1.0 Introduction

1.1 Overview

As inflation and competition for public funds places more restrictions on public building programs, the desire to control project costs becomes the central focus of decision making. Within the context of tightening budget constraints, building programs are often subject to criticism due to the apparent higher costs of public facilities relative to private development. For example, during the course of this study, the higher costs for construction and maintenance of public university buildings was a frequently cited perception among facility managers, administrators and trustees.

Background of the Problem

The topic of economy and efficiency in the state building program has been discussed for some time between the University of Wisconsin-System Administration, UW-Madison, UW-Milwaukee, and the Division of Facilities Development (DFD) in the Department of Administration (DOA). Motivated by a concern for understanding why public university buildings appear to cost more than private sector buildings, the Division of Facilities Development and the Division of Capital Budget and Architectural/Engineering Services of the University of Wisconsin-System have expressed an interest in investigating state building practices. One of the concerns is the extent to which the Wisconsin state building program in general, and the UW-System building program in particular, have contributed to, or are partially responsible for, perceived and/or actual problems of cost and quality control.

Due to the DFD and UW-System's shared sense of concern over the perceived deficiencies of the state building program, and concerns over the cost and quality of facilities that they are able to construct, the DFD requested the UW-Milwaukee School of Architecture and Urban Planning (SARUP) conduct an objective outside assessment of the building practices which may lead to a set of recommendations aimed at improving perceptions of the program.

Purpose of the Proposed Study

The goals and purposes of this study include:

(a) identifying and analyzing problems and issues within the UW-System and state building program which can begin to resolve the concerns of the DFD, the legislature and the public-at-large related to the high costs of facility development; and,

(b) analyzing the issue of whether Wisconsin private commercial sector development is less expensive than comparable Wisconsin state public sector development, and why.

(c) if private development is less expensive than comparable public sector development, identifying potential factors and conditions within the building process, or with the building product, which account for more expensive buildings in the Wisconsin's public sector, and why.

(d) providing recommendations for improving the efficiency of the state building program, building increased flexibility into the process, and positively affecting the quality of future building projects.
1.2 Premises and Hypotheses

This section presents the premises and hypotheses of this study.

An initial premise of the study states that different organizations' expectations of their buildings' purposes and intents lead to different facility development processes and decisions, resulting in observed cost differences.

A second premise of this study is that the facility development process being followed to initiate, design and implement building projects affects the final project outcomes in terms of time, cost and quality of the constructed product.

Following these two premises and the implications of the study framework (see Figure 1), this study hypothesizes that

(a) due to the state's administrative processes, intentions and expectations for building, public building projects take longer to develop than private projects, subjecting public projects to more uncertain longer-term economic fluctuations,

(b) public institutions see the development of public buildings as a long-term investment, in contrast to private sector development which focuses more narrowly on short-term return on investment,

(c) as a result of a long-term investment focus, public institutions place more attention on building life-cycle analysis, program requirements, and durable high quality building systems and materials than does the private sector.

1.3 Outline of Report

This report is divided into three sections. Section 1 presents an introduction to the study, a critical literature review of the recent studies that focus on comparative cost analyses of public and private facilities, and a description of the methodology used in the present study. Section 2 presents a detailed comparative analysis between and across the five paired case studies. Section 3 offers discussion and conclusions based on the previous comparative analysis.
2.0 Review of the Literature

2.1 Overview

After providing an overview of the issues involved in building costs, this section reviews the most recent studies that have investigated building cost differences between public and private facilities. Studies to be reviewed include: the Stanford University Study (Kershner, 1987); The Princeton University Value Study (Ballinger, 1990); University of Wisconsin-System Administration (Jenson & Hardesty, 1991); General Services Administration Cost and Performance Study (Hanscomb and Associates, 1975); and the Higher Education Colloquium on Science Facilities Task Force on Academic Facilities Costs (Higher Education Colloquium, 1993).

According to a report by McIntick (1986) estimates from the construction industry concerning the cost difference between federal projects and privately owned structures of similar size ranges anywhere from 4% to 15%. A frequent speculation is that special laws and conditions increase costs. It is further speculated that stringent requirements for public accountability may also influence cost levels adversely when viewed against the greater procurement flexibility available to the private sector.

There are a number of factors other than building hardware and configuration that may impose on costs on public sector projects which do not have an impact on many private sector projects. These issues are at present a matter of speculation and hypothesis; hypotheses that have not been tested by empirical research. Factors that have been discussed in the literature (Chiu, 1990; Hanscomb and Associates, 1976; McIntick, 1986; NRC, 1991) are summarized below:

1. Legislative enactments

Legislative enactments include labor standards such as Davis-Bacon Act, Equal Employment Opportunity Act; environmental protection laws for water, air, noise pollution control, proper land use, waste disposal requirements, protection of historic buildings; and safety requirements such as OSHA requirements.

2. Building life-cycle costs

Public buildings are designed to last longer than typical private projects increasing the first costs of government projects with respect to private projects. Durability of buildings is an explicit design criteria of many government related projects. As a result, life-cycle costs become a major design consideration in these projects. The argument is that first costs may be higher for government building projects (e.g. materials chosen cost more but require less maintenance attention), but operating costs over time will be less than private sector buildings.

