads)

CONDITIONS: PRIVATE OWNER'S PROJECTS

Rank the following methods for construction quality control with regard to their effectiveness (1=most to 5 = least)		PRIVATE OWNER VS. DESIGNER				PRIVATE OWNER VS. CONTRACTOR				DESIGNER VS CONTRACTOR.			
Ques. no.	Question description	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?
22a	By the designer as Q.C. inspector	41.489	.0001	S	D	3.055	.0809	NS	A	28.661	.0001	S	D
22b	By the owner's staff person as Q.C. inspector	138.695	.0001	S	D	140.81	.0001	S	D	.014	.9048	NS	A
22c	By an independent Q.C. inspector	21.897	.0001	S	D	9.526	.0021	S	D	.755	.3858	NS	A
22d	By contracting staff	4.915	.0267	S	D	126.64	.0001	S	D	44.535	.0001	S	D
22e	Other (methods)	22.396	.0001	S	D	.000	.9922	NS	A	12.239	.0012	S	D

LEGEND:
S - SIGNIFICANCE OF F VALUE: Probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance. (95% confidence interval)
D - the responses of the groups being compared disagree
A - the responses of the groups being compared do agree.

Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations

Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PRI_22-23

Table 7.15 NON-PARAMETRIC ANOVA SUMMARY (OWNER'S SATISFACTION - COST AND SCHEDULE)

Hypothesis testing of gaps in perception between the parties to construction.
CONDITIONS: **PUBLIC & PRIVATE OWNER'S PROJECTS**

OWNER'S SATISFACTION WITH INCREASES IN COST AND SCHEDULE: Rate the following factors on a scale of 1= not at all to 5 = very much		PRIVATE OWNERS VS. DESIGNERS				PRIVATE OWNERS VS. CONTRACTORS				DESIGNERS VS. CONTRACTORS			
Ques. no.	Question description SECTION A (Schedule delay expressed as a percentage)	F value	prob. (p)	Sig	A/D?	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?
27a	0 - 5%	36.798	.0001	S	D	4.775	.0291	S	D	5.671	.0179	S	D
27b	5% - 15%	7.777	.0053	S	D	5.159	.0233	S	D	.000	.9877	NS	A
27c	15% - 30%	4.062	.044	S	D	5.952	.0149	S	D	.392	.5317	NS	A
27d	30% - 50%	.139	.7091	NS	A	.943	.3317	NS	A	1.494	.2225	NS	A
27e	Over 50%	2.157	.1420	NS	A	1.091	.2964	NS	A	1.008	.3161	NS	A
	SECTION B (Cost overruns expressed as a percentage)												
27a	0 - 5%	18.465	.0001	S	D	.588	.4435	NS	A	4.572	.0333	S	D
27b	5% - 15%	12.534	.0004	S	D	9.743	.0019	S	D	.098	.7539	NS	A
27c	15% - 30%	3.106	.0781	NS	A	24.172	.0001	S	D	8.456	.0039	S	D
27d	30% - 50%	.148	.7004	NS	A	2.741	.0981	NS	A	4.777	.0296	S	D
27e	Over 50%	3.394	.0655	NS	A	.076	.7833	NS	A	4.508	.0345	S	D

LEGEND:
S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval)
D - the responses of the groups being compared disagree
A - the responses of the groups being compared do agree.

Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations
Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PRI_27-28

Table 7.16 NON-PARAMETRIC ANOVA SUMMARY (OWNER'S SATISFACTION - COST AND SCHEDULE)

Hypothesis testing of gaps in perception between the parties to construction.
CONDITIONS: **PUBLIC & PRIVATE OWNER'S PROJECTS**

OWNER'S SATISFACTION WITH INCREASES IN COST AND SCHEDULE: Rate the following factors on a scale of 1= not at all to 5 = very much		PUBLIC OWNERS VS. DESIGNERS				PUBLIC OWNERS VS. CONTRACTORS				PUBLIC OWNERS VS. PRIVATE OWNERS			
Ques. no.	Question description SECTION A (Schedule delay expressed as a percentage)	F value	prob. (p)	Sig	A/D?	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?
27a	0 - 5%	6.176	.0130	S	D	.015	.9011	NS	A	2.133	.146	NS	A
27b	5% - 15%	.465	.4955	NS	A	.313	.5758	NS	A	1.228	.2691.	NS	A
27c	15% - 30%	.039	.8431	NS	A	.163	.6866	NS	A	1.889	.1708	NS	A
27d	30% - 50%	.241	.6233	NS	A	.014	.9072	NS	A	.315	.5754	NS	A
27e	Over 50%	.105	.7454	NS	A	.039	.8440	NS	A	.246	.6201	NS	A
	SECTION B (Cost overruns expressed as a percentage)												
27a	0 - 5%	11.473	.0007	S	D	.294	.5880	NS	A	.006	.9397	NS	A
27b	5% - 15%	5.657	.0174	S	D	4.788	.0289	S	D	.138	.7107	NS	A
27c	15% - 30%	.059	.8079	NS	A	7.204	.0074	S	D	1.677	.1967	NS	A
27d	30% - 50%	.015	.9026	NS	A	2.336	.1268	NS	A	.014	.9067	NS	A
27e	Over 50%	.449	.5026	NS	A	2.345	.1260	NS	A	1.515	.2197	NS	A

