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An Investigation of Project Delivery Methods Relating to Repetitive Commercial Construction

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ABSTRACT

An Investigation of Project Delivery Methods
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Construction

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The Design/Bid/Build (DBB) delivery method has historically been the most popular and the most effective means of determining the least cost for building a project based upon a set of construction documents. In recent years, however, other project delivery methods, including but limited to Construction Manager/General Contractor (CM/GC) and Design/Build (DB), have slowly taken a share of the construction market away from the DBB delivery method. The choice of delivery method that will produce the best value for an owner in the measurements of efficiency in quality, cost, and timeliness depends upon the type of project and the business culture of the project owner.

A unique opportunity for a comparative study was presented by the Meetinghouse Facilities Department (MFD) of the Church of Jesus Christ of Latter-day Saints. The MFD completed over 200 repetitive meetinghouse projects in the U.S. over a five-year period (1999-2003), contracting approximately two-thirds of the projects using a CM/GC delivery method with an attached partnering agreement. The remaining meetinghouses were contracted using a DBB delivery method. A comprehensive comparison was conducted measuring all of the efficiencies created by the selection of delivery method, including short- and long-term costs, direct and indirect costs, construction cycle time, and quality assessment scores.

After identifying and then adjusting for several confounding variables in the historical data, the statistical analysis provided evidence that the CM/GC delivery method proved to be the best value for the MFD by producing a total cost savings of over 5.5 percent on the meetinghouse projects when compared to the DBB meetinghouse projects. Construction cycle time was 20% shorter on the CM/GC meetinghouse projects and quality assessment (QA) scores were consistently higher. In regards to a 10-year life cycle repair costs, the CM/GC delivery method produced a higher quality meetinghouse, reducing repair costs by 34% when compared to the DBB meetinghouse projects.

Keywords: project delivery method, repetitive building projects, commercial construction, partnering, design-bid-build, construction manager-general contractor

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"Don't injure the problem—Kill it!"

Larry Kitchen 1923-2013

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1 INTRODUCTION

The construction industry describes a successful building project as one that is completed on time, within budget constraints, and meets a certain quality standard. All of these criteria are dictated by the construction documents which, in turn, are a reflection of the owner's expectations for the project.[1] Success, as defined above, is heavily influenced by the process used to design, manage, and deliver a project. Common approaches to this process are typically referred to as "project delivery methods."[2] There are various project delivery methods in use in today's marketplace. Each is designed to optimize results for certain types of projects and owners' business cultures. No one single method fits all projects. Selecting the optimal project delivery method involves weighing the advantages and disadvantages of each in order to find the best fit for both the project and the owner.[3]

Several studies have been conducted in the past to define and compare different project delivery methods. The majority of delivery styles fall into one of four categories: Design/Bid/Build (DBB); Construction Manager/General Contractor (CM/GC), also known as

[1] Martin R. Skitmore and Peter E.D. Love, "Construction Project Delivery Systems: An Analysis of Selection Criteria Weighting. In Proceedings ICEC Symposium "Construction Economics - the essential management tool (1995)", pages pp. 295-310, Gold Coast, Australia, Internet, available from http://eprints.qut.edu.au/archive/00004525, accessed 6 March 2014.

[2] Mark Linch, "Project Delivery Methods," Linch *Development Services*, Internet, available from www.docstoc.com/docs/68136547/Project-Delivery-Methods, accessed 19 February 2014.

[3] Nick Chism and Geno Armstrong, "Project Delivery Strategy: Getting It Right," *KPMG International*, Internet, available from http://www.kpmg.com/NZ/en/IssuesAndInsights/ArticlesPublications/SmarterProcurement/Documents/Getting-it-Right.PDF, accessed 8 October 2013.

Construction Manager At Risk (CMAR); Design/Build (DB); and Integrated Project Delivery (IPD). While other delivery methods may exist, they are often simply variations of these four methods.[4]

This investigation is a comparative study focused on two of these delivery methods that were employed by a large U.S. corporation that builds, owns, and operates its facilities. Those companies involved in this industry are characterized by building similar projects repetitively such as multi-story buildings, highways, and chain-commercial outlets.[5] The two delivery methods compared in this study were the traditional DBB method, using the lowest responsible bidder, and the CM/GC method, with an attached partnering agreement. The purpose of this investigation was to determine which of these two delivery methods resulted in a higher rate of efficiency in the areas of quality, cost, and timeliness for repetitive building projects over a set time period.

1.1 Background Setting

In 1996, the directors in the Meetinghouse Facilities Department (MFD), the division responsible for the design, construction, operation, and maintenance of all religious meetinghouses for the Church of Jesus Christ of Latter-day Saints (LDS), desired to do a comprehensive assessment of their main repetitive meetinghouse design for the US and Canada along with associated construction processes. With the growing need for new meetinghouses to meet the expanding church membership, the directors of the MFD desired to be as efficient as

[4] Construction Management Association of America, "An Owner's Guide to Project Delivery Methods, 2012," *CMAA*, Internet, available from http://cmaanet.org/files/Owners%20 Guide%20to% 20Project%20Delivery%20Methods%20Final.pdf, accessed 17 December 2012.

[5] Marco Bragadin and Kalle Kahkonen, "Heuristic Solution for Resource Scheduling for Repetitive Construction Projects (2011)," *Management and Innovation for a Sustainable Built Environment,* Internet, available from misbe2011.fyper.com/proceedings/ documents/202.pdf, accessed 6 March 2014.

possible in the use of their employees' time and in the expenditure of allocated building funds. The directors' purpose was to look for ways to enhance the quality, cost, and timeliness (QCT) of their repetitive meetinghouse construction projects.

This assessment became a re-engineering effort by the directors of the MFD to examine all of the physical facilities operations in the U.S. and Canada, including planning, design, construction, operations, and maintenance. For more than a year, the re-engineering effort was applied to evaluate all of the processes being utilized by the MFD and to gather the best practices of other companies in the repetitive commercial private sector that build, own, and operate their properties.

1.2 The Standard Floor Plan

The repetitive meetinghouse floor plan in greatest demand at that time was the "Heritage" meetinghouse plan that accommodated LDS congregations, ranging from 200 to 500 members, in the U.S. and Canada. The MFD had previously designed different versions of this plan, trying to create a resilient standardized plan. Previous standardized Heritage meetinghouse plans had lasted only short periods of time before being altered or modified; for all practical purposes these modifications resulted in each new meetinghouse project being built as though it were a completely new design.

The much needed standardized Heritage meetinghouse plan was improved and finalized by bringing together 30 years of previous plans along with comments and suggestions by meetinghouse contractors, church employed project managers, and lay clergy of the various congregations nationwide. In 1997, a standard plan, known as the Heritage 98, was released for construction use. The Heritage 98 offered five different exterior finishes, all based on a common floor plan as shown in Figure 1-1 below. The structure was engineered to satisfy most geological and climatic conditions in the U.S. and Canada, including seismic resistance, snow loads, and heat loss or gain. The Heritage 98 was so well designed that it is still being built in the U.S. and Canada 16 years from inception.

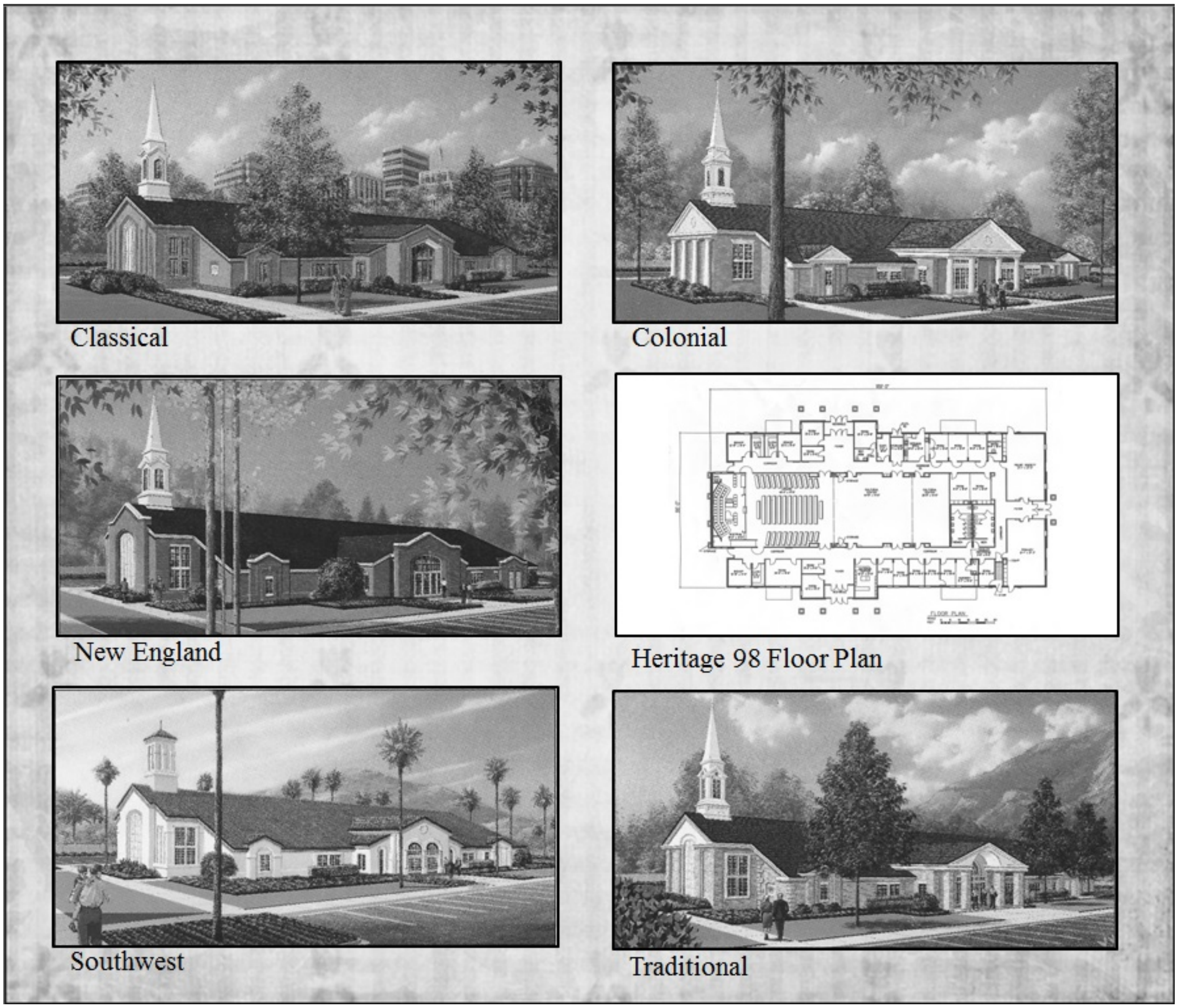

Figure 1-1: Heritage 98 Standard Plans

1.3 Re-Engineering Report

At the conclusion of the MFD re-engineering effort regarding construction processes, initiatives were accepted by the MFD directors that focused on project delivery methods, partnering, quality assurance, and materials procurement. Central to each initiative were construction best practices unique to repetitive building projects. In addition, tools to measure the performance of each initiative in the areas of quality, cost, and timeliness were created.

1.3.1 Delivery Methods

Prior to the time of the MFD re-engineering effort, the department exclusively used the traditional Design/Bid/Build (DBB) method of project delivery, the most common method used in the construction industry. The DBB method consists of a linear sequence of activities generally occurring in the following order: project inception by the owner, design, creation of construction documents by an architect, competitive bidding process and acceptance of the lowest-responsible-bidder; and ultimately, construction of the project. Historically, competitive bidding has been considered by many to be the most effective means of determining the least cost for building a project based upon a set of construction documents.[6]

The re-engineering effort by the MFD begun in 1996 to improve construction processes resulted in the introduction of a Construction Manager/General Contractor (CM/GC) project delivery method to challenge the DBB method being exclusively used by the MFD prior to 1998. With this CM/GC method, the MFD would usually hire a construction manager (CM), while still in the design phase of the project. Selection of the CM would be based upon qualification criteria established by the MFD. The CM would then act in an advisory role during

[6] CSI, *The Construction Specifications Institute Project Delivery Practice Guide* (New Jersey: John Wiley & Sons, Inc., 2011), 120-136.

the design phase by providing suggestions and insights regarding project constructability, value engineering, estimates, and other construction-related recommendations based upon the general contractor's construction experience. Based upon a nearly completed design, the owner and the CM would negotiate a guaranteed maximum price (GMP) for the project at which time the CM would become the general contractor (GC) and construction could begin, creating an overlap of design and construction phases. Typically, a GMP agreement would include a shared savings provision as an incentive for the contractor to complete the project for less than the GMP.[7] As part of the department's CM/GC method, all construction expenditures by the contractor would be audited by the LDS finance department to ensure that all charges were accurate and valid as per the construction documents. All subcontractors would be jointly selected by the MFD and GC based upon price as well as qualifications.

An additional feature of the CM/GC delivery method, as adopted by the MFD, was the creation of a short list of pre-qualified meetinghouse contractors, referred as preferred contractors. These contractors were chosen based upon their previous meetinghouse construction experience and their capacity to construct multiple meetinghouse projects in different locations at the same time. Expected advantages included the establishment of long-term relationships with preferred contractors, predicted cost savings with multiple projects per contractor, quality improvements, and a reduction in construction cycle time. These expected advantages were based on multiple meetinghouses being constructed simultaneously by these preferred contractors.

The CM/GC delivery method was initiated in 1998, with the first Heritage 98 meetinghouses being completed in 1999. Although the CM/GC method of delivery was adopted

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[7] Trauner Consulting Services, Inc., "Construction Project Delivery Systems and Procurement Practices: Considerations, Alternatives, Advantages, Disadvantages, April 2007," *Trauner Consulting Services, Inc.,*Internet, available from http://www.fefpa.org/pdf/ summer2007/Pros-Cons-handout.pdf, accessed 17 Decemebr 2012.

for most meetinghouses, approximately one-third of the Heritage 98 projects, for the duration of this study, were still contracted using the existing DBB method. Preferred contractors were allowed to contract on both the CM/GC and the DBB projects. The MFD determined which delivery method to use on each project based upon project location and the degree of difficulty for site preparation.

1.3.2 Collaborative Partnering

To help facilitate a spirit of teamwork, cooperation, and communication with the preferred contractors involved in the CM/GC delivery method, the MFD required the CM/GC contractors to enter into a collaborative partnering agreement. Collaborative partnering should not be confused with contractual business partnering. Collaborative "partnering is a structured management approach to facilitate team working across contractual boundaries. Its fundamental components are formalized mutual objectives, agreed problem resolution methods, and an active search for continuous measurable improvements."[8]

The partnering agreement states that the commitments made by the project owner and general contractor include: 1) commitments to work as a team as full collaborative partners; 2) shared project objectives and goals; 3) roles of partnering members; 4) a dispute resolution plan; and 5) a system to measure commitment through follow-up[9]. This agreement is non-binding and

[8] Kawneer, "Kawneer White Paper 2001, Partnering," *Kawneer, An Alcoa Company,* Internet, available from http://www.kawneer.com/kawneer/united_kingdom/en/pdf/Partnering.pdf, accessed 20 January, 2014.

[9] International Partnering Institute, "Collaborative Construction, Lessons Learned for Creating a Culture of Partnership," *IPI,* Internet, available from http://www.partneringinstitute.org/PDF/A_Working_Model_for_Collaborative_Partnering_Special_Report_May_2010.pdf, accessed 30 October 2013.

does not change the contractual relationships between the two parties. It is a document reflecting the trust between the participants.[10]

As part of the MFD's partnering program, a steering committee was formed comprised of CEO's from some of the preferred contracting companies, an administrative member of the MFD, and a few construction industry peers. An operational committee was created using the MFD project managers, and finally a quality assurance committee was also formed, made up of an MFD quality assessment team.

With the partnering agreement, the CM/GC delivery method, as described above, was termed by the MFD as the "partnering program". The partnering program ran from 1998 until 2008, at which time it went through several changes and subsequently was renamed. For purposes of consistency, this paper will use the term CM/GC, instead of the term partnering, to describe the delivery method employed by the MFD.

1.3.3 Quality Assessment (QA) Program

The quality assurance/assessment (QA) program that the MFD had in place prior to the re-engineering effort begun in 1996 could be characterized as a simple audit performed by the MFD after the architect had certified substantial completion for each meetinghouse project. This audit typically resulted in another punch list for the general contractor to satisfy. The existing QA program at that time had no formal training element and no way to measure quality upon project completion.

[10] AGC, "Partnering, A Concept for Success (1991)," *The Associated General Contractors of America,* Internet, available from http://store.agc.org/Management-And-Operations/Marketing-Business-Development/2900E, accessed 30 October 2013.

As part of the re-engineering effort, the MFD directors recommended the development of a QA tool that would objectively measure performance and quality on a scheduled basis. The previous QA program was redesigned, over a nine-month period, with the assistance of MFD design engineers and architects, MFD project managers, and the regional preferred contractors. The resulting QA tool evaluated the quality of construction using approximately 100 questions, which each measured item receiving a rating from one to three. A score of one represented a high level of workmanship and strict adherence to contract documents; whereas, a score of three represented poor workmanship and non-compliance with project plans and specifications. In contrast to the previous QA tool, the new tool conducted the quality testing throughout the construction cycle in addition to providing a final score upon project completion.

1.3.4 Value Managed Resources (VMR)

Once a standardized set of plans for the Heritage 98 meetinghouse was developed and adopted, long-term commitments between the MFD and specific vendors were established to take advantage of quantity pricing discounts for the procurement of key materials and equipment. By establishing VMR's with a few select vendors, it was believed that future maintenance and warranty work would be easier for MFD employees to manage. These VMR's were to be used by all contractors regardless of the delivery method selected (CM/GC or DBB).

1.4 Total Cost of Delivery

With the inclusion of CM/GC meetinghouse projects in addition to the DBB projects during the approximate 10-year period in question (1999-2008), the MFD and the church finance department periodically conducted side-by-side comparison studies of the two delivery methods. Both the MFD and the finance department measured differences between CM/GC and DBB with respect to costs of construction. The conclusion drawn by both departments was that the CM/GC method of contracting was costing between two and three percent more than the DBB method for the initial construction cost of the Heritage 98 meetinghouses. This conclusion along with subsequent studies seemed to lack a comprehensive metric that could measure all aspects of construction affected by the choice of delivery method, both in the short term as well as in the long term; in other words, a total cost of delivery over a given time period.

The total cost of delivery operates much like the concept of total cost of ownership (TCO), or the total cost of an asset over a given period of time.[11] For this study, a ten-year time period after project completion was used for compute costs between the two delivery methods in question. The criteria used to compare costs of construction included meetinghouse maintenance and repairs that were affected by, or were a result of, the respective delivery method. In order to gather the necessary data for maintenance and repairs over a ten-year period of time, for only projects completed from 1999, the first year using CM/GC, through 2003 were identified for this investigation. Any meetinghouse project constructed after 2003 would not have completed a 10-year life span by the time data was collected for this study. This important comparison of costs incurred within the first ten years of operation of the Heritage 98 meetinghouses was not considered in any prior studies. Only costs occurring through final completion had been evaluated previously.

For purposes of this study, the total cost of delivery also included any indirect, or soft, costs that were incurred as a result of the respective delivery methods. These soft costs included such things as contract administration, construction cycle time, and construction-related litigation

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[11] Jen Creighton and David Jobs, "Make a Case for Sustainability: Apply Total Cost of Ownership," *Construction Management Association of America,* Internet, available from http://cmaanet.org/files/shared/tco_white_paper.pdf, accessed 11 February 2013.

costs. Quality measurements between the two delivery methods were also compared using the QA tool scores as explained earlier.

