COST COMPARISON OF PUBLIC ELEMENTARY SCHOOL CONSTRUCTION COSTS BASED ON PROJECT DELIVERY SYSTEM IN THE STATE OF TEXAS

A Thesis

by

ASHLEY NICOLE REINISCH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2011

Major Subject: Construction Management

Cost Comparison of Public Elementary School Construction Costs Based on Project Delivery System in the State of Texas

COST COMPARISON OF PUBLIC ELEMENTARY SCHOOL CONSTRUCTION

COSTS BASED ON PROJECT DELIVERY SYSTEM IN THE STATE OF TEXAS

A Thesis

by

ASHLEY NICOLE REINISCH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Approved by:

Co-Chairs of Committee,	John M. Nichols
	Anne B. Nichols
Committee Members,	Leslie H. Feigenbaum
Head of Department,	Joseph P. Horlen

December 2011

Major Subject: Construction Management

ABSTRACT

Cost Comparison of Public Elementary School Construction Costs Based on Project Delivery System in the State of Texas. (December 2011)

Ashley Nicole Reinisch,, B.E.D, Texas A&M University College Station, Texas

Chair of Advisory Committee: Dr. John M. Nichols

If a correlation exists between cost and project delivery system then this is crucial knowledge for any group organizing a new construction project. It has been observed anecdotally that the construction cost per student of public elementary schools has been observed to continue to increase in the state of Texas, even with the recent downturn in the economy.

The recent economic depression in the USA has seen construction material costs stagnate and construction costs dropping. This is a direct result of the competitive nature of a market that has a lack of business. The issue of a rising cost at the time of a falling market is of more than a passing research interest to school superintendents and the people of Texas.

This study investigated the relationship between cost and project delivery systems. A survey was sent to all school superintendents in Texas requesting recent data on elementary school enrollment, project delivery type and construction costs. One hundred and thirty six responses were received from one thousand and seventy six Texas school districts. A comparative means test was used to determine if a relationship exists between construction cost per student and project delivery system for public elementary schools in Texas. The research shows that Texas school districts are primarily using two types of project delivery systems for their new school construction, Construction Management at Risk and Competitive Sealed Proposals. After comparing the average construction cost per student for these two project delivery systems, the statistical analysis showed that Competitive Sealed Proposals cost approximately four thousand dollar less per student than Construction Management at Risk. The clear question is then as to why are districts using Construction Management at Risk when the comparative benefits of the contract type are not worth this amount of money per student.

DEDICATION

To my parents: for instilling in me a sense of adventure, and always having presents under the Christmas tree.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. John Nichols, and my committee members, Dr. Anne Nichols, and Professor Leslie Feigenbaum, for their guidance and support throughout the course of this research. Your dedication to your students and passion for teaching have spurred me to pursue the professional world by these principles.

I would also like to thank those who let me sit on their couches to escape the rigors of graduate school. I am convinced that without your couches, I would not have produced this work.

Thank you to my roommates over the years at the Day house in Bryan. Not only did you put up with my complaining, but you also encouraged me to finish school.

Special thanks to the women in my Bible study at Grace Bible Church. Your wisdom and prayer throughout the past five years have been greatly appreciated. I hope to pour into others as you all have poured into me.

Thank you to my best friend Kelly, here's to being "good friends livin' large in Texas. Texas forever!"

Finally, thanks to my mother, father, and brothers for all of the free lunches and encouragement over the years.

TABLE OF CONTENTS

LIST OF FIGURES

FIGURE Page

LIST OF TABLES

CHAPTER I

INTRODUCTION

BACKGROUND TO THE STUDY

The construction industry plays a pivotal role in the United States economy. New construction and renovations will have an impact on almost every aspect of business at some stage. Public expenditure in construction generally make ups twenty to twenty-five percent of construction dollars spent in the USA (U.S. Census Bureau, 2011b). Commercial buildings, educational facilities, office buildings, healthcare facilities, and highways traditionally compromise the non-residential sector of the construction industry.

The construction of educational facilities has ranked highest in total value of nonresidential construction for the past several years, and maintains this rank in 2011 (McGraw-Hill Construction, 2011). Texas is a currently a leader in the nonresidential construction market breaking ground on two large high schools with a combined worth of $112 million (McGraw-Hill, 2011).

The past few years have been a turbulent time for the economy; some would argue it has been comparable or worse than that of the depression the United States faced in the 1930's (Gascon, 2009). This research investigates the relationship between cost and delivery system for elementary schools in Texas.

This thesis follows the style of *Adult Education Quarterly*.

SIGNIFIGANCE OF THE STUDY

This study seeks to compare the cost in tax dollars being spent on public elementary school construction in Texas for the different delivery methods. The results from this study will be public information and can help interested groups understand the cost implications of their decisions and determine whether a more economically efficient method exists to achieve a set of project objectives.

PROBLEM STATEMENT

The purpose of this study is to investigate statistically the difference that project delivery systems have on the construction cost per student in public elementary schools in the state of Texas.

RESEARCH OBJECTIVES

The primary research objective of this study is to determine the relationship between construction cost per student and project delivery system used in the construction of Texas public elementary schools.

HYPOTHESIS

The hypothesis is that the average public elementary school construction cost using the traditional hard bid contract, termed design bid build method, or the variant competitive sealed proposals method, is lower than the average public elementary school construction cost for other project delivery systems available in the state of Texas. Construction cost per student will be used as the comparison method.

STUDY LIMITATIONS

The study limitations are:

1. restricted to elementary school projects completed after the year 2000 in Independent School Districts (ISD) within the state of Texas
2. analysis is limited to the project delivery systems that have enough data to perform a sound statistical analysis

STUDY ASSUMPTIONS

The study assumptions are:

1. the superintendents surveyed are assumed to have the option to select the project delivery system of their choice
2. it is assumed that the superintendents providing the data for the research provided true and reliable information
3. superintendents responding to the survey are assumed to have answered to the best of their professional knowledge and honestly
4. construction cost per student is calculated using the planned enrollment of students for the facility

CHAPTER II

LITERATURE REVIEW

INTRODUCTION

This study builds on recent research in the Construction Science Department at Texas A&M University in two areas of critical interest to modern construction practices. These two areas are school construction practices in Texas and competitive behavior studied using a Reverse Auction bidding game. The information obtained in these previous studies provided the basis for the development of this research question and data used to understand the results obtained from the research data.

Reverse Auction bidding is a form of bidding gaining popularity in some part of the construction community, but like all changes it comes with some forms of enquiry and resistance. Van Vleet (2004) initiated the research into reverse auction bidding at TAMU. This work has now included fourteen studies covering the development of the system, the bidding strategies used by the study participants and the distribution of returns (Guhya, 2010; Kim, 2004; Saigaonkar, 2010).

The second research area relates to school construction practices in Texas. Two studies have looked at forecasting the construction time for schools in Texas (Sethi, 2009) and factors affecting the duration of school projects in Texas. Neither of these studies addresses the real issue of construction costs, but they pointed to a need for this type of research into the impacts of the delivery method for construction.

This literature review presents the definition used in the study and then outlines the relevant information on the Texas educational structure and construction costs.

DEFINITIONS

Texas Education Agency (TEA): An entity "responsible for guiding and monitoring certain activities related to public education in Texas" (Texas Education Agency, 2010b).

Education Service Centers (ESC): The state of Texas has grouped school districts within twenty regional educational service centers.

Independent School District (ISD): Signifies that the school district is an independent political entity, with a Board of Trustees controlled by State Government legislation.

Elementary School: School facility built for education, which houses Kindergarten – 5th grade, elementary schools sometimes include the Pre-Kindergarten and 6th – 8th grades.

Project Delivery System (PDS): The method by which a building is contractually delivered to a client.

Bidder: An entity that submits a bid. In most school contracts, there are usually three to ten bidders, and each is usually a company.

Construction cost: The final amount paid by the ISD as specified by the superintendent. All amounts will be in millions of U.S. dollars.

Construction cost per student: For the purpose of this study, cost per student was achieved by dividing the actual cost to build the elementary school by the planned enrollment number.

Planned enrolment: The number of students a school building is designed and built to cater for, in terms of applicable state law.

Intrafirm: Service is located within the firm and is controlled directly by the firm.

Interfirm: Services is obtained via contractual arrangement, whether written or verbal.

Mortgage Backed Security (MBS): A type of security that is asset backed, the backing for these securities is mortgages. These securities generally include periodic payouts to investors (U.S. Securities and Exchange Commission, 2010).

Collateralized Debt Obligation (CDO): Consolidated debt that is sold in a package as an investment, which usually does not include mortgage loans or bonds.

Construction cost per student: For the purpose of this study, cost per student was achieved by dividing the actual cost to build the elementary school by the planned enrollment number.

Construction Management Agency (CMA): CMA is not a procurement method in and of itself.

Guaranteed maximum price An owner may seek an absolute legally binding upper price for a contract.

TEXAS EDUCATION AGENCY

The Texas Education Agency manages twenty education service centers, which assist school districts.

Figure 1 shows the locations and names of the Education Service Centers.

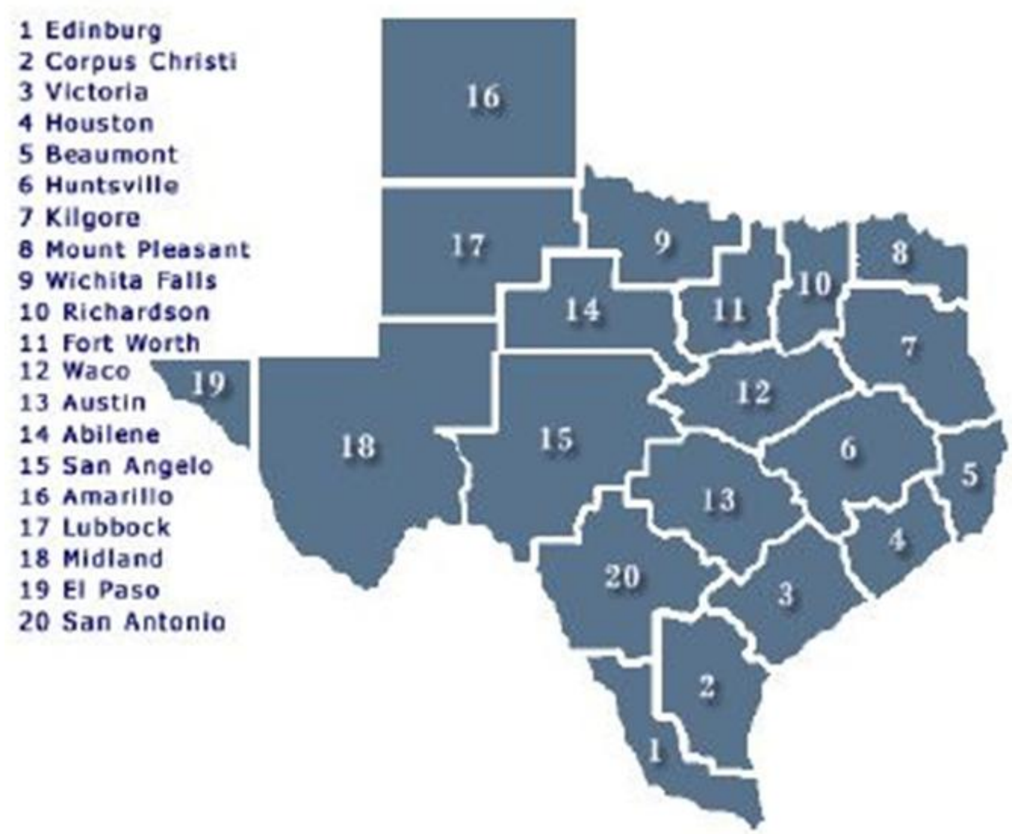

Figure 1. Texas showing the Educational Service Centers[1]

[1] (Texas Education Agency, 2010b)

Major state educational initiatives are delivered to the school districts through educational service centers, they also "*provide a full range of core and expanded services to ISDs, such as accountability; professional development for classroom teachers and administrative leaders; instructional strategies in all areas of the statewide curriculum; and support to struggling campuses and districts*" (Texas Education Agency, 2010b).

INDEPENDENT SCHOOL DISTRICTS

The Oxford English Dictionary (Little, Fowler, Coulson, Onions, & Friedrichsen, 1973) defines independent as "*Not depending upon the authority of another, not in a position of subordination or subjection; not subject to external control or rule; self-governing, autonomous, free.*" An example cited within the OED is from the year 1612:

"H. Jacob <u>Declar. Christes True Church</u> [*Each congregation is] an entire and independent body-politic, endued with power immediately under and from Christ.*

The issue here is whether the ISD is a truly independent body politic or a dependent body under state law. Each ISD is created by the state and answerable to the state indicates that the ISD is a dependent body politic within the accepted meaning. This point is important when considering the purchasing practices in Texas schools.

PROJECT DELIVERY SYSTEMS

The systems available in Texas to the school districts are:

1. design bid build (DBB) or alternatively called traditional hard bid system (THB)
2. competitive sealed proposal (CSP)

3. construction management agency (CMA)
4. construction management at risk (CMR)
5. design build (DB)
6. bridging.

TRADITONAL HARD BID SYSTEM

Known throughout the construction industry as the traditional method, design bid build has been a project delivery method that has been used extensively in the public sector. The DBB process has three phases: design, bid, and construct.

In this method, one hundred percent of the design documents and contract documents are completed prior to construction. This systematic approach gives bidders a well-defined scope and eliminates the risk associated with the design phase.

Figure 2 shows the legal form of a hard bid contract.

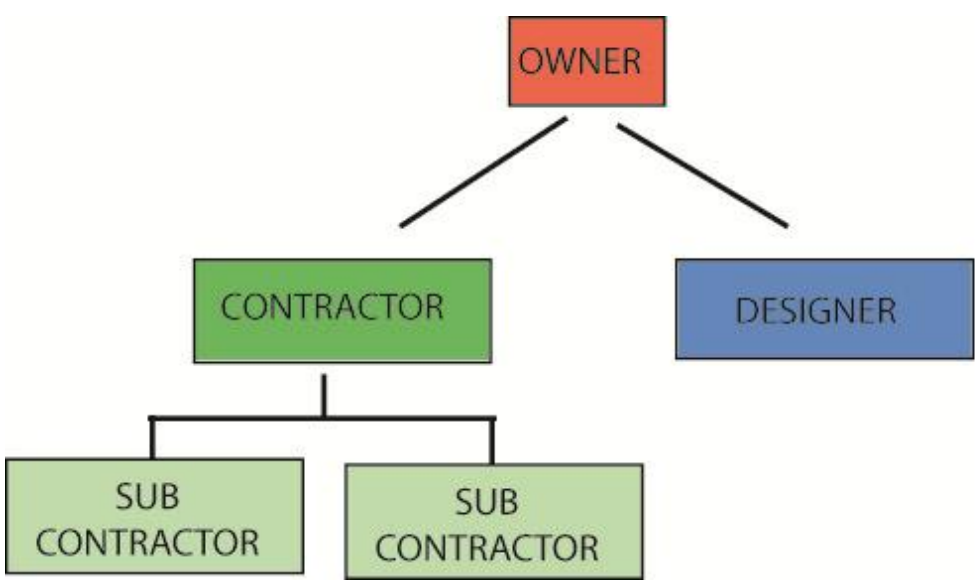

Figure 2. Traditional Hard Bid or Design Bid Build Form

Figure 3 shows a representation of the Design Bid Build timeline for construction.