LEGEND:	
S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval) D - the responses of the groups being compared disagree A - the responses of the groups being compared do agree.	Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PUB_27-28

Table 7.17 NON-PARAMETRIC ANOVA SUMMARY (BARRIERS TO OWNER SATISFACTION)

Hypothesis testing of gaps in perception between the parties to construction.
CONDITIONS: **PUBLIC & PRIVATE OWNER'S PROJECTS**

BARRIERS TO OWNER SATISFACTION: Rank the following factors in order of importance.		PRIVATE OWNER VS. PUBLIC OWNERS				PRIVATE OWNERS VS. DESIGNERS				PUBLIC OWNERS VS. DESIGNERS			
Ques. no.	Question description	F value	prob. (p)	Sig	A/D?	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?
30a	Underbidding by contractors	.021	.8853	NS	A	.066	.7974	NS	A	.004	.9490	NS	A
30b	Inadequacy of project funding	.718	.3976	NS	A	32.542	.0001	S	D	16.162	.0001	S	D
30c	Underpricing of estimates by designers	.751	.387	NS	A	1.016	.3142	NS	A	3.449	.0642	NS	A
30d	Poor day-to-day project planning	.029	.8647	NS	A	2.684	.1022	NS	A	2.572	.1098	NS	A
30e	Inadequate cost control	2.752	.0986	NS	A	22.081	.0001	S	D	36.624	.0001	S	D
30f	Unfamiliarity of designers with project	.293	.5886	NS	A	.600	.4390	NS	A	1.585	.2090	NS	A
30g	Unfamiliarity of contractors	2.372	.1250	NS	A	.748	.3877	NS	A	.997	.3189	NS	A
30h	Lateness of information needed	.640	.4245	NS	A	1.297	.2555	NS	A	3.770	.0531	NS	A
30i	Lack of detail in drawings/specs	.211	.6461	S	D	36.257	.0001	S	D	33.584	.0001	S	D
30j	Failure of codes - workmanship/finish	.045	.8323	NS	A	16.378	.0001	S	D	14.586	.0002	S	D
30k	Other factors	.165	.6862	NS	A	1.116	.2937	NS	A	1.649	.2033	NS	A

LEGEND:
S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval)
D - the responses of the groups being compared disagree
A - the responses of the groups being compared do agree.

Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations
Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PRI_30-31

Table 7.18 NON-PARAMETRIC ANOVA SUMMARY (BARRIERS TO OWNER SATISFACTION)

Hypothesis testing of gaps in perception between the parties to construction.
CONDITIONS: **PUBLIC & PRIVATE OWNER'S PROJECTS**

BARRIERS TO OWNER SATISFACTION: Rank the following factors in order of importance.		DESIGNERS VS. CONTRACTORS				PRIVATE OWNERS VS. CONTRACTORS				PUBLIC OWNERS VS. CONTRACTORS			
Ques. no.	Question description	F value	prob. (p)	Sig	A/D?	F value	prob. (p)	Sig	A/D ?	F value	prob. (p)	Sig	A/D ?
30a	Underbidding by contractors	3.299	.0703	NS	A	9.488	.0022	S	D	5.808	.0161	S	D
30b	Inadequacy of project funding	.698	.4042	NS	A	44.493	.0001	S	D	19.132	.0001	S	D
30c	Underpricing of estimates by designers	4.089	.044	S	D	12.770	.0004	S	D	16.683	.0001	S	D
30d	Poor day-to-day project planning	.633	.4267	NS	A	14.724	.0001	S	D	11.896	.0006	S	D
30e	Inadequate cost control	36.122	.0001	S	D	4.560	.0330	S	D	.088	.7668	NS	A
30f	Unfamiliarity of designers with project	3.418	.0654	NS	A	3.971	.0466	S	D	.973	.3241	NS	A
30g	Unfamiliarity of contractors	.700	.4035	NS	A	.028	.8678	NS	A	4.791	.0289	S	D
30h	Lateness of information needed	.704	.4020	NS	A	.061	.8043	NS	A	.613	.4337	NS	A
30i	Lack of detail in drawings/specs	5.832	.0163	S	D	8.808	.0031	S	D	9.045	.0027	S	D
30j	Failure of codes - workmanship/finish	.116	.7333	NS	A	44.706	.0001	S	D	37.092	.0001	S	D
30k	Other factors	6.382	.0138	S	D	8.598	.0036	S	D	3.024	.0832	NS	A

LEGEND:	
S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval) D - the responses of the groups being compared disagree A - the responses of the groups being compared do agree.	Null hypothesis: H0 : The variable of interest is ranked equally by both populations Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both populations.