1.5 The Problem Statement

The purpose of this research was to compare the two methods of project delivery, DBB and CM/GC, as used by the MFD for their Heritage 98 meetinghouse projects completed in the U.S. from 1999 through 2003, by comparing the total cost of delivery as explained above, to determine which method was the best value.

1.6 The Hypothesis

H_o: There are no significant differences between DBB and CM/GC delivery methods in measurements of cost, time, quality, or contract administration in the Heritage 98 meetinghouses completed from 1999 through 2003.

H_a: There are significant differences between DBB and CM/GC delivery methods in measurements of cost, time, quality, or contract administration in the Heritage 98 meetinghouses completed from 1999 through 2003.

2 REVIEW OF RELATED LITERATURE

2.1 Evolution of the Construction Delivery System

Throughout ancient history, the "master builder" was the backbone of every large construction project. His skills encompassed those of architect, engineer, and construction manager, providing a seamless service. The monumental structures of classical antiquity, the cathedrals of the Middle Ages, and the audacious domes of the Renaissance are just a few examples. Imhotep, master builder of the step pyramids of the 27th century BC, was considered the first master builder. Later, master builders included Filippo Brunelleschi and Michelangelo of the 14th Century[12] and John A. Roebling of the 19th Century.[13]

With the fall of empires, after the Renaissance, and reductions in seemingly endless amounts of building resources, master builders had to be more proficient in estimating costs and durations. Projects became smaller and more master builders were introduced into the market, creating more competition in the construction industry.[14] Figure 2-1 illustrates the contractual relationships entered into by master builders.

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[12] Lee Ellingson, "An Historical Perspective to Project Delivery Systems," *Indiana State University,* Internet, available from http://ascpro0.ascweb.org/archives/cd/2004/ 2004pro/2003/Ellingson04.htm, accessed 9 December 2013.

[13] Greg Ohrn and Thomas Rogers, "Defining Project Delivery Methods for Design, Construction, and Other Construction-Related Services in the United States," *Northern Arizona University,* Internet, available from http://ascpro0.ascweb.org/archives/cd/2008/paper/ CPGT293 002008.pdf, accessed 24 February 2014.

[14] Mark Konchar, "A Comparison of United States Project Delivery Systems," *Computer Integrated Construction,* Internet, available from http://www.engr.psu.edu/ae/cic/ publications/TechReports/TR_038_Konchar_Comparison_of_US_Proj_Del_Systems. pdf, accessed 27 December 2012.

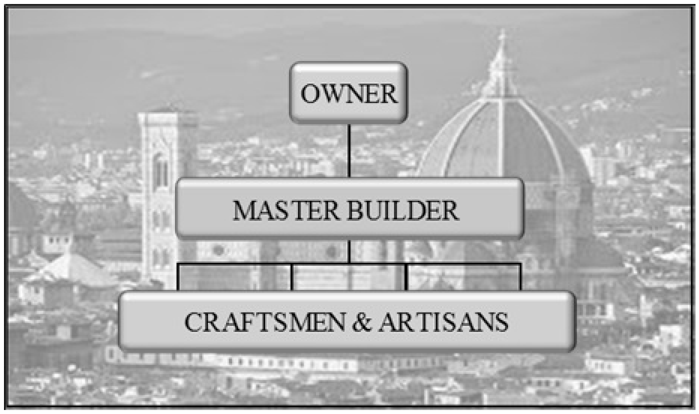

Figure 2-1: Contractual Relationships - Master Builder

The U.S. Industrial Revolution of the 1800's, brought about technological advances in both material and machinery resulting in more complicated structures. The 1800's saw a rise in professional societies in the construction industry which created a separation between design and construction. Architects and engineers became the design professionals, while construction contractors became the constructors. The American Society of Civil Engineers and Architects (later became the ASCE) was founded in 1852 to "promote the professional status of civil engineers and architects". Later, in 1918, the Associated General Contractors of America (AGC) was founded to promote the interests of the construction industry. This specialization divided the once seamless service of the Master Builder into distinct divisions of labor.[15]

The federal government, one of the largest purchasers of construction services, led the way in their requirements for construction services. Architectural and engineering services were based on qualification, but construction contractors were hired based on lowest bid. In order for competing contractors to produce accurate proposals, the drawings had to be as complete as

[15] Ellingson, "An Historical Perspective to Project Delivery Systems."

possible, creating a clear division between designers and constructors. This evolutionary process produced the linear sequence of the traditional design/bid/build (DBB) delivery method.

The competitive bidding process of DBB has historically been considered to be the most effective method of determining the lowest cost for constructing work described and defined by the bidding documents. However, the same competitive bidding process that results in the lowest cost of construction tends to create an adversarial relationship among all parties involved, including the designer who is expected to produce flawless plans. Due to the separation and sequence of design and construction, any constructive input by the contractor has typically been available only during the construction phase in the form of change orders. In summary, DBB creates several distinct teams, each one at odds with other contracting parties when any disagreements arise, creating a blame game. Figure 2-2 illustrates the contractual relationship in the DBB process.

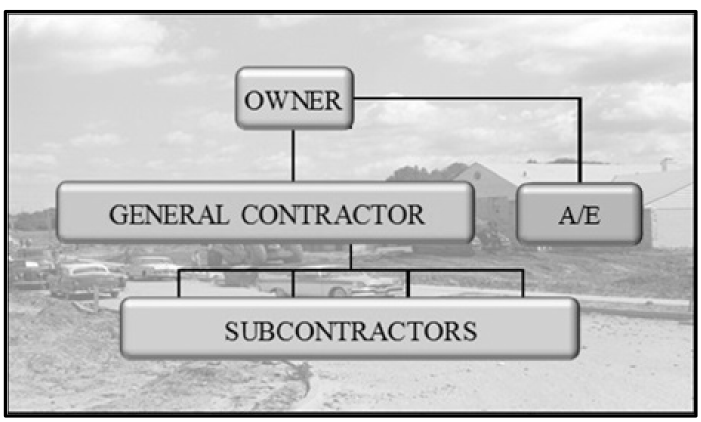

Figure 2-2: Contractual Relationships - Design/Bid/Build

In the 1960's high inflation added to the increasing sophistication of construction systems, creating a need for an advocate on behalf of the owner to bridge the gap between the owner, designer, and contractor.[16] The role of Construction Manager (CM) was developed with specialized knowledge, experience and resources to navigate through the complexities of a construction project.[17] From this service grew more delivery options for the project owner, namely Construction Manager as Agent/Advisor (CMa) and Construction Manager/General Contractor (CM/GC), also known as Construction Manager at Risk (CM@R) or Construction Manager as Contractor (CMc). In all of these arrangements the construction manager is brought onto the project in the early design phase. This is commonly termed as Early Contractor Involvement (ECI).[18] The experience of the construction manager can be of great value in regards to value engineering, means and methods, scheduling, and early design estimating. This results in a joint effort that encourages time and resource economy among the contracting parties. Figure 2-3 illustrates the contractual relationship in the CM/GC delivery system.

The late 1970's brought a spike in interest rates that translated literally into "time is money". As with CM/GC in the 1960's, a new delivery method was introduced in the 1970's, or rather the return of an ancient delivery system was witnessed. In 1978 the American Institute of Architects (AIA) lifted a ban on architects' participating in building contracting, thus ushering back the Master Builder concept of contracting in the form of Design/Build (DB). DB allowed

[16] George Heery, "A History of Construction Management, Program management, and Development Management," *Brookwood Group,* Internet, available from http://www.brookwoodgroup.com/downloads/2011_history_CMPMDM.pdf, accessed 24 February 2014.

[17] Construction Management Association of America, "An Owner's Guide to Construction Management, 2007," *CMAA,* Internet, available from http://www.healthdesign.org/sites/ default/files/an_owners_guide_to_construction_management.pdf, accessed 24 February 2014.

[18] Trauner Consulting Services, Inc., "Construction Project Delivery Systems and Procurement Practices: Considerations, Alternatives, Advantages, Disadvantages, April 2007."

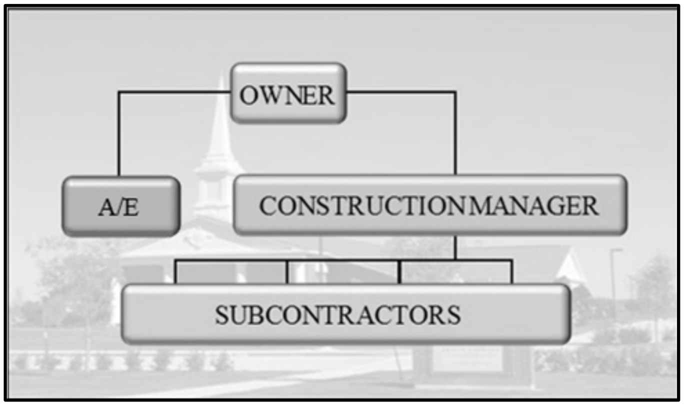

Figure 2-3: Contractual Relationships - Construction Manager/General Contractor

for an overlap in design and construction and a savings in time, which equates to money when financing a large construction project.[19] Figure 2-4 illustrates the contractual relationships for the DB delivery method.

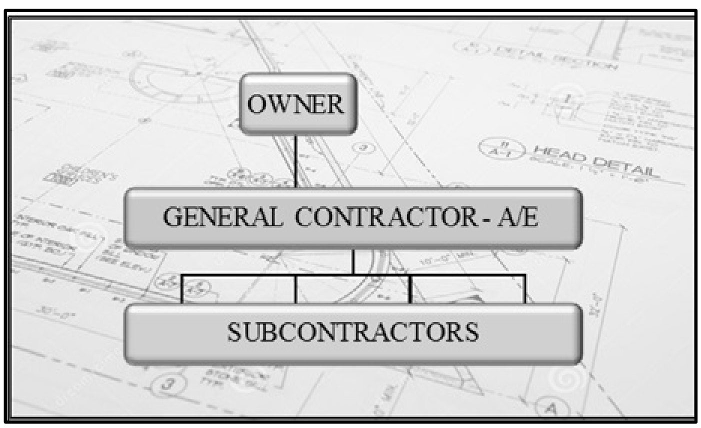

Figure 2-4: Contractual Relationships - Design/Build

With the introduction of computers and the Internet, the information revolution brought more changes and more delivery options to the construction industry. In conjunction with

[19] Ingram's, "A Brief History of Design/Build," *Ingram's* 29, no. 4 (2003):10. http://www.ingramsonline.com/april_2003/designbuild.html.

technology, the green movement has encouraged more efficient buildings which are less harmful to the environment. From this was born the Integrated Project Delivery (IPD) method, which has been defined by the AIA as "a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to reduce waste and optimize efficiency through all phases of design, fabrication and construction."[20] A major component of IPD is building information modeling (BIM) technology which uses "cutting edge digital technology to establish a computable representation of all physical and functional characteristics of a facility."[21] BIM has the ability to bring all of the stakeholders together in the early stages of design to effectively integrate contributions of each participant.[22] Figure 2-5 illustrates the IPD contractual relationships.

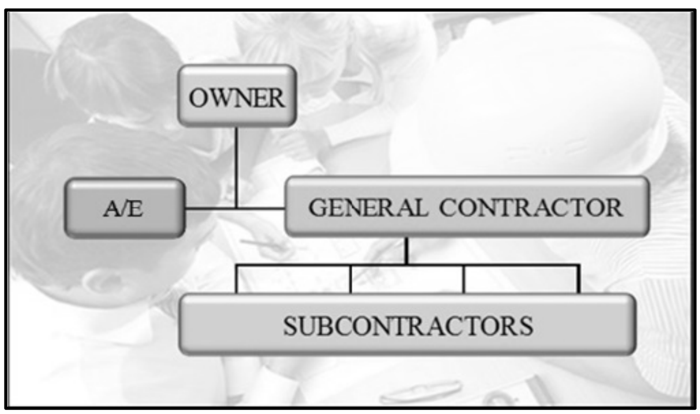

Figure 2-5: Contractual Relationships - Integrated Project Delivery

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[20] AIA," Integrated Project Delivery: A Guide (2007)," *The American Institute of Architects,* Internet, available from http://info.aia.org/siteobjects/files/ipd_guide_2007.pdf, accessed 14 April 2014.

[21] CSI, *The Construction Specifications Institute Project Delivery Practice Guide,* 149.

[22] Michael Kenig, "Integrated Project Delivery For Public and Private Owners (2010)," *NASFA, COAA, APPA, AGC and AIA,* Internet, available from http://www.agc.org/galleries/projectd/ IPD%20for%20Public%20and%20Private%20Owners.pdf, accessed 17 December 2012.

2.2 Delivery Method Market Share

According to RS Means, a leading construction information business, the DBB delivery method for the non-residential construction industry has been slowly declining while the use the DB and CM/GC delivery methods have been increasing in popularity, as observed in Figure 2-6.[23]

In the *Nonresidential Construction Index Report* for the first quarter of 2012, published by FMI Management Consultants for the Engineering and Construction Industry, the increased market share of CM/GC and Design/Build is directly related to poor results from inferior contractors using the Design/Bid/Build method. CM/GC was increasing in popularity because owners desired to involve construction managers earlier in the project for pre-construction services.[24]

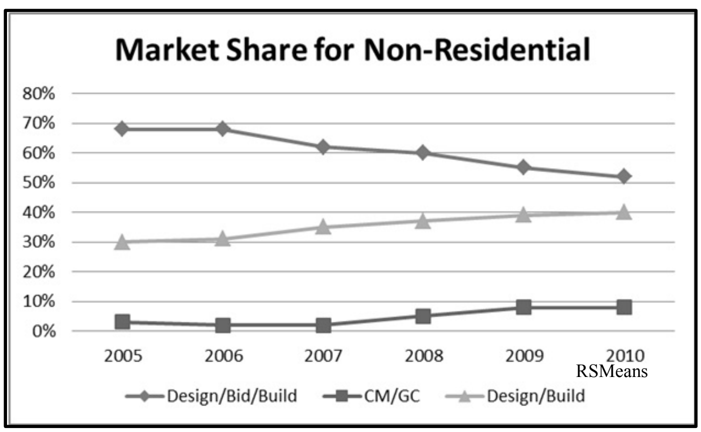

Figure 2-6: Delivery Method Market Share

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[23] DBIA, "Report by Reed Construction data/RSMeans Market intelligence," *Design-Build Institue of America,* Internet, available from www.dbia.org/resource-center/Pages/Report-by-RCD-RSMeans-Market-Intelligence.aspx, accessed 24 February 2014.

[24] FMI, "First Quarter 2012 Nonresidential Construction Index Report," *FMI Management Consulting for the Engineering and Construction Industry,* available from http://www. fminet.com/media/pdf/forecasts/NRCI_Q1_2012.pdf., accessed on 24 February 2014.

2.3 The Adversarial Delivery

The construction industry, like other economies, is based on the concept of supply and demand. Bringing supply (the building contractor) and demand (the project owner) together often involves an adversarial process, or tug-of-war between owner and contractor, where each party makes concessions in order to reach an acceptable agreement on contractual terms and price. Once in agreement, these "adversaries" ideally transition into collaborative partners in order to successfully complete the project. This transition into a team setting does not always occur smoothly, especially in the low-bid approach. Too often, the adversarial relationship persists between the project owner and the building contractor throughout the entire project and well after its completion.[25]

The idea of an adversarial relationship is not new to the construction industry. Even with the seamless service of the master builders of antiquity, disputes and disagreements existed during the construction process. In 1427, while the master builder Filippo Brunelleschi was working on the Florence Cathedral in Italy, tensions amongst the artisans reached such a rancorous level that Filippo and other citizens of Florence were made to swear an oath to "forgive injuries, lay down all hatred, entirely free themselves of any faction and bias, and to attend only to the good and the honour and the greatness of the Republic, forgetting all offences received to this day through the passions of party or faction or for any reason."[26]

The most common evidence today of the existence of an adversarial relationship in the construction process takes the form of contractual disputes and the resulting legal claims. In a

[25] Dennis Doran, "Roadblocks to Collaboration, FMI/CMAAs Fourth Annual Survey of Owners," *FMI/CMAA,* Internet, available from http://www.cmaafoundation.org/files/surveys/2003-survey.pdf, accessed 12 December 2013.

[26] Ross King, *Brunelleschi's Dome: The Story of the Great Cathedral in Florence* (London: Pimlico, 2001), 117-118.

proceedings report by the Federal Facilities Council titled, "Reducing Construction Costs", it was estimated that the transactional costs for resolving construction disputes and claims in the U.S. may total $4 billion to $12 billion or more each year. This is of importance because the cost of every commercial project affects the prices that must be charged for the goods and services that are produced in them—a ripple effect. These prices in turn affect the consumer as well as the ability of US businesses to compete in the global market.[27] Beyond the direct financial costs of disputes and claims are the indirect costs of time delays. A recent study found that construction disputes in the US lasted an average of 14.4 months each which translates into schedule overruns, reduced productivity, and additional debt service.[28] Jocelyn Knoll, from the construction law firm Dorsey & Whitney LLP, states that disputes and claims are an inevitable part of the construction process.[29]

Studies have been conducted to help pinpoint the causes of construction disputes and claims in order to find ways to reduce the damaging effects of adversarial relationships. Disputes arise from the nature of risk, or uncertainty, inherently a part of the construction industry where conditions and variables are very dynamic rather than static.[30] Material and labor prices rise and fall, victims of the supply and demand process with no regard to signed documents. Site conditions are not homogenous across the U.S., let alone on the construction site itself. In a study

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[27] Federal Facilities Council, "Reducing Construction Costs: Uses of Best Dispute Resolution Practices by Project Owners, Proceedings Report," *National Research Council,* Internet, available from http://www.nap.edu/openbook.php?record_id=11846, accessed 3 December 2013.

[28] Julie Goldstein, "Cost of Construction Disputes Going Down," *Fox Rothchild LLP,* Internet, available from file:///I:/Literature%20Review/Litigation/Cost%20of%20construction %20disputes%20going%20down%20%20%20Construction%20Law%20Blog.htm, accessed 9 November 2013.

[29] Jocelyn Knoll, "Construction Litigation," *Dorsey & Whitney LLP,* Internet, available from http://www.dorsey.com/en-US/abc.aspx?xpST=abc&url=http://www.dorsey.com/en-US/practices/uniEntity.aspx?xpST%3DServiceDetail%26service%3D149, accessed 3 December 2013.

[30] Federal Facilities Council, "Reducing Construction Costs: Uses of Best Dispute Resolution Practices by Project Owners, Proceedings Report (2007)."

conducted in 2011 by ARCADIS the most common causes of disputes in US construction projects were found to be[31]:

- Ambiguities in a contract document
- Incomplete design information
- Conflicting party interests
- Failure to make interim awards on extensions of time and monetary relief
- Failure to properly administer the contract

Because of these adversarial relationships, the construction industry has been very proactive in developing tools to prevent, control, and resolve disputes. For example, Building Information Modeling (BIM) is at the forefront of reducing design conflicts between trades by resolving potential dispute issues during the design phase rather than during construction. BIM helps give a more complete design through the use of 3-dimensional drawings of the construction elements.[32] Another tool, Critical Path Method (CPM) of scheduling, was developed to identify the dependent relationships between construction activities in order to find the critical ones that dictate the shortest possible schedule. Attention can be focused on the critical trades where potential conflicts or delays may arise. CPM also helps avoid disputes over time delays that do not affect the critical path or the ability to absorb a delay by shortening the duration of another critical activity.[33] Total Quality Management (TQM) and Continuous Improvement (CI) are also important methods aimed at improving the quality of goods and services in construction, where

[31] Goldstein, "Cost of Construction Disputes Going Down."

[32] Howard Ashcraft, "Building Information Modeling: A Framework for Collaboration," *Construction Lawyer* 28, no. 3 (2008): 1.