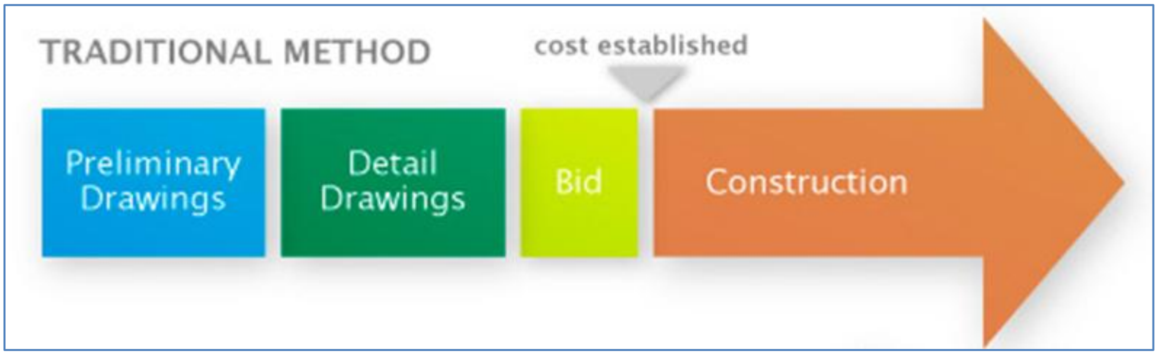

Figure 3. Representation of a Design Bid Build Timeline

There are well known problems with hard bid contracts including the time for completion and the issue of design errors causing cost increases. Buvik and Haugland (2005) in part discuss the issues of contractual arrangements between parties over a longer period than one contract. Owners trying to finish large projects in the lowest amount of time may be unsuccessful due to this methods known limitation, presents the rationale for the development of other forms of contract. The more interesting driving feature observed in recent times is the development of long-term relationships between supplier and purchaser, which can be observed in terms of considering prior performance as one of the criteria for awarding a contract.

However, as Feigenbaum (2011) noted there is an economic limit to criteria other than price. One method used by other Construction Authorities to overcome the problems of traditional bidding is to prequalify bidders. This technique ensures that a future bidder is capable of performing the work required by the authority (Mowery, 1983). Mowery provides the example of research and development being housed intra-firm as means of exploring these types of issues.

COMPETITIVE SEALED PROPOSAL

CSP is very similar to the traditional DBB method. The difference occurs in selection of the contractor, selection is based on criteria outlined by the owner. The criteria are weighted and generally include, price, project duration, qualifications, and other criteria. The owner using CSP as a procurement method chooses the general contractor that makes the best score in regard to the weighted criteria.

Complete objectivity is supposedly obtained because contractors submit their proposals without knowledge of each other's work, although the traditional bidding system with prequalified bidders is clearly a more objective system. A drawback of this method is if all bids on the project are over the owner's budget. The owner then runs the risk of having to "*re-bid the project with the same scope*" (Grasmick, 2009). Owners should be careful to have completed architectural/engineering documents and a clear scope of work. Without a solid idea of the building desired, bids will not properly reflect the cost of the project. Mowery's work (1983) clearly shows that for some forms of work that level of control provided by intrafirm management is preferable to interfirm or contractual management. CSP is merely a first step in achieving the goals presented by having intrafirm management.

CONSTRUCTION MANAGEMENT AGENCY (CMA)

CMA is not a procurement method in and of itself. The CMA is best used when owners are not experienced in construction and need assistance in the entire building process. A CMA acts as a "pre-construction consultant as well as a construction-phase manager" (Grasmick, 2009). Similar to DBB and CSP the owner holds contracts with the multiple parties involved in the building process. This process has been used successfully by Lend Lease in Australia to manage the development of shopping centers, but within a tightly vertically integrated management structure (Nichols, 2011).

CONSTRUCTION MANAGEMENT AT RISK (CMR)

A Construction Manager at Risk should not be confused with a CMA. The CMR is an actual project delivery method relative to the CMA. Initially the construction manager is brought on early in the design phase with a separate contract from the architect or engineer (A/E). At this point, the construction manager acts as a construction consultant and works closely with the A/E to develop a plan and design that best suits the owner. *Figure 4* shows a representation of the Construction Manager at Risk structure.

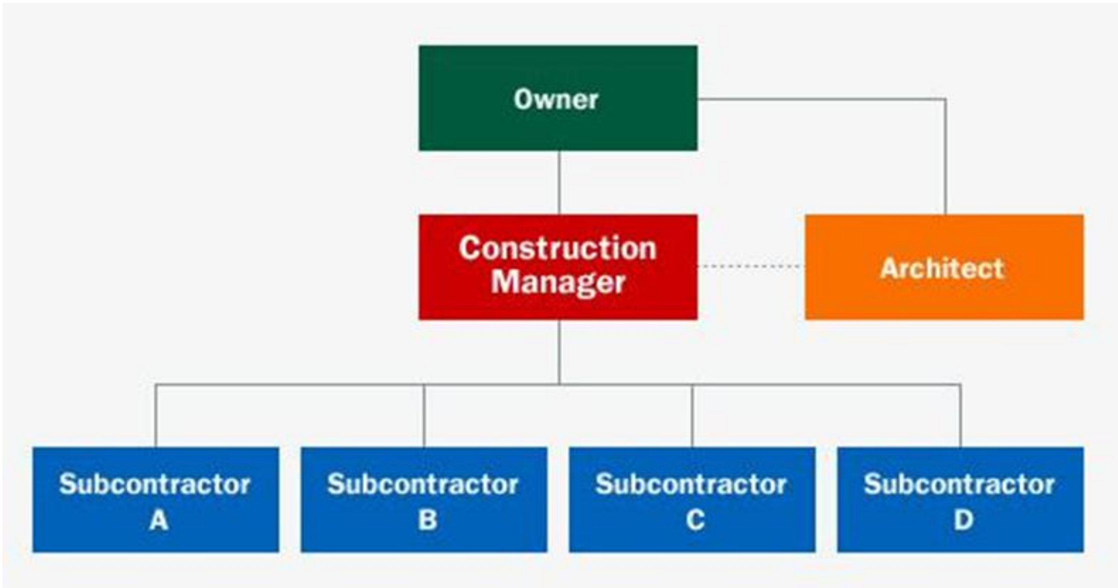

Figure 4. Construction Manager at Risk

If the owner accepts the continued services of the construction manager and obtains a guaranteed maximum price, better known as GMP, that is acceptable, the owner can then hire the construction manager for the construction phase of the project. Here the construction manager incurs the risk of construction, because he/she is now the general contractor of the project. This changes the role of the construction manager because they are more inclined to act in their best interest to maximize their profits. However, the CMR usually works on an open book basis that can keep unethical contractors from trying to swindle owners (Reinisch & Caguioa, 2010).

DESIGN BUILD CONTRACT FORM

The Design Build project delivery method is not a new system in the construction industry. It has actually been around since the industrial revolution. Only in the past few years have owners and contractors recognized all of the benefits to this project delivery method. One of its foremost qualities is the flexibility in the schedule that helps fast track projects. *Figure 5* shows a representation of the Design Build structure contract.

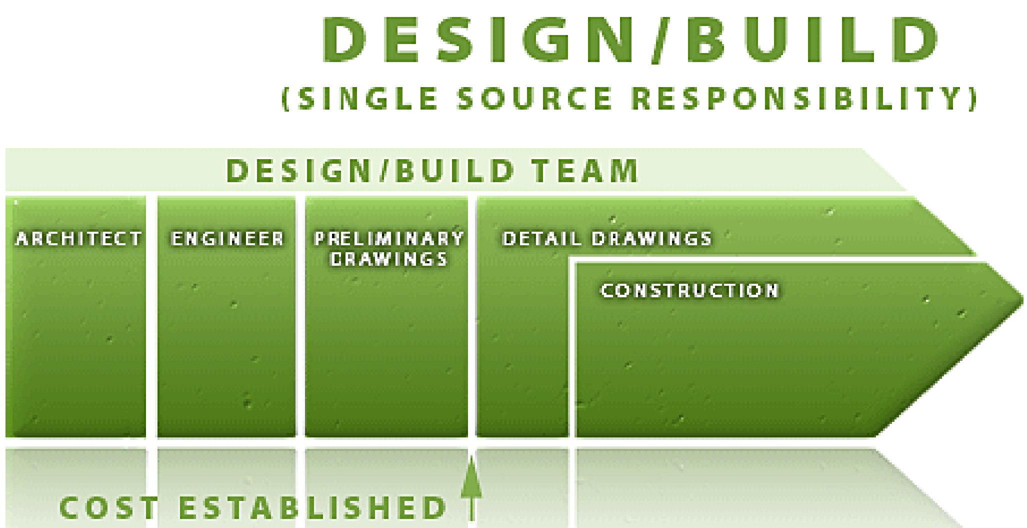

Figure 5. Representation of Design Build (Sunbelt Builders, 2009)

By overlapping the design phase and construction phase, contractors are able to break ground prior to complete design documents. This is possible because the owner hires one entity for the design and construction. The entity can be one company or a joint venture. The advantage of this system is that there is only one contract signed with the owner to perform the work and for payment. When choosing a design builder, owners should look for highly experienced contractors that can show proof of their credentials. This way during the selection process owners have the ability to evaluate the DB contractor on price and qualifications. The price given is usually a guaranteed maximum price, better known as GMP, with a contingency or lump sum. The GMP is a contract with the owner that the cost of the project will not be higher than the specified price (Reinisch & Caguioa, 2010).

BRIDGING CONTRACT FORM

The bridging PDS is a sort of hybrid of DB, the traditional DBB, and CMR. Bridging: The major difference between this system and other PDSs is how and when cost is established as illustrated in *Figure 6*.

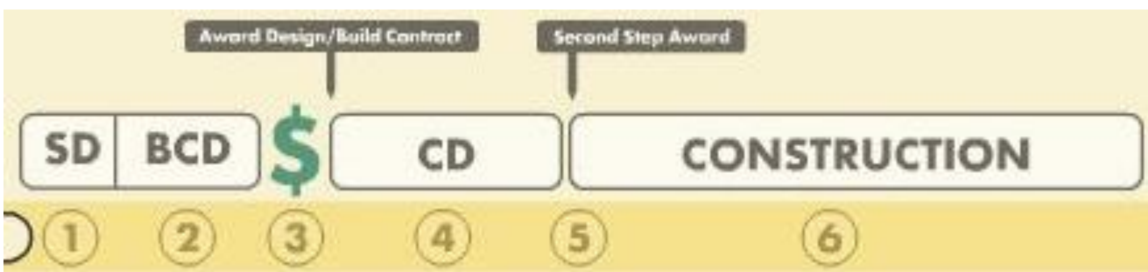

Figure 6. Representation of Bridging[2]

In phase 1, an architect put together schematic design drawings. In phase 2, the architect and construction manager create bridging contract documents. These documents are very different from the traditional design development documents. With the completion of the bridging documents, the architect and construction manager are

[2] (Heery, 2011)

able to give the owner a lump sum fixed price. This comes in the form of a design build contract. This stage, Phase 3, is unique to bridging; in no other PDS are owners able to receive a fixed price so early in the design phase of the project. If the owner accepts the price in phase 3, the project continues onto stage 4 where the architect and construction manager prepare final construction documents. The final documents reflect the design developed in phase 3.

In phase 5, the owner has a few choices; he/she can continue with the project with the current team, or the owner can bring in a new general contractor to finish the project, or the owner can terminate the project without cause. Assuming the owner continues with the project, the construction manager carries out the work and represents the owner to subcontractors very similar to how a CMR would carry out the work (Heery, 2011).

EXISTING DATA AND STUDIES

Statistical data relating to the construction industry and the economic downturn that has occurred in the last decade were obtained from McGraw-Hill Construction (2011) and the U.S. Census Bureau (2011b). A number of sources, including those listed below provided construction costs for educational facilities and other construction data:

- the Texas Education AgencY, (Texas Education Agency, 2010a; 2010; 2010b)
- Paul Abramson, (2010, 2011)
- U.S. Census Bureau, (2011b)

No specific previous research was found that established a correlation between cost and project delivery system used for new construction, although notes are provided on the potential impact of different systems (Martin Skitmore & Thomas Ng, 2003).

Konchar and others created criteria for performance comparison of three main project delivery systems, which include Design Build, Design Bid Build, and Construction Manager at Risk (Konchar & Sanvido, 1998). These criteria focus on commercial building projects. Mahdi and others used the AHP, or analytical hierarchy process, to define a set of factors and assist in the decision making process for project delivery systems (Mahdi, Riley, Fereig, & Alex, 2002). Oyetunji and Anderson (2006) created a weighted matrix with 20 criteria for choosing the best project delivery system, focusing on time and cost controls. Reinisch and Caguioa (2010) noted that there are several methods for choosing what the construction authority considers the most appropriate project delivery system.

Nichols and Feigenbaum (Feigenbaum, 2011; Nichols, 2011) observed that there is a limit to the loss of economic efficiency that is acceptable when using any criteria other than price to determine a winning bid. Recent research on reverse auction bidding systems demonstrates the problem of gaining an acceptable price for goods even under a controlled situation (Guhya, 2010). A sample of the normalized profit distribution from a number of reverse auction bidding studies (Guhya, 2010; Gupta, 2010; Plumber, 2010; Saigaonkar, 2010; van Vleet, 2004). *Table 1* shows the profit distribution in normalized terms for a series of reverse auction bidding studies. The results are generally considered to be in a competitive setting, however the results presented in the studies clearly show the impact of competitive play in maximizing profit.

Table 1. Adjusted No. of Entries in Each Normalized Profit Range

Range	Plumber	Gupta	Saigaonkar	Van Vleet	Bedekar
<0	0.25	0.08	0.14	0.00	
0-0.1	0.25	1.00	0.79	0.09	
0.11-0.2	1.00	0.02	0.50	1.00	
0.21-0.3	0.54	0.00	1.00	0.37	
0.31-0.4	0.50	0.00	0.64	0.11	
0.41-0.5	0.32	0.00	0.43	0.14	
0.51-0.6	0.25	0.02	0.14	0.06	
0.61-0.7	0.11	0.23	0.29	0.20	
0.71-0.8	0.04	0.25	0.14	0.06	
0.81-0.9	0.04	0.19	0.07	0.03	
0.91-1.0	0.00	0.15	0.36	0.03	

This data from *Table 1* is shown schematically in *Figure 7* and in *Figure 8.*

The Texas ISD system ensures a relative wall between the distinct ISD and creates a problem with the free flow of data between the districts at a professional level as to the problems and real costs of different delivery systems. A similar problem has been noted in Taiwan (Chen, Liao, Lu, & Mortis, 2010). Chan and Kumaraswamy used the "mean score" method of analysis for their study, "An Evaluation of Construction Time Performance in the Building Industry." In their study they interviewed contractors in an attempt to identify delay factors in building construction (Chan & Kumaraswamy, 1996). This is a time intensive method of analysis.