F_PUB_30-31

Table 7.19 NON-PARAMETRIC ANOVA SUMMARY (PERFORMANCE EVALUATION CRITERIA)

Hypothesis testing of gaps in perception between the parties to construction (dyads)

CONDITIONS: **PUBLIC vs PRIVATE OWNERS**

PERFORMANCE EVALUATION CRITERIA. What specific performance indicators do you generally use to judge the success of completed construction projects? Rank the following factors in order of importance.		PUBLIC OWNERS VS. PRIVATE OWNERS			
Ques.no. 15	: Question description	F value	prob. (p)	Sig	A/D?
15a	Finishing within the time stipulated	5.132	.0245	S	D
15b	Adherence to budget agreed	12.642	.0005	S	D
15c	Quality of appearance	.857	.3556	NS	A
15d	Satisfactory job relations with designers	.872	.3513	NS	A
15e	Satisfactory job relations with contractors	.351	.5542	NS	A
15f	Building works well - meets end users' needs	.205	.6513	NS	A
15g	Performance of all electrical/mechanical systems to specs.	6.471	.0117	S	D
15h	Minimal number and value of change orders	9.25	.0026	S	D
15i	Other	.293	.5902	NS	A

LEGEND: S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the .05 level of significance (95% confidence interval) D - the responses of the groups being compared disagree A - the responses of the groups being compared do agree.	Null hypothesis: H0 : The variable of interest is ranked equally by both sample populations Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PUB-PRI-15-16

Table 7.20 NON-PARAMETRIC ANOVA SUMMARY (PERFORMANCE EVALUATION)

Hypothesis testing of gaps in perception between the parties to construction.

CONDITIONS: PUBLIC/PRIVATE OWNERS/CONTRACTORS

PERFORMANCE EVALUATION CRITERIA: What specific performance indicators do you use to judge the success of completed projects. Rank in order of importance		PUBLIC OWNER VS. CONTRACTOR				PRIVATE OWNER VS CONTRACTOR.			
Ques.no :		F value	prob. (p)	Sig	A/D?	F value	prob. (p)	Sig	A/D?
15a	Finishing within the time stipulated	22.854	.0001	S	D	.135	.7132	NS	A
15b	Adherence to budget agreed	5.438	.0201	S	D	7.189	.0075	S	D
15c	Quality of appearance	2.439	.1190	NS	A	4.111	.043	S	D
15e	satisfactory job relations with contractors	14.415	.0001	S	D	35.84	.0001	S	D
15f	Building works well - meets end users' needs	92.708	.0002	S	D	108.176	.0001	S	D
15g	Performance of all mech/elec systems to specs	166.767	.0001	S	D	108.143	.0001	S	D
15h	Minimal number and value of change orders	16.939	.0001	S	D	3.617	.0577	NS	A
15i	Other	10.969	.0001	S	D	10.698	.0012	S	D

LEGEND:
S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the 95% level of significance
D - the responses of the groups being compared disagree
A - the responses of the groups being compared do agree.

Null hypothesis: H0 : The variable of interest is ranked equally by both samplepopulations
Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PUB_16-17

Table 7.21 NON-PARAMETRIC ANOVA SUMMARY (PERFORMANCE EVALUATION CRITERIA)

Hypothesis testing of gaps in perception between the parties to construction.

CONDITIONS: **PUBLIC/PRIVATE OWNERS/DESIGNERS**

PERFORMANCE EVALUATION CRITERIA. What specific performance indicators do you generally use to judge the success of completed construction projects?		PUBLIC OWNER VS. DESIGNER				PRIVATE OWNER VS DESIGNER.			
Ques.no :		F value	prob. (p)	Sig	A/D?	F value	prob. (p)	Sig	A/D?
15a	Finishing within the time stipulated	.754	.3853	NS	A	53.592	.0001	S	D
15b	Adherence to budget agreed	29.958	.0001	S	D	21.171	.0001	S	D
15c	Quality of appearance	25.667	.0001	S	D	100.194	.0001	S	D
15d	satisfactory job relations with designers	273.597	.0001	S	D	816.91	.0001	S	D
15f	Building works well - meets end users' needs	.022	.8834	NS	A	.396	.5292	NS	A
15g	Performance of all mech/elec systems to specs	179.80	.0001	S	D	139.856	.0001	S	D
15h	Minimal number and value of change orders	2.76	.0968	NS	A	8.209	.0042	S	D
15i	Other	5.039	.0253	S	D	1.872	.1717	NS	A

LEGEND:
S - SIGNIFICANCE OF F VALUE - probability (p) values .05 or less allow the null hypothesis to be rejected at the 95% level of significance
D - the responses of the groups being compared disagree
A - the responses of the groups being compared do agree.

Null hypothesis: H0 : The variable of interest is ranked equally by both samplepopulations
Alternative hypothesis : H1 : The variable of interest is NOT ranked equally by both sample populations.

F_PUB_PRI_DES 15-16