[33] Jesse Santiago and Desirae Magallon, "Critical Path Method," *Stanford University,* Internet, available from http://www.stanford.edu/class/cee320/CEE320B/CPM.pdf, accessed 18 January 2014.

all parties to the contract contribute to the success of the process. By carefully monitoring the processes, the quality and timeliness meet or exceed the contract requirements as well as the owner's expectations, once again avoiding disputes.[34] Another important tool to help reduce uncertainty and tension between owner and contractor, known as Alternative Dispute Resolution (ADR), includes practical options developed to resolve disputes without costly and lengthy court litigation. By using methods such as mediation and/or arbitration, disputes can be resolved quickly and with less expense than going to court while minimizing the amount of adversity and preserving the relationship between owner and contractor.[35]

2.4 Collaborative Partnering

In the late 1980's, the commercial construction industry experienced an especially high level of claims and litigation, effects of the adversarial delivery system. Total quality management (TQM) and alternative dispute resolution (ADR), both discussed earlier, provided techniques of team-building and collaboration to form a new construction process that came to be known as "partnering." Early advocates of the partnering movement included the Construction Industry Institute at the University of Texas, the US Army Corps of Engineers, and the Associated General Contractors of America (AGC).[36]

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[34] PHCC, "Total Quality Management: A Continuous Improvement Process," *PHCC Educational Foundation,* Internet, available from foundation.phccweb.org/files/2011Foundation /PDFs/TQM.doc. accessed 4 December 2013.

[35] Matthew Tucker, "An Overview of Alternative Dispute Resolution Use in the Construction Industry," *The University of Texas at Austin,* Internet, available from http://www.dtic. mil/dtic/tr/fulltext/u2/a458748.pdf, accessed 18 January 2014.

[36] Frank Carr, "Partnering, Aligning Interests, Collaboration, and Achieving Common Goals," *International Institute for Conflict Prevention & Resolution,* Internet, available from http://www.cpradr.org/Portals/0/Resources/ADR%20Tools/Tools/CPR%20Construction%20Partnering%20Briefing.pdf, accessed 25 February 2014.

According to these pioneers of partnering, the project contract is what establishes the legal relationship between construction stakeholders, whereas the non-binding partnering agreement "attempts to establish working relationships among the parties through a mutually-developed, formal strategy of commitment and communication." Teamwork and trust come together to create a win/win environment to facilitate a successful project completion.[37]

The US Army Corps of Engineers was the first organization to put partnering to the test. Seven essential characteristics of Partnering were identified in order to bring about its success. These essential characteristics can be seen in Figure 2-7 below.

ESSENTIAL CHARACTERISTICS OF PARTNERING [38]

Shared Interests – Stakeholders agree on a shared vision for the project and shared values for their relationship.

Mutual Goals – Stakeholders agree on a shared set of common objectives to achieve at project completion.

Commitment – Each stakeholder must be willing to make a real effort to participate in the partnership.

Teamwork – Partnering is not a one-way street and success comes from stakeholders working together for their mutual success.

Trust – Stakeholders actions are consistent and predictable, and their communications are open and honest.

Problem Solving – Stakeholders confront and resolve issues quickly and at the lowest level.

Synergistic Relationship – The stakeholders' joint efforts are more powerful than any of the stakeholders working alone because it is based on the collective resources of all stakeholders.

Figure 2-7: Essential Characteristics of Partnering

[37] AGC, "Partnering, A Concept for Success (1991)," *The Associated General Contractors of America,* Internet, available from http://store.agc.org/Management-And-Operations/Marketing-Business-Development/2900E, accessed 30 October 2013.

[38] US Army Corp of Engineers, "Partnering: A Tool for USACE, Engineering, Construction, and Operations," *US Army Corp of Engineers,* Internet, available from http://www.iwr.usace. army.mil/Portals/70/docs/iwrreports/91-ADR-P-4.pdf, accessed 18 October 2013.

The partnering charter brings all of the developed objectives into a written and signed agreement. Upon selection of a contractor, a partnering workshop is the key to educating all stakeholders involved to create the sense of teamwork. Periodic follow-up meetings are held to ensure that roles are understood and concerns are resolved.[39]

2.5 Conclusion

The project delivery process has evolved from the all-in-one master builder of antiquity to the distinct division of labor inherent in the DBB process dominating the today's modern construction industry. Ironically, shadows of the master builder are reappearing as evidenced with the increasing popularity of collaborative delivery methods such as CM/GC, DB, and IPD.

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[39] AGC, "Guidelines for a Successful Construction Project (2003)," *The Associated General Contractors of America,* Internet, available from http://www.mpgroup.com /documents/Guidelines.pdf, accessed 12 October 2013.

3 RESEARCH METHODOLOGY

3.1 Introduction

The purpose of this research was to determine whether the CM/GC delivery method made a significant difference in the total cost of delivery for the Heritage 98 meetinghouse projects completed from 1999 through 2003 as compared to the DBB delivery method. Financial data, including costs of construction, costs of operation and maintenance, legal costs, etc., for all meetinghouses built during the period of time addressed in this study was made available to the author by the MFD at their headquarters in Salt Lake City, Utah. In addition to the financial costs associated with the meetinghouses, survey instruments were developed to gather perceptions of both the preferred contractors and the MFD project managers that were involved in both methods of delivery during the time frame of this study. Respondents were asked to evaluate specific aspects of the contracting process. Most responses in the surveys were measured using a Likert scale. Each survey also included a section allowing respondents to list in priority order best practices for project success.

3.2 Populations of Interest

For this study, there were three populations of interest. The first population consisted of Heritage 98 meetinghouse projects completed in the U.S. from 1999 through 2003. The other populations of interest were the preferred contractors and MFD project managers that were involved in meetinghouse projects of both delivery styles, CM/GC and DBB.

3.2.1 Heritage 98 Meetinghouse Projects

The MFD generated a list of 205 qualifying projects that were completed from 1999 through 2003 in the U.S. As explained earlier, the preferred contractors identified by the MFD were also allowed to bid on DBB meetinghouse projects. This resulted in a third delivery method in addition to CM/GC and DBB. These DBB meetinghouse projects contracted by a preferred contractor (DBB/PC) were treated as a separate delivery method for this study. An MFD project manager commented that his relationship with preferred contractors did not change significantly whether the preferred contractor was on a CM/GC or a DBB meetinghouse project. For this reason, the study will compare meetinghouses delivered using the CM/GC method with preferred contractors to meetinghouses delivered using the DBB method contracted only by non-preferred contractors. The 205 projects were separated into the three different delivery methods for this study as explained in Table 3-1 below.

Table 3-1: Delivery Method Distribution

Method	Year Completed					Total
	1999	2000	2001	2002	2003	
CM/GC	8	12	24	46	39	129
DBB	8	15	9	5	7	44
DBB/PC	8	15	4	1	4	32
Total	24	42	37	52	50	205

Only the 129 meetinghouses built by preferred contractors using the CM/GC delivery method and the 44 meetinghouses built by non-preferred contractors using the DBB delivery method were subjects of this comparative study. The distribution of meetinghouses examined in this study by location (state) and year of completion are shown in Table 3-2 below.

Table 3-2: Project Distribution by State and Year

State	Year Completed					Total
	1999	2000	2001	2002	2003	
Alaska	0	0	1	1	0	2
Arizona	1	4	3	4	7	19
California	0	0	2	1	2	5
Colorado	0	1	0	1	0	2
Florida	0	0	1	0	0	1
Georgia	0	0	0	1	1	2
Hawaii	0	0	0	1	1	2
Idaho	2	3	1	2	2	10
Maryland	0	0	0	1	0	1
Massachusetts	0	0	0	1	0	1
Minnesota	0	0	0	0	1	1
Missouri	0	1	0	0	0	1
Nebraska	0	1	0	0	0	1
Nevada	1	2	1	2	6	12
North Carolina	0	0	1	0	0	1
Ohio	0	0	0	1	0	1
Oregon	0	1	0	0	1	2
Pennsylvania	0	0	0	0	1	1
Texas	1	0	0	2	4	7
Utah	11	13	20	33	18	95
Washington	0	1	3	0	2	6
Total	16	27	33	51	46	173

3.2.2 Preferred Contractors

Seventeen preferred contractors were originally identified by the MFD for this study, of which five were no longer in business or had sold out to another company at the time of this report. An important feature of the MFD's CM/GC delivery method was the condensed list of preferred contractors. Of the 17 preferred contractors identified, 12 of them built all 129 CM/GC meetinghouse projects, while 32 non-preferred contractors built the 44 DBB projects in this study. Of the 12 preferred contractors, 2 of them built approximately 53 percent of the 129 CM/GC meetinghouse projects. The most meetinghouses built by any single non-preferred contractor using the DBB delivery were 4. Tables 3-3 and 3-4, below, list the number of projects per contractor for both non-preferred (DBB) contractors and preferred (CM/GC). Capital letters in the first column of each table represent individual contractors.

Table 3-3: Projects Completed per Individual CM/GC Contractor

CM/GC Contractors	Year Completed					Total
	1999	2000	2001	2002	2003	
AG	-	-	-	-	1	1
AH	-	-	1	1	1	3
AI	-	-	1	3	1	5
AJ	-	-	1	3	2	6
AK	-	3	1	2	1	7
AL	-	-	2	3	2	7
AM	-	-	2	3	3	8
AN	-	-	1	4	3	8
AO	-	-	2	2	4	8
AP	-	-	3	3	2	8
AQ	5	4	5	9	9	32
AR	3	5	5	13	10	36
Total	8	12	23	45	37	129

Table 3-4: Projects Completed per DBB Contractor

DBB Contractors	Year Completed					Total
	1999	2000	2001	2002	2003	
A	-	1	-	-	-	1
B	-	1	-	-	-	1
C	-	-	1	-	-	1
D	-	-	-	1	-	1
E	-	1	-	-	-	1
F	-	1	-	-	-	1
G	-	-	1	-	-	1
H	-	-	-	-	1	1
I	-	-	1	-	-	1
J	-	-	1	-	-	1
K	-	1	-	-	-	1
L	-	-	1	-	-	1
M	1	-	-	-	-	1
N	-	1	-	-	-	1
O	-	1	-	-	-	1
P	1	-	-	-	-	1
Q	1	-	-	-	-	1
R	-	-	1	-	-	1
S	-	-	-	1	-	1
T	-	1	-	-	-	1
U	-	1	-	-	-	1
V	-	-	-	-	1	1
W	-	-	-	-	1	1
X	-	-	-	1	-	1
Y	2	-	-	-	-	2
Z	2	-	-	-	-	2
AA	-	-	-	1	1	2
AB	-	2	-	-	-	2
AC	-	-	2	-	-	2
AD	-	-	-	-	3	3
AE	-	1	1	1	-	3
AF	1	3	-	-	-	4
Total	3	9	6	3	3	44

3.2.3 Project Managers

Twenty-three MFD project managers were identified as owner's representatives on the 173 meetinghouse projects examined in this study. Of these, 9 were no longer employed by the department and were unavailable at the time of this study.

3.3 Data Gathering

Due to the sensitivity of the financial information regarding meetinghouse construction, and as per agreement with the MFD, all costs in this study will be expressed as percentages of average costs. The comparative findings for this study would be the same, whether actual dollar amounts or percentages were used.

All Heritage 98 meetinghouse data pertinent to this study was made available to the author of this study at the MFD headquarters in Salt Lake City, Utah beginning in April of 2013 with the permission of the Presiding Bishopric of the Church of Jesus Christ of Latter-day Saints. The financial data accessed consisted primarily of the construction cost breakdowns for the Heritage 98 meetinghouses built in the U.S. and completed from 1999 through 2008. Due to the 10-year life cycle for this study, those meetinghouses completed after 2003 were removed from the population. Once the number of meetinghouses was determined, Operations & Maintenance (O&M) and Repair & Improvement (R&I) expenditure reports for the first ten years of operation for each meetinghouse were retrieved and also made available to the author. All financial data came from primary sources.

3.3.1 Initial Costs

The initial construction cost database used in this report was generated with the help of MFD employees and consolidated onto one spreadsheet which included the property control number, property location, name of contractor, delivery method, contractor preferred status, start and finish dates, and itemized construction costs for each meetinghouse. The spreadsheet expressing the initial cost of each meetinghouse project as a percentage of the average cost of all meetinghouse projects is included in Appendix A.

3.3.2 Maintenance and Repairs

The maintenance and repairs cost database used in this report was generated with the help of MFD employees and included the property control number, property location, date of expenditure, description or category of service, and cost breakdown. Due to the detailed description of property repairs, only the repair costs that resulted from defective work associated with the original construction contract were included in the study. Routine maintenance costs for typical wear and tear were excluded as well as repairs due to vandalism, fire, or flood, unless they were caused by errors or omissions in the original construction.

3.3.3 Construction-Related Litigation Costs

Detailed information regarding the construction-related litigation costs was unavailable from the MFD legal representatives. However, the MFD provided litigation data from an earlier report by their legal firm based upon the same time period of this study. These costs were considered by the Directors of the MFD to fairly represent legal costs incurred for initiating or defending claims arising from contract disputes associated with the meetinghouses described in this study.

3.3.4 MFD Employee Allocation

The MFD provided data from an earlier study regarding the number of full-time MFD project managers employed before implementation of the standardized Heritage 98 meetinghouse plan and the adoption of the CM/GC delivery method and the reduced number of full-time MFD project managers employed after implementation of the standardized Heritage 98 meetinghouse plan and the adoption of the CM/GC delivery method. This reduction of full-time MFD projects managers was partially offset by the hiring of lower pay-grade project clerks. The savings resulting from the reduction of full-time MFD project managers was not broken down to isolate the specific savings attributable to the CM/GC delivery method, only an overall savings.

3.3.5 Quality Assurance (QA) Scores

Due to the proprietary nature of the QA tool developed by the MFD, permission to include the tool content was not extended for this study. However, the results of over 300 randomly sampled QA inspections on meetinghouses included in this study, conducted by the MFD's QA team, were integrated into this report. The previous study included data from the same time period of this current study and was based on random samplings of the two methods of delivery in question, CM/GC and DBB.

3.3.6 Contract Administration Surveys

Contract administration survey instruments were developed with the assistance of construction professionals, an associate research professor in the Department of Statistics, and several full-time faculty members in the Construction Management Program in the School of Technology at Brigham Young University. The surveys were directed to those preferred contractors and MFD project managers that were involved with the completion of Heritage 98 meetinghouses from 1999 through 2003 consisting of both CM/GC and DBB methods of delivery.

The survey consisted of eleven statements focused on the objectives of partnering, of limiting the number of preferred contractors, and of construction management methods. A twelfth statement focused on one possible disadvantage of the GMP pricing method as part of the CM/GC delivery method (see Figure 3-1 below).

The Twelve Survey Statements

1. CM/GC projects exhibited better teamwork and mutual trust when compared to DBB projects.
2. CM/GC projects had fewer owner/contractor initiated change order delays when compared to DBB projects.
3. CM/GC projects were easier to supervise as compared to DBB projects.
4. Communications with MFD employed PM's/job superintendents were more fluid on CM/GC projects when compared to DBB projects.
5. Disputes arising from change orders were fewer with CM/GC projects when compared to DBB projects.
6. I processed/requested fewer RFIs with CM/GC projects when compared to DBB projects.
7. Project related paperwork was lighter with CM/GC projects when compared to DBB projects.
8. Project Quality Assurance inspections had fewer corrections with CM/GC projects when compared to DBB projects.
9. Cost, quality, and timeliness efficiencies improved faster on CM/GC projects when compared to DBB projects.
10. The project quality was expected to exceed on CM/GC projects when compared to DBB projects.
11. I experienced no litigation on my CM/GC projects.
12. The CM/GC delivery method was a win/win delivery method.

Figure 3-1: Twelve Survey Statements

For the twelve statements listed in the survey, a five-point Likert scale was used to measure the degree to which the respondent agreed with the each statement. The answers consisted of five possible numeric responses, ranging from Strongly Disagree (1) to Strongly Agree (5). The survey ended with a request for the respondent to list and rank the top three to five best practices contributing to a successful meetinghouse project.

A preliminary test was conducted to determine relevancy and accuracy of the first draft of the survey. Two potential participants in this study were contacted by phone and asked to respond to the 12 statements and give comments regarding the survey itself. One of the participants was a preferred contractor, and the other was an MFD project manager. Based upon their feedback, the survey instrument was adjusted slightly and finalized for distribution to all participants.

These twelve statements were grouped into four main categories as described below.

Partnering Objectives – Statements 1 and 2 focused on teambuilding, based on mutual trust and open communication. Statements 4, 5, 11 and 12 are related to goals and objectives that create a win/win mindset where problem solving occurs at the lowest levels, potentially reducing the occurrence of change orders, disputes, and litigation

Limiting the Number of Preferred Contractors – Statements 8 and 10 focused on the MFD's goal to use fewer preferred contractors to achieve higher quality meetinghouses through continuous improvements in the quality of construction, project schedule duration, and cost of construction. Statement 3 reflects the goal that with preferred contractors, it would be easier for MFD project managers to supervise projects and establish long-term relationships.

Construction Management Objectives – Statement 6 reflected the goal of involving the preferred contractor early in the process to reduce the need for RFI's. Statement 9 is focused on improved working relationships to develop continuous improvement by removing non-value-added costs, by value-engineering, and by encouraging aggressive learning curves among participants.

Guaranteed Maximum Price – Statement 7 focused on the paperwork requirements associated with the CM/GC's Guaranteed Maximum Price agreement as compared to the DBB's lump-sum contract pricing.

A survey instrument was mailed to each of the twelve preferred contractors identified in this study. A title page was included to explain the purposes of the survey, and a self-addressed envelope was also included for ease of returning the completed survey to the author of the study.

Of the twelve contractors, seven responded with completed surveys. The other five were contacted at least two additional times but did not respond. The MFD project managers were first contacted via e-mail to solicit their involvement in the survey and to obtain mailing addresses. Of the fourteen project managers identified, eight responded with addresses, and six eventually completed the survey. (A copy of the survey instrument and title page can be found in Appendix B.)

3.4 Observational Study

This study is classified as observational in nature, because the researcher had no control over the variables or the selection and assignment of the participants. Observational studies attempt to understand cause-and-effect relationships. In an observational study one cannot rule out confounding variables, also termed plausible alternative explanations, for group differences in measured outcomes. In simple terms, there might exist more than one reason for a measured result[40].

With the help of an MFD analyst and an associate statistical research professor from the university, a meeting was held to identify and define any possible confounding variables related to the cost data provided that might bias the study results. Several possible confounding variables were recognized, including the following: inflation during the 15-year time period of this study, the regional effect on the cost of labor and materials during construction; differing site conditions

[40] Fred L. Ramsey and Daniel W. Schafer, *The Statistical Sleuth* (Belmont: Brooks/Cole, 2002), 5-7.

affecting the initial cost of construction; the construction cycle time for each method; project-specific modifications to each meetinghouse; the choice of exterior finish style; and the contractor's fees.

3.4.1 Cost Basis

This study involves meetinghouse projects completed in the U.S. over a 5-year period, from 1999 through 2003. The time value of money for this 5-year time period was taken into consideration due to the effect of inflation. In addition to adjusting for inflation, the price for labor and materials differed from state to state and from city to city, due in large part to the regional effects of the supply of labor and materials. In order to perform a more accurate comparison between meetinghouse projects throughout different regions of the U.S., a standard cost basis was identified to account for these differences in the costs of construction based on time and location.

The Reed Construction Data Company (RSMeans), a leading construction information business has been a trusted name in estimating construction costs for more than 70 years and publishes *Historical Costs Indexes* annually. The index tables are calculated based on a 30-city national average of costs on January 1, 1993. This base index average has a value of 100, or 100 percent.