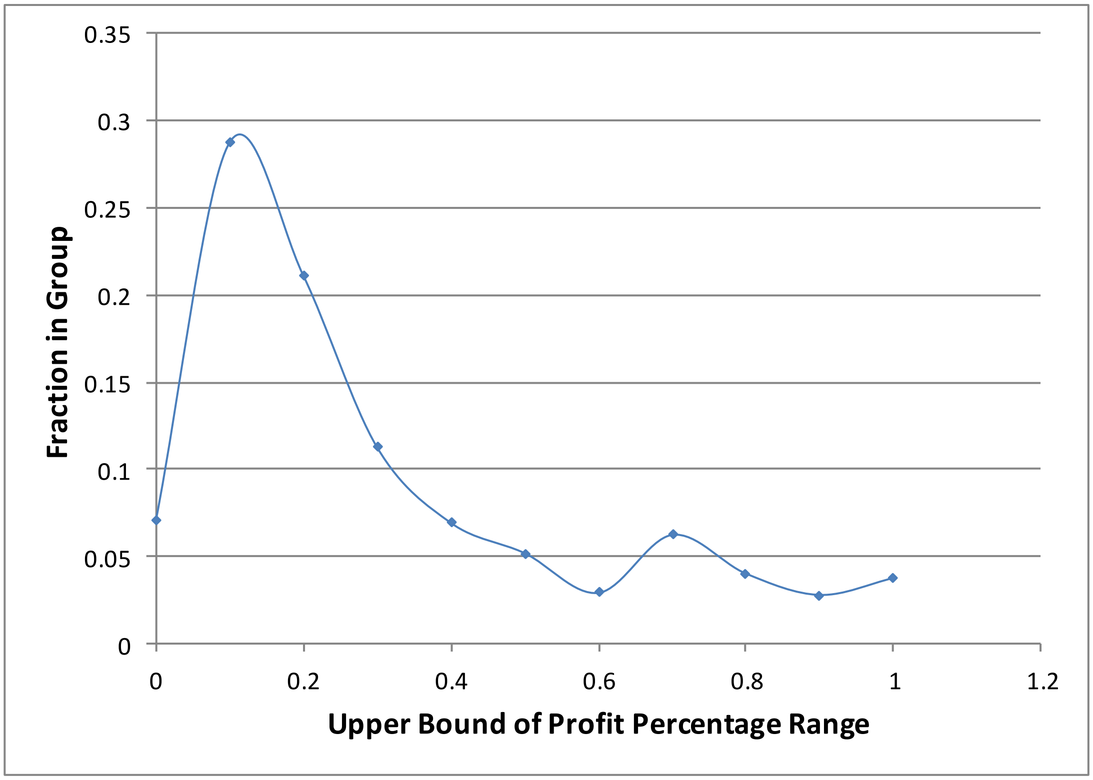

Figure 7. Profit Distribution for Reverse Auction Bidding

Studies conducted by Singh (2008) and Sethi (2009) at Texas A&M University provided the basis for formulating this study question on school construction costs and delivery systems. These two earlier studies focused on the relationship the project delivery system has to the time schedule used for a school construction project.

This current study will change the relationship being evaluated by analyzing the correlation between project delivery systems and construction cost per student. Debella and Ries (2006) conducted a study in which they performed a comparative analysis of project delivery system performance within school districts. Their study was restricted to the states of Ohio, New Jersey, Pennsylvania, Massachusetts, and Virginia. Both quantitative and qualitative measures were accounted for in this study.

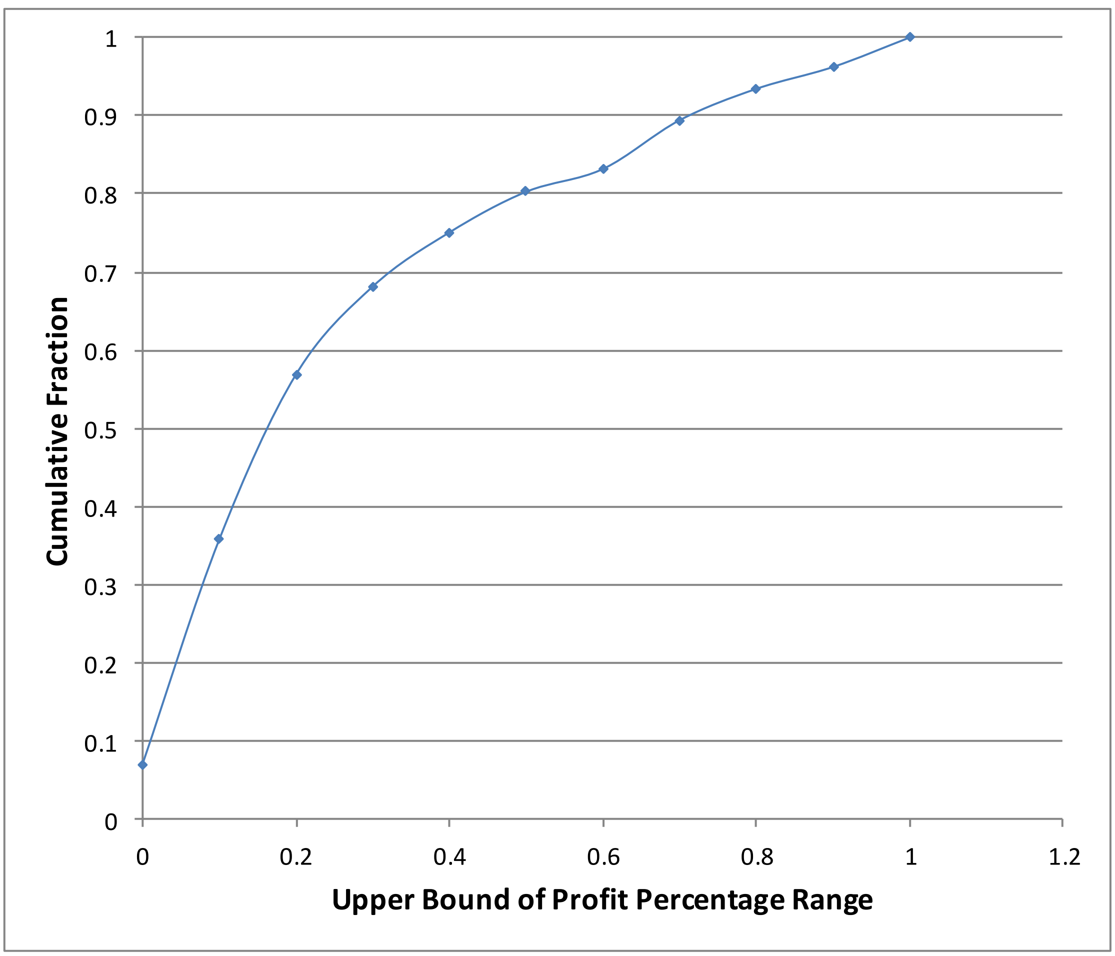

Figure 8. Cumulative Profit Distribution for Reverse Auction Bidding

They focused on "*variables related to cost, schedule and litigation*" for the quantitative portion and for the qualitative portion, this included "*punch list, startup, call backs, administrative burden, team communication, team chemistry and project complexity*" They observed that "*Projects are building blocks that help organizations achieve objectives and goals that support their mission and vision*". Three key criteria are always involved in a project: Schedule, cost, and technical performance (Debella & Ries, 2006). The idea of having multiple variables was adopted in the formation of this study, along with the use of comparative analysis.

TEXAS PUBLIC SCHOOL FINANCE

To better understand the significance of comparing project delivery system to construction cost per student, it is important to understand how Texas public schools are funded by each ISD. The state of Texas receives its funding for public schools from three sources, the federal government, the state government, and the school districts themselves. *Figure 9* shows a graphical representation of the cost breakdown.

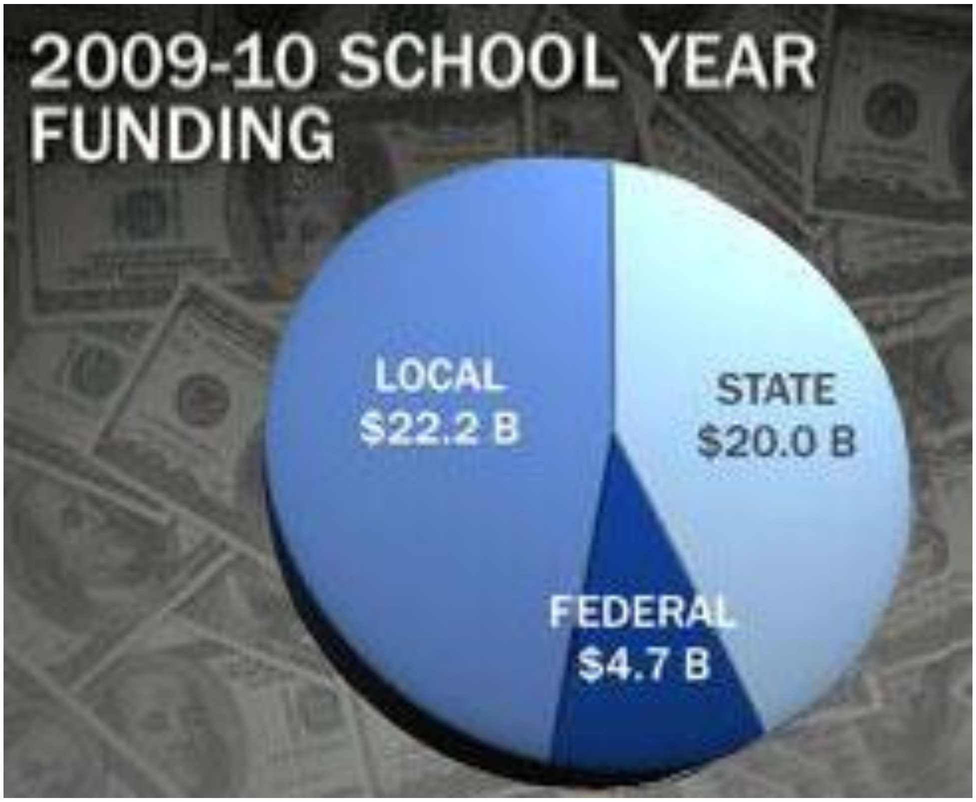

Figure 9. Texas School Funding for 2009 – 2010 School Year[3]

For the 2009 -2010 school year, the federal government funded the total costs for approximately ten percent of Texas public schools, with the state paying for approximately forty-three percent, and the districts covering approximately forty-seven percent (Smith, 2011).

The federal government funds public schools in two major ways; the main way is money that is granted to school districts through Title I. Title I is a law that assists districts in educating economically disadvantaged students. Money is awarded to schools

---

[3] (Texas Education Agency 2010)

based on the number of students it has that qualify for free and reduced meal plans (Smith, 2011). The federal government also issues "specialized grants to schools for students with disabilities, English-language learners, preschool programs, migrant students and vocational education (Smith, 2011)."

The state contributes to school funding from a number of taxes including but not limited to fuel tax, lottery proceeds, oil and natural gas tax, franchise tax, tobacco tax, and used cars sales tax. The school districts contribution comes from property taxes.

The residential housing market plays a large role in the availability of public school dollars as the two units are linked by state law. Warren Buffet postulated that easy to secure mortgages for homes caused a housing bubble that oversaturated the housing market. In the mid 2000's the supply of houses boomed to approximately two-million housing starts a year (Frye, 2010). The only problem with this rapid growth was that the population could not keep up. The need for homes was roughly only 1.2 million. The inflated market came to a stop in 2007, which caused one of the most unstable economies the U.S. has experienced.

The years since 2007 have been slow, while the demand for homes catches up with the overwhelming supply. Buffet hypothesized in 2010 that the oversaturated housing market would begin to bounce back in 2011. With houses undergoing foreclosures, school districts are in a precarious situation when it comes to their budget. It is crucial at this time to be prudent with tax dollars when it comes to school district spending, as Feigenbaum observed it is wise to be prudent at all times.

LEGISLATION AFFECTING TEXAS PUBLIC SCHOOL CONSTRUCTION

In 1995 the Texas Legislature passed Bill No. 1, this legislation allowed ISDs to choose from several different project delivery systems. Those systems are (Sethi, 2009):

- Competitive Bidding, also known as the traditional method or Design Bid Build (DBB)
- Competitive Sealed Proposals (CSP)
- Construction Manager Agent (CMA)
- Construction Manager at Risk (CMR)
- Design Build (DB)
- Bridging (Heery, 2011)

Prior to this legislation, school districts were only allowed to use the traditional DBB method. It was decided by legislators that giving ISDs the choice between project delivery systems would allow school districts to achieve a better value throughout the construction process. In 1997 the Senate "provided definitions and procedures for these new procurement tools (Steck, 2009)," these came in the form of Senate Bill No. 583.

Over the past fifteen years Texas has seen a dramatic change in the ISD preferred type of project delivery systems chosen for new school construction. DBB is now rarely used and CSP and CMR are the preferred methods for ISDs. This trend could explain why new school construction prices have continued to rise, while the country has been in recession and new construction at a standstill (Feigenbaum, 2011).

2008 THE U.S. FINANCIAL CRISIS

The U.S. construction industry has seen some serious shifts in spending in the past decade. Much of this can be attributed to the financial crisis that struck the U.S. economy in the late 2000's. "Between 1997 and 2006, according to the S&P/Case-Shiller national home-price index, American house prices rose by 124% ("CSI: Credit Crunch, Central Banks have Played a Starring Role ", 2007). "Adjustable subprime lending played a part in the creation of conditions leading to recession as Americans with bad credit were able to take out mortgages on homes they would never normally be able to afford.

Under the impression that homes would never lose their values, Americans went into excessive debt. With low interest rates and easy to secure mortgages, demand for new homes sky rocketed. With banking regulations at a minimum, these high risk subprime mortgages were combined and sold to investors globally as AAA rated MBSs (mortgage-backed securities) and CDOs (collateralized debt obligations) with no regard as to whether or not mortgage holders were going to actually pay their loans (NEWS, 2009). The securitization of mortgages did not stop at the individual level. Commercial lenders also found securitizations beneficial. Similarly, CMBSs (commercial mortgage-backed securities) allowed banks to make loans on commercial property to be developed, collect the financing fees, and immediately turn and sell the loan to be combined with others, cut up into tranches, repackaged, and sold to investors based on the preserved risk of the underlying loans. Essentially, this system effectively gave banks no "skin in the game" causing them to ease lending standards more than they had historically.

During the height of the market, banks were extending construction loans at over 110% of construction cost at times. The excessive availability of capital made new construction attractive for developers while also causing a run up on bids for existing products causing values to sky rocket.

This type of lending led to oversaturated housing and commercial markets. Both markets came to a halt in 2007. In late 2006, the adjustable subprime interest rates began to rise to their market-based rates and beyond. This left over leveraged home owners unable to pay their mortgages. In 2007, foreclosures began to start across the country and in 2008, there was a recorded twenty percent decrease in home values. The same happened to commercial mortgages shortly thereafter. Suddenly millions of homeowners, commercial property owners, and developers were effectively "under-water" on their mortgages. For the first time in twelve years, the majority of U.S. homes were worth significantly less than the mortgages people held for them (NEWS, 2009). As people defaulted on their mortgages, financial institutions began to bleed out money. In September of 2008, Wall Street experienced the "*biggest shake-up on Wall Street in decades* (Duncan, 2008)." Lehman Brothers Investment Bank "*felled by the weight of about $60 billion in toxic bad debts*" collapsed, signifying the beginning of a "global financial meltdown (Duncan, 2008)."

"*Investors suffered losses, making them reluctant to take on more CDOs. Credit markets started to freeze as banks became reluctant to lend to each other, not knowing how many bad loans could be on their rival's books* (NEWS, 2009)." In an effort to keep the economy moving, the U.S. Federal Bank made "*funds available for banks to borrow* *on more favorable terms* (NEWS, 2009)." This aid was not enough to keep the inevitable from happening. The lack of liquidity in the banking system left banks skeptical of lending or borrowing from each other. The tightening up of cash left corporations and individuals unable to obtain loans. The lack of accessible cash also had a profound impact on real estate development, which is undoubtedly a major driver of the construction industry. The fail of Lehman Brothers started a chain reaction. There was a run on money-market funds after one big money-market fund revealed that it owned a lot of suddenly worthless Lehman debt. London-based hedge funds that relied on Lehman for day-to-day financing found themselves unable to do business because their accounts with Lehman's U.K. subsidiary were frozen. Similar dislocations played out around the world. Before long, financial institutions were paralyzed by fear. They simply did not trust each other anymore, and did not want to lend to each other. The financial system proved too fragile to handle the stress (Fox, 2009). With no access to cash, the economy faced recession, more bankruptcies, repossessions, increased cost of living, and job losses (NEWS, 2009). In late 2008 the U.S. Government pumped $700 billion into the U.S. economy, "*buying up Wall Street's bad debts in return for share in the banks* (NEWS, 2009)."