The lack of building life-cycle cost analysis in current development practice, and its role in potentially decreasing project costs over the long term, are well documented in both public and private sectors. The role of life-cycle cost analysis in analyzing building cost comparisons has not been looked at in the literature. A recent report conducted jointly by the Federal Construction Council and the Building Research Board (N.R.C., 1991) summarizes an expert panel inquiry which formulated criteria and recommendations for using life-cycle cost analysis in building design in an effort to improve government agency building development. Designers and owners of buildings recognize that there are many trade-offs which can be made during planning and design which can affect initial construction costs, recurring operations and maintenance costs, and building performance.
Substantial obstacles to implementing life-cycle cost control in practice include: (1) failure of designers to include life-cycle cost goals in their design criteria; (2) failure of owners or managers with short-term responsibility of a building to consider effectively the longer-term impact of their decisions on the building's O&M requirements; (3) general desire of many decision makers to minimized their initial expenditures in an effort to increase return on investment, and/or meet budgetary restrictions; and (4) lack of data and accepted industry standards for describing the maintenance effect and operational performance of building components (N.R.C., 1991).

3. Profit Incentives

Profit incentives may have an affect on private building costs that is missing from public projects: in short, the motives for development are radically different. The motives for development on the private sector is focused on short-term investment opportunities, while the public sector focuses on long-term investment and public accountability.

4. Low-bid construction contracts

The use of low-bid construction contracts may actually add to costs versus reducing them. The process by which low bids are obtained may actually reward less qualified contractors to win contracts consequently compromising the quality of construction management, generate delays and/or change orders and reduce the quality of the final constructed product.

5. Specification restrictions

Government projects often require non-proprietary specifications while private sector projects often specify companies and trade names and accept "as equals."

6. Documentation

Governmental processes require very complex and bulky documentation during all phases of the process, while the private sector streamlines the documentation process in favor of expediency. The volume of documentation required often discourages prospective bidders from competing with contractors that have learned how to manage the system.

7. Procurement policies and standards

Policies and standards are driven by public accountability. A system of open competitive bidding is seen as the most expedient way to facilitate a process that demonstrates to the public at large that facilities are being procured at the best possible price. This process has as a result evolved into a system of extensive rules, regulations and documentation at all levels of government. By contrast the private sector has a greater degree of flexibility in adopting methods and procurement strategies that reduce costs. The principle difference between public and private sector development strategies has to do with the freedom private sector developers have to negotiate direct with a construction manager or contractor, or to limit bidding lists by pre-qualification. It is often argued that negotiation and pre-qualification usually insure better workmanship, as well as, the selection of a responsible contractor leading to better prices and product quality. At the same time, it is argued that the solicitation of open bids in fact reduces cost, but at the expense of performance.

The selection of design consultants is also a lengthy and complicated selection process based upon experience, ability, resources and suitability for the project as
well as price, while in the private sector there is a tendency to select consultants on
the basis of reputation and ability with relationships between corporations and
architects lasting several generations with the same firm.

Design decision-making is another related issue which ultimately affects cost outcomes. The choices which are made and the timing in which they are made can drastically affect project costs. To illustrate, Chiu (1990) studied the links between corporate office facility investment decision-making and building performance investigating case studies to identify cost effective methods to achieve better building performance. The findings indicated that developers make design decisions based on inadequate information, and do not sufficiently understand the impact of the early decisions on final building performance. In addition, Chiu found that developers and designers learn about building performance in an insufficient way from their previous projects. Office tenants do not always know their alternatives and often settle on what they can afford without looking at better choices.

8. Project Duration (Time)

Significant time differences can be observed in all phases of the development process between public and private sectors. Extended periods of time are taken up in all forms of approval processes from project inception to occupancy: approvals for funding, program, conceptual design, design development, construction documents, bidding and contracting as well as construction change orders. Time could be seen as a more critical for speculative developers motivated by the possibility of the loss of rental or additional interest. Issues of time are not as easily translated into dollars lost in public projects. Time does come into play with the inflation of costs of construction due to increases in the costs of supplies, materials, labor and equipment. Delays in construction can cost the owner with respect to inflation. When budgets are set early on in the procurement process and time is allowed to slip by the dollar does not stretch as far. Players in the construction game often use delays to justify cost overruns that may have been due to other less acceptable reasons.

9. Tax considerations

All investment decisions have tax implications — often based on accepted accounting procedures that devalue long-term or life-cycle costs and benefits — that may have the effect of minimizing the incentives that private developers may have for improving building quality and thus assist in reducing the cost of their buildings.

10. Cost control procedures

The private sector builds for the purpose of making a return or profit on an investment, while the government builds to satisfy a physical space need on the part of its agencies. The objectives of both sectors are different and as a result, the public sector will be at a disadvantage when it comes to cost control with respect to the private sector whose dominant mode is one of reducing costs, while maintaining minimal acceptable standards. The public sector on the other hand attempts to optimize its investment in favor of agency needs first and to do this at a publicly acceptable price.

Responsibility for cost control in the private sector is retained by the developer or owner with the assistance of the construction manager or architect, while in the public sector responsibility for cost control is often abdicated by the agency transferred to the designer or construction manager who do not generally have reputations as comprehensive project cost control experts.
11. Options for Project Cancellation

Another point is that many private sector buildings never get to or leave the drawing table if initial cost estimates and even if bids are found to be unacceptable with respect to return on investment. On the other hand, public sector generally has little latitude as to whether to build or not; a physical space problem exists and it must be resolved through some strategy. Often, public agencies lease badly needed space, taking the costs out of their operating budgets until new space becomes available.

Because of these differences in approaches to budgetary planning, public and private sectors often manifest different attitudes toward the budgetary process: private sector developers realize greater penalties for exceeding costs and greater benefits if a project comes in under budget, while the public sector often regards budgets as minimums and accept the probability of exceeding them.