The tables contain indexes for 199 major US cities on a yearly basis from 1993 to 2013 and on a ten-year basis for each decade from 1940 to 1990 as seen below in Table 3-5. Each index value, for a particular city and for a particular year, is a comparison to the base national average of 1993 (see circled value in column 2 titled Base National Average in Table 3-5 below). For example, the index of 149.7 for Salt Lake City, Utah in 2008 (see circled value in column 3 titled Salt Lake City, Utah 2008 in Table 3-5 below) means that the cost of constructing a building in Salt Lake City, Utah in 2008 would be approximately 149.7 percent of the national average to construct the exact same building in 1993, the base year referenced. The same building constructed in Salt Lake City, Utah in 1975, on the other hand, would be 40.1 percent of the dollar amount cost when compared to the 1993 national average basis (see circled value in column 3 titled Salt Lake City, Utah 1975 in Table 3-5 below).

Table 3-5: Historical Cost Index 1940 - 2013

Means Historical Cost Indexes 2013

Year	National 30 City Average	Utah Salt Lake City	Vermont Burlington	Vermont Rutland	Virginia Alexandria	Virginia Newport News	Virginia Norfolk	Virginia Richmond	Virginia Roanoke	Washington Seattle	Washington Spokane	Washington Tacoma	West Virginia Charleston	West Virginia Huntington	Wisconsin Green Bay	Wisconsin Kenosha
Jan 2013	196.9	171.1	178.7	176.6	185.0	170.0	171.5	170.7	168.3	203.4	184.3	199.1	187.2	193.2	193.9	201.2
2012	194.0	168.8	172.4	170.5	182.4	168.3	169.7	169.4	166.4	201.9	181.6	194.3	183.4	186.4	190.0	195.5
2011	185.7	161.8	158.8	157.1	174.5	159.8	161.1	159.0	154.2	194.1	175.5	187.6	177.5	180.3	181.4	187.6
2010	181.6	160.9	156.3	154.6	170.9	156.7	158.0	156.6	151.8	191.8	171.5	186.0	171.6	176.1	179.0	185.1
2009	182.5	160.4	158.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	188.5	173.0	186.3	174.6	177.4	175.5	182.5
2008	171.0	149.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	176.9	162.4	174.9	162.8	165.7	165.6	172.2
2007	165.0	144.6	144.4	143.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	171.4	156.7	168.7	158.7	160.1	159.4	164.8
2006	156.2	137.7	131.7	130.7	146.2	133.7	134.6	134.8	129.7	162.9	150.1	160.7	149.4	151.4	152.7	157.1
2005	146.7	129.4	124.6	123.8	136.5	123.5	124.4	125.4	112.2	153.9	141.9	151.5	140.8	141.0	144.4	148.3
2004	132.8	117.8	113.0	112.3	121.5	108.9	110.2	110.9	99.7	138.0	127.6	134.5	124.8	125.6	128.9	132.4
2003	129.7	116.0	110.7	110.1	119.5	104.8	106.2	108.6	97.0	134.9	125.9	133.0	123.3	123.6	127.4	130.9
2002	126.7	113.7	109.0	108.4	115.1	102.9	104.1	106.6	95.2	132.7	123.9	131.4	121.2	120.9	123.0	127.3
2001	122.2	109.1	105.7	105.2	110.8	99.8	100.3	102.9	92.1	127.9	120.3	125.7	114.6	117.5	119.1	123.6
2000	118.9	106.5	98.9	98.3	108.1	96.5	97.6	100.2	90.7	124.6	118.3	122.9	111.5	114.4	114.6	119.1
1999	116.6	104.5	98.2	97.7	106.1	95.6	96.5	98.8	89.8	123.3	116.7	121.6	110.6	113.4	112.1	115.8
1998	113.6	99.5	97.8	97.3	104.1	93.7	93.9	97.0	88.3	119.4	114.3	118.3	106.7	109.0	109.5	112.9
1997	111.5	97.2	96.6	96.3	101.2	91.6	91.7	92.9	86.9	118.1	111.7	117.2	105.3	107.7	105.6	109.1
1996	108.9	94.9	95.1	94.8	99.7	90.2	90.4	91.6	85.5	115.2	109.2	114.3	103.1	104.8	103.8	106.4
1995	105.6	93.1	91.1	[illegible]	[illegible]	[illegible]	[illegible]	87.8	82.8	113.7	107.4	112.8	95.8	97.2	97.6	97.9
1994	103.0	90.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	81.4	109.9	104.0	108.3	94.3	95.3	96.3	96.2
1993	100.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	79.5	107.3	103.9	106.7	92.6	93.5	94.0	94.3
1990	93.2	84.3	83.0	[illegible]	[illegible]	[illegible]	[illegible]	77.6	76.1	100.1	98.5	100.5	86.1	86.8	86.7	87.8
1985	81.8	75.9	74.8	74.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	88.3	89.0	91.2	77.7	77.7	76.7	77.4
1980	60.7	57.0	55.3	58.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	67.9	66.3	66.7	57.7	58.3	58.6	58.3
1975	43.7	40.1	[illegible]	43.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44.9	44.4	44.5	41.0	40.0	40.9	40.5
1970	27.8	26.1	25.4	26.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	28.8	29.3	29.6	26.1	25.8	26.4	26.5
1965	21.5	20.0	19.8	20.6	20.2	18.4	17.1	17.2	18.3	22.4	22.5	22.8	20.1	19.9	20.3	20.4
1960	19.5	18.4	18.0	18.8	18.4	16.7	15.4	15.6	16.6	20.4	20.8	20.8	18.3	18.1	18.4	18.6
1955	16.3	15.4	15.1	15.7	15.4	14.0	12.9	13.1	13.9	17.1	17.4	17.4	15.4	15.2	15.5	15.6
1950	13.5	12.7	12.4	13.0	12.7	11.6	10.7	10.8	11.5	14.1	14.4	14.4	12.7	12.5	12.8	12.9
1945	8.6	8.1	7.9	8.3	8.1	7.4	6.8	6.9	7.3	9.0	9.2	9.2	8.1	8.0	8.1	8.2
1940	6.6	6.3	6.1	6.4	6.2	5.7	5.3	5.3	5.7	7.0	7.1	7.1	6.2	6.2	6.3	6.3

Salt Lake City, Utah 2008

Base National Average

Salt Lake City, Utah 1975

To help illustrate how the index is used, an example follows. A building was constructed in Spokane, Washington in 2000 for a known cost of $100,000.00. To estimate the cost of the same building had it been built in Salt Lake City, Utah in 2013, a simple calculation is performed using the Historical Cost Indexes. The index of 171.1 for the estimate city (see circled value in column 3 titled Salt Lake City, Utah 2013 in Table 3-6 below) is divided by the index of 118.3 for the actual city, Spokane, Wa. 2000 (see circled value in column 12 of Table 3-6 below). The result is then multiplied by the known cost ($100,000.00) producing the estimated cost ($144,801.35) for Salt Lake City, Utah in 2013 as seen in Figure 3-2 below.

Table 3-6: Example Index

Means Historical Cost Indexes 2013

	National	Utah	Vermont		Virginia					Washington			West Virginia		Wisconsin	
Year	30 City Average	Salt Lake City	Bur-lington	Rutla[illegible]	Alex-[illegible]	Newport [illegible]	[illegible]	Rich-[illegible]	[illegible]	Seattle	Spokane	Tacoma	Charles-ton	Hunt-ington	Green Bay	Kenosha
Jan 2013	196.9	171.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	203.4	184.3	199.1	187.2	193.2	193.9	201.2
2012	194.0	168.8	172.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	201.9	181.6	194.3	183.4	186.4	190.0	195.5
2011	185.7	161.8	158.8	157.1	174.5	159.8	161.1	159.0	154.2	194.1	175.5	187.6	177.5	180.3	181.4	187.6
2010	181.6	160.9	156.3	154.6	170.9	156.7	158.0	156.6	151.8	191.8	171.5	186.0	171.6	176.1	179.0	185.1
2009	182.5	160.4	158.3	156.7	172.5	160.0	161.9	160.7	155.6	188.5	173.0	186.3	174.6	177.4	175.5	182.5
2008	171.0	149.7	147.2	145.8	161.8	150.8	150.8	150.9	145.9	176.9	162.4	174.9	162.8	165.7	165.6	172.2
2007	165.0	144.6	144.4	143.2	155.0	146.2	146.1	147.3	142.9	171.4	156.7	168.7	158.7	160.1	159.4	164.8
2006	156.2	137.7	131.7	130.7	146.2	133.7	134.6	134.8	129.7	162.9	150.1	160.7	149.4	151.4	152.7	157.1
2005	146.7	129.4	124.6	123.8	136.5	123.5	124.4	125.4	112.2	153.9	141.9	151.5	140.8	141.0	144.4	148.3
2004	132.8	117.8	113.0	112.3	121.5	108.9	110.2	110.9	99.7	138.0	127.6	134.5	124.8	125.6	128.9	132.4
2003	129.7	116.0	110.7	110.1	119.5	104.8	106.2	108.6	97.0	134.9	125.9	133.0	123.3	123.6	127.4	130.9
2002	126.7	113.7	109.0	108.4	115.1	102.9	104.1	106.6	95.2	132.7	123.9	131.4	121.2	120.9	123.0	127.3
2001	122.2	109.1	105.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	127.9	120.3	125.7	114.6	117.5	119.1	123.6
2000	118.9	106.5	98.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	118.3	122.9	111.5	114.4	114.6	119.1
1999	116.6	104.5	98.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	123.3	116.7	121.6	110.6	113.4	112.1	115.8
1998	113.6	99.5	97.8	97.3	104.1	93.7	93.9	97.0	88.3	119.4	114.3	118.3	106.7	109.0	109.5	112.9
1997	111.5	97.2	96.6	96.3	101.2	91.6	91.7	92.9	86.9	118.1	111.7	117.2	105.3	107.7	105.6	109.1
1996	108.9	94.9	95.1	94.8	99.7	90.2	90.4	91.6	85.5	115.2	109.2	114.3	103.1	104.8	103.8	106.4
1995	105.6	93.1	91.1	90.8	96.3	86.0	86.4	87.8	82.8	113.7	107.4	112.8	95.8	97.2	97.6	97.9
1994	103.0	90.2	89.5	89.3	93.9	84.6	84.8	86.3	81.4	109.9	104.0	108.3	94.3	95.3	96.3	96.2
1993	100.0	87.9	87.6	87.6	91.6	82.9	83.0	84.3	79.5	107.3	103.9	106.7	92.6	93.5	94.0	94.3
1990	93.2	84.3	83.0	82.9	86.1	76.3	76.7	77.6	76.1	100.1	98.5	100.5	86.1	86.8	86.7	87.8
1985	81.8	75.9	74.8	74.9	75.1	68.7	68.8	69.5	67.2	88.3	89.0	91.2	77.7	77.7	76.7	77.4
1980	60.7	57.0	55.3	58.3	57.3	52.5	52.4	54.3	51.3	67.9	66.3	66.7	57.7	58.3	58.6	58.3
1975	43.7	40.1	41.8	43.9	41.7	37.2	36.9	37.1	37.1	44.9	44.4	44.5	41.0	40.0	40.9	40.5
1970	27.8	26.1	25.4	26.8	26.2	23.9	21.5	22.0	23.7	28.8	29.3	29.6	26.1	25.8	26.4	26.5
1965	21.5	20.0	19.8	20.6	20.2	18.4	17.1	17.2	18.3	22.4	22.5	22.8	20.1	19.9	20.3	20.4
1960	19.5	18.4	18.0	18.8	18.4	16.7	15.4	15.6	16.6	20.4	20.8	20.8	18.3	18.1	18.4	18.6
1955	16.3	15.4	15.1	15.7	15.4	14.0	12.9	13.1	13.9	17.1	17.4	17.4	15.4	15.2	15.5	15.6
1950	13.5	12.7	12.4	13.0	12.7	11.6	10.7	10.8	11.5	14.1	14.4	14.4	12.7	12.5	12.8	12.9
1945	8.6	8.1	7.9	8.3	8.1	7.4	6.8	6.9	7.3	9.0	9.2	9.2	8.1	8.0	8.1	8.2
1940	6.6	6.3	6.1	6.4	6.2	5.7	5.3	5.3	5.7	7.0	7.1	7.1	6.2	6.2	6.3	6.3

Salt Lake City, Utah 2013

Spokane, Washington 2000

$$\frac{\text{ESTIMATE CITY INDEX}}{\text{ACTUAL CITY INDEX}} \text{ x ACTUAL COST = ESTIMATED COST}$$

INDEX SALT LAKE CITY, UT in 2013 = 171.1
INDEX SPOKANE, WA in 2013 = 118.3

$$\frac{\text{INDEX SALT LAKE CITY, UT 2013}}{\text{INDEX SPOKANE, WA 2000}} \text{ x Cost SPOKANE 2000 = Cost SLC 2013}$$

$$\frac{171.3}{118.3} \text{ x \$100,000.00 = \$144,801.35}$$

Figure 3-2: Example Calculation

Based on the above calculation, the exact same building that was constructed in Spokane, Washington in 2000 for $100,000.00 “would have” cost approximately $144,801.35 “if” it had been built in Salt Lake City, Utah in 2013. All meetinghouse costs of construction were thus adjusted for comparative purposes making it possible to compare apples to apples.

The *Means Historical Costs Indexes 2013* was provided courtesy of RSMeans to be used specifically for this study. The data set in Appendix A includes the index values of each meetinghouse project in this study. For purposes of accuracy, the closest indexed city to each meetinghouse project was identified, but only the state in which each meetinghouse was built is noted in Appendix A, column 4.

3.4.2 Initial Cost of Construction and Cycle Time

Due to differing site conditions and local building codes specific to each meetinghouse, no feasible solution to adjust the data for comparing site preparation and foundation costs was discovered, so it was decided to exclude all costs incurred for site preparation and foundation work on each meetinghouse. These costs included demolition, grading and earthwork, engineering, excavation, footings and foundation, asphalt, landscaping, and other related expenditures. With the exception of owner-provided materials and furnishings, building permits, architectural fees, taxes, and other goods and services that were not relevant to the method of project delivery or controlled by the general contractor, only the costs incurred above-slab were taken into consideration for this study

The construction cycle time of each meetinghouse project was calculated in calendar days, starting with the Notice to Proceed (NTP) date and ending with the Certificate of Substantial Completion (CSC) date. The cycle time included any extensions of time granted for change orders. Because the cycle times provided for this study included site and foundation work, there was a possible confounding variable of not knowing which projects required more time due to more difficult site conditions. As mentioned earlier, the MFD stated that site conditions were an integral part of the decision-making process as to which method of delivery to assign to a project. In almost all cases, the more difficult projects were contracted using the CM/GC delivery method. It is logical to infer that the more difficult the site conditions were, the more costly the site and foundation work would be. To verify this inference, an analysis was performed on all 173 meetinghouse projects, ranking each CM/GC and DBB projects based on the project site and foundation costs after adjusting for time and location with the Historical Cost Indexes. The costs were converted to a percentage of the overall average cost for reasons of privacy. The list of project rankings can be found in Appendix C.

After ranking the projects from the most expensive to the least expensive, each project was given a ranking value from 1 (the most expensive) to 173 (the least expensive). After adding together the ranking values for each delivery method, the average ranking value for the CM/GC projects was 81.2 (more expensive) while the DBB projects averaged 104.1 (less expensive) where a ranking value of 86.5 (173/2) would represent no difference in ranking between the two methods (see Figure 3-2 below). This meant that the CM/GC projects were, on average, more expensive than the DBB projects. The CM/GC slab/below-slab costs were, on average, 12.75% more than the DBB slab/below-slab costs. Based upon these studies it was feasible to say that the majority of projects with more difficult site conditions, potentially causing longer construction cycles, were performed by the CM/GC contractors rather than by the DBB contractors, which confirmed the statements made by the MFD directors.

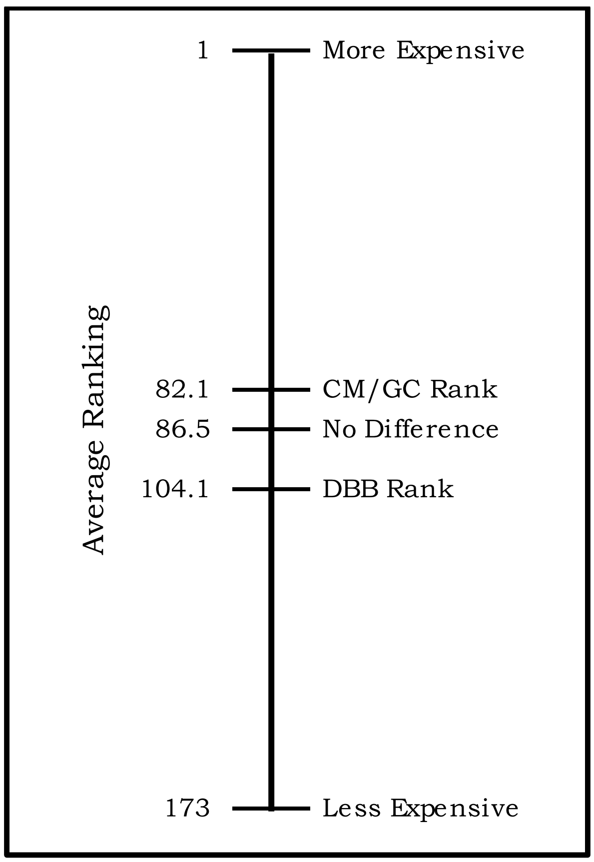

Figure 3-3: Average Ranking Graph

3.4.3 Physical Variations

Each of the 173 meetinghouse projects was examined using construction documents and/or Google Earth to confirm location, floor plan model, physical variances, and additions or deletions that were part of the original construction.

Eight projects had physical variances that were part of the original contract. Of the eight affected projects, properties #155 and #165 had wing additions, property #50 had a portico addition, property #75 had a steeple deletion, property #2 had the cost of a perimeter masonry wall built into the above-slab costs, and properties #46, #67, and #106 had exterior finish material upgrades, different from their standard plans.

To fairly compare these 8 projects to all other meetinghouses, the following adjustments were made. The costs of the wing additions were discounted from the construction costs of properties #155 and #165 based upon their respective square footages. An average steeple cost calculated from several meetinghouse projects in adjacent areas was added to the construction cost of property #75. A cost estimate of the perimeter masonry wall was discounted from the construction cost of property #2. The exterior material upgrades on properties #46, #67, and #106 were discounted from the construction costs to reflect the original plan specifications.

The Heritage 98 meetinghouse plan, designed by the MFD, offered a choice of five different exterior finishes in addition to a choice between two types of roofing material. The cost of materials differed to such a degree that adjustments needed to be made to account for the cost difference of labor and material in the exterior finishes and roofing.

The audited exterior finish and roofing costs of the preferred CM/GC contractors were used to calculate adjustment indexes, following the style of the RSMeans Historical Cost Indexes. The average cost of each type of exterior finish was divided by the overall average exterior finish for all 5 types and multiplied by 100 to obtain the index value. The same process was repeated for roofing materials. Based on these calculations, Table 3-7 below shows the resulting values (indexes), for the 5 types of exterior finishes as compared to the average of all 5.

Table 3-7: Exterior Finish and Roofing Indexes

Finish Type	Index	Quantity
Average	100.0	173
Classical	94.6	20
Colonial	109.5	24
New England	102.7	4
Southwest	52.8	7
Traditional	100.8	118
Roofing Type	Index	Quantity
Average	100.0	173
Asphalt Shingle	86.3	133
Tile	115.9	40

The Colonial exterior finish had an index of 109.5 (see circled value in column 2 in Table 3-7 above) which denotes that the Colonial finish, on average, cost 9.9 percent more than the average of all 5 exterior finish styles assigned an index of 100.0 (see circled value in column 2 in Table 3-7 above). In contrast, the Southwest exterior finish had an index value of 52.8 (see circled value in column 2 in Table 3-7 above), demonstrating that the Southwest finish, on average, costs 47.2 percent less than the average cost of all five exterior finish styles. With the creation of the above indexes, comparisons were made possible between meetinghouses of different exterior finishes and roofing materials.