In the aftermath of the crisis, the economy has slowed to a near halt. The perception that financing is unavailable and the private market uncertainty concerning the public sector's involvement with the financial markets have both extended the period of little to no real estate development, housing, or commercial, nationwide according to Dr. Mark Dotzour Chief Economist at the Real Estate Center at Texas A&M University.

Consequently, the construction industry has not escaped the aftermath of these events and the slow down as affected nearly all facets of the industry.

THE EFFECTS OF THE FINANCIAL CRISIS ON THE CONSTRUCTION INDUSTRY

From the years 2000 to 2003, the construction industry remained stable with average spending increases and decreases. In 2004, the dollars being spent started to sky rocket in comparison to previous years, from a spending high of roughly $891,000,000 in 2003 to an unprecedented high in 2006 at $1,167,554,000. The radical spending decreased in 2007 and did nothing but decrease significantly in the succeeding years. In 2009, the industry saw an unprecedented $136,000,000 decrease in spending from the previous year, a roughly 12.7% drop. In 1991, the U.S. faced a similar decrease in spending with a 9.2% drop in construction dollars spent.

Figure 10 shows a graph of the construction expenditure for the US since 1964 to 2009. (U.S. Census Bureau, 2011b). The graph clearly shows the surge in expenditure during the 1990's to early this century and then the stalled growth commencing in about 2006.

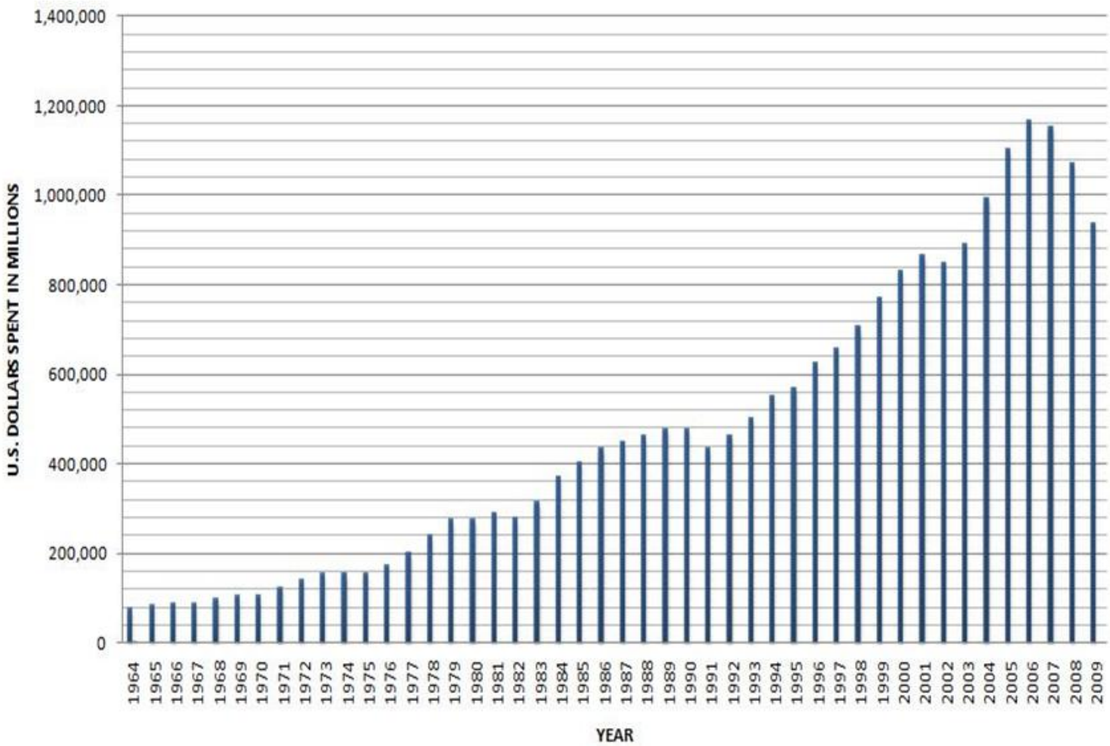

Figure 10. Construction Costs 1964 - 2009 USA (courtesy US Census Bureau)

Figure 11 presents the US construction expenditure from 1993 to 2010.

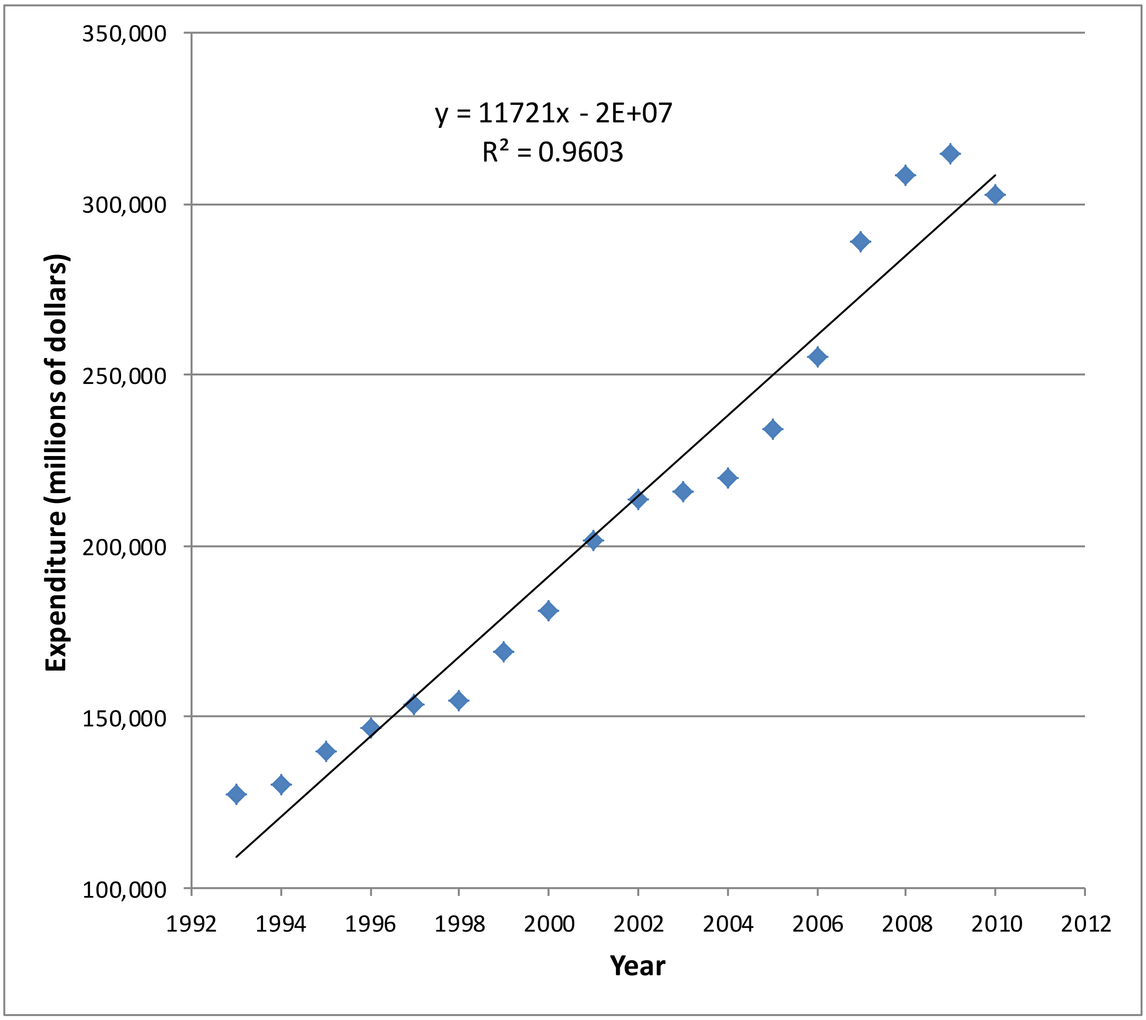

Figure 11. US Construction Expenditure 1993 to 2010

THE TEXAS ECONOMY DURING THE FINANCIAL CRISIS

In 2009, the states of Texas, Oklahoma, Louisiana, and Arkansas, which amount to approximately twelve percent of the United States population, made up 13.8% of U.S. educational facility spending dollars (U.S. Census Bureau, 2011a). The region came in second in educational facility spending dollars behind California, Nevada, and Arizona, which accounts for approximately fifteen percent of the United States population (U.S. Census Bureau, 2011a). The market crash in 2007 was a huge hit to the entire U.S. economy. However, Texas maintained a relatively stable economy considering the gravity of the financial situation across the country. Texas' strong economy can be attributed to a number of factors.

One of the major drivers of Texas' economic stability is the oil industry and now gas industry. Oil drives the state's economy, in 2008 crude oil had an approximately $42 increase in the price per barrel. Rising oil prices opened up job growth in Texas relative to other states in the country. Texas also reaps the benefits of military spending. The Fort Hood Public Affairs Office announced in 2009 that "*Fort Hood was the largest single site employer in Texas, directly inserting nearly $3 billion annually into the Texas economy*" (Smialek, 2011). Unlike other state Texas only has six percent of its mortgages in foreclosures; the national average for foreclosures is nearly ten percent.

Fewer houses under foreclosure means banks are able to maintain liquidity and to loan. Easily accessible money leads to business growth, as companies are able to invest money in their businesses to assist them in generating more revenue, although the issue at the moment is one of banks sitting on cash (Lahart, 2010).

Texas is also the headquarters of many high tech manufacturers including Dell, which ranks #41 on CNN Money's Fortune 500 list (CNN Money, 2011). Texas Instruments is also on CNN Money's Fortune 500 list, ranking #175. The demand for high tech products has remained high and exporting these, amongst other products has been good for the Texas economy.

In 2011, Texas was exporting twelve percent more goods than it did before the economic crisis. Over half of the 496,000 jobs added to the U.S. economy between 2009 and 2011 were supplied in Texas (Smialek, 2011).

PUBLIC SCHOOL CONSTRUCTION IN THE STATE OF TEXAS

The construction of educational facilities made up 77.3% of new school construction in the Texas, Oklahoma, Louisiana, Arkansas region. "Most school districts have multiple construction needs. Whether caused by an expanding student population, need for technology, questions of safety and accessibility or the need to upgrade schools built in another time, school boards are often faced with multiple demands for construction dollars" (Abramson, 2010). Public elementary schools made up 40% of completed educational facility construction in 2009 (Abramson, 2010). Across the U.S. an attempt by policy makers to lower class sizes in elementary schools has caused an 85% increase in cost per student since the year 2000. Currently the national average square foot provided per child in public elementary schools is 125 (Abramson, 2011). *Figure 12* presents Construction Costs from 1995 to 2010 for Schools per unit student.

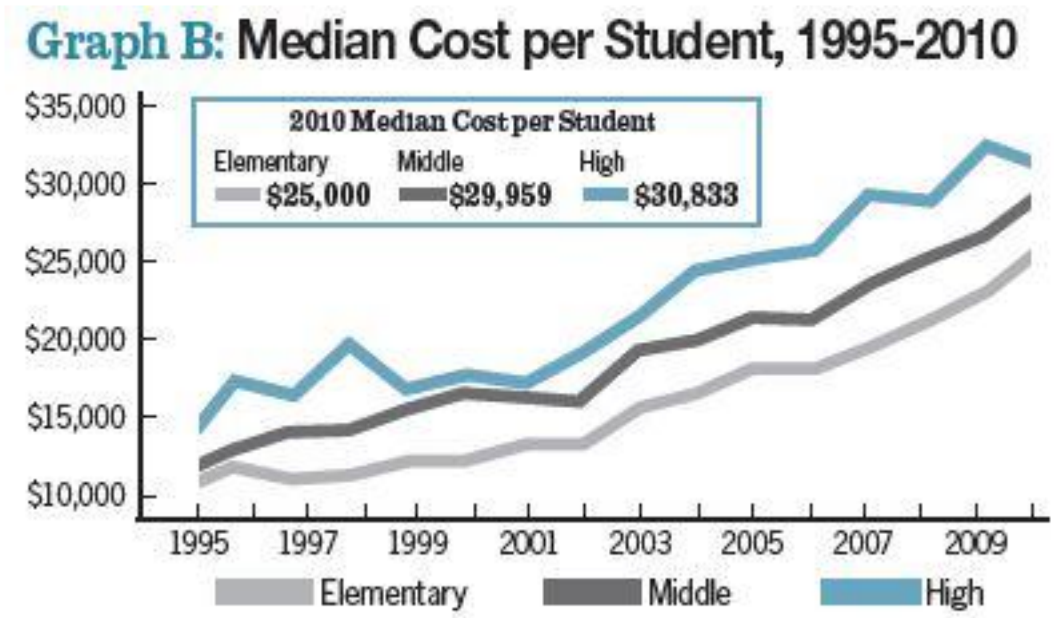

Figure 12. Construction Costs from 1995 to 2010 for Schools per unit student (after Abramson 2011)

Texas holds eight percent of the U.S. population and subsequently it accounts for the most school construction dollars spent for the Texas, Oklahoma, Louisiana, and Arkansas region. Oklahoma, Louisiana, and Arkansas are each approximately one percent of the U.S. economy. Elementary schools in Texas come in a little below the national average of square feet allotted per student at 118.8. In Texas, the cost per square foot for students is $162.50, roughly $22.00 below the national average. Over the past decade the national cost per square foot for elementary school construction rose 81 percent from approximately $102 per square foot to about $185 (Abramson, 2010).

A group of superintendents and facility planners in the state of Maryland came to the conclusion that “project financing, project procurement, and project delivery are thoroughly interwoven into one another” (Grasmick, 2009) in the process of getting a public school facility constructed. The project delivery system chosen for a project affects the entire construction process. From the way that the design is brought into motion, to scheduling, calculating costs, and finally owner satisfaction; selecting the correct project delivery system is crucial to achieving any desired end goals (Grasmick, 2009). School districts can gain the biggest cost benefit by choosing the appropriate project delivery system to fill their needs (Thom Clark, Mark Kelley, & Torone, 2002). project delivery systems available for ISDs in the state of Texas to choose from include; design bid build (DBB), competitive sealed proposal (CSP), construction management agency (CMA), construction management at risk (CMR), design build (DB), and bridging. As previously mentioned, the state of Texas is one of the largest school regions in the country; with 7,885 schools that educate approximately 4.75 million students. There are 1076 ISDs in the state of Texas which are “organized under 20 Regional Educational Service Centers (ESCs)” (Texas Education Agency, 2010a).

In 2008 and 2009 the United States public spending percentage increased to record highs of 28% and 33% due to government stimulus packages (U.S. Census Bureau, 2011b). However, these stimulus packages will not last forever and subsequently construction spending dollars will have to be found elsewhere. With budget cuts across the board it is crucial to be prudent with tax payer’s dollars in orchestrating the new construction of public schools.

US CONSTRUCTION EXPENDITURE 1993 TO 2010 REGRESSION ANALYSIS

Figure 11 provides a summary of the construction expenditure in the period 1993 to 2010. This section provides a linear regression analysis of this data using the EXCEL linear regression analysis method. *Figure 13* shows a plot of the normal probability analysis. The data is in trillions of US dollars.