These speculations have not been subject to systematic empirical investigation. Whether any of these factors lead to any better or lower prices in the private sector is open to question. The remainder of this chapter reviews what is known empirically concerning cost differences between public and private facilities in the U.S.

2.2 Stanford University Study

Kershner (1987) conducted a study of how Stanford University buildings compared to other buildings, both institutional (private) and non-institutional (commercial). Data was collected through telephone surveys and presented in comparative tables and graphs. The problems connected with developing a methodology used to judge the validity of a building's comparative cost include units of measurement for cost comparison (cost per gross vs. net square foot, construction vs. total project cost) uniqueness and level of complexity of the building's (number of program requirements) and categories of analysis (cost/gross sq. ft. vs. building components). In an effort to generalize beyond the sample of Stanford buildings, it was suggested that buildings at Stanford were comparable in cost to other university buildings due to the fact that the complexity of the Stanford buildings was comparable to those on other university campuses.

Although the study found that educational institutional buildings were 15-30% more expensive than non-institutional buildings, there were "definitive and usually justifiable reasons for the additional cost" (Kershner, 1987; 29). Reasons the author cites for this difference in cost include the educational institution's more complex program requirements, longer expected life of buildings, concern for unified campus aesthetics and limited location choices. Several recommendations are forwarded to achieve greater cost effectiveness such as analyzing the quantity of program needs, analyzing the quality of building systems, considering generic-design approaches, selecting cost-conscious professionals, making use of value engineering, selecting the proper contracting method, and being attuned to market conditions (season, shortages, and local conditions).

The Stanford study, as reported, did not explicitly compare specific private institutional buildings against specific commercial buildings, but instead conducted a comparison based on average costs between institutional and non-institutional buildings. It is not known how large the sample of the study was, nevertheless the average cost comparisons method provides an opportunity for a more generalized conclusion about cost comparisons than the specific comparative building case study matching approach may allow. Generalization can also be seen as a disadvantage of the average cost comparisons method in that specific reasons for cost outcomes cannot be identified in much depth as is possible with the comparative building
approach. Finally, the Stanford study did not look beyond outcome project cost data in making comparisons. Many underlying factors which may affect cost such as organizational factors (organizational structure, management styles) and building delivery processes and procedures were not addressed.

2.3 Princeton University Value Study

The Princeton University Value Study (Ballinger, 1990) compared five building types on campus (laboratory, library, computer sciences, pool, and economics building) to nine other educational institutions (University of Michigan, Oklahoma State, University of Pennsylvania, Brown University, Penn State University, Harvard, Cornell, U.C.L.A. and the University of North Carolina). Similar to the Stanford study the comparisons were based solely on building construction costs and project costs. Overall, the study revealed that Princeton is paying consistently more for facilities than the average of 38 respondents: $268.9/SF vs. $176.2/SF for a total premium project cost of $92.7/SF. Reasons cited for this difference included Princeton’s policy of site selection which maintains optimum functional adjacencies and increases site costs due to difficult infill site strategies, selection of prestigious architects to develop distinctive, high-quality buildings, emphasis on systems selection standards for long-term economics, use of construction management services in lieu of lump sum bidding, and acceptance of add alternates and change orders to enhance further building function and quality.

In the examination of the five projects, Ballinger (1990) sought to understand the processes that led to the results through in-depth interviews with the specific project managers as well as site visits to each building. From these interviews and site visits the report focuses on three areas of the design process, namely, project formation, contracting methods and specifications/standards. "Value premium categories" were used to identify patterns of policy decisions which may lead to premium costs: site selection, architectural quality (selection of renowned architects), systems, project delivery, and add alternates.

The Princeton study is unique in that an attempt was made to look at the processes and procedures as well as the values behind the cost differentials to answer the questions of why their buildings cost so much more than comparable institutions.

2.4 The University of Wisconsin- System Administration Study

In response to the Regents discussion about costs of facilities for university versus the private sector Jenson and Hardey (1991) conducted a preliminary case comparison study between several university laboratories and a single private sector laboratory of a Madison-based environmental consulting and engineering firm. The goal of the study was to identify additional reasons for the apparent difference in costs between public and private buildings.

Comparisons were based on total construction costs measured in 1989 dollars. While six of the eight university laboratory buildings (ranging from $102/ASF to $220/ASF) compared to the private laboratory ($127/ASF) were more expensive in terms of assignable square footage, seven of the eight were lower in terms of gross square feet. The different set of conclusions drawn by this study between ASF and GSF highlights the problem of what constitutes a measure of cost, in this case, the definition of assignable square footage.
Several design standard differences reported between the private and the university laboratory (RMT) include:

1. Wage rates: The state requires wage rates which are reported in the specifications; while RMT used a non-union contractor who was able to pay lower labor rates.

2. Site selection: The campus land is restricted and usually dictates a smaller building footprint vs. RMT which built on a more generous lot size.

3. Vertical construction: Due to limited land the university is forced to build vertically requiring stronger and more fireproof structural systems and requires vertical ducting systems versus RMT which can build one story buildings, requires no vertical risers and can be constructed with multiple trades working concurrently.

4. Internal layout for worker/space needs: University labs have a higher density of casework for stations than RMT.

5. Material quality standards: Levels of construction quality dictated by DFD are higher (brick exterior w/ masonry back up) than RMT (exterior metal stud back-up w/ stucco)

6. HVAC: University campus buildings are heated and cooled by central systems with direct return ducts which require balancing between return and supply versus RMT which uses inexpensive roof top HVAC units with open ducts in ceiling which require no balancing.

Some other general reasons why state facilities may cost more than private sectors cited in the report include the tendency of the state to build facilities which promise up to 100 years of life and therefore the time allowed for planning is significantly longer, the quality of materials selected is higher, and the construction bidding process is more rigid in its guidelines than private sector development.