3.4.4 Contractor's Fees

The MFD director stated that the contractor's fee for CM/GC projects was based on a 4.5 percent markup on the total cost of construction. Furthermore, the director stated that all contractors during this study period were required to separate the slab/below-slab cost from the above-slab cost on their schedule of values (SOV) due to differing site conditions as discussed earlier in this study. It was assumed that a portion of the contractor's fee would also be identified along with the slab/below-slab cost such that if the slab/below-slab costs were one-third of the total construction cost, then one-third of the contractor's fee would be assigned to the slab/below-slab portion of construction. In order to verify this assumption, when the contractor's fee, which was listed on the SOV along with the above-slab cost, was divided by the above-slab cost, it averaged 6.0 percent, not 4.5 percent (see left column of Figure 3-4). A second calculation was performed by dividing the contractor's fee by the total construction cost. This resulted in a 4.3 percent average (see right column of Figure 3-4), concluding that the contractor's fee listed was actually for the entire project. Figure 3-4 shows the two calculations of the 126 projects that listed a contractor's fee on the SOV. The average (mean) percentage is circled for each calculation. Based on this finding, a percentage of the contractor's fee equal to the slab/below-slab cost was removed and divided by the total construction cost for purposes of this study.

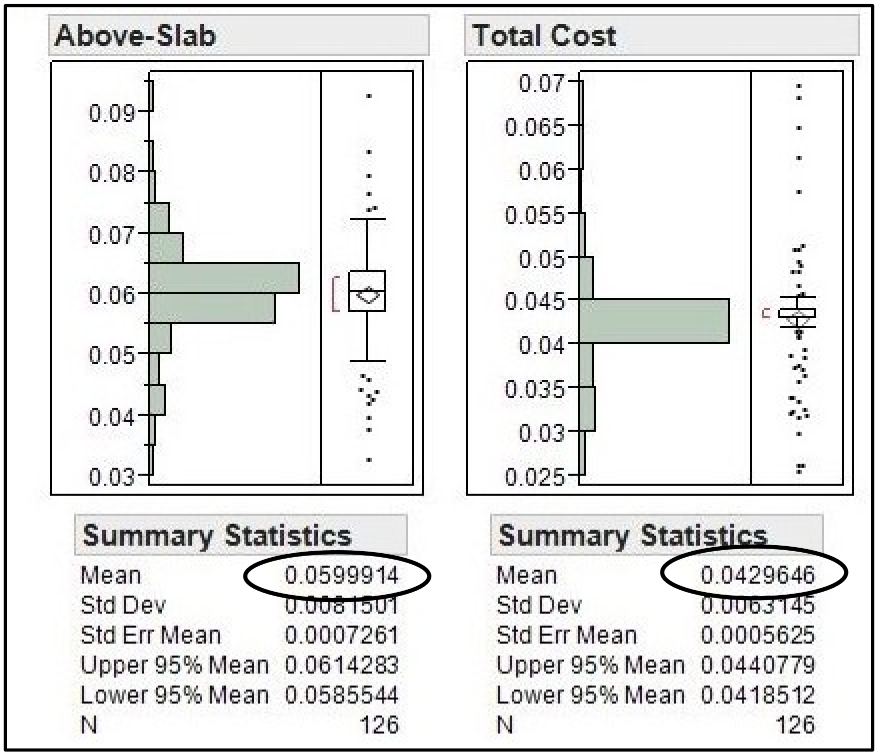

Figure 3-4: Distribution of Contractor's Fee Percentages

3.5 Comparison Model

An apples-to-apples comparison of project costs for the 173 meetinghouse projects of this study was accomplished by making adjustments for the four main confounding variables, namely, location of project, year of completion, exterior finish style, and roofing material. These adjustment calculations were made with the use of databases of index values established in Chapter 3 for each of the confounding variables. An ideal meetinghouse model to compare all meetinghouses against was created by selecting the average meetinghouses occurring most frequently based on city (location), year completed, exterior finish, and roofing material used. This ideal model required the least number of cost adjustments, since each adjustment would affect the overall accuracy of the comparisons. Using this logic, the model was based upon the most frequent occurrence in each of the four descriptive categories. One-hundred eighteen, or 68 percent, of the 173 projects were built using the Traditional exterior finish (see highlighted box in Table 3-8 below). One-hundred thirty-three, or 78 percent, of the meetinghouses had asphalt shingle roofs (see highlighted box in Table 3-9 below). As shown in Table 3-10 below, on a yearly basis, the highest number of meetinghouses built in a particular year and in a particular city was Salt Lake City for 2002.

Table 3-8: Exterior Finishes of Meetinghouses

Style	Total
Traditional	118
Colonial	24
Classical	20
Southwest	7
New England	4
Total	173

Table 3-9: Roofing Materials Used

Roofing	Total
Shingle	133
Tile	40
Total	173

Table 3-10: Top 5 Cities with Most Meetinghouses Completed by Year

City*	Year Completed				
	1999	2000	2001	2002	2003
Salt Lake City	8	11	16	28	16
Phoenix	1	4	4	3	6
Ogden	3	2	4	5	2
Las Vegas	1	1	2	1	5
Boise	2	3	1	1	1
*As defined by the RSMeans HCI 2013					

Based upon these results, the ideal meetinghouse model to which all other meetinghouses could be compared was a Traditional style meetinghouse with asphalt shingles built in Salt Lake City, Utah in 2002. For comparison purposes, all meetinghouses not matching each of the four criteria of this meetinghouse model - location, year completed, exterior finish, and roofing material used - were adjusted accordingly.

3.6 Hypothetical Example

In order to better understand how the confounding variables associated with the initial cost of construction were removed, a fictitious example of the step-by-step process is included below. The example is made up of two hypothetical versions of the Heritage 98 meetinghouse, projects A and B. The year built, location, exterior finish, roofing material and financial numbers are all invented and do not represent any real data. Table 3-11 contains the data regarding the aforementioned variables, and Table 3-12 contains the invented dollar amounts. These two hypothetical examples use the same ideal meetinghouse model for comparison as was discussed earlier in this study, a Traditional style meetinghouse with an asphalt shingle roof built in Salt Lake City, Utah in 2002.

Table 3-11: Example Criteria

Project	Year Built	State Location	Exterior Finish	Roofing Material	Historical Index
A	1999	Utah	Southwest	Shingle	104.5
B	2003	Mass.	Colonial	Tile	133.8

Table 3-12: Cost Breakdown

Slab/ Below-Slab	Above Slab		Contractor's Fee	Owner Provided	Total Cost
	Interior	Exterior			
$14,000.00	$26,000.00	$4,000.00	$0.00	$6,000.00	$50,000.00
$22,000.00	$33,000.00	$8,000.00	$3,000.00	$9,000.00	$75,000.00

Without making any adjustments for confounding variables, the Total Cost line item amount results in a $25,000 savings or a 33.3 percent savings for project A as compared with project B. To fairly compare the two projects, the first two steps are to remove the Owner Provided costs from each one and to disperse the Contractor's Fee between the Slab/Below-Slab and Above Slab costs. Table 3-13 reflects the first two adjustments.

Table 3-13: Steps 1 & 2

Slab/ Below-Slab	Above Slab		Contractor's Fee	Owner Provided	Total Cost
	Interior	Exterior			
$14,000.00	$26,000.00	$4,000.00			$44,000.00
$23,047.62	$34,571.43	$8,380.95			$66,000.00

The next step in the process is to remove the Slab/Below-Slab costs, followed by adjusting for the exterior finish and roofing material. Project A only had to be adjusted for the exterior finish since the roof already consisted of asphalt shingles. Project A's exterior finish was the less expensive Southwest style which was increased by $3,614.37 to reflect the Traditional brick exterior. Project B was adjusted for both the exterior finish as well as for the roofing material. Project B's more expensive Colonial exterior and tile roof were decreased by $550.09 and $151.50 respectively to reflect the Traditional style exterior with asphalt shingles. Table 3-14 reflects these adjustments. Note that the gap between the two projects has decreased by almost one-half at this point.

Table 3-14: Steps 3 & 4

Slab/ Below-Slab	Above Slab		Contractor's Fee	Owner Provided	Total Cost
	Interior	Exterior			
	$26,000.00	$7,614.37			$33,614.37
	$34,571.43	$7,679.36			$42,250.79

The final step is to adjust for both time and location using the Historical Cost Index values from Table 3-5. The ideal meetinghouse (Estimate City) that we are comparing all others to is a Traditional style meetinghouse with an asphalt shingle roof built in 2002 in Salt Lake City, Utah having a Historical Cost Index of 113.7. Table 3-11 shows that Project A (Actual City) has an index value of 104.5 while Project B (Actual City) has an index value of 133.8. The ESTIMATE CITY index is divided by each ACTUAL CITY index as demonstrated in Figure 3-5 below. The resulting estimated costs of both projects for this comparison example are shown in Figure 3-6.

$$\frac{\text{ESTIMATE CITY INDEX}}{\text{ACTUAL CITY INDEX}} \times \text{ACTUAL COST} = \text{ESTIMATED COST}$$

Figure 3-5 Adjustment Formula

Project A

$$\frac{113.7}{104.5} \times \$33{,}614.37 = \$36{,}573.72$$

Project B

$$\frac{113.7}{133.8} \times \$42{,}250.79 = \$35{,}903.70$$

Figure 3-6: Historical Adjustment Calculation

Table 3-15: Last Step

Slab/ Below-Slab	Above Slab		Contractor's Fee	Owner Provided	Adjusted Total
	Interior	Exterior			
	$28,289.00	$8,284.72			$36,573.72
	$29,377.96	$6,525.74			$35,903.70

After adjusting for confounding variables, the resulting adjustment shows that Project B is now the less expensive of the two, with a savings of approximately 2% when compared to Project A (see summary Table 3-16 below).

Table 3-16: Adjustment Summary

Description	Project A	Project B
Total Costs	$50,000.00	$75,000.00
Owner Provided Costs Adjustment	-$6,000.00	-$9,000.00
Slab/Below-Slab w/ Fee Adjustment	-$14,000.00	-$23,047.62
Exterior Finish Adjustment	$3,614.37	-$550.09
Roofing Material Adjustment	$0.00	-$151.50
City & Year Adjustment	$2,959.35	-$6,347.09
Costs after Adjustments	$36,573.72	$35,903.70
Savings		2%

3.7 Summary

In order to establish a cause-and-effect relationship in this study, great efforts were expended to both identify and adjust for confounding variables that could create bias in the comparative measurements of best value between the CM/GC and DBB delivery methods.

4 DATA ANALYSIS AND RESULTS

4.1 Introduction

This chapter consists of an analysis of the data collected with the purpose of determining which of the two delivery methods being investigated, CM/GC or DBB, resulted in a higher rate of efficiency in the areas of cost and timeliness, and an increased level of quality for the Heritage 98 meetinghouses completed from 1999 through 2003. The measurements in cost for each building included the short-term, above-slab costs of construction and the long-term maintenance and repairs costs covering a ten-year period after completion. Soft costs of dispute litigation fees and MFD employee overhead were also considered. Timeliness consisted of the construction cycle time measured in calendar days. Quality was measured using Quality Assessment scores and a responses from a survey conducted in 2013 of MFD project managers and CM/GC contractors about their meetinghouse construction experience comparing the DBB and CM/GC delivery methods.

4.2 Cost

Due to the sensitive nature of the data, dollars and cents were not used to describe costs identified in this study. Instead, cost values in this study are expressed as percentages of the total average cost of all projects. In addition, because site conditions varied from project to project, all slab/below-slab costs were removed for this study, including but not limited to, demolition, excavation, footings and foundation, paving, and landscape. Contractor's fees associated with site and foundation work were removed to allow for better comparison. Any above-slab, non-contractor-related goods and service expenses were also deducted from the initial cost of construction used for comparison. Adjustments were made for any additions, deletions, or modifications to each meetinghouse project, applying adjustments for differences in exterior finish and roofing costs. All project costs were adjusted to reflect costs for the traditional meetinghouse style with asphalt shingles for comparative purposes. Location and inflation were accounted for by applying indexes from RSMeans Historical Cost Indexes 2013 and adjusting all projects to Salt Lake City, Utah 2002 costs of construction for comparative purposes. The distribution graph below in Figure 4-1 displays an average initial cost of construction of 98.96 percent for CM/GC meetinghouse projects as compared to 103.05 percent for DBB, netting a 4.0 percent savings for the CM/GC delivery method for the five-year study period (1999-2003). The DBB meetinghouse projects used in this study did not include any that were performed by preferred contractors because of possible bias to the analysis results as discussed earlier in Chapter 3.

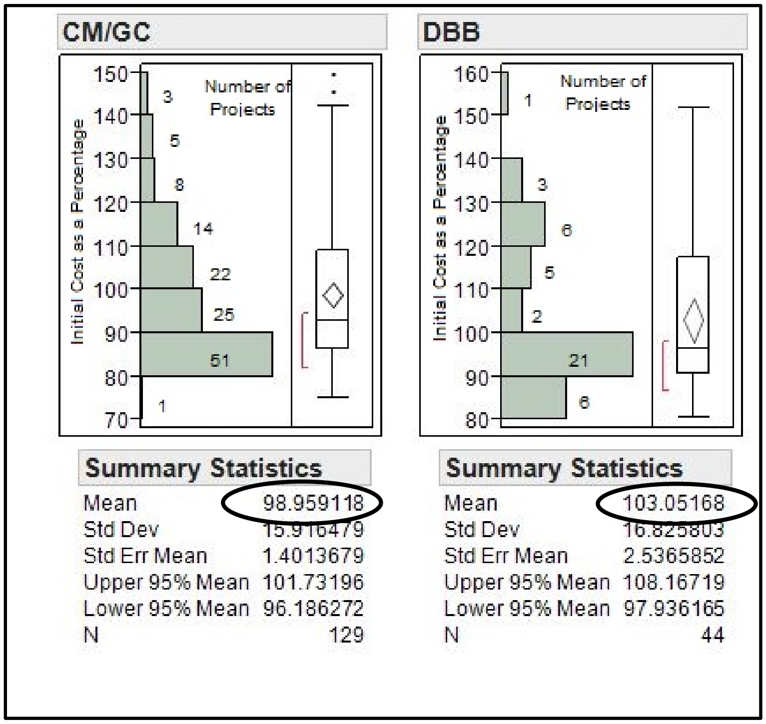

Figure 4-1: Distribution of Initial Cost of Construction

The 4.0 percent savings in initial cost of construction using the CM/GC project delivery method contradicted previous studies conducted by the MFD and their finance department. To resolve this discrepancy, one of the studies performed during 2007 was reproduced in order to document the methodology employed in the study.

The 2007 study population consisted only of Heritage 98 meetinghouses built in the state of Utah, excluding Washington County, since over 50 percent of the meetinghouses completed from 1999 through 2003 were constructed in Utah. For these meetinghouses built in Utah, site conditions and climate were relatively homogenous with the exception of Washington County which experiences a warmer climate than the majority of the state. The DBB meetinghouse projects in the 2007 study included those completed by both non-preferred and preferred contractors. The construction costs were above-slab only, the same as this comparative study, but no adjustments were made for the confounding variables of the year of construction, location, physical variations, and contractors' fees. With these confounding variables not being accounted for, the 2007 study produced an average economical savings of 2.1 percent on meetinghouse projects completed from 1999 through 2003 using the DBB delivery method as compared to the CM/GC delivery method, thus validating the initial MFD study.

Based upon the findings for confounding variables in Chapter 3, the 2007 study was recalculated resolving each variable, step by step. The removal of the DBB/PC projects caused the original DBB savings to drop by 0.1 percent. Removal of contractor's fees proportionate to the slab/below-slab costs caused an additional reduction in savings of 1.1 percent. Next, costs for each project were adjusted for year of completion and site location using the *RSMeans Historical Cost Indexes 2013* creating an additional reduction of 4.4 percent for CM/GC. Last of all, each project was adjusted according to physical variations which resulted in an increase in savings of 0.4 percent for the DBB delivery method. After adjusting for the confounding variables not accounted for in the 2007 study, the CM/GC delivery method actually netted an overall 3.2 percent savings when compared to DBB for meetinghouse projects only in Utah, excluding Washington County.

Once again, these adjusted findings contradict the original study that derived a 2.1 percent savings for DBB. The distribution graph below in Figure 4-2 displays an average initial cost of construction of 98.63 percent for CM/GC meetinghouse projects as compared to 101.76 percent for DBB, netting a 3.2 percent savings for the CM/GC delivery method after adjusting the data of the 2007 study for meetinghouse projects built in Utah, excluding Washington County, from 1999 through 2003.

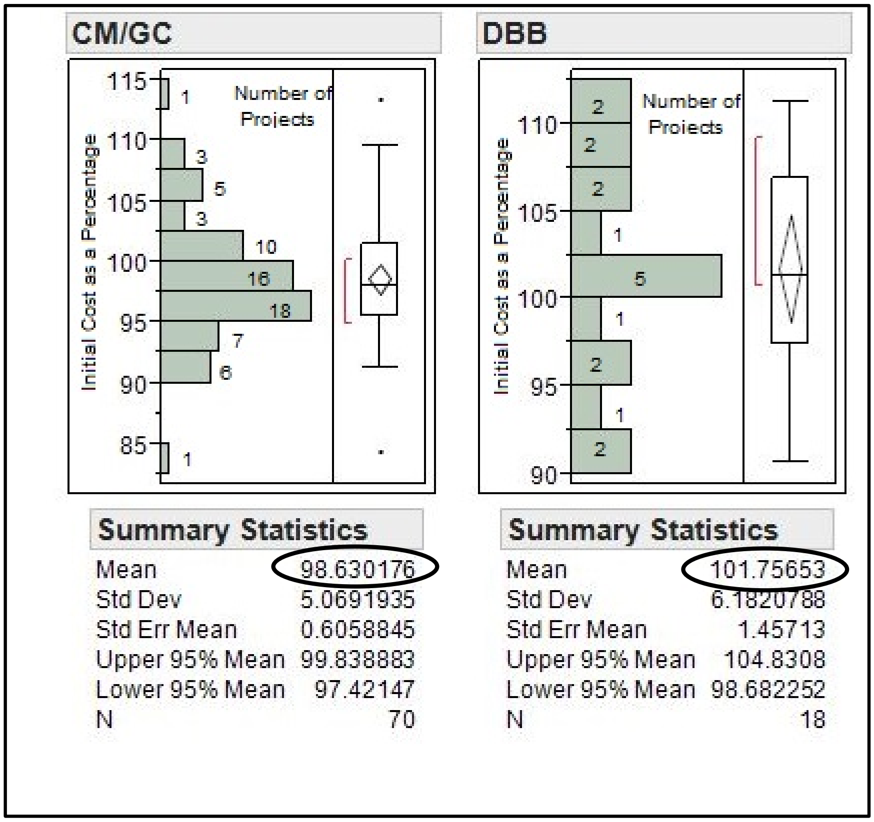

Figure 4-2: Distribution of Revised 2007 Study

Repair costs associated with defective construction and incurred by the MFD for the 173 meetinghouses during the 10-year period of this study were identified from over 1100 expensed items per meetinghouse. Normal repairs that were not required because of defective work associated with the initial construction project were not considered in this study. The ten-year period was used to capture necessary repairs beyond the standard contractor warranty time period and to correct latent defects due to poor quality materials and/or craftsmanship used in the original construction phase of each meetinghouse. Such failures in materials and craftsmanship resulted in repairs and/or replacements, such as repairing a leaky roof or replacing improperly installed flooring. The ten-year average contractor-related repair costs for the meetinghouses completed by the DBB delivery method represented 2.5 percent of the average above-slab construction cost. In comparison, similar repair costs for meetinghouses completed using the

CM/GC delivery method represented only 1.6 percent of the average above-slab construction cost. This constituted a .9 percent savings for the CM/GC delivery method over the ten-year time period. As with the initial construction costs, repair costs were adjusted for inflation and project location prior to analysis. Adding this .9 percent to the previously identified 4.0 percent savings resulted in a new savings of 4.9 for CM/GC as compared to DBB.