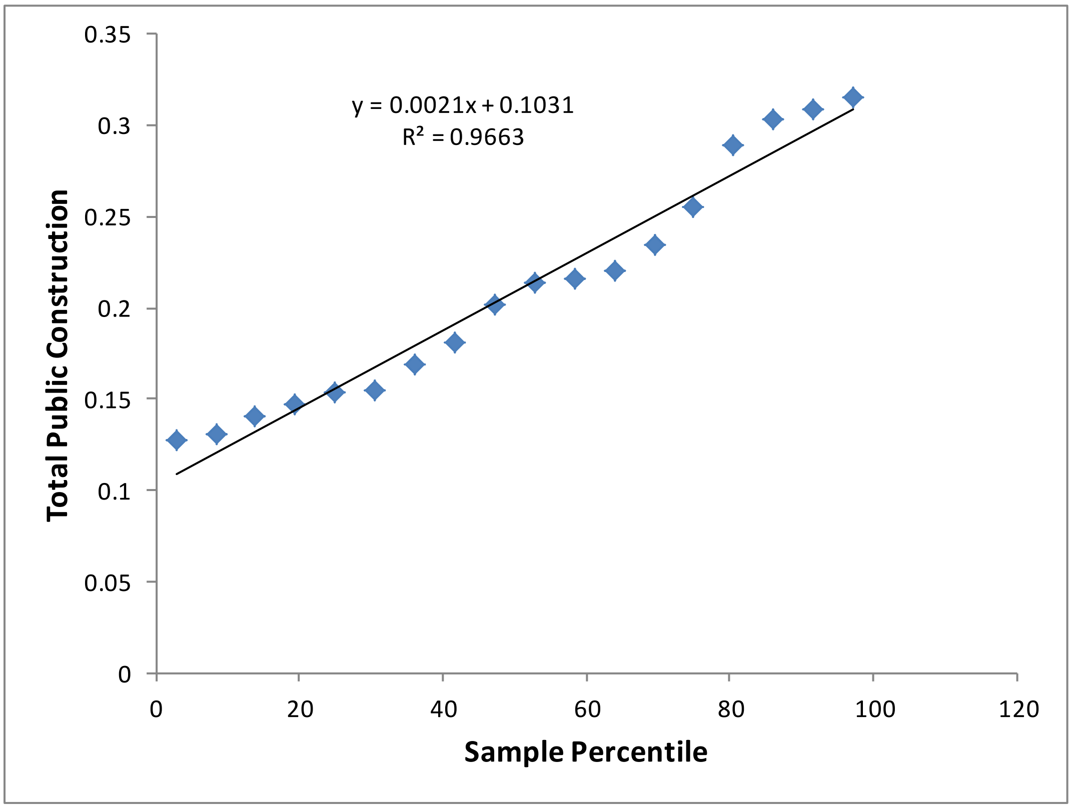

Figure 13. Normal Probability Plot of Construction Data

The results show that the construction data from 1993 to 2010 can be considered to be reasonably approximated by a normal distribution. *Figure 14* and *Figure 15* show the linear regression plot and the residual data for the construction costs.

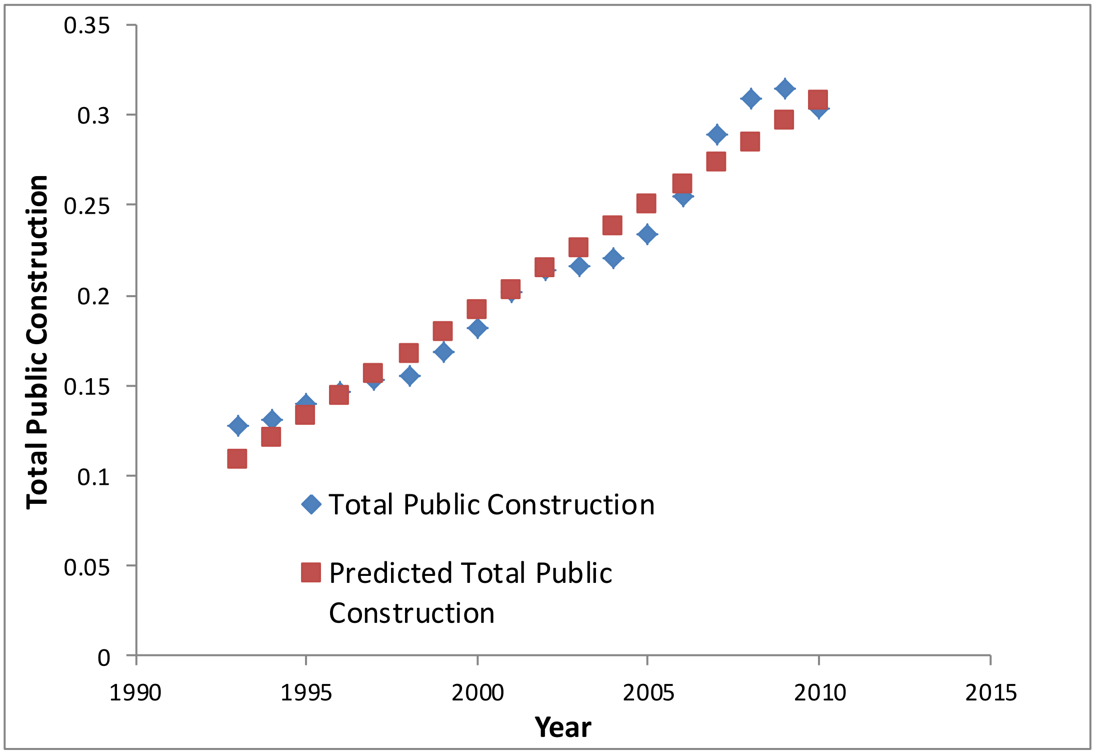

Figure 14. Estimated Public Consumption versus Actual

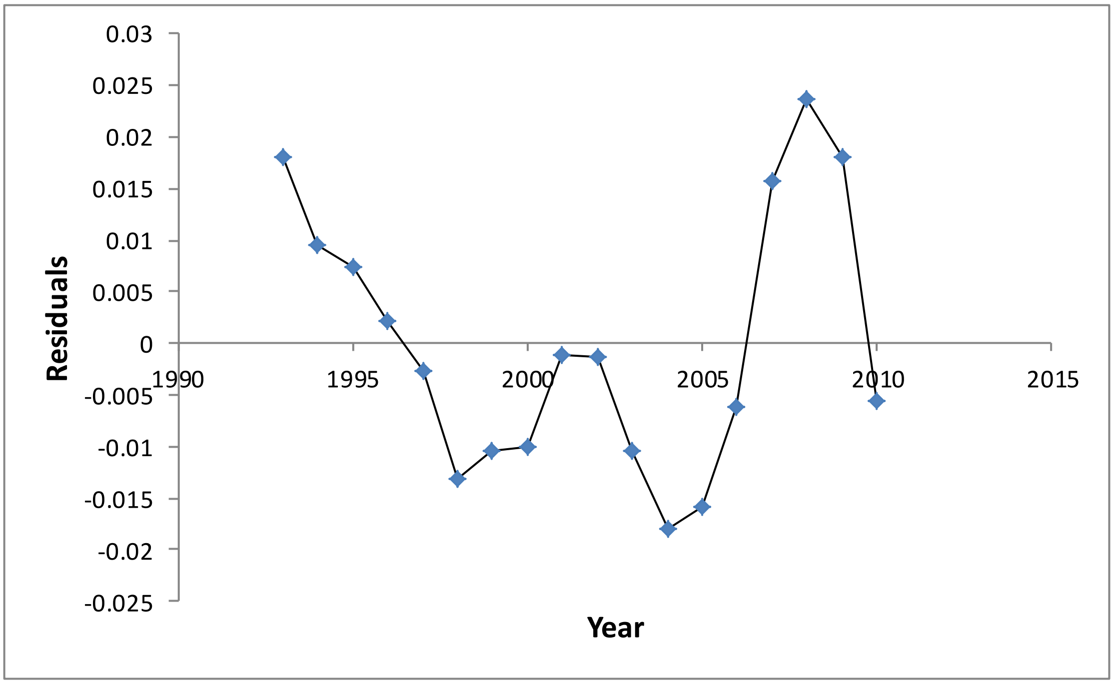

Figure 15. Residual Data from Actual to Estimated

A Fast Fourier transform analysis is not required to observe a cyclic pattern in the data shown in *Figure 15*. The pattern would suggest it would be several more years before the US climbs out of this recession in construction spending and absorbs the excess capacity generated in the period 2003 to 2010. This matches the observation by Buffett (Frye, 2010), although the timeframe for the recovery is not likely based on this figure before 2013.

SUMMARY

Some would consider that the "best value" project delivery system does not always mean achieving the lowest cost. However, the contractual regulations placed on public schools and the use of taxpayer's dollars, it would be considered to be economically efficient that superintendents should be more concerned with achieving the best cost when having new elementary schools constructed within the state guidelines (Harford, 1995).

The economic downturn in the new millennium lead researchers to question why construction costs were going up while demand for work was going down and material costs remained stagnant. Across the United States, new construction costs plummeted nearly 40 percent. Public school construction costs rose. Limited research has been devoted to the determinants of school construction costs (Vincent & Monkkonen, 2010).

The early work, by Sethi and Singh (Sethi, 2009; Singh, 2008), points to the issue of construction costs as being of fundamental research interest in understanding construction issues with Texas schools. Feigenbaum (2011) opined that elementary schools would provide a good study tool for this research.

CHAPTER III

STUDY METHODOLOGY

INTRODUCTION

The hypothesis for this study is to determine if a relationship exists between project delivery systems and the cost of new school construction. The null view is that there is no impact of the choice of project delivery system on the cost of construction, as is a reasonable view to take from an owner's viewpoint. This study uses a survey of superintendents of Independent School Districts in Texas to determine the cost of the school, design capacity and the delivery system. A standard statistical technique is used to analyze the data from the survey.

The study methodology is to develop a survey form for data collection, identify the recipients of the survey and then analysis of the collected data.

SURVEY FORM

Data for this study was collected with the use of an online survey. Specifically, the online program "*Survey Monkey*" [provide reference] was used to gather data. The online survey ensured that superintendents were given a simple and quick method for responding, it also ensured the anonymity of those participating in the study. The survey was only intended to take approximately fifteen - twenty minutes of respondent's time.

The survey questioned superintendents of ISDs about the following information for their ISD:

1. The number of elementary schools they had built since the year 2000.

2. The planned and actual enrollment (as of the 2011-2012 school year) of students in the school.
3. The estimated and actual construction costs.
4. The project delivery system used and their overall satisfaction with that system.
5. There were also open ended questions included on the survey.

The survey form is presented in Appendix A of this report. The Institutional Review Board's (IRB) approval at Texas A&M University was secured for this study. The IRB approval form is presented in Appendix A.

STAGE 1 - IDENTIFYING PARTICIPANTS

Because of the limited research dedicated to the construction of Texas public schools, the survey was forwarded to all 1076 ISDs in Texas. Feigenbaum suggested that only information be sought on elementary schools as these are consistent units of construction. The Texas Education Agency (TEA) has a regularly updated source of information regarding Texas public schools K-12. With the large number of ISDs in Texas it was decided that the survey would be sent out via e-mail. The TEA website was used to gather the email addresses for each of the 1076 ISDs in Texas (reference TEA) Superintendents were identified as the participants of the study based on their extensive knowledge of their own ISDs; their participation in the study was completely voluntary. Superintendents received an email that briefly described this study. The email explained both their anonymity in participating and the previously obtained IRB approval. The e-mail included a link to the online survey monkey where the data was securely gathered and stored. By clicking the link to take the survey Superintendents accepted the terms of the study. This email is formally known as a “letter of consent” and is attached as Appendix A.

STAGE 2 - DATA COLLECTION

Microsoft Outlook was used to send out the letter of consent. This program was chosen as the means for sending out the survey because emails can be sent from lists of addresses in Microsoft Excel. The list of ISD email addresses provided by the TEA was in an Excel format. By using Outlook to send out the letter of consent consolidated the task of sending out 1076 emails individually to sending out a hundred at a time. To ensure that each batch of emails was received, an extra email address that the researcher was able to check was included. When the first week did not yield enough results, a follow up email using the same process was sent to ISDs that had yet to respond to the survey.

STAGE 3 - STATISTICAL ANALYSIS

Using Statcrunch, a t-test was conducted to compare the CMR and CSP project delivery systems. To run the t-test CMR and CSP were coded. CMR was coded with the number 0 (zero) and CSP was coded with the number 1 (one). The t- test simply compares two data sets with two averages to each other. To be able to conduct the test, the data must be classified as normal.

Not enough data was collected for DBB, DB, CMR, and bridging for analysis to be conducted on those PDSs. The CSP project delivery method and the CMR project delivery method were used an even number of times and will be compared based on cost per student.

CHAPTER IV

STUDY ANALYSIS

INTRODUCTION

The results are:

1. Response count
2. Costs Estimates
3. Initial analysis: Results of demographic distribution of schools in Texas.
4. Distribution of Project Delivery System (PDS) practiced to construct schools.

The analysis method is comparative means test or an alternative form of the Student's t Test (Miller & Freund, 1976) using StatCrunch.

RESPONSE COUNT AND DATA

The survey document was sent out to each of the 1076 ISDs in Texas. Results collected for this study are a result of superintendents responding to this online survey that asked them specific questions about school construction in their ISDs. A total of 132 ISDs responded to the survey.

Out of those 132 ISDs, 61 (46%) had not had any schools built since the year 2000. Out of the remaining 71 ISDs that had built schools since 2000, only 52 ISDs had constructed new elementary schools since the year 2000. From the 52 ISDs that had built schools since the year 2000, only 31 ISDs (24% of 132) gave enough information to participate in the study. These 31 ISDs built 55 public elementary schools that were used as the data for comparison in this study.

One ISD had a budgeted school construction cost of over $13 million and an actual school construction cost of $100,000. Due to the large discrepancy between the budgeted and the actual costs, and the other actual costs of new schools, this data entry was taken out of the study. The analysis of the data does not include this outlying entry.

ACTUAL AND ESTIMATED COSTS

Figure 16 shows a plot of the estimated costs against the actual costs. The high regression coefficient suggests a estimation method exists for elementary school costs. But, the equation form for the linear regression shows a consistent overestimating of the budget costs to the actual costs which is interesting and would indicate some conservatism in estimating construction costs.

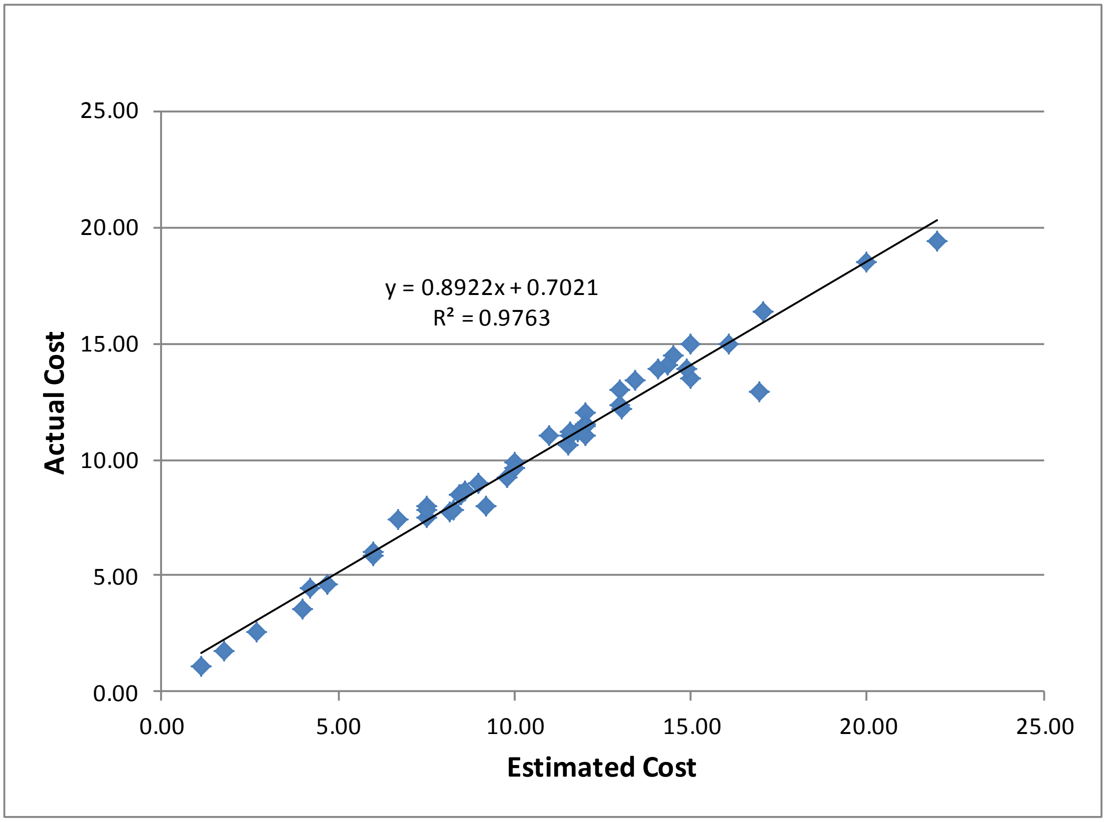

Figure 16. Estimated Costs against Actual Costs

INITIAL ANALYSIS

Responses to the survey were kept secure in an online database at www.surveymonkey.com (Sethi, 2009). Data was exported from the survey monkey database to an Excel spreadsheet. In this initial analysis, ISDs that responded to the survey that they had built a new public elementary school since 2000 were plotted on a map of Texas to see where this construction was happening, as shown on *Figure 17*. The red marks on the map represent these new schools.