The U.W.-System Administration study is a step forward in the direction of finding additional reasons for cost differentials in its analysis of the comparative practices of the public and private sector. One limitation of the study is that it cannot generalize beyond the cases presented. Only one building type was analyzed with only one single private commercial building. The usefulness of the study is its conceptual emphasis on the general differences between the motivations of public versus private sector development practices. The study helps frame part of the research problem faced by state agencies when confronted with the claims that private commercial development is more cost effective. There are many hidden costs and consequences to both approaches to development which must be made explicit in a study which attempts to determine the relationships between time, cost and quality.

2.5 General Services Administration Cost and Performance Study

The Cost and Performance Study, conducted by Hanscomb (1976) of Greenwich, Connecticut, compared a cross section of five federally and six privately constructed office buildings. The privately constructed office building sample included three multi-tenant speculative buildings and three owner-occupied buildings. For comparative purposes, actual costs of each building were analyzed into UNIFORMAT categories and indexed to 1976 dollars using Boeckh's construction cost index.
Extensive statistical, performance and specification data was assembled on each building.

The majority of the report concentrates on comparisons of construction costs only since project cost information for private sector projects was difficult to obtain. From the comparative data analysis of the projects in the study sample it was found that there is a difference in the cost for Federal buildings. It was found that private owner-occupied buildings cost on average $34.22/GFA while Federal buildings cost on average $46.30/GFA for a difference of $12.08/GFA or 35.3% greater.

Reasons for the differences include four areas:

1. Scope: Federal buildings have more in them than private sector counterparts (e.g., interior tenant work, special facilities and features). The study recommends transferring cost responsibility for interior tenant work to user agencies, leaving GSA to constructing open office space. This strategy does not necessarily offer any real cost savings.

2. Quantitative: Federal projects require more quantities of materials and components to enclose the same given floor area (e.g., their plan forms and geometric layouts). The study recommends limiting floor to floor heights and setting efficiency ratios for designers at the outset of the project. The study concluded that if Federal projects in the study achieved the same rate of efficiency as the average of the private projects then a reduction of 7% in total cost could be realized. The result will be the speculative developer's "box" which is the most cost effective form for office building construction.

3. Qualitative: Federal buildings demand higher performance and specify better quality. The study suggests that cost variances can be eliminated by simply reducing acceptable standards. There are obvious trade-offs with this approach.

4. Unidentified Causes: Those causes that cannot be attributed to any one of the factors above, or which may arise due to intangible factors (e.g. legislative factors, specification restrictions, extensive documentation, restrictive procurement policies required to establish reasonable levels of public accountability, and additional time during preconstruction stage for approval and processing of projects). The study concluded that even though it was difficult to quantify with any degree of accuracy or support, nonetheless, there are "grounds to believe that certain of the restrictions and conditions under which Federal construction must be carried out do not help in insuring that the best price is obtained in the market place.

2.6 Higher Education Colloquium on Science Facilities Task Force on Academic Facilities Costs

The conclusion reached by the Higher Education Colloquium (1993) was that academic science and engineering facilities could be procured and built more efficiently and that universities can learn from their corporate counterparts. The report bases its findings on a major survey questionnaire (multiple choice and narrative responses) which was sent to 100 respondents and had an 81% return rate. Respondents included nine research-intensive corporations, 16 architectural and engineering design firms, 59 public universities, and 30 private universities. The Task Force examined differences between corporate and academic practice, effects of laws and regulations, and effects of technological change.
"In one comparison, based on composite construction data for a research facility, the
time taken to the midpoint of the construction period was twice as long for the
academic facility as for the corporate one. That translated into an inflationary cost
escalation that was three times greater for the academic facility than for the corporate
one. Nevertheless, laws and regulations sometimes prevent universities from using
corporate construction practices usually considered sound. Universities generally
believe that building and life-safety codes are worth the extra costs they entail, and
they appreciate the necessity of conforming to zoning regulations....State controls
on public universities, the Task Force finds, are the most counterproductive
influences on the construction of research facilities. They tend to impose time-
consuming procedures of marginal value. Commonly they require universities to
accept construction bids from any bidder, regardless of competence."

The task force noted that comparison analysis must recognize (a) the effects of
different missions of academic and corporate institutions, (b) facility-specific factors
such as requirements imposed by location, (c) various laws and/or regulations prevent
universities of adopting construction practices regarded as sound in the corporate
world, and (d) different building delivery systems such as construction manager,
design/build and general contractor approaches.

The Task Force identified only one specific comparison of an academic facility with a
corporate research facility. It involved SmithKline Beecham Corporation (SKB) and
Princeton University. Two molecular-biology facilities were compared which had
similar size and programs and missions. Construction cost for the SKB facility
completed in 1983 was $143/GSF, while the Princeton facility completed in 1986
cost $206/GSF without taking the effects of inflation into account. (which SARA
Systems, Inc have assumed 5.1%/year average for construction projects in the US
during the past 75 years).

"Some reasons for the difference are plain. Princeton wanted distinctive treatment of
all four exterior walls of its building, whereas all but the entry facade of the SKB
building are relatively simple brick facades. Hence the exterior skin cost Princeton
$27/SF $14 more than it cost SKB....The costs of structure/foundations,
equipment/finishes, HVAC/plumbing, and electrical systems totalled $146/SF for
Princeton and only $109/SF for SKB." The reason? Princeton payed premium prices
for longer life cycles in building. The Task Force claims that inflation a big factor: an
example of the time value of money.