According to the legal firm representing the MFD, the CM/GC delivery method reduced the MFD's annual legal costs by approximately .5 percent of the total annual meetinghouse construction costs. Furthermore, there were no legal claims brought by or filed against any of the CM/GC contractors.

The CM/GC delivery method, the partnering agreements, the standardizing of the meetinghouse designs, and the hiring of project clerks to support project managers all helped to reduce the MFD meetinghouse construction supervision overhead by 24.4 percent by reducing the number of full-time employed MFD project managers during the study time period. Unfortunately, the amount directly attributable to the CM/GC delivery method was never calculated by the MFD or the finance department. For this reason, these savings, although potentially significant, were not be included in this analysis.

4.3 Cycle Time

The average total construction cycle time, which included site and foundation work, for the projects completed using the DBB delivery method averaged 411 calendar days from the date of the Notice to Proceed (NTP) until the date of the Certificate of Substantial Completion (CSC). In contrast, the projects completed using the CM/GC delivery method averaged 329 calendar days, a savings of 82 days or 20.0 percent over the DBB delivery method. As mentioned above, these construction durations included site and foundation work of which the CM/GC projects included the more difficult site conditions. Figure 4-3, shows the distribution and average total construction duration for each method including slab/below-slab construction. Note that the cycle-time distribution of the CM/GC projects is more of a bell shape, grouped together, demonstrating more consistency of cycle time amongst projects as compared to the scattered shape of the DBB project cycle times.

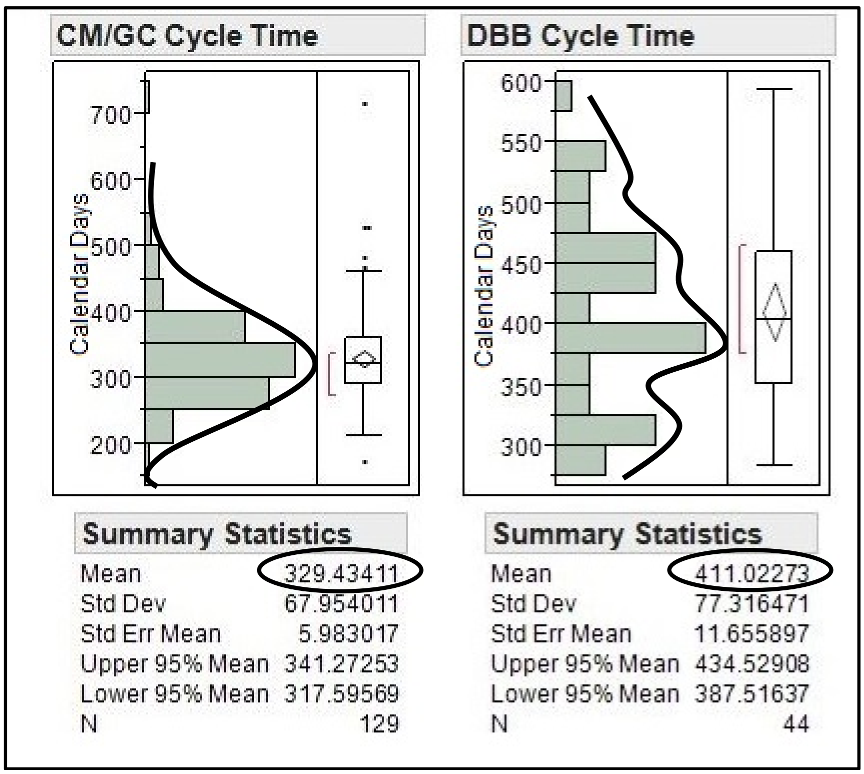

Figure 4-3: Construction Cycle Time Distribution in Calendar Days

4.4 Quality Assessment Scores

The re-engineered Quality Assessment tool explained previously consisted of approximately 100 questions rated with a score from one-third of a point to one point for each question. A score of one signified a high level of workmanship and strict adherence to contract documents while a score of one-third signified poor workmanship and non-strict compliance with plans and specifications. A total of 100 points was considered a perfect score. The MFD previously conducted and provided the results of random samplings of the CM/GC and DBB meetinghouse project scores, including over 300 total meetinghouse inspections over the five-year study time period. Figure 4-5 shows the average QA score for the Heritage 98 meetinghouse projects by delivery method and by year. The CM/GC projects scored an average of 2.7 percent higher than DBB over the five-year period of this study. Note that scores for both the CM/GC and DBB meetinghouse projects generally trended upward during the study period.

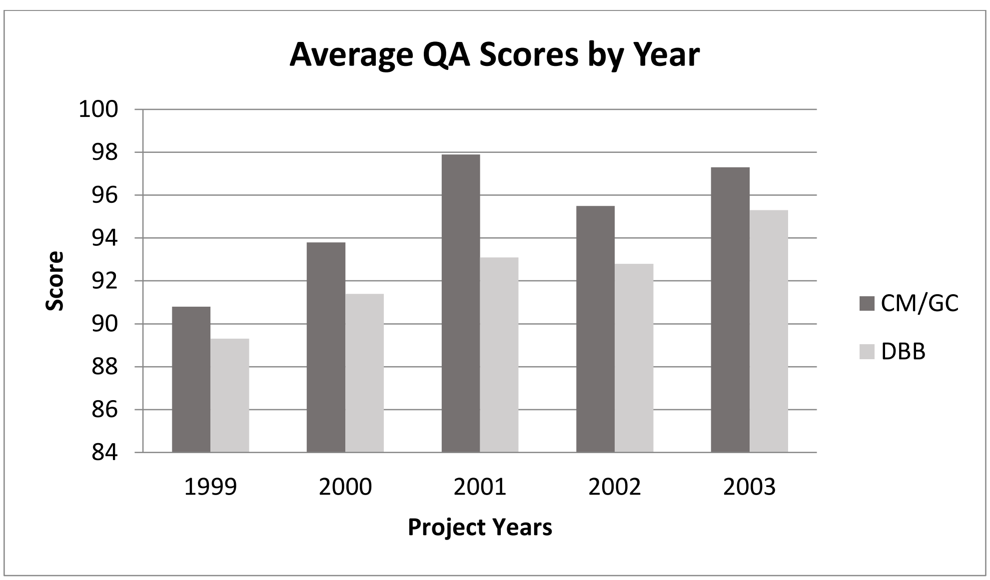

Figure 4-4: Quality Assessment Scores

As shown on the quality assessment score graph in Figure 4-5, both the CM/GC and the DBB delivery methods experienced general improvements in increased quality over time. This result would be expected of the CM/GC contractors in light of the fact that each of the contractors built an average of ten meetinghouses for the five-year study period, in contrast to an average of 1.4 meetinghouses built per DBB contractor. However, the DBB projects improved as well in cycle time reduction and high quality, but not as dramatically as CM/GC meetinghouse projects.

All of the CM/GC and DBB contractors employed subcontractors for a majority if not all of the trades needed to construct a meetinghouse. Many of these subcontractors worked for different meetinghouse contractors, many times submitting bids on the same project to competing general contractors. It was observed that many of the same subcontractors that were working on CM/GC projects were also working on DBB projects, helping to contribute to the improvement of quality on both types of delivery. The construction cycle time and quality assessment score graphs support this observation made by the MFD.

4.5 Contract Administration Survey

CM/GC contractors and MFD project managers were asked to rate twelve statements corresponding to the objectives of the CM/GC delivery method compared to the DBB delivery method. Each statement was rated using a Likert scale with five possible numeric responses, ranging from Strongly Disagree (1) to Strongly Agree (5). The responses of the contractors and the project managers were individually tallied and averaged for each statement as shown in Figure 4-5 below. The contractors (GC's) and project managers (PM's) both agreed with, in varying strengths, all of the statements except for the one regarding the burden of paperwork stemming from the requirement to audit all construction expenses with the CM/GC delivery method.

	Statement	Strongly Disagree 1 – Strongly Agree 5	Average
1	CM/GC projects exhibited better teamwork and mutual trust when compared to DBB projects.	Partnering Contractors	4.86
		MFD Project Managers	4.00
2	CM/GC projects had fewer owner/contractor initiated change order delays when compared to DBB projects.	Partnering Contractors	4.14
		MFD Project Managers	3.60
3	CM/GC projects were easier to supervise when compared to DBB projects.	Partnering Contractors	4.29
		MFD Project Managers	4.00
4	Communications with MFD employed PM's/job supers were more fluid with CM/GC projects as compared to DBB projects.	Partnering Contractors	4.57
		MFD Project Managers	4.00
5	Disputes arising from change orders were fewer with CM/GC projects when compared to DBB projects.	Partnering Contractors	4.71
		MFD Project Managers	4.20
6	I requested/processed fewer RFIs with CM/GC projects when compared to DBB projects.	Partnering Contractors	3.86
		MFD Project Managers	3.40
7	Project related paperwork was lighter with CM/GC projects when compared to DBB projects.	Partnering Contractors	2.43
		MFD Project Managers	2.20
8	Project Quality Assurance inspections had fewer corrections with CM/GC projects when compared to DBB projects.	Partnering Contractors	4.43
		MFD Project Managers	4.00
9	Cost, quality, and timeliness efficiencies improved faster on CM/GC projects when compared to DBB projects.	Partnering Contractors	4.57
		MFD Project Managers	4.00
10	The project quality was expected to exceed on CM/GC projects when compared to DBB projects	Partnering Contractors	4.43
		MFD Project Managers	4.20
11	I experienced no litigation on my CM/GC projects	Partnering Contractors	4.86
		MFD Project Managers	3.80
12	The CM/GC delivery method was a win/win situation	Partnering Contractors	4.57
		MFD Project Managers	3.40

Partnering Contractors

MFD Project Managers

Figure 4-5: Survey Perceptions of Preferred GC's and MFD PM's

Preferred general contractors and MFD project managers were also asked to list in priority order best practices for a successful meetinghouse project. Because the answers were given in priority order, listed one through five, a weighted scoring system was used to compile the results. For purposes of this study, a respondent's first answer was assigned five points, the second was assigned four points and so forth, with the respondent's fifth answer receiving a single point. In the case of those who gave fewer than five answers, the same point system followed for the responses given, with the first response receiving five points, the second receiving four points, and so forth.

Most of the seven preferred contractors, but not all, responded to the open-ended question by listing five best practices for a successful meetinghouse project. Twelve general categories of best practices were determined based on these responses. Each individual response and its corresponding score were assigned to one of these twelve categories. Total scores for each category are shown in Table 4-1, entitled CM/GC Best Practices According to Contractors.

Most of the eight MFD project managers responded to the same open-ended question regarding best practices for a successful meetinghouse project. Only ten general categories of best practices were identified to assign responses and their corresponding scores. Total scores for each category are shown below in Table 4-2, entitled CM/GC Best Practices According to MFD Project Managers.

At least half of the responses from both surveys lined up in regards to their categories. The six common responses are as follows from highest to lowest total scores:

1. **Selection of Subcontractors** – With the CM/GC delivery method, the MFD project manager or another MFD representative jointly selected the project subcontractors along with the project general contractor. With both parties having input for this selection, the choice of subcontractor was a team decision, reinforcing a spirit of collaboration and communication.

2. **Win/Win Teamwork** – The greatest efficiency with two people is when they work together as a team, where both parties are benefitted. All of the activities on a construction project are interdependent in that the failure of one contributor creates a chain reaction detrimental to the entire project[41]. Teamwork is a main aspect of the partnering program.

Table 4-1: CM/GC Best Practices According to Contractors

CM/GC Contractrors' Best Practices		
Rank	Best Practice	Score
1	Joint selection of subcontractors	26
2	Win/win Team concept	15
3	Early planning	10
4	Communication	6
5	Remodel work discovery	6
6	Transparency	5
7	Thorough bid preparation	5
8	Consolidation of contractors	5
9	Competent supervision	4
10	Trust	3
11	Multiple projects	3
12	QA/QC techniques	2

[41] International Partnering Institute, "Collaborative Construction, Changing the Game (May 2011)," *IPI,* Internet, available from http://www.partneringinstitute.org/collaborative_ construction.html#changing_the_game, accessed 4 December 2013.

Table 4-2: CM/GC Best Practices According to MFD Project Managers

MFD Project Managers' Best Practices		
Rank	Best Practice	Score
1	Selection of contractor	14
2	Selection of subcontractors	13
3	Quality specs	13
4	Job superintendent	11
5	Schedule	8
6	Qualified architect	7
7	Teamwork	6
8	Trust	3
9	RFI Process	3
10	Minimal change orders	3

3. **Selection/Consolidation of Contractors** – The short list of preferred general contractors benefitted the MFD as they were able to establish long-term relationships with contractors of their choosing, based upon the contractor's qualifications. Based on the consolidated list of contractors, the preferred contractors enjoyed the benefit of constructing multiple projects as evidenced by this response on the survey and the amount of projects on average they each built during the study time period.

4. **Schedule/Planning** – With the usual early involvement of the general contractor in the CM/GC delivery method, scheduling was established earlier on in the project as compared to the DBB method where scheduling is finalized only after the project is awarded.

5. **Job Supervision** – The job superintendent personally orchestrates the daily activities on a project site. His responsibility is like that of a team captain that will either lead his team to victory or to failure. The ability to problem solve through communication is essential.

6. **Trust/Transparency** – Transparency is a sign of trust. According to German sociologist Niklas Luhmann, the alternative to trust is chaos and paralyzing fear. Trust is the

most critical factor for a successful construction partnering relationship. This increased trust leads to open communication between an owner and a contractor. The lack of trust between project participants has been considered perhaps the most prominent weakness in the construction industry.[42]

The balance of the responses by the MFD project managers were inter related in that a qualified architect would produce quality project specifications resulting in minimal change orders. If additional information was needed, the same architect would process the requests for information (RFI) in an efficient way.

The balance of the responses by the preferred contractors mentioned the benefit of discovery on meetinghouse remodels where the contractor can do some limited demolition to help uncover any potential construction problems prior to establishing the GMP and avoid change orders. As mentioned earlier in this study, the new QA program involved inspections periodically throughout the construction process, rather than only upon project completion.

[42] James Smith and Zofia Rybkowski, "Literature review on Trust and Current Construction Industry Trends, Proceedings for the 20th Annual Conference of the International Group for Lean Construction (2012)," *International Group for Lean Construction,* Internet, available from http://www.iglc20.sdsu.edu/papers/wp-content/uploads/2012/07/32%20P%20078.pdf, accessed 2 April 2014.

5 SUMMARY & CONCLUSION

5.1 Summary of Research

The directors of the MFD adopted the CM/GC project delivery method accompanied with a partnering agreement with the goal of reducing costs, and improving timeliness and quality by identifying a few highly qualified general contractors and usually involving them early in the project design phase to take advantage of their construction experience. The partnering agreement was designed to focus on building relationships of trusting, collaborating, and sharing common goals and objectives to create a more efficient delivery method. Although the MFD adopted the new CM/GC delivery method in 1998, they also continued to employ the pre-existing DBB delivery method on approximately one-third of the Heritage 98 meetinghouse projects completed from 1999 through 2003. The purpose of this study was to determine whether one of these two delivery methods resulted in a significantly higher rate of efficiency in the areas of cost, timeliness, and quality for the meetinghouse projects completed from 1999 through 2003.

The concept of total cost of delivery was used in this study to measure more than just the initial cost, completion time, and quality of construction. It also measured indirect and long-term costs and quality to obtain a more comprehensive evaluation and comparison of the two methods.

5.2 Findings and Conclusion

5.2.1 Initial Construction Costs

After adjusting for confounding variables, the statistical analysis of the initial above-slab construction cost of Heritage 98 meetinghouses completed from 1999 through 2003 resulted in an average economical savings of 4.0 percent using the CM/GC project delivery method in comparison to the traditional DBB project delivery method. This result contradicted previous studies conducted by the MFD and the finance department, including a 2007 study which did not account for several confounding variables.

Most experts in the construction industry agree that the competitive bidding process of the DBB delivery method is the most effective method of determining the least cost for constructing a project according to the bidding documents as compared to a guaranteed maximum price based on an incomplete set of construction documents typical of the CM/GC delivery method.[43] For this study population, the CM/GC delivery method framework included a short list of qualified contractors and the implementation of a collaborative partnering agreement. The usual early involvement of the preferred contractor, combined with a limited number of contractors doing multiple projects and working as a collaborative team with the MFD resulted in a net cost savings for the meetinghouse projects delivered using the CM/GC method.

The overall 4.0 percent economic savings, in initial construction costs, with the CM/GC delivery method occurred even though both CM/GC and DBB projects had the volume pricing advantage of VMR vendors. Of the 32 DBB contractors, three-fourths of them built only one meetinghouse during the study time-period, from 1999 through 2003, and only one contractor

[43] FMI, "First Quarter 2012 Nonresidential Construction Index Report."

built four meetinghouses, the highest number built by a non-preferred DBB contractor. Without the VMR advantage for both methods, the CM/GC delivery method might have had more savings due to the economies of scale where CM/GC contractors built an average of ten meetinghouses during the five-year period.

5.2.2 Indirect Costs

The cost of meetinghouse repairs as a result of faulty materials or inferior installation is an indirect long-term cost of construction. A ten-year period of time was used to capture the repair expenditures incurred by the MFD not covered under a contractor warranty. The projects completed using the CM/GC delivery method during the study period incurred repairs amounting to 1.6 percent of the average initial construction cost. This is in contrast to repair costs totaling 2.5 percent of initial construction costs for the DBB projects. This resulted in a difference of 0.9 percent. The repair costs were converted to the same standard of cost as used on the initial construction cost data. With this increased savings, the CM/GC delivery method averaged a total combined 4.9 percent savings when compared to DBB in the short- and long-terms.

Litigation, another indirect expense associated with any delivery method, decreased by one-half of a percent of the average above-slab construction cost for CM/GC contractors, making the new economic savings for using the CM/GC delivery method a total of 5.4 percent.

The reduction of full-time project managers on staff was attributed to several factors, including the CM/GC delivery method, the partnering agreements, the standardizing of the meetinghouse designs and the hiring of project clerks to support project managers. The MFD was unable to isolate the savings directly attributable to this reduction in employees caused by the CM/GC delivery method or the partnering agreement. It can only be said that additional economic savings were definitely derived from the reduction of project managers as a direct result of the CM/GC delivery method.

5.2.3 Construction Cycle Time and Quality Assessment Scores

One of the objectives behind the adoption of the CM/GC delivery method was the aggressive reduction of construction cycle time and the acceleration of quality improvement. With an average of 10 meetinghouses per preferred contractor for the study time period, the CM/GC construction cycle time for the last year of this study averaged 324 days compared with 377 days for the first year of this study, a 14 percent improvement over the five-year study period.

5.2.4 Contract Administration

All of the survey statements except one, regarding paperwork, were answered positively by both the CM/GC contractors and the MFD project managers in favor of the CM/GC delivery method with the slight variation that the project managers were slightly less in favor in their responses when compared to the preferred contractors. As mentioned earlier, the director of the MFD stated that prior to the adoption of the CM/GC delivery method in 1998, all meetinghouse projects were constructed using the traditional DBB delivery method. Because of this, none of the MFD project managers had any experience using alternative delivery methods on any of the meetinghouse projects prior to 1999. In contrast, all of the CM/GC contractors had some prior experience with the CM/GC method. With this understanding, it would not be out of character for the project managers to have reservations about the success of the CM/GC delivery method, especially when the CM/GC projects were viewed as costing more than DBB projects, based upon studies such as the 2007 comparative study which were made available to all MFD project managers.