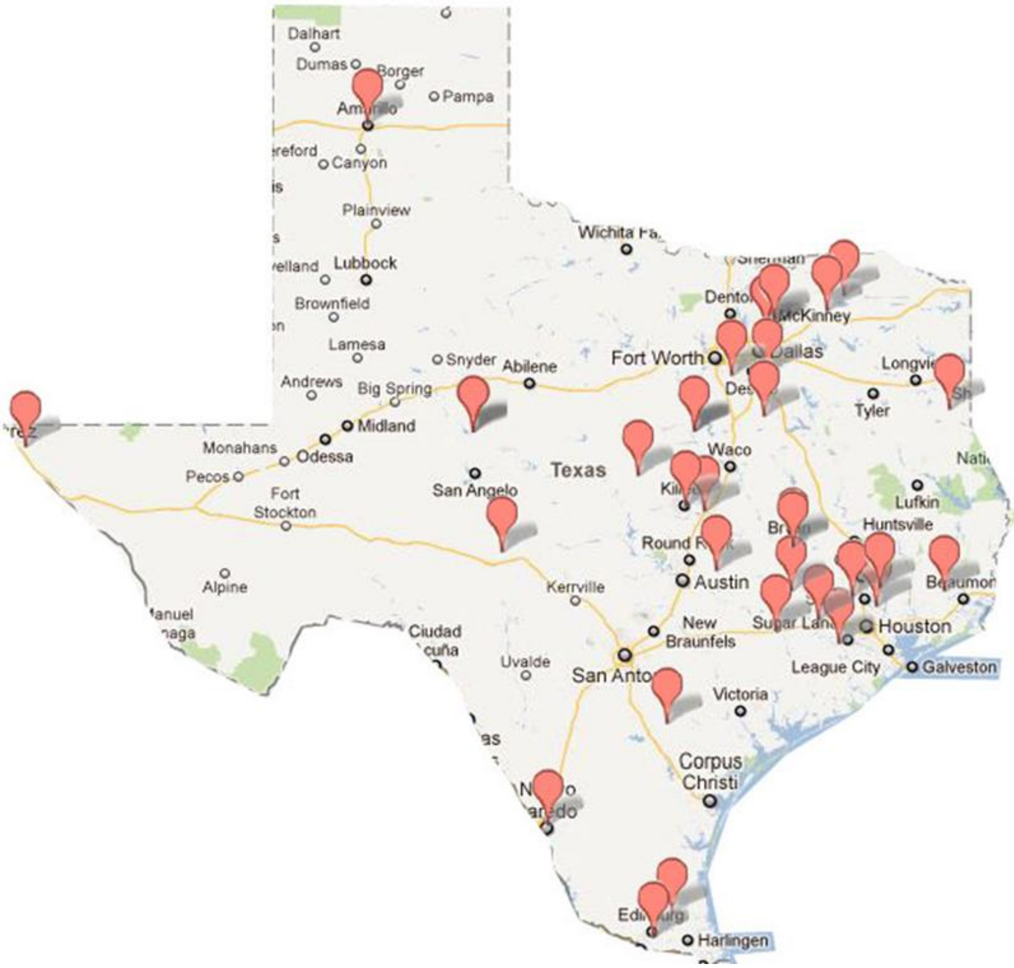

Figure 17. Demographic distribution of new public elementary school construction since 2000 (after Google maps 2011)

The results highlight the dominance of the Houston to Dallas corridor in the growth of Texas. The results do show a reasonable spread of schools amongst the growing districts.

Figure 18 shows the distribution of the construction within an Educational Service Center.

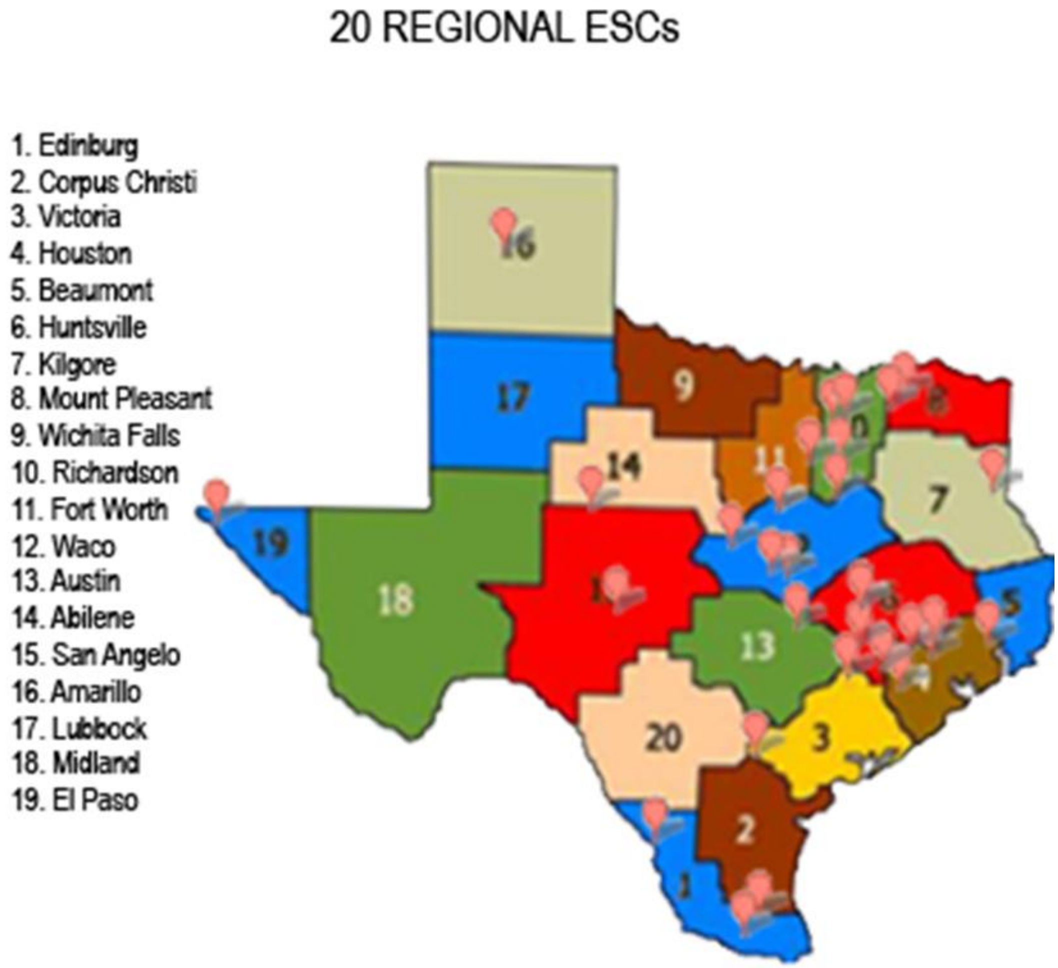

Figure 18. Distribution of new public elementary school construction since 2000 by ESC

The coding system for the different contract types is presented in *Table 2*.

Table 2. Contract Coding

Code	Type
0	Construction Management at Risk
1	Competitive Sealed Proposals
2	Design Bid Build or Traditional Hard Bid
3	Design Build

Figure 19 shows the distribution of the different delivery systems.

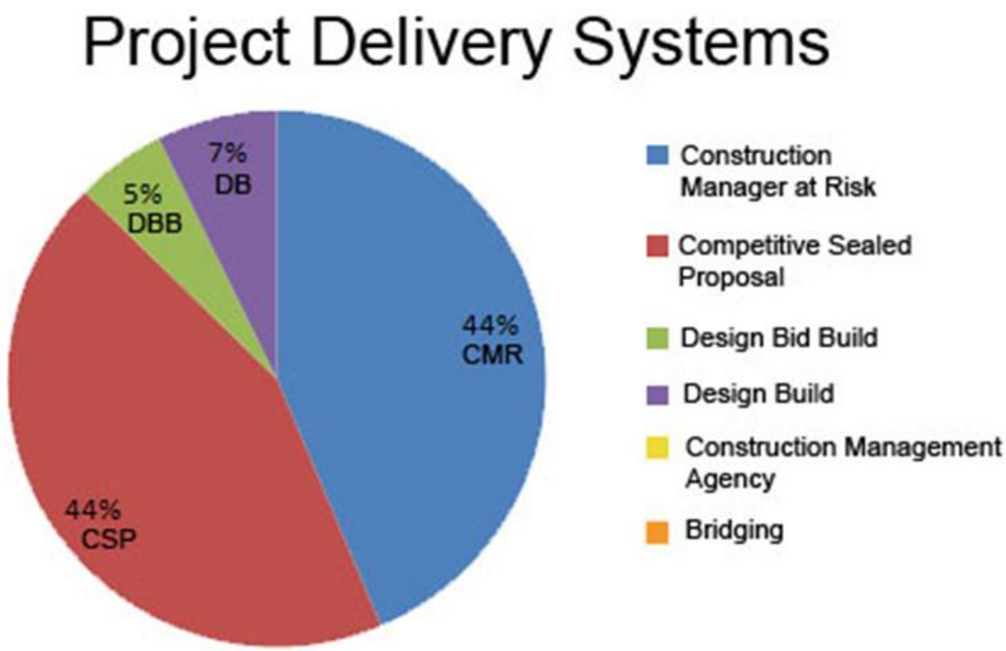

Figure 19. Project Delivery Systems

Table 3 presents the details of the delivery system total counts in each educational service center in Texas.

Table 3. Educational Service Center Contract Coding

Educational Service Center	Project Delivery System Coding			
	0	1	2	3
1	-	3	1	3
2	-	1	-	-
3	-	-	-	-
4	1	5	-	-
5	1	-	-	-
6	8	1	-	-
7	1	-	-	-
8	-	-	-	
9	-	-	-	-
10	3	3	-	-
11	-	3	-	-
12	5	4	2	3
13	1	1	-	-
14	-	-	-	-
15	1	-	-	-
16	-	3	-	-
17	-	-	1	-
18	-	-	-	-
19	3	-	-	-
20	-	-	-	-
Totals	24	24	3	4

Figure 20 shows the distribution of school in each Education Service Center.

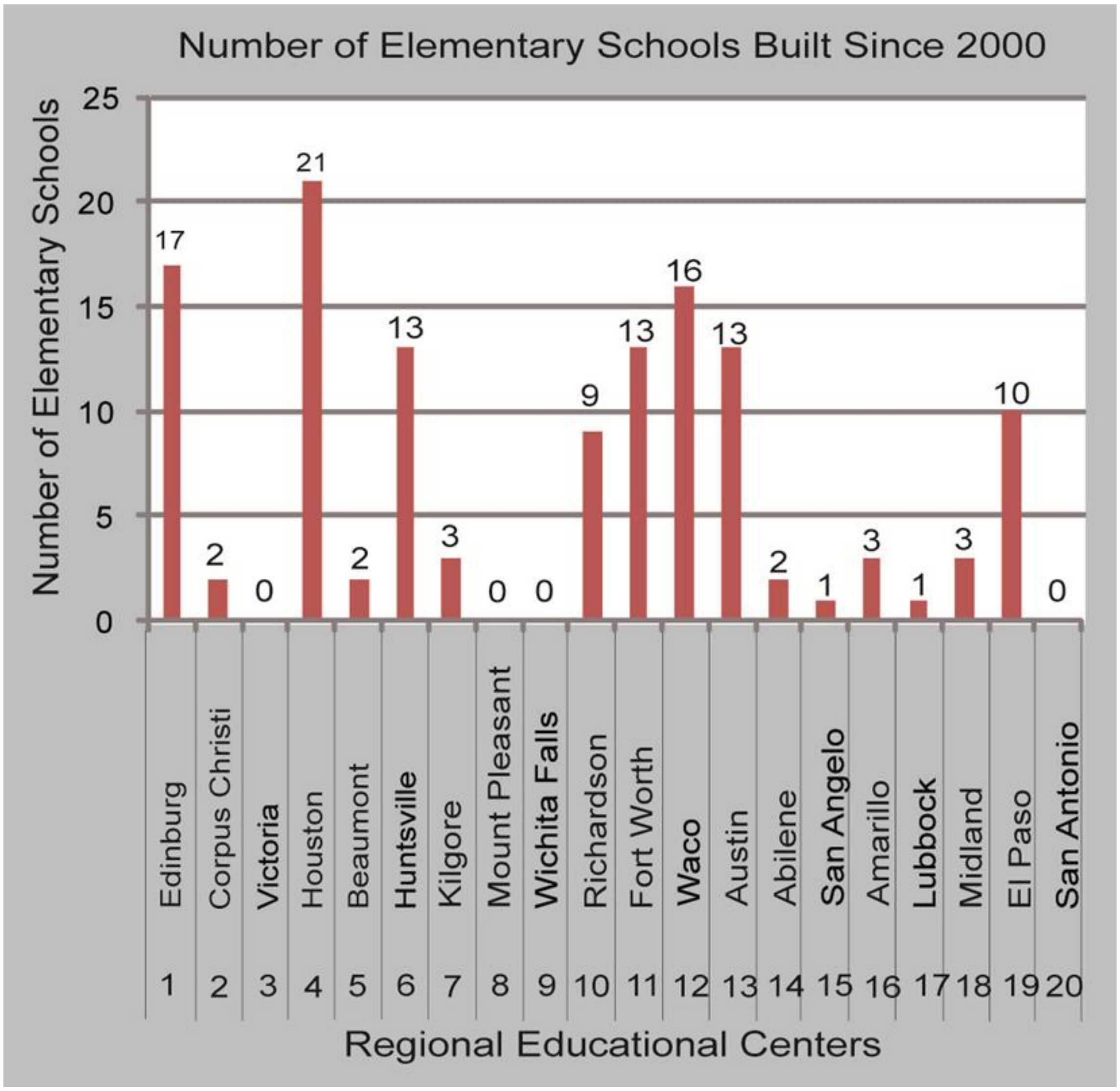

Figure 20. Total Number of Elementary Schools built by Region Education Centers

Elementary school construction has seen a large growth in the following ESCs: Edinburg, Houston, Huntsville, Richardson, Fort Worth, Waco, Austin, and El Paso, as would be expected given recent demographic shifts in the state.

Table 4 presents the costs ranges for the different delivery types.