The Task Force also suggested that another counterproductive influence on
construction of research facilities are state controls on public universities: consultant
selection, diffusion of responsibility in project management, state legislation, series of
review procedures, state-imposed mechanisms all creating delays in the process with
the attendant costs.

The report concludes with a number of recommendations and a set of principles and
guidelines for implementing efficient building methods, which include:

• assigning to one person the responsibility for building or renovating a research
  facility;

• paying greater attention to the time value of money as it relates to streamlining
  approval processes for the construction of facilities;

• fostering the sharing and joint use of facilities by considering efficiency of use
  campus wide, not just department by department;
• obtaining trade data on trends in space planning and programming from designers, consultants, and seminars;

• revising methods of awarding contracts for the construction of major facilities;

• and establishing a national data bank on the planning, costs, and procurement of facilities for science and engineering.

The report stresses the advantages of centralized control of design and construction along the lines of the corporate model. It calls for analyses based on life-cycle costs as well as initial costs; designing for adaptability of space and utilities; prequalifying consultants and contractors and establishing replacement reserves for new or renovated facilities.

2.7 Summary

There are many issues which must be addressed when attempting comparative cost analyses of building projects. The Stanford University Study emphasized the need to have similar comparisons between measurement of unit costs, develop appropriate categories of analysis, and consider the level of complexity of program requirements. The Princeton University Value Study is unique in that it went beyond the simple comparisons of cost to investigating the impact of project formulation strategies prior to design, the design process itself, contracting methods and standards and specifications on final cost outcomes. The University of Wisconsin-System Administration Study, was unique in that it framed a series of unrecognized issues in need of further research. Several issues not explicitly discussed in the studies, namely the impact of life-cycle costing and design decision-making on final cost and quality outcomes, are additional factors which should be investigated.

The present proposal combines as well as extends the previous studies in several ways:

1. Acknowledges the need to investigate a variety of building types to gain a clearer sense of how cost and quality are affected.

2. Analyzes cost not only in terms of gross square footage, construction and project costs, but also in terms of operations and maintenance costs and life-cycle cost.

3. Emphasizes the differences between both public and private educational institution's and private commercial sector's facility development processes and design decision-making practices.

4. Unlike all the previous studies, the present study emphasizes a two-tiered matching process, the first with reference to organizational context factors such as organizational type and structure, and development experience, and the second with reference to project scope such as building size, configuration and complexity, as well as, locational factors and site conditions, in addition to construction materials and building systems.
3.0 Methodology

3.1 Overview

This section presents the research approach taken in the study, the research design, sampling and sampling techniques, and the study framework procedures, followed by a guide to the case study comparison reports in Section 2.

Initial meetings, between the researchers and the DFD/UW-System staff, defined and developed the case study framework from which a pilot study was conducted.

The supervising committee then identified several projects that could act as case studies. During the course of this review members of the researcher team consulted with various DFD and/or UW System staff to gain a better understanding of the problems and issues associated with using the specific projects for comparison. The primary goal of this activity was to establish a common baseline understanding of the overall process and issues involved and to insure a consistency between the variables used for the study.

The project was divided into two distinct phases, each with its own set of findings and conclusions. At the completion of each stage, the case study framework was reviewed with the supervising committee and revised as necessary prior to being implemented in the subsequent phase. The scope of work for the two phases is as follows:

Phase I.
The first phase consisted of testing the validity of the study framework by conducting a pilot study comparing a public and private facility. Based on the results of the pilot study, the research team reported to the supervising committee on the viability of the case study framework, revising the framework as necessary.

Phase II.
The body of the case study investigations were conducted using the revised case study framework. The five pairs of comparable case study projects were identified, data was collected from the four leveled matching/comparing strategy, then analyzed. This document presents the findings of this analysis.

3.2 Approach

The methodology or approach adopted for the study was derived from the nature of the questions being asked. In order to determine if, in fact, public sector buildings do cost more than private sector buildings, an analysis of comparative quantitative cost data would be required. Several issues would have to be addressed in the collection of this data: first, what level of detail should be collected to make a valid comparison, and second, what level of detail is possible in collecting data as a result of poor project documentation, the lack of memory on the part of project players, or simply the lack of willingness to cooperate in providing cost data (as is often the case with private owners and developers).

Understanding why public sector buildings may cost more than private sector buildings necessitated collecting a set of interpretative or qualitative data from a variety of sources: the literature on construction practices, the general experience of experts in construction practice, the experience of players and the documented
reasons in the sample cases studies, as well as the researchers' own professional experiences. The trustworthiness of such qualitative data in explaining reasons why buildings cost more would be dependent on the level of corroboration obtained across various sources. The time and resources required to gather this qualitative data limited the ability of the research team to investigate a large sample of buildings.

The objective of the study, then, was to make some linkages, some assignment of qualitative findings (reasons why) with quantitative findings (cost differentials). Establishing the linkages between differences in these two case study "databases" we believe is critical to understanding and ultimately explaining why some buildings cost more than others. Looking at quantitative outcome measures alone will not help us understand why these differences exist. By the same token, from qualitative data we can derive some interesting theories about why buildings cost more, but we cannot test them without knowing if actual quantitative differences exist in the sample we are investigating. This study represents a first attempt at finding patterns and links between these two distinct, and sometimes contradictory sets of data to determine what factors are worthy of further investigation.

Due to the considerations and research objectives outlined above, a comparative case study was chosen as the most appropriate method or approach to answering the questions being raised. The case study allows for in depth documentation of project conditions and processes that lie behind costs. The advantage of this approach is that a more comprehensive evaluation of the reasons why can be documented and unearthed. The limitation of this approach is that the study cannot generalize beyond the cases being investigated. However, findings from this study can serve to focus attention on the most critical factors, as well as, generate hypotheses for further research.