The common complaint by all respondents to the survey dealt with the extra paperwork required for the CM/GC expense auditing process to verify costs. One project manager suggested that the guaranteed maximum price should be replaced with a negotiated fixed price that would not mandate any auditing by the finance department. With ten years of experience of building the same floor plan, a fixed price would seem to be relatively easy to negotiate.

Both the CM/GC contractors and the MFD project managers listed the joint selection of subcontractors as one of the best practices for meetinghouse construction success. This joint selection was only required with the CM/GC delivery method. No general contractors in this study self-performed all of the work to complete its projects. Rather, all general contractors relied on skilled subcontractors to supplement their respective self-performed trades. The selection of subcontractors based upon price alone does not always ensure quality and success for a project. A previous study regarding subcontracting agreed with this assessment, noting that the four important hiring criteria were price, technical know-how, quality, and cooperation. The study pointed out that when subcontractors perform the majority of work on a project, the project success is highly dependent upon the subcontractors.[44] One of the MFD project managers summed up the importance of the selection of subcontractors when he stated, "The general is as good as his worst sub."

[44] Andreas Hartmann, Florence Y. Ling, and Jane S. Tan. (2009). "Relative Importance of Subcontractor Selection Criteria: Evidence from Singapore." *J. Constr. Eng. Manage*. 135, no. 9 (2009), 826–832.

5.2.5 Conclusions

The traditional Design/Bid/Build (DBB) construction delivery method has long been the dominant and familiar type of delivery for the construction industry as a whole. Unfortunately, the competitive bidding process connected to DBB delivery tends to create an adversarial relationship between a project owner and the contractor. This adversarial relationship surfaces in the form of disputes, change orders, inferior work, and litigation. The Federal Facilities Council has estimated that the transactional costs for resolving construction disputes and claims may total $4 billion to $12 billion or more each year in the U.S. One of the ways that the construction industry approached this costly litigation problem was by modifying the DBB delivery method itself and the lack of stakeholder collaboration, bringing about alternative delivery methods that have helped reduce these negative costs.[45]

In the late 1980's, in an effort to address the rising costs of construction disputes, the Construction Industry Institute at the University of Texas, the US Army Corps of Engineers, and the Associated General Contractors of America (AGC) collaboratively developed a construction teambuilding process to "establish working relationships among the parties through a mutually-developed, formal strategy of commitment and communication", known as partnering. Partnering does not change the legal contractual agreement between parties, but rather it enhances the relationships among owners, architects, and general contractors by committing contracting parties to use trust, collaboration, and communication starting early in the project.

Another effort to address the adversarial relationship inherent in the DBB delivery method has been the development of alternative delivery methods, namely Design/Build (DB), Construction Manager/General Contractor (CM/GC), and Integrated Project Delivery (IPD). All

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[45] Ken Rubenstein, "Why the Project Delivery Method Matters in Construction Litigation," Preti, Flaherty, Beliveau & Pachios, *Chartered, LLP,* Internet, available from http://pretiprofessionalliability.blogspot.com/2013/12/Construction-Product-Delivery.html, accessed 16 April 2014.

three methods focus on contracting parties' working as a team with a shared vision and common goals for success. Surveys in the nonresidential construction industry indicate a trend of moving away from DBB delivery and adopting the DB and CM/GC delivery methods. Comparative studies have been performed to rate the success of alternative delivery methods when compared to DBB, using as study samples similar-sized projects constructed by similar-sized companies in similar markets. The comparative study performed in this paper was unique in that one owner, the MFD, built over 200 nearly identical meetinghouse projects over a five-year period using two distinct delivery methods, DBB and CM/GC.

The MFD enabled this study by authorizing access to the needed databases used for the comparative measurement of cost, timeliness, and quality between the DBB and CM/GC delivery methods. After identifying and making provisions for confounding variables present in the meetinghouse data, the results found were compelling:

1. **Reduced Repair Costs:** The ten-year average contractor-related repair costs for the meetinghouses completed by the DBB delivery method was 2.5 percent of the average above-slab construction cost; whereas, the CM/GC delivery method represented only 1.6 percent of the average above-slab construction cost resulting in a 0.9 percent savings and a 34 percent reduction for repair costs over DBB.
2. **Reduced Construction Costs:** CM/GC projects averaged 4.0 percent savings in the initial above-slab construction costs for the five-year study period from 1999 through 2003 when compared to the same construction costs on DBB projects, using 2002 SLC index dollars as a baseline for comparison. This result ran contrary to previous studies performed by the MFD due to the inclusion of confounding variables in these previous studies.

3. **Improved Construction Cycle Time**: The average construction cycle time for CM/GC projects during the five-year study period was 20% less or 82 days shorter when compared to the DBB projects.

   The DBB delivery method averaged 411 calendar days form the date of the Notice to Proceed (NTP) until the date of the Certificate of Substantial Completion (CSC). The CM/GC delivery method averaged 329 calendar days.

4. **Better Quality Assessment Scores:** Quality Assessment scores for CM/GC projects averaged 2.7% higher when compared to DBB projects. Training of subcontractors done by CM/GC contractors benefited DBB contractors who many times used the same subcontractors. The net effect was that the overall Church meetinghouse building program improved in quality.

5. **Fewer Indirect Costs:** Indirect costs were reduced for owner-related overhead for contract administration, construction cycle time and related litigation costs to manage CM/GC projects by about 1 percent.

Based upon the statistical analysis performed in this study, the CM/GC delivery method, as developed by the MFD, was the best value for project delivery for the meetinghouse construction program of the Church of Jesus Christ of Latter-day Saints in the areas of cost, timeliness, and quality in the U.S. during the 5-year build-out period identified. This supports the trend of increasing numbers of projects being delivered with the CM/GC delivery method in the commercial construction industry, including the repetitive construction market.

5.3 Future Research

Thirty-two DBB meetinghouse projects completed during the five-year period of this study were not considered because they were performed by contractors who were also working on CM/GC projects. These projects were termed DBB with a preferred contractor (DBB/PC). The CM/GC delivery method was built upon trust, open communication, and collaboration between owner and contactor. In an interview with an MFD project manager, he commented that his working relationship with a CM/GC contractor remained the same whether the contractor was on a DBB project or a CM/GC project. A future study measuring the success of the DBB/PC projects when compared to the DBB and CM/GC projects might be beneficial to the MFD.

A similar study to this one would be beneficial in another 5 years from now when the remainder of the CM/GC meetinghouse projects built by the MFD from 2004 through 2008 have all experienced a 10-year life cycle for purposes of repair costs calculations.

REFERENCES

AIA," Integrated Project Delivery: A Guide (2007)," *The American Institute of Architects,* Internet, available from http://info.aia.org/siteobjects/files/ipd_guide_2007.pdf, accessed 14 April 2014.

AGC, "Partnering, A Concept for Success (1991)," *The Associated General Contractors of America,* Internet, available from http://store.agc.org/Management-And-Operations/Marketing-Business-Development/2900E, accessed 30 October 2013.

AGC, "Guidelines for a Successful Construction Project (2003)," *The Associated General Contractors of America,* Internet, available from http://www.mpgroup.com /documents/Guidelines.pdf, accessed 12 October 2013.

Ashcraft, Howard, "Building Information Modeling: A Framework for Collaboration," *Construction Lawyer* 28, no. 3 (2008): 1.

Bragadin, Marco, and Kahkonen, Kalle, "Heuristic Solution for Resource Scheduling for Repetitive Construction Projects (2011)," *Management and Innovation for a Sustainable Built Environment,* Internet, available from misbe2011.fyper.com/proceedings/ documents/202.pdf, accessed 6 March 2014.

Carr, Frank, "Partnering, Aligning Interests, Collaboration, and Achieving Common Goals," *International Institute for Conflict Prevention & Resolution,* Internet, available from http://www.cpradr.org/Portals/0/Resources/ADR%20Tools/Tools/CPR%20Construction %20Partnering%20Briefing.pdf, accessed 25 February 2014.

Construction Management Association of America, "An Owner's Guide to Project Delivery Methods, 2012," *CMAA*, Internet, available from http://cmaanet.org/files/Owners%20 Guide%20to% 20Project%20Delivery%20Methods%20Final.pdf, accessed 17 December 2012.

Construction Management Association of America, "An Owner's Guide to Construction Management, 2007," *CMAA,* Internet, available from http://www.healthdesign.org/sites/ default/files/an_owners_guide_to_construction_management.pdf, accessed 24 February 2014.

Chism, Nick, and Armstrong, Geno, "Project Delivery Strategy: Getting It Right," *KPMG International*, Internet, available from http://www.kpmg.com/NZ/en/IssuesAndInsights/ ArticlesPublications/SmarterProcurement/Documents/Getting-it-Right.PDF, accessed 8 October 2013.

Creighton, Jen and Jobs, David, "Make a Case for Sustainability: Apply Total Cost of Ownership," *Construction Management Association of America,* Internet, available from http://cmaanet.org/files/shared/tco_white_paper.pdf, accessed 11 February 2013.

CSI, *The Construction Specifications Institute Project Delivery Practice Guide* (New Jersey: John Wiley & Sons, Inc., 2011), 120-136, 149.

DBIA, "Report by Reed Construction data/RSMeans Market intelligence," *Design-Build Institue of America,* Internet, available from www.dbia.org/resource-center/Pages/Report-by-RCD-RSMeans-Market-Intelligence.aspx, accessed 24 February 2014.

Doran, Dennis, "Roadblocks to Collaboration, FMI/CMAAs Fourth Annual Survey of Owners," *FMI/CMAA,* Internet, available from http://www.cmaafoundation.org/files/surveys/2003-survey.pdf, accessed 12 December 2013.

Ellingson, Lee, "An Historical Perspective to Project Delivery Systems," *Indiana State University,* Internet, available from http://ascpro0.ascweb.org/archives/cd/2004/2004pro/2003/Ellingson04.htm, accessed 9 December 2013.

FMI, "First Quarter 2012 Nonresidential Construction Index Report," *FMI Management Consulting for the Engineering and Construction Industry,* available from http://www.fminet.com/media/pdf/forecasts/NRCI_Q1_2012.pdf. accessed on 24 February 2014.

Federal Facilities Council, "Reducing Construction Costs: Uses of Best Dispute Resolution Practices by Project Owners, Proceedings Report," *National Research Council,* Internet, available from http://www.nap.edu/openbook.php?record_id=11846, accessed 3 December 2013.

Goldstein, Julie, "Cost of Construction Disputes Going Down," *Fox Rothchild LLP,* Internet, available from file:///I:/Literature%20Review/Litigation/Cost%20of%20construction%20disputes%20going%20down%20%20%20Construction%20Law%20Blog.htm, accessed 9 November 2013.

Hartmann, Andreas, Ling, Florence Y., and Tan, Jane S.. (2009). "Relative Importance of Subcontractor Selection Criteria: Evidence from Singapore." *J. Constr. Eng. Manage.* 135, no. 9 (2009), 826–832.

Heery, George, "A History of Construction Management, Program management, and Development Management," *Brookwood Group,* Internet, available from http://www.brookwoodgroup.com/downloads/2011_history_CMPMDM.pdf, accessed 24 February 2014.

Ingram's, "A Brief History of Design/Build," *Ingram's* 29, no. 4 (2003):10. http://www.ingramsonline.com/april_2003/designbuild.html.

International Partnering Institute, "Collaborative Construction, Changing the Game (May 2011)," *IPI,* Internet, available from http://www.partneringinstitute.org/collaborative_construction.html#changing_the_game, accessed 4 December 2013.

International Partnering Institute, "Collaborative Construction, Lessons Learned for Creating a Culture of Partnership," *IPI,* Internet, available from http://www.partneringinstitute.org/PDF/A_Working_Model_for_Collaborative_Partnering_Special_Report_May_2010.pdf, accessed 30 October 2013.

Kawneer, "Kawneer White Paper 2001, Partnering," *Kawneer, An Alcoa Company,* Internet, available from http://www.kawneer.com/kawneer/united_kingdom/en/pdf/Partnering.pdf, accessed 20 January, 2014.

Kenig, Michael, "Integrated Project Delivery For Public and Private Owners (2010)," *NASFA, COAA, APPA, AGC and AIA,* Internet, available from http://www.agc.org/galleries/projectd/IPD%20for%20Public%20and%20Private%20Owners.pdf, accessed 17 December 2012.

King, Ross, *Brunelleschi's Dome: The Story of the Great Cathedral in Florence* (London: Pimlico, 2001), 117-118.

Knoll, Jocelyn, "Construction Litigation," *Dorsey & Whitney LLP,* Internet, available from http://www.dorsey.com/en-US/abc.aspx?xpST=abc&url=http://www.dorsey.com/en-US/practices/uniEntity.aspx?xpST%3DServiceDetail%26service%3D149, accessed 3 December 2013.

Konchar, Mark, "A Comparison of United States Project Delivery Systems," *Computer Integrated Construction,* Internet, available from http://www.engr.psu.edu/ae/cic/publications/TechReports/TR_038_Konchar_Comparison_of_US_Proj_Del_Systems.pdf, accessed 27 December 2012.

Linch, Mark, "Project Delivery Methods," *Linch Development Services,* Internet, available from www.docstoc.com/docs/68136547/Project-Delivery-Methods, accessed 19 February 2014.

McGreevy, Susan, "The Myth of the One-Year Warranty and Other Construction Warranty Issues (2005)," *Husch & Eppenberger LLC,* Internet, available from http://www.americanbar.org/publications/probate_property_magazine_home/rppt_publications_magazine_2005_ja_mcgreevy.html, accessed 27 February 2014.

Ohrn, Greg and Rogers, Thomas, "Defining Project Delivery Methods for Design, Construction, and Other Construction-Related Services in the United States," *Northern Arizona University,* Internet, available from http://ascpro0.ascweb.org/archives/cd/2008/paper/CPGT293 002008.pdf, accessed 24 February 2014.

PHCC, "Total Quality Management: A Continuous Improvement Process," *PHCC Educational Foundation,* Internet, available from foundation.phccweb.org/files/2011Foundation /PDFs/TQM.doc. accessed 4 December 2013.

Ramsey, Fred L., and Daniel W. Schafer, *The Statistical Sleuth.* Belmont: Brooks/Cole, 2002.

Rubenstein, Ken, "Why the Project Delivery Method Matters in Construction Litigation," *Preti, Flaherty, Beliveau & Pachios, Chartered, LLP*,Internet, available from http://pretiprofessionalliability.blogspot.com/2013/12/ Construction-Product-Delivery. html, accessed 16 April 2014.

Santiago, Jesse and Magallon, Desirae, "Critical Path Method," *Stanford University,* Internet, available from http://www.stanford.edu/class/cee320/CEE320B/CPM.pdf, accessed 18 January 2014.

Skitmore, Martin R. and Love, Peter E.D., "Construction Project Delivery Systems: An Analysis of Selection Criteria Weighting. In Proceedings ICEC Symposium "Construction Economics - the essential management tool (1995)", pages pp. 295-310, Gold Coast, Australia, Internet, available from http://eprints.qut.edu.au/archive/00004525, accessed 6 March 2014.

Smith, James and Rybkowski, Zofia, "Literature Review on Trust and Current Construction Industry Trends, Proceedings for the 20th Annual Conference of the International Group for Lean Construction (2012)," *Internation Group for Lean Construction,*Internet, available from http://www.iglc20.sdsu.edu/papers/wp-content/uploads/2012/07/32%20P%20078.pdf, accessed 2 April 2014.

Trauner Consulting Services, Inc., "Construction Project Delivery Systems and Procurement Practices: Considerations, Alternatives, Advantages, Disadvantages, April 2007," *Trauner Consulting Services, Inc.,*Internet, available from http://www.fefpa.org/pdf/ summer2007/Pros-Cons-handout.pdf, accessed 17 Decemebr 2012.

Tucker, Matthew, "An Overview of Alternative Dispute Resolution Use in the Construction Industry," *The University of Texas at Austin,* Internet, available from http://www.dtic. mil/dtic/tr/fulltext/u2/a458748.pdf, accessed 18 January 2014.

US Army Corp of Engineers, "Partnering: A Tool for USACE, Engineering, Construction, and Operations," *US Army Corp of Engineers,* Internet, available from http://www.iwr.usace. army.mil/Portals/70/docs/iwrreports/91-ADR-P-4.pdf, accessed 18 October 2013.

APPENDICES

APPENDIX A. INITIAL COST DATABASE

Property ID#	Delivery Method	Historical Index	State	Exterior Finish	Roof Material	Cycle Time	Year Completed	Percentage of Average
1	CM/GC	110.8	Utah	Traditional	Shingle	237	2002	88%
2	DBB	104.5	Utah	Traditional	Shingle	442	1999	98%
3	CM/GC	116	Utah	Traditional	Shingle	246	2003	83%
4	CM/GC	110.8	Utah	Traditional	Shingle	372	2002	89%
5	DBB	104.5	Utah	Traditional	Shingle	464	1999	90%
6	CM/GC	106.5	Utah	Traditional	Shingle	297	2000	90%
7	CM/GC	116	Utah	Traditional	Shingle	282	2003	82%
8	CM/GC	113.7	Utah	Traditional	Shingle	392	2002	86%
9	CM/GC	112.7	Utah	Traditional	Shingle	332	2003	88%
10	CM/GC	116	Utah	Traditional	Shingle	240	2003	82%
11	CM/GC	109.1	Utah	Traditional	Shingle	325	2001	92%
12	CM/GC	109.1	Utah	Traditional	Tile	313	2001	95%
13	DBB	103.3	Utah	Traditional	Shingle	461	1999	99%
14	CM/GC	106.5	Utah	Traditional	Shingle	345	2000	97%
15	DBB	91.5	North Carolina	Colonial	Shingle	535	2001	132%
16	DBB	116	Utah	Classical	Shingle	320	2003	81%
17	CM/GC	104.6	Texas	Traditional	Shingle	354	1999	125%
18	CM/GC	157.2	Hawaii	Classical	Shingle	365	2002	116%
19	CM/GC	113.3	Arizona	Traditional	Tile	467	2002	109%
20	DBB	118.2	Missouri	Colonial	Shingle	396	2000	123%
21	CM/GC	109.1	Utah	Traditional	Shingle	304	2001	92%
22	DBB	135.5	California	Classical	Tile	593	2001	111%
23	CM/GC	107.7	Utah	Traditional	Shingle	291	2001	89%
24	DBB	104.6	Utah	Colonial	Shingle	396	2000	97%
25	DBB	106.5	Utah	Traditional	Shingle	319	2000	91%
26	CM/GC	113.3	Arizona	Colonial	Tile	262	2002	111%
27	CM/GC	118.7	Idaho	Traditional	Shingle	172	2003	85%
28	CM/GC	113.7	Utah	Classical	Shingle	317	2002	83%
29	CM/GC	110.8	Utah	Traditional	Shingle	362	2002	94%
30	CM/GC	104.5	Utah	Traditional	Shingle	345	1999	105%
31	CM/GC	125.9	Washington	Colonial	Shingle	330	2003	117%
32	CM/GC	133.8	Nevada	Traditional	Tile	483	2003	106%
33	DBB	104.5	Utah	Traditional	Shingle	475	1999	94%
34	CM/GC	109.1	Utah	Traditional	Shingle	361	2001	96%
35	DBB	127.4	Oregon	Classical	Shingle	424	2000	117%
36	CM/GC	139.6	California	Traditional	Tile	462	2003	105%
37	DBB	122.9	Washington	Classical	Shingle	393	2000	121%

INITIAL COST DATA (CONT'D)