Table 4. Maximum, Mean and Minimum Costs for Each Delivery Type

Description	Delivery Type Coding			
	0	1	2	3
Maximum	32432	29297	25946	8493
Mean	18383	14749	16600	7344
Minimum	9240	5000	11000	4333
Standard Deviation	6200	4783	8146	2009

A Q-Q Plot was completed on each data set to show that the two PDSs being compared are normal. *Figure 21* shows the normal probability plot for construction manager at risk.

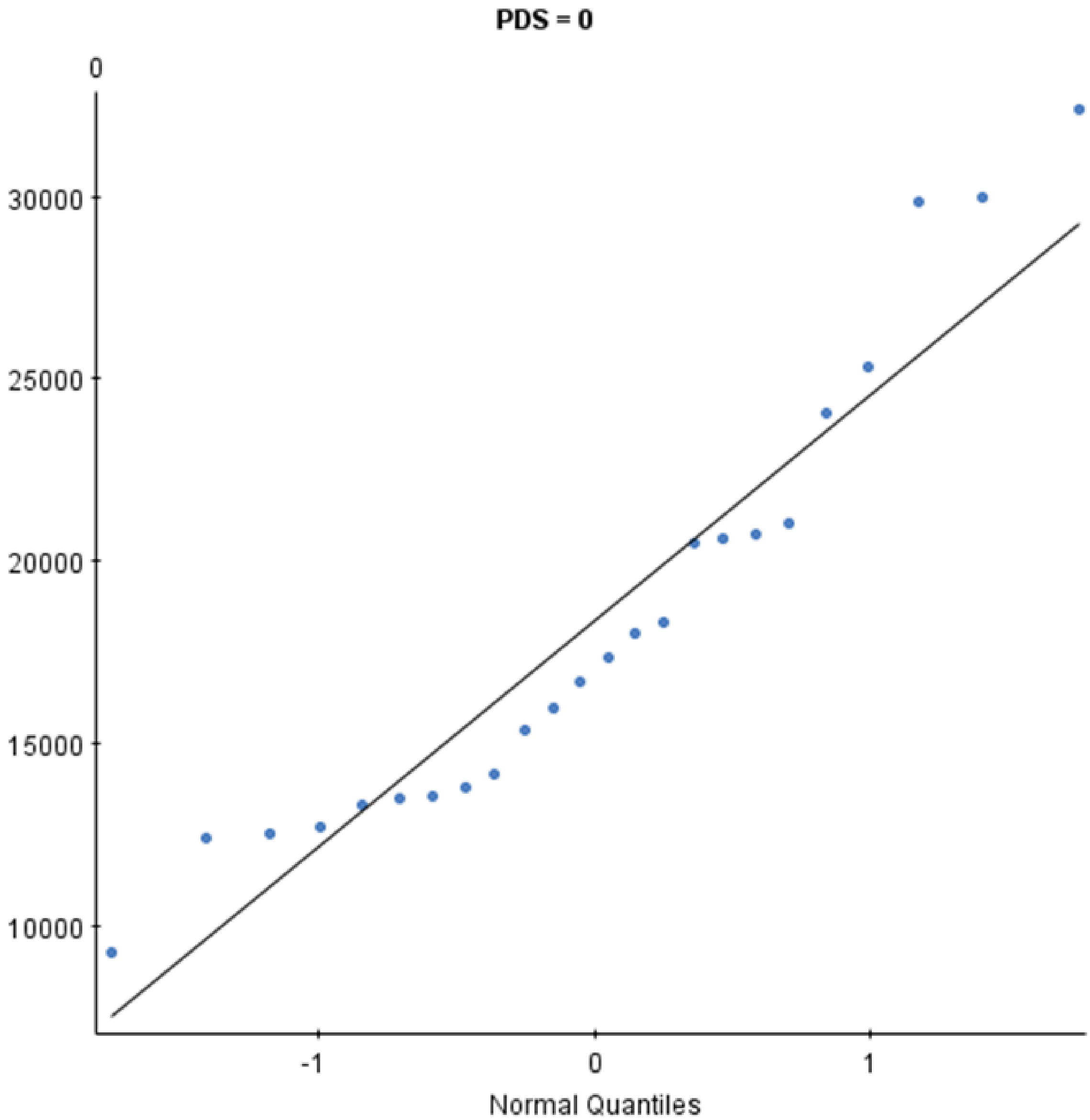

Figure 21. Normal Probability Plot – Construction Manager at Risk

Figure 22 shows the normal probability plot for competitive sealed proposal.

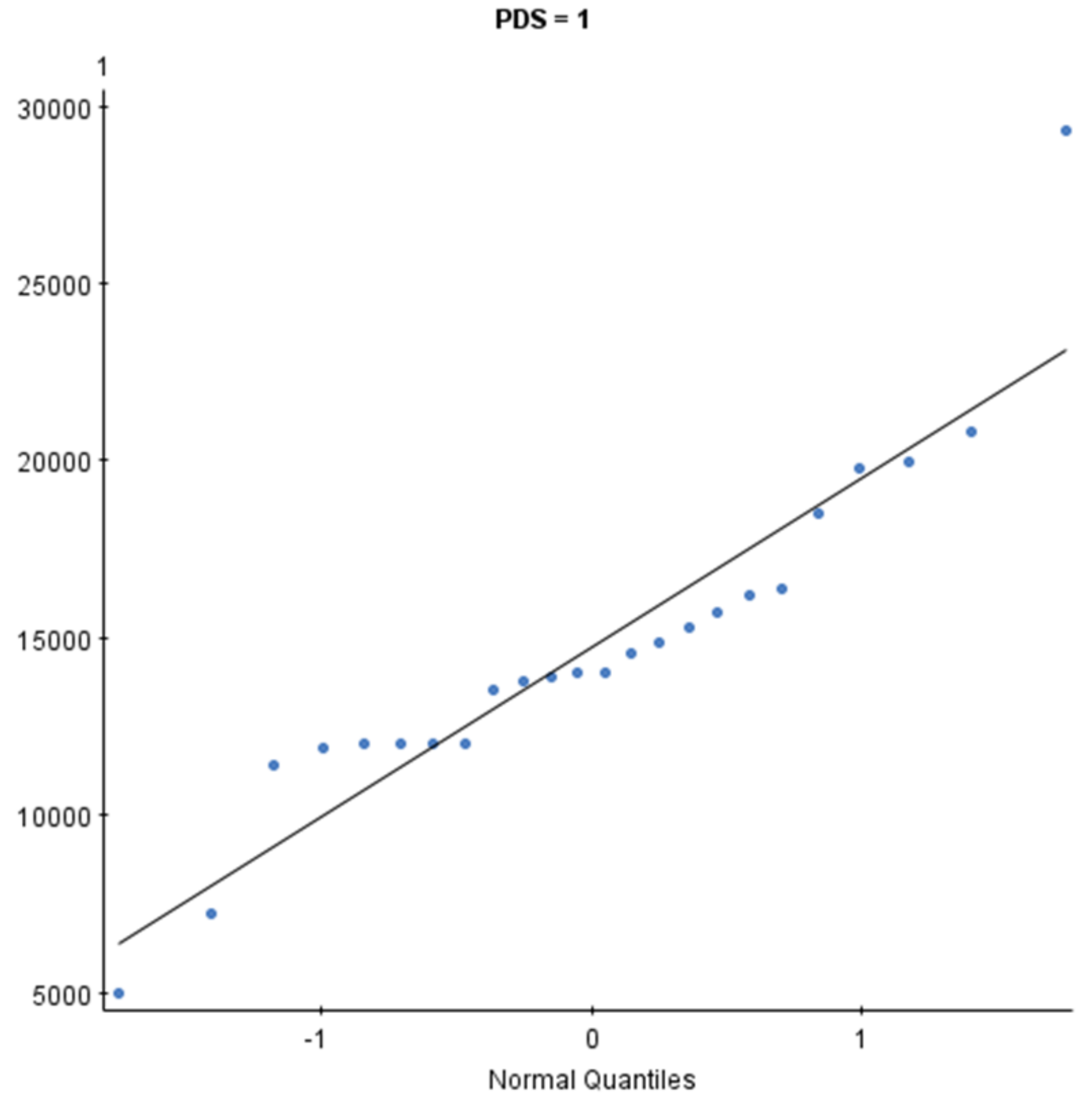

Figure 22. Normal Probability Plot - Competitive Sealed Proposal

CSP has an average cost per student of approximately $14,500. Comparatively, PDS 0 (CMR) has a larger range in cost per student. The average cost per student using CMR is approximately $18,500. The difference in average cost per student between the two PDSs is approximately $4,000. A Student's t Test analysis shows a probability of 2.8% that the two results are the same and 97.2% probability that the results are statistically different.

DISTRIBUTION OF COSTS PER STUDENT

Figure 23 shows the distribution off the costs per student.

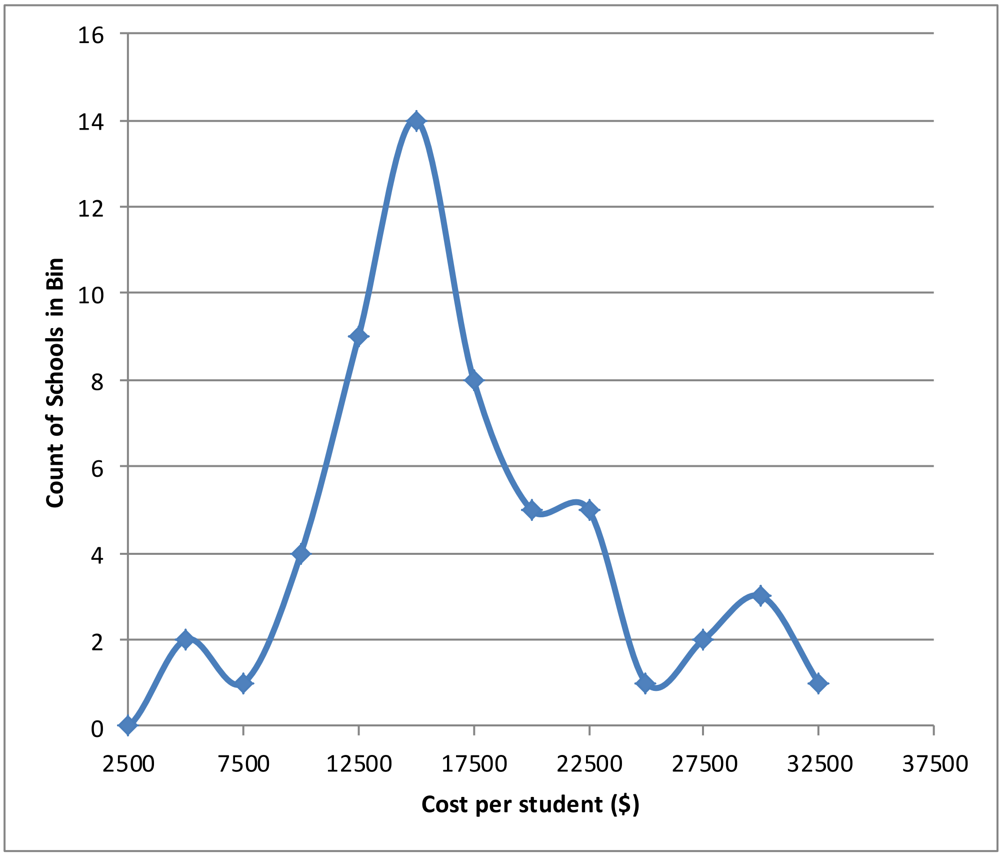

Figure 23. Distribution of Costs per Student

This should be compared to the distribution of costs for the reverse auction bidding system shown in the literature review. The data suggests that delivery system affects the cost of the school.

CHAPTER V

CONCLUSIONS

SUMMARY

The purpose of this study was to compare the costs of PDSs used by Texas ISDs in the new construction of public elementary schools. It was hypothesized that using a hard bid method would, on average, cost less per student than using another PDSs available to ISDs in Texas.

A comparative means test was used to compare the cost per student amongst ISDs that used CMR and CSP as their PDSs. CSP is not the traditional DBB project delivery method, however, its only varies from the traditional method in the bids are placed my contractors un-be-known to others and the owner chooses the contractor based on criteria, as opposed to choosing the lowest bidder. This proved to be beneficial to cutting costs. The CSP method resulted in ISDs spending approximately $4,000 less per student to have new schools constructed.

A $4,000 savings when construction Texas public elementary schools is a significant savings. Had the twenty-four ISDs that used the CMR project delivery method used CSP, they would have saved $96,000 in their total costs per student.

Ultimately, the dollars being saved can be translated into many new avenues for school construction. The money could be used to build better schools. The money could be given back to constituents in the form of a tax break. Alternatively the money could go towards school renovations. This study showed that ISDs are spending more money to use alternative PDSs when they could be using a hybrid of the traditional method, CSP, for significantly less money.

SUGGESTIONS FOR FUTURE RESEARCH

This study used cost per student as a comparison means for the cost of public elementary school construction. It is suggested that the next study include a cost comparison of building square footage. It is important to remember to strictly define building square footage when gathering data.

Further work is required on comparing the demographic data for the school districts to the costs and the distribution of costs against a known competitive distribution.

REFERENCES

Abramson, P. (2010). 15th Annual School Construction Report. *School Planning & Management*, *15*, 1-16.

Abramson, P. (2011). 16th Annual School Construction Report. *School Planning & Management*, *16,* 1-16.

Buvik, A., & Haugland, S. A. (2005). The Allocation of Specific Assets, Relationship Duration, and Contractual Coordination in Buyer–Seller Relationships. *Scandinavian Journal of Management, 21*(1), 41-60. doi: 10.1016/j.scaman.2005.02.003

Chan, D. W. M., & Kumaraswamy, M. M. (1996). An Evaluation of Construction Time Performance in the Building Industry. *Building and Environment, 31*(6), 569-578. doi: 10.1016/0360-1323(96)00031-5

Chen, W. T., Liao, S. L., Lu, C. S., & Mortis, L. (2010). Evaluating Satisfaction with PCM Services for School Construction: A case study of primary school projects. *International Journal of Project Management, 28*(3), 296-310. doi: 10.1016/j.ijproman.2009.06.003

CNN Money. (2011). Fortune 500 - #41 Dell. *Fortune Magazine*, Retrieved May 5, 2011, from http://money.cnn.com/magazines/fortune/fortune500/2011/snapshots/1053.html

The Economist. (2007). CSI: Credit Crunch, Central Banks have played a Starring Role. *The Economist,* Retrieved October 8, 2011, from http://www.economist.com/node/9972489?story_id=9972489

Debella, D. C., & Ries, R. (2006). Construction Delivery Systems: A comparative analysis of their performance within school districts. *Journal of Construction Engineering and Management, 132*(11), 1131-1138. doi: 10.1061/(asce)0733-9364(2006)132:11(1131)

Duncan, G. (2008). Lehman Brothers Collapse Sends Shockwave Round World, *The Sunday Times,* Retrieved September 16, 2011, from http://business.timesonline.co.uk/tol/business/industry_sectors/banking_and_finance/article4761892.ece

Feigenbaum, L. H. (2011). (personal communication to A. Reinisch, July 2011) *Current Texas Public School Construction Issues,* College Station, Texas.

Fox, J. (2009). Three Lessons of the Lehman Brothers Collapse, from http://www.time.com/time/business/article/0,8599,1923197,00.html#ixzz1Zqm1yBrb

Frye, A. (2010). Warren Buffett Sees Housing Market Bouncing Back by 2011, *USA Today,* from http://www.usatoday.com/money/economy/housing/2010-03-01-buffett01_ST_N.htm

Gascon, C. S. (2009). The Current Recession: How bad is it? *Economic Synopses, 4*, 2.

Grasmick, N. S. (2009). Construction of Public School Facilities *Annual report on the status of alternative procurement, project delivery and financing for Maryland public school construction*. Maryland.