3.3 Research Design

A multiple-case study analysis was chosen as the research design best suited to explore the research questions generated from initial discussions with DFD, UW-System and the literature review.

Previous studies have compared building pairs according to a limited number of building variables, such as square footage or building type. The investigators of this study were concerned with identifying paired cases which could be compared across a wider series of variables, in an effort to examine the inherent complexities associated with each paired case. The case studies investigated the historical background and current status of both the facility itself and the organization which occupies the facility. Detailed background descriptions of each case provides an opportunity to compare buildings across several levels of analysis simultaneously.

Case studies were chosen for investigation according to how well they matched certain groups of factors established for comparison, such as organizational context and project scope (see Figure 1). Five pairs of case studies, each representing different building types, were chosen on the basis of how well they matched in terms of organization and project scope.

Data collection included conducting individual and group interviews, and collecting relevant archival materials (organizational records, contract documents, specifications, and project records). Data analysis consisted of identifying similarities and differences across matched and comparison levels of analysis for each case pair.
3.4 Sample and Sampling Techniques

The sample of building projects from which the study drew upon to find comparables included all buildings in the University of Wisconsin-System, buildings leased or owned by the State of Wisconsin, as well as comparative private buildings near these public facilities. In addition, private educational institutions within the state were considered for comparison with the state's public buildings. The sample of private commercial development projects considered for comparison to UW-System projects included only owner-occupied buildings within the State of Wisconsin. (No speculative building developments were considered in the sample in an effort to increase the validity of the match with state-owned buildings). When feasible, projects were chosen which were located geographically near each other and constructed about the same time period.

Comparable facilities were not randomly sampled, but were chosen based on a set of predetermined criteria:

1. the ability of the research team and/or supervisory committee to find a comparable matched set of facilities,

2. facility type,

3. the ability of the research team and/or supervisory committee to find individuals familiar with the facility development process conducted for the building,

4. the location of the facility was implicitly limited to, but not exclusive of, southeast Wisconsin,

5. a facility no more than 10 years old,

6. owner-occupied.

The subgroups of the sample were divided into five representative facility types which characterize a variety of facility development. From these subgroups, facility were selected based on how well they matched the remaining the case study criteria.
3.5 Study Framework & Procedures

This section presents the matching/comparison strategy which acted as the framework for conceptually and operationally organizing this study. Public sector buildings were compared with private institutional and commercial sector buildings on the basis of a two-tiered matching strategy (see Figure 1). Data was collected from a total of four levels of analysis: the organizational context, facility development process, project scope and project outcomes. The matching strategy allowed for the matching of paired buildings at levels one and three and comparison of them at levels two and four. A general outline of each of the four levels of analysis are as follows (see Appendix C for the full master questionnaire):

1. Organizational Context
   The first phase of the process of matching identified comparable organizations from which to draw a set of buildings. The organizations were matched as closely as possible based on several factors:
   a. Organizational Structure: size of staffed employees; levels of management; number of departments.
   b. Organizational Experience: level of facility development experience; number of buildings which are currently owned, operated, and managed by the organization; amount of capital expenditures allocated for management of facilities per year.
   c. Organizational Function: the stated goals and mission of the organization; relation of organizational goals to facility development.

2. Facility Development Process
   Once the organizations were matched, information concerning the facility development process was compared:
   a. Procedures followed during the facility development process: feasibility planning, definition of scope, staff/consultant selection, design development and review, construction documents and estimates, bids and negotiation, construction and project management, occupancy and facility management.
   b. Consultant selection process: participants in the facility development process.
   c. Decision-making: key decision makers during each phase in the project.
   d. Project budgets: relationship and effect on design concepts, design and construction decisions.
   e. Evaluation of process: Overall perceived effectiveness of the facility development process for case; expectations of process followed for specific project compared to general project experience of the organization.

3. Project Scope
   Next, the overall project parameters for all case study building projects were matched as closely as possible. Project scope items were the controlling factors for comparing case study pairs. The scope items that were identified for matching included:
SECTION 1: INTRODUCTION TO THE STUDY

a. Documentation: building program, drawings, specifications and project files for this project.

b. Building performance standards: special established building performance/durability or quality/finish standard requirements.

c. Location factors/site conditions: advantages or disadvantages of the location or site conditions and context; relative cost market; parking accommodations; grading/clearing.

d. Size/form/configuration: total square footage, per floor square footage, footprint, floor area ratio, efficiency ratio, number of stories, overall building configuration; special design features; compact or loose organization on the site.

e. Construction materials & building systems: construction type; structural, mechanical, and enclosure systems; anticipated design life; level of finish.

f. Occupancy: total occupancy; primary users of the facility; daily pattern of building use.