Guhya, D. (2010). Reverse Auction Bidding: A statisitcal review of the first case study. *Master of Science (Construction Management) Thesis,* Texas A&M University, College Station.

Gupta, A. K. (2010). Studying the Reverse Auction Bidding Game for the Role Variants of Guardians in the Facilities Management Industry. *Master of Science (Construction Management) Thesis,* Texas A&M University, College Station.

Harford, T. (1995). The Undercover Economist: Exposing why the rich are rich, the poor are poor-and why you can never buy a decent used car! *Oxford University Press,* New York.

Heery, G. (2011). The Bridging Method. Retrieved May 2, 2011, from http://www.bridgingmethod.com/?sec=0

Kim, W. (2004). Reverse Auction Bid Data Collection Web Site, from http://bid.arch.tamu.edu/

Konchar, M., & Sanvido, V. (1998). Comparison of U.S. Project Delivery Systems. *Journal of Construction Engineering and Management, 124*(6), 435-444. doi: 10.1061/(asce)0733-9364(1998)124:6(435)

Lahart, J. (2010). U.S. Firms Build up Record Cash Piles, *Wall Street Journal*. *6.*

Little, W., Fowler, H. W., Coulson, J., Onions, C. T., & Friedrichsen, G. W. S. (1973). The Shorter Oxford English Dictionary on Historical Principles. *Oxford: Clarendon Press.*

Mahdi, I. M., Riley, M. J., Fereig, S. M., & Alex, A. P. (2002). A Multi Criteria Approach to Contractor Selection. *Engineering Construction and Architectural Management, 9*(1), 29-37.

Martin Skitmore, R., & Thomas Ng, S. (2003). Forecast Models for Actual Construction Time and Cost. *Building and Environment, 38*(8), 1075-1083. doi: 10.1016/s0360-1323(03)00067-2

McGraw-Hill Construction. (2011). Forecasts & Trends January Construction Falls 6%. *Engineering News Record*. from www.construction.com

Miller, I., & Freund, J. E. (1976). Probability and Statistics for Engineers (2nd. ed.). Englewood Cliffs, New Jersey.: Prentice-Hall, c1977.

Mowery, D. C. (1983). The Relationship Between Intrafirm and Contractual Forms of Industrial Research in American Manufacturing, 1900–1940. *Explorations in Economic History, 20*(4), 351-374. doi: 10.1016/0014-4983(83)90024-4

NEWS, BBC. (2009). Timeline: Credit Crunch to Downturn. *BBC NEWS,* Retrieved August 25, 2011, from http://news.bbc.co.uk/2/hi/business/7521250.stm#table

Nichols, J. M. (2011). (personal communication to A. Reinisch, July 2011) *Shopping Mall Development in Australia,* College Station, Texas.

Oyetunji, A. A., & Anderson, S. D. (2006). Relative Effectiveness of Project Delivery and Contract Strategies. *Journal of Construction Engineering Management, 132*(1), 3-13.

Plumber, M. A. (2010). Studying the Reverse Auction Bidding Game to Identify the Significance of Personality Types and Strength of Role Variants on the Impact of

Returns. *Master of Science (Construction Management) Thesis,* Texas A&M University, College Station.

Reinisch, A., & Caguioa, C. (2010). Selecting a Project Delivery Method for Nonprofit Organizations *(D. o. C. S. College of Architecture, Trans.).* Texas: Texas A&M University.

Saigaonkar, S. (2010). Reverse Auction of Bidding, Bidding Personality, its Significance and Impact on Returns. *Texas A&M University,* College Station.

Sethi, M. (2009). Forecasting the Construction Time for New Construction in Texas. Master of Science *(Construction Management)* Professional Paper*,* Texas A&M University, College Station.

Singh, G. (2008). Factors Affecting Construction Duration for New School Projects in Texas. Master of Science Master of Science (Construction Management) *Professional Paper,* Texas A&M University, College Station.

Smialek, J. (2011). Ten Reasons Why the Texas Economy is Growing That Have Nothing to do With Rick Perry, *Hearst Washington Bureau*. from http://blog.chron.com/txpotomac/2011/07/ten-reasons-why-the-texas-economy-is-growing-that-have-nothing-to-do-with-rick-perry/

Smith, M. (2011). How to Navigate Texas' School Finance System. from http://www.texastribune.org/texas-education/public-education/how-to-navigate-texas-school-finance-system/

Steck, H. E. (2009). Construction Procurement for Public Schools. *Construction Law News.* from http://www.harrisonsteck.com/news_constructProcure.htm

Sunbelt Builders. (2009). Design Build Advantage. Retrieved October 20, 2011, from http://www.sunbeltbuilders.com/metro_atlanta_building_contact.htm

Texas Education Agency (2010). School Year Funding. *Austin Texas: TEA.*

Texas Education Agency. (2010a). Enrollment in Texas Public Schools 2009-10. *Austin Texas: TEA*, from http://www.tea.state.tx.us/index4.aspx?id=4128

Texas Education Agency. (2010b). Strategic Plan for the Fiscal Years 2011–2015. *Austin, Texas: TEA.*

Thom Clark, Mark Kelley, & Torone, B. (2002). The Top 10 Ways to Survive Design/Build. California.

U.S. Census Bureau. (2011a). State & County Quick Facts. Retrieved July 17, 2011, from http://quickfacts.census.gov/qfd/index.html

U.S. Census Bureau. (2011b). Statistical Abstract of the United States: 2011 Construction and Housing. Retrieved July 17, 2011, from http://quickfacts.census.gov/qfd/index.html United States.

U.S. Securities and Exchange Commission. (2010). Mortgage-Backed Securities. *U.S. Securities and Exchange Commission,* from http://www.sec.gov/answers/mortgagesecurities.htm

Van Vleet, R. G. (2004). Reverse Auction Bidding: An analysis of a case study. *Texas A&M University,* College Station.

Vincent, J. M., & Monkkonen, P. (2010). The Impact of State Regulations on the Costs of Public School Construction. *Journal of Education Finance, 35*(4), 313-330. doi: 10.1353/jef.0.0020

APPENDIX A

SURVEY SENT TO INDEPENDENT SCHOOL DISTRICTS

SURVEY DOCUMENT

Cost Comparison of Public Elementary School Construction Costs in the State of Texas

1. What is your ISD (Independent School District)? __________________________
2. Have any schools been constructed in your ISD since the year 2000?
   - Yes
   - No
3. How many elementary schools have been constructed in your ISD since the year 2000?
   - 1
   - 2
   - 3
   - 4
   - 5
   - Other (please specify) ________________
4. What is the name of the first, second etc elementary school you constructed?
   - 1st school ____
   - 2nd school ____
   - 3rd school ____
   - 4th school ____
   - 5th school ____

CONTINUE SURVEY HERE FOR 1ST SCHOOL

1. What year was the school occupied? _________________________
2. What is the planned enrollment of students in the school? ________________________
3. What is the actual enrollment of students in the school? ________________________
4. What grades are at the school? ____
5. What was the construction budget of the school building? (in millions of US dollars) ________________________________
6. What was the actual construction cost of the school building? (in millions of US dollars) ____________________________________

7. What was the project delivery system used?
    - Competitive sealed proposal
    - Design bid build
    - Construction management at risk
    - Design build
    - Bridging
    - Other (please specify) ___________________________________
8. Rate your satisfaction with the construction contracting method that was used.
    - 1. Very satisfied
    - 2.
    - 3. Satisfied
    - 4.
    - 5. Dissatisfied
9. Do you use the same firms for the bulk of your work?
    - Yes
    - No
10. Do you use the same construction firm to do the bulk of new construction in your school district?
    - Yes
    - No
11. Can we contact you if we have questions?
    - Yes
    - No
    - If yes, kindly provide the complete address and email/contact #____________
12. Any other comments?
    ____

INTERNATIONAL REVIEW BOARD APPROVAL LETTER

TEXAS A&M UNIVERSITY
DIVISION OF RESEARCH AND GRADUATE STUDIES - OFFICE OF RESEARCH COMPLIANCE

1186 TAMU, General Services Complex
College Station, TX 77843-1186
750 Agronomy Road, #3500

979.458.1467
FAX 979.862.3176
http://researchcompliance.tamu.edu

Human Subjects Protection Program — Institutional Review Board

APPROVAL DATE: 02-Sep-2011

MEMORANDUM

TO:	REINISCH, ASHLEY 77843-3578
FROM:	Office of Research Compliance Institutional Review Board
SUBJECT:	Initial Review

Protocol Number:	2011-0630
Title:	Cost Comparison of Public Elementary Schools Construction Costs in the State of Texas
Review Category:	Expedited
Approval Period:	02-Sep-2011 **To** 01-Sep-2012

Approval determination was based on the following Code of Federal Regulations:

45 CFR 46.110(b)(1) - Some or all of the research appearing on the list and found by the reviewer(s) to involve no more than minimal risk.

Criteria for Approval has been met (45 CFR 46.111) - The criteria for approval listed in 45 CFR 46.111 have been met (or if previously met, have not changed).

----

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation or quality assurance methodologies.

(Note: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b) (3). This listing refers only to research that is not exempt.)

Provisions:

Comments:

This research project has been approved. As principal investigator, you assume the following responsibilities

1. **Continuing Review:** The protocol must be renewed each year in order to continue with the research project. A Continuing Review along with required documents must be submitted 30 days before the end of the approval period. Failure to do so may result in processing delays and/or non-renewal.
2. **Completion Report:** Upon completion of the research project (including data analysis and final written papers), a Completion Report must be submitted to the IRB Office.
3. **Adverse Events:** Adverse events must be reported to the IRB Office immediately.
4. **Amendments:** Changes to the protocol must be requested by submitting an Amendment to the IRB Office for review. The Amendment must be approved by the IRB before being implemented.
5. **Informed Consent:** Information must be presented to enable persons to voluntarily decide whether or not to participate in the research project.

This electronic document provides notification of the review results by the Institutional Review Board.

EMAIL RECRUITMENT AND LETTER OF CONSENT

EMAIL RECRUITMENT /LETTER OF CONSENT

Dear Superintendent,

My name is Ashley Reinisch, and I am a graduate student from the Department of Construction Science, Texas A&M University. I am currently conducting research for my graduate thesis titled "Cost Comparison of Public Elementary School Construction Costs in the State of Texas." The purpose of this research is to study the effects project delivery systems have on elementary school construction costs.

Participation in this study is voluntary. The records of this study will be kept private. Information about you will be kept confidential to the extent permitted or required by law. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only the researcher, Ashley Reinisch, will have access to the records. Participants are free to terminate their participation at any time and without prejudice; also completion and return of the questionnaire implies their consent to participate. Participation in the survey should take no more than 20 minutes. The research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context. This research study has been reviewed by the Human Subjects' Protection Program and/or the Institutional Review Board at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact these offices at (979)458-4067 or irb@tamu.edu.

The school data collected would be compiled as a single data set. This data set would then be used to analyze the relationship between project cost, gross floor area, enrollment and project delivery system; for school construction in Texas. The results of this comparative analysis could be used as a decision making tool that will allow superintendents, contractors and construction managers to make informed decisions about project delivery systems, based on project size measured by project cost and gross floor area.

I invite you to please take part in my survey. This survey is designed to take no more than twenty minutes of your time. The survey will remain open for participation until October 14, 2011. To participate in the survey please click the link below:

https://www.surveymonkey.com/s/P757WSG

Upon completion of this study, the student wishes to give a copy of all findings of this research to each of the participants as a token of appreciation for their valuable input. For more information, please contact me at:

Ashley Reinisch
Construction Management Major, Department of Construction Science, Texas A&M University,
College Station, TX 77843-3137
Cell phone number: (979) 450-2260
Email address: reinisch10@yahoo.com

Research advisor's contact details:
Dr. John Nichols
Department of Construction Science, College of Architecture, Texas A&M University,
College Station, TX 77843-3137

Texas A&M University IRB Approval	From: 9-2-11	To: 9-1-12
IRB Protocol # 2011-0630	Authorized by:	

APPENDIX B

DATA SUMMARY

Table 5. Summary of the Delivery System Cost Data for Each Educational Service Centre

Educational Service Centre	# of students in ESC	Planned Enrolment	Estimated Cost $	Actual Cost (million) $	PDS
1	408125	350	4,200,000.00	4.5	2
1	408125	940	8,163,575.00	7,75	3
1	408125	940	8,243,575.00	7,80	3
1	408125	940	9,168,541.00	7,98	3
1	408125	750	9,000,000.00	9,000,000.00	1
1	408125	750	9,000,000.00	9,000,000.00	1
1	408125	750	9,000,000.00	9,000,000.00	1
2	104,637	200	6,006,500.00	5,859,361.73	1
4	1091978	900	13,000,000.	100,000.00	1
4	1091978	950		17,100,000.	0
4	1091978	950		13,200,000.	1
4	1091978	750		10,900,000.0	1
4	1091978	870	16,965,000.	12,951,250.0	1
4	1091978	732	14,500,000.0	14,488,666.0	1
4	1091978	878	13,399,000.0	13,399,000.0	1
5	80574	500	4,700,000.00	4,620,000.00	0
6	169900	650	11,500,000.	10,655,000.00	1
6	169900	650	22,000,000.	19,394,000.00	0
6	169900	1000	15,000,000.	13,500,000.00	0
6	169900	850	12,000,000.	12,000,000.00	0
6	169900	850	12,000,000.	11,500,000.00	0

Table 6. Summary of the Delivery System Cost Data for Each Educational Service Centre

Educational Service Centre	# of students in ESC	Planned Enrolment	Estimated Cost $	Actual Cost (million) $	PDS
6	169900	800	10,000,000.	9,900,000.	0
6	169900	670	14,314,953.	14,098,420	0
6	169900	680	17,043,350.	16,357,977	0
6	169900	670	14,059,000.	13,879,335	0
7	169455	500	15,000,000.	15,000,000	0
10	749836	717	11,950,470.	11,446,210	0
	749836	710	8,412,650.00	8,448,566.	1
	749836	710	8,483,650.00	8,520,222.	1
10	749836	700	7,500,000.00	8,000,000.	1
10	749836	660	11,000,000.	11,000,000	0
10	749836	450	12,000,000	11,400,000	0
11	542201	800	11,800,000	11,200,000	1
	542201	800	11,600,000.	11,000,000	1
	542201	800	11,600,000.	11,200,000	1
12	156960	600	7,500,000.	7,500,000.	0
12	156960	750	16,059,589.	14,964,859	1
	156960	750	14,889,990.	13,856,380	1
	156960	750	13,028,024.	12,142,465	1
12	156960	750	13,000,000.	13,000,000	0
	156960	500	4,000,000.00	3,600,000.	1
12	156960	1000		13,804,83.	0
	156960	1000		13,288,265	0
	156960	1000		12,699,682	0
12	156960	100	1,100,000.00	1,100,000.	2
12	156960	600	2,700,000.00	2,600,000.	3
13	366203	375	7,500,000.00	7,800,000.	1
13	366203	600	9,800,000.00	9,200,000.	0
15	48351	185	6,000,000.00	6,000,000.	0
16	48351	350	1,750,000.00	1,750,000.	1
16	48351	550	6,697,320.00	7,452,910.	1
16	48351	550	8,600,000.00	8,624,531.	1
17	81354	370	10,000,000.	9,600,000.	2
19	182133	900	20,000,000.	18,525,885	0
19	182133	600	12,000,000.0	10,996,647	0
19	182133	600	13,000,000.0	12,306,397	0

VITA

Name: Ashley Nicole Reinisch

Address: Department of Construction Science, Texas A&M University

College Station, Texas 77843-3137

Email Address: Reinisch10@yahoo.com

Education: B.E.D., Texas A&M University, 2009

M.S., Construction Management, Texas A&M University, 2011