4. Project Outcomes

Finally, once all five case study pairs were successfully matched the outcome variables were compared. These dependent variables included:

a. TIME

The total time (project duration) to deliver the building from project inception to occupancy was documented and compared between cases. For the purposes of comparison, the eight facility development stages referred to above were collapsed into three distinct activities: the planning process, the design process and the construction process. The planning process collapsed stages 2.1-2.3; the design process collapsed stages 2.4-2.5; and the construction process collapsed stages 2.6 and 2.7 (see Appendix B for a description of these stages).

b. COMPLEXITY

Complexity, as it is used in this study, should be understood as the recognition of a large number of interacting considerations, elements and factors that make up the process of delivering a building. In this study complexity is organized into a taxonomy of eight factors. These factors were derived from an analysis of the qualitative data and found to be the most salient defining categories of complexity. The data between projects were then compared with respect to these attributes to identify qualitative differences. A facility development complexity profile was used to measure and compare the degree of complexity of each project to narrow the field of possible factors associated with time and cost differentials. The project profile operationally defines eight attributes of "complexity": decision-making structure and procedures, methods of contracting, major incidents, program, location factors and side conditions, number of studies, building configuration, construction materials and specifications (see Table 1). The combined score of the attributes provides an indicator of the complexity of the project that can be correlated with time and cost factors.

c. COST

Data collection and grouping: Cost data was collected from project records, final certificates of payment (AIA Document G702), contractors' line itemized invoices, and owners' project close-out summaries (when available). Data was
screened line-by-line and cost items were uniformly grouped in four cost levels:

(1) **Building Construction Cost** (GMPE) comprised of General, Mechanical, Plumbing, and Electrical;

(2) **Construction Cost** comprised of Building Cost + Site Development Costs (demolition/excavation and paving/landscaping);

(3) **Total Project Costs** comprised of Construction Cost + Design & Supervision Fees (AVE fees, DFD/DSFM fees for public facilities and other fees);

(4) **Change Order Costs** for General, Mechanical, Plumbing, Electrical and Design & Supervision.

**Cost Adjustments/unit Cost Conversion:** Public facility development costs were adjusted for inflation and location to the completion year and location of the Private facility using Means Local Cost Indexes and Location Factors.

Because total costs would obviously not be comparable measures, the data was converted to unit costs in dollars per gross square foot ($/GSF) for the four cost levels (Building Cost/GSF, Construction Cost/GSF, Total Project Cost/GSF and Change Order Cost/GSF). Comparison of costs per net assignable square foot was considered to address building efficiency issues (net-to-gross ratios) however, calculation of net assignable areas for each case proved to be too difficult with the available program information and different procedures for calculating net assignable areas.

Cost data was also examined in other ways. Building Cost analyses included the relative distribution of General, Mechanical, Electrical and Plumbing Costs as percentages of Building Cost. Design & Supervision costs were calculated as a percentage of Construction Cost (standard method in the architecture and construction industry) and Change Order Costs were calculated as a percentage of Total Project Cost. (The cost analysis for each case can be found in Appendix A: Case Study Descriptions)

**Comparison:** The $/GSF at each cost level were then compared for each case pair. In addition to $/GSF comparisons, costs were analyzed in other ways. The relative distribution of General, Mechanical, Electrical and Plumbing Costs as a percentage of Building Cost was compared in each pair and generally confirmed program matching. Design & Supervision costs as a percentage of Construction Cost were compared. Change Order Costs as a percentage of Total Project Cost were compared as possible indicators of development process efficiency.

d. **COMPARATIVE ANALYSIS**

Once the project outcomes of time, complexity and cost were documented, a comparative analysis was undertaken. Factors of Complexity that differed between the paired cases were identified as possible reasons or potential contributors to differences in project duration (time) and costs. Specific examples from the case studies are highlighted to illustrate how these Factors of Complexity may have affected project duration and costs.
Table 1. Facility Development Complexity Profile: Operational Definitions

| Attributes                             | Scale of Complexity
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>3 (High)</td>
</tr>
<tr>
<td></td>
<td>2 (Moderate)</td>
</tr>
<tr>
<td></td>
<td>1 (Low)</td>
</tr>
<tr>
<td><strong>Facility Development Process</strong></td>
<td></td>
</tr>
<tr>
<td>(1) Decision-making</td>
<td>Procedures are explicit, differentiated, and followed strictly as possible.</td>
</tr>
<tr>
<td>Structure &amp; Procedures</td>
<td>Procedures are explicit and followed when appropriate; more flexible.</td>
</tr>
<tr>
<td>Major budgetary, project scope, and</td>
<td>The majority of budgetary, project scope, and design decisions made by a building committee.</td>
</tr>
<tr>
<td>design decisions made at several</td>
<td>Procedures are implicit and are negotiated with each project depending on circumstances and context.</td>
</tr>
<tr>
<td>differentiated management levels</td>
<td>Few levels of decision-making; The majority of budgetary, project scope and design decisions made in an integrated way by a single owner or owner representative.</td>
</tr>
<tr>
<td>within the client organization.</td>
<td></td>
</tr>
<tr>
<td>(2) Methods of contracting</td>
<td>Conventional: multiple prime contractors; A/E hired as owner representative.</td>
</tr>
<tr>
<td></td>
<td>Modified conventional: single prime contractor hired as owner representative.</td>
</tr>
<tr>
<td></td>
<td>Design/build: contractor/developer responsible for total project on a turn-key basis.</td>
</tr>
<tr>
<td>(3) Major Incidents</td>
<td>Several significant incidents occurred evidenced by documentation in project records.</td>
</tr>
<tr>
<td></td>
<td>A few significant incidents occurred evidenced by documentation in project records.</td>
</tr>
<tr>
<td></td>
<td>Little or no significant incidents occurred evidenced by documentation in project records.</td>
</tr>
<tr>
<td><strong>Project Scope</strong></td>
<td></td>
</tr>
<tr>
<td>(4) Program</td>
<td>The program consists of a number of highly specialized and diverse requirements.</td>
</tr>
<tr>
<td></td>
<td>The program consists of a balance of specialized and standardized requirements.</td>
</tr>
<tr>
<td></td>
<td>The program consists primarily of standardized requirements.</td>
</tr>
<tr>
<td>(5) Location factors and site conditions</td>
<td>All three or four factors below apply</td>
</tr>
<tr>
<td>Infill site</td>
<td>One or two factors below apply</td>
</tr>
<tr>
<td>Demolition</td>
<td>None of the factors below apply.</td>
</tr>
<tr>
<td>Additional/renovation</td>
<td>Is the project located on an infill site? yes/no</td>
</tr>
<tr>
<td>Do the project require building</td>
<td>Does the project require building demolition? yes/no</td>
</tr>
<tr>
<td>Demolition</td>
<td>Is the project an addition, and/or include renovation work? yes/no</td>
</tr>
<tr>
<td>Site size</td>
<td>Is developed site significantly larger than that required to optimally accommodate occupancy? yes/no</td>
</tr>
<tr>
<td>(6) Number of stories</td>
<td>More than two floors</td>
</tr>
<tr>
<td></td>
<td>Two floors</td>
</tr>
<tr>
<td></td>
<td>Single floor</td>
</tr>
<tr>
<td>(7) Building configuration</td>
<td>The building configuration can be described as having highly variable floor plates.</td>
</tr>
<tr>
<td></td>
<td>The building configuration can be described as having somewhat variable floor plates.</td>
</tr>
<tr>
<td></td>
<td>The building configuration can be described as prismatic (all floor plates identical).</td>
</tr>
<tr>
<td>(8) Construction materials and</td>
<td>The project consists of high quality institutional-grade construction materials and specifications.</td>
</tr>
<tr>
<td>specifications</td>
<td>The project consists of medium quality, commercial-grade construction materials and specifications.</td>
</tr>
<tr>
<td></td>
<td>The project consists of lower quality, residential-grade construction materials and specifications.</td>
</tr>
</tbody>
</table>

Study conducted for the State of Wisconsin
Department of Facilities Development
3.6 Guide to Case Study Comparison Reports

The remainder of this report consists of five individual case study pairs and a summary of an across case analysis. Each of the five case study pair chapters is presented in two parts. The first part presents the criteria for matching the case study pair from a standpoint of both organizational context and project scope. The second part presents the comparison criteria from which these two buildings were analyzed. The following subsections give a detailed description of the procedures followed in each case study.

Part 1: Matching

Project Descriptions
Each case study pair is presented in summary form in a side-by-side format consisting of building photographs, project team, year constructed, overall gross square footage and adjusted project costs.

Matching: Functional Plans
Floor plans and summary program element gross square footage (i.e. office, instruction, support, etc.) for each case study pair are presented in a side-by-side format.

Matching: Organizational Context
The organizational context matched along three specific areas: organizational structure, experience and function. In the Remarks column the match is judged to be either Comparable, Moderately Comparable or Not Comparable.

Matching: Project Scope
The project scope was matched according to several criteria: program scope, location factors/site conditions, size/form/configuration, construction materials and building systems, and occupancy patterns and characteristics. In the Remarks column the match is judged to be either Comparable, Moderately Comparable or Not Comparable similar to the organizational context matching process.

Part 2: Comparison

TIME
Comparison: Facility Development Process
A detailed description of the facility development process is presented for each case in a side-by-side comparison consisting of major events that occurred during the eight design stages.

Comparison: Project Duration Profile
The project duration profile consists of a comparative analysis of the facility development process collapsed to three phases: planning, design and construction.

COMPLEXITY
Comparison: Facility Development Complexity Profile
The facility development complexity profile consists of a comparison of project profiles with respect to the eight attributes of "complexity" operationally defined above. Beneath this profile is a description of the profiles in narrative form.

COST
The cost analysis for each case pair is comprised of four levels of comparison: Building Cost (GMPE), Construction Cost, Total Project Cost, and Change Order Cost. The cost comparison section begins with a cost summary profile followed by tables and charts that detail cost differences.
Comparison: Facility Development Cost Profile
This summary chart identifies the percentage by which the Public facility cost MORE or LESS than the Private facility in terms of Building Cost (GMPE), Site Development Cost, Design & Supervision Cost, Total Project Cost, and Change Order Cost. Positive percentages indicate the Public facility cost MORE and negative percentages indicate the Public facility cost LESS.

Comparison: Building Costs
This analysis indicates Building Cost component differences in $/GSF and as a percentage by which the Public facility cost MORE or LESS than the Private facility. The chart depicts the comparison as well as the relative portion of Building Cost that each component comprises (further identified in the Building Cost Distribution table).

Comparison: Construction Costs
This analysis indicates Construction Cost component differences in $/GSF and as a percentage by which the Public facility cost MORE or LESS than the Private facility. The chart depicts the comparison as well as the relative portion of Construction Cost that each component comprises.

Comparison: Total Project Costs
This analysis indicates Total Project Cost component differences in $/GSF and as a percentage by which the Public facility cost MORE or LESS than the Private facility. The chart depicts the comparison as well as the relative portion of Total Project Cost that each component comprises. The table at the bottom compares Design & Supervision fees as a percentage of Construction Cost (standard method in the architecture and construction industry).

Comparison: Change Order Costs
This analysis indicates Change Order Cost component differences in $/GSF and as a percentage by which the Public facility cost MORE or LESS than the Private facility. The chart depicts the comparison. The table at the bottom compares Change Order cost as a percentage of Total Project Cost (a possible indicator of development process efficiency).

COMPARATIVE ANALYSIS

Findings
This table summarizes project duration and cost findings by categories of complexity identified as potential reasons for duration and cost differentials.

Discussion
Following the table of findings, the discussion elaborates on the identified Factors of Complexity with narrative examples from the case studies being compared.