Property ID#	Delivery Method	Historical Index	State	Exterior Finish	Roof Material	Cycle Time	Year Completed	Percentage of Average
38	CM/GC	104.9	Arizona	Traditional	Tile	366	2000	122%
39	CM/GC	125.7	Washington	Traditional	Shingle	283	2001	121%
40	DBB	107	Nebraska	New England	Shingle	445	2000	125%
41	CM/GC	113.9	Arizona	Traditional	Tile	330	2003	109%
42	DBB	104.6	Utah	Traditional	Shingle	453	2000	90%
43	CM/GC	128.3	Nevada	Traditional	Shingle	231	2003	105%
44	CM/GC	136.5	California	Traditional	Tile	386	2002	120%
45	CM/GC	110.8	Utah	Traditional	Shingle	278	2002	86%
46	CM/GC	109	Arizona	Southwest	Tile	305	2001	110%
47	DBB	106.5	Utah	Traditional	Shingle	388	2000	87%
48	CM/GC	104.5	Utah	Colonial	Tile	435	1999	104%
49	CM/GC	127.9	Washington	Traditional	Shingle	388	2001	120%
50	DBB	103.8	Florida	Colonial	Shingle	384	2001	152%
51	DBB	152.6	Alaska	Traditional	Shingle	434	2001	116%
52	CM/GC	106.9	Arizona	Traditional	Tile	243	2000	116%
53	CM/GC	159.5	Alaska	Traditional	Shingle	407	2002	118%
54	CM/GC	127.8	Nevada	Traditional	Tile	333	2001	108%
55	CM/GC	113.7	Utah	Traditional	Shingle	271	2002	86%
56	CM/GC	104.5	Utah	Colonial	Shingle	263	1999	97%
57	CM/GC	104.5	Utah	Traditional	Shingle	290	1999	95%
58	CM/GC	118.2	Nevada	Traditional	Shingle	376	2000	107%
59	CM/GC	113.7	Utah	Colonial	Shingle	292	2002	87%
60	CM/GC	121.9	Nevada	Traditional	Tile	717	1999	113%
61	CM/GC	113.7	Utah	Traditional	Shingle	357	2002	85%
62	DBB	106.5	Utah	Colonial	Shingle	495	2000	87%
63	DBB	112.9	Idaho	Traditional	Shingle	458	2000	92%
64	CM/GC	106.9	Arizona	Traditional	Tile	361	2000	116%
65	CM/GC	113.7	Utah	Traditional	Tile	358	2002	92%
66	DBB	110.2	Idaho	Colonial	Shingle	365	1999	95%
67	CM/GC	104.8	Texas	Southwest	Tile	415	2003	135%
68	CM/GC	109.3	Texas	Traditional	Shingle	381	2003	150%
69	CM/GC	113.7	Utah	Colonial	Shingle	367	2002	88%
70	DBB	110.2	Idaho	Colonial	Shingle	448	1999	96%
71	DBB	112.9	Idaho	Traditional	Shingle	315	2000	93%
72	CM/GC	109.1	Utah	Traditional	Shingle	294	2001	90%
73	DBB	103.3	Utah	Traditional	Shingle	463	1999	97%
74	CM/GC	106.9	Arizona	Traditional	Tile	303	2000	120%
75	DBB	110.6	Arizona	Southwest	Tile	304	2003	104%
76	DBB	125.7	Washington	Traditional	Shingle	306	2001	121%
77	DBB	106.5	Utah	Colonial	Shingle	347	2000	90%
78	CM/GC	113.7	Utah	Traditional	Tile	322	2002	88%
79	CM/GC	159.4	Hawaii	Traditional	Shingle	392	2003	118%
80	CM/GC	109	Utah	Traditional	Shingle	344	2001	90%
81	DBB	103.3	Utah	Colonial	Shingle	449	1999	95%
82	CM/GC	116	Utah	Traditional	Shingle	297	2003	85%
83	DBB	109.1	Utah	Traditional	Shingle	283	2001	93%
84	CM/GC	109.1	Utah	Classical	Shingle	312	2001	87%

INITIAL COST DATA (CONT"D)

Property ID#	Delivery Method	Historical Index	State	Exterior Finish	Roof Material	Cycle Time	Year Completed	Percentage of Average
85	CM/GC	105.5	Arizona	Traditional	Tile	298	1999	121%
86	CM/GC	135.9	Oregon	Traditional	Shingle	385	2003	105%
87	CM/GC	106.5	Utah	Classical	Shingle	347	2000	94%
88	CM/GC	109	Arizona	Traditional	Tile	303	2001	112%
89	CM/GC	104.5	Utah	Colonial	Shingle	312	1999	101%
90	DBB	118.3	Idaho	Traditional	Shingle	361	2002	92%
91	DBB	109.8	Colorado	Traditional	Shingle	393	2000	117%
92	CM/GC	106.5	Utah	New England	Shingle	304	2000	95%
93	DBB	112.9	Idaho	Traditional	Shingle	411	2000	92%
94	CM/GC	116	Utah	Traditional	Shingle	330	2003	83%
95	CM/GC	126.4	Nevada	Traditional	Shingle	298	2002	103%
96	CM/GC	109	Arizona	Traditional	Tile	332	2001	115%
97	CM/GC	106.5	Utah	Colonial	Tile	352	2000	100%
98	CM/GC	113.7	Utah	Traditional	Shingle	279	2002	83%
99	DBB	115.6	Maryland	Colonial	Shingle	507	2002	121%
100	DBB	134.1	California	Traditional	Shingle	440	2001	109%
101	CM/GC	109.1	Utah	Traditional	Shingle	305	2001	90%
102	DBB	137.3	Massachusetts	Colonial	Shingle	375	2002	130%
103	CM/GC	113.9	Arizona	Traditional	Tile	260	2003	104%
104	CM/GC	113.7	Utah	Traditional	Shingle	285	2002	82%
105	DBB	106.5	Utah	Traditional	Shingle	398	2000	88%
106	CM/GC	100.4	Texas	Southwest	Tile	422	2003	142%
107	CM/GC	107.7	Utah	Classical	Shingle	282	2001	95%
108	CM/GC	125.8	Nevada	Traditional	Tile	392	2000	96%
109	CM/GC	106.5	Utah	Colonial	Shingle	291	2000	93%
110	CM/GC	109.1	Utah	Traditional	Shingle	285	2001	88%
111	CM/GC	109.1	Utah	Traditional	Shingle	299	2001	88%
112	CM/GC	113.7	Utah	Classical	Shingle	307	2002	84%
113	DBB	116	Utah	Traditional	Shingle	295	2003	81%
114	CM/GC	113.7	Utah	Classical	Shingle	322	2002	84%
115	CM/GC	107.9	Texas	Traditional	Shingle	529	2002	145%
116	CM/GC	109.1	Utah	Traditional	Shingle	297	2001	90%
117	CM/GC	133.8	Nevada	Colonial	Tile	315	2003	100%
118	CM/GC	113.7	Utah	Traditional	Shingle	332	2002	88%
119	DBB	119.2	Ohio	Traditional	Shingle	533	2002	124%
120	DBB	125.9	Washington	Traditional	Shingle	545	2003	92%
121	CM/GC	113.7	Utah	Classical	Shingle	320	2002	86%
122	CM/GC	113.7	Utah	Traditional	Shingle	312	2002	83%
123	DBB	112.7	Utah	Traditional	Shingle	304	2003	84%
124	DBB	109.1	Utah	Traditional	Shingle	289	2001	90%
125	CM/GC	113.7	Utah	Traditional	Shingle	271	2002	86%
126	CM/GC	109.1	Utah	Traditional	Shingle	324	2001	89%
127	DBB	146.5	Minnesota	Traditional	Shingle	384	2003	90%
128	DBB	114.3	Idaho	Traditional	Shingle	329	2001	96%
129	CM/GC	117.1	Idaho	Traditional	Shingle	258	2002	98%
130	CM/GC	116	Utah	Traditional	Shingle	323	2003	91%
131	CM/GC	109.1	Utah	Traditional	Tile	343	2001	97%

INITIAL COST DATA (CONT'D)

Property ID#	Delivery Method	Historical Index	State	Exterior Finish	Roof Material	Cycle Time	Year Completed	Percentage of Average
132	CM/GC	107.7	Utah	Traditional	Shingle	257	2001	90%
133	CM/GC	110.8	Utah	Traditional	Shingle	336	2002	86%
134	CM/GC	113.7	Utah	Colonial	Shingle	292	2002	86%
135	CM/GC	133.8	Nevada	Classical	Tile	300	2003	106%
136	CM/GC	116	Utah	Traditional	Shingle	307	2003	81%
137	CM/GC	131.9	Nevada	New England	Tile	327	2002	100%
138	CM/GC	113.9	Arizona	Classical	Tile	334	2003	109%
139	CM/GC	113.7	Utah	Traditional	Shingle	313	2002	85%
140	CM/GC	113.7	Utah	Traditional	Shingle	299	2002	85%
141	CM/GC	113.7	Utah	Traditional	Shingle	361	2002	85%
142	CM/GC	111.5	Texas	Traditional	Shingle	412	2002	136%
143	CM/GC	110.2	Arizona	Traditional	Tile	365	2002	111%
144	CM/GC	113.3	Arizona	Southwest	Tile	356	2002	104%
145	CM/GC	116	Utah	Classical	Shingle	347	2003	87%
146	CM/GC	107.7	Utah	Classical	Shingle	369	2001	91%
147	CM/GC	138.7	California	Traditional	Tile	360	2003	111%
148	CM/GC	145.5	Pennsylvania	Traditional	Shingle	529	2003	125%
149	CM/GC	113.9	Arizona	Southwest	Tile	347	2003	110%
150	CM/GC	109.8	Colorado	Colonial	Shingle	451	2002	136%
151	CM/GC	113.7	Utah	Traditional	Shingle	308	2002	86%
152	CM/GC	116	Utah	Traditional	Shingle	254	2003	82%
153	CM/GC	116	Utah	Traditional	Shingle	381	2003	85%
154	CM/GC	133.8	Nevada	Traditional	Tile	272	2003	135%
155	CM/GC	113.7	Utah	New England	Shingle	352	2002	75%
156	DBB	113	Georgia	Colonial	Shingle	452	2002	135%
157	CM/GC	109.1	Utah	Traditional	Shingle	285	2001	88%
158	CM/GC	113.9	Arizona	Southwest	Tile	305	2003	108%
159	CM/GC	120.2	Idaho	Traditional	Shingle	271	2003	90%
160	CM/GC	113.7	Utah	Classical	Shingle	356	2002	87%
161	CM/GC	113.7	Utah	Traditional	Shingle	341	2002	86%
162	CM/GC	113.7	Utah	Classical	Shingle	290	2002	88%
163	CM/GC	113.7	Utah	Classical	Shingle	274	2002	88%
164	CM/GC	113.7	Utah	Traditional	Shingle	302	2002	85%
165	CM/GC	133.8	Nevada	Traditional	Tile	238	2003	101%
166	CM/GC	113.7	Utah	Traditional	Shingle	286	2002	89%
167	CM/GC	113.4	Texas	Traditional	Shingle	385	2003	138%
168	DBB	115.8	Georgia	Traditional	Shingle	514	2003	110%
169	CM/GC	116	Utah	Traditional	Shingle	353	2003	88%
170	CM/GC	116	Utah	Classical	Shingle	293	2003	86%
171	CM/GC	116	Utah	Traditional	Shingle	274	2003	85%
172	CM/GC	113.9	Arizona	Traditional	Tile	212	2003	105%
173	CM/GC	116	Utah	Traditional	Shingle	236	2003	82%

APPENDIX B. CONTRACT ADMINISTRATION SURVEY INSTRUMENTS

DESIGN/BID/BUILD VERSUS CM/GC

A COMPARATIVE STUDY

Project Name

From 1999 to 2008, the Meetinghouse Facilities Department of the Church of Jesus Christ of Latter-day Saints employed two methods of project delivery for their Heritage 98 meetinghouses constructed in North America, Design/Bid/Build and CM/GC. According to historical records, your company was contracted to build meetinghouses using both styles of project delivery.

With the permission of the Meetinghouse Facilities Department and as the basis of my Master's thesis, I am conducting a comparative study of these two methods of project delivery from your perspective as general contractor. This survey in an attempt to identify any significant differences between building meetinghouses using the CM/GC delivery method as compared to the DBB method. Your response should be to the best of your recollection and should only be reflective of the repetitive projects built from 1999 to 2008.

Please complete this questionnaire and return it in the postage-paid envelope provided. The information you provide will be compiled with responses from other qualifying general contractors like yourself. The information will be used to compare delivery practices and all individual responses will remain strictly confidential with no company names attached to the questionnaire results.

General Contractor Survey Page 1

CONTRACT ADMINISTRATION SURVEY INSTRUMENTS (CONT'D)

Instructions: Please respond to each statement by circling the number that best describes your experience.

Remember that all answers are confidential. Return of this questionnaire implies your consent to provide information that will be used only for studying construction project delivery methods.

	Strongly Disagree				Strongly Agree
1. CM/GC projects exhibited better teamwork and mutual trust as compared to DBB projects..	1	2	3	4	5
2. CM/GC projects had fewer owner initiated change order delays as compared to DBB projects.....................................	1	2	3	4	5
3. CM/GC projects were easier to supervise as compared to DBB projects..	1	2	3	4	5
4. Communication with church employed PMs were more fluid with CM/GC projects as compared to DBB projects.............	1	2	3	4	5
5. Disputes arising from change orders were fewer with CM/GC projects as compared to DBB projects.....................	1	2	3	4	5
6. I requested fewer RFIs with CM/GC projects as compared to DBB projects..	1	2	3	4	5
7. Project related paperwork was lighter with CM/GC projects as compared to DBB projects.................................	1	2	3	4	5
8. Project Quality Assurance inspections had fewer corrections with CM/GC projects as compared to DBB projects.............	1	2	3	4	5
9. Cost, quality, and timeliness efficiencies improved faster on CM/GC projects as compared to DBB projects.....................	1	2	3	4	5
10. The project quality was expected to exceed on CM/GC projects as compared to DBB projects................................	1	2	3	4	5
11. I experienced no litigation on my CM/GC projects...............	1	2	3	4	5
12. The CM/GC method was a win/win delivery method............	1	2	3	4	5

General Contractor Survey Page 2

CONTRACT ADMINISTRATION SURVEY INSTRUMENTS (CONT'D)

DESIGN/BID/BUILD VERSUS CM/GC

A COMPARATIVE STUDY

Falcon Hill Chapel

From 1999 to 2008, the Meetinghouse Facilities Department of the Church of Jesus Christ of Latter-day Saints employed two methods of project delivery for their Heritage 98 meetinghouses constructed in North America, Design/Bid/Build and CM/GC. According to historical records, you project managed meetinghouses using both styles of project delivery.

With the permission of the Meetinghouse Facilities Department and as the basis of my Master's thesis, I am conducting a comparative study of these two methods of project delivery from your perspective as project manager. This survey in an attempt to identify any significant differences between managing meetinghouses using the CM/GC delivery method as compared to the DBB method. Your response should be to the best of your recollection and should only be reflective of the Heritage 98 meetinghouses built from 1999 to 2008.

Please complete this questionnaire and return it in the postage-paid envelope provided. The information you provide will be compiled with responses from other qualifying project managers like yourself. The information will be used to compare delivery practices and all individual responses will remain strictly confidential with no names attached to the questionnaire results.

Project Manager Survey Page 1

CONTRACT ADMINISTRATION SURVEY INSTRUMENTS (CONT'D)

Instructions: Please respond to each statement by circling the number that best describes your experience.

Remember that all answers are confidential. Return of this questionnaire implies your consent to provide information that will be used only for studying construction project delivery methods.

	Strongly Disagree				Strongly Agree
1. CM/GC projects exhibited better teamwork and mutual trust as compared to DBB projects..	1	2	3	4	5
2. CM/GC projects had fewer contactor initiated change order delays as compared to DBB projects....................................	1	2	3	4	5
3. CM/GC projects were easier to supervise as compared to DBB projects..	1	2	3	4	5
4. Communication with job superintendents were more fluid with CM/GC projects as compared to DBB projects.............	1	2	3	4	5
5. Disputes arising from change orders were fewer with CM/GC projects as compared to DBB projects....................	1	2	3	4	5
6. I processed fewer RFIs with CM/GC projects as compared to DBB projects..	1	2	3	4	5
7. Project related paperwork was lighter with CM/GC projects as compared to DBB projects.................................	1	2	3	4	5
8. Project Quality Assurance inspections had fewer corrections with CM/GC projects as compared to DBB projects.............	1	2	3	4	5
9. Cost, quality, and timeliness efficiencies improved faster on CM/GC projects as compared to DBB projects....................	1	2	3	4	5
10. The project quality was above my expectations on CM/GC projects as compared to DBB projects................................	1	2	3	4	5
11. I experienced no litigation on my CM/GC projects...............	1	2	3	4	5
12. The CM/GC method was a win/win delivery method...........	1	2	3	4	5

Project Manager Survey Page 2

CONTRACT ADMINISTRATION SURVEY INSTRUMENTS (CONT'D)

In order of priority, please list 3-5 practices that contributed most to successful meetinghouse projects for you.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Comments:

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Common Page 3

APPENDIX C. SITE PREP RANKING DATA

Property ID	Delivery Method	Cost Ranking	Percentage of Average
49	CM/GC	1	241%
18	CM/GC	2	200%
79	CM/GC	3	198%
31	CM/GC	4	191%
44	CM/GC	5	177%
115	CM/GC	6	167%
167	CM/GC	7	163%
140	CM/GC	8	160%
68	CM/GC	9	160%
51	DBB	10	158%
53	CM/GC	11	158%
58	CM/GC	12	158%
150	CM/GC	13	151%
36	CM/GC	14	150%
91	DBB	15	149%
19	CM/GC	16	147%
62	DBB	17	147%
143	CM/GC	18	145%
100	DBB	19	141%
67	CM/GC	20	140%
76	DBB	21	139%
102	DBB	22	137%
12	CM/GC	23	136%
156	DBB	24	133%
151	CM/GC	25	132%
149	CM/GC	26	132%
117	CM/GC	27	132%
96	CM/GC	28	131%
85	CM/GC	29	131%
86	CM/GC	30	130%
43	CM/GC	31	129%
97	CM/GC	32	128%
2	DBB	33	128%
50	DBB	34	126%
163	CM/GC	35	126%
74	CM/GC	36	124%
46	CM/GC	37	122%
164	CM/GC	38	121%
54	CM/GC	39	119%
170	CM/GC	40	118%
137	CM/GC	41	117%
111	CM/GC	42	116%
1	CM/GC	43	116%
154	CM/GC	44	113%
116	CM/GC	45	113%
171	CM/GC	46	113%
103	CM/GC	47	112%
158	CM/GC	48	112%
148	CM/GC	49	111%
129	CM/GC	50	111%
147	CM/GC	51	110%
141	CM/GC	52	109%
126	CM/GC	53	109%
7	CM/GC	54	108%
95	CM/GC	55	107%
122	CM/GC	56	106%
142	CM/GC	57	105%
88	CM/GC	58	105%
24	DBB	59	105%
39	CM/GC	60	105%
168	DBB	61	104%
166	CM/GC	62	104%
72	CM/GC	63	104%
78	CM/GC	64	104%
33	DBB	65	102%
120	DBB	66	102%
17	CM/GC	67	102%
134	CM/GC	68	101%
69	CM/GC	69	101%
94	CM/GC	70	101%

SITE PREP RANKING DATA (CONT'D)

Property ID	Delivery Method	Cost Ranking	Percentage of Average
165	CM/GC	71	100%
22	DBB	72	100%
27	CM/GC	73	98%
75	DBB	74	96%
21	CM/GC	75	94%
37	DBB	76	94%
118	CM/GC	77	94%
45	CM/GC	78	94%
32	CM/GC	79	94%
55	CM/GC	80	94%
131	CM/GC	81	93%
25	DBB	82	93%
10	CM/GC	83	93%
112	CM/GC	84	92%
153	CM/GC	85	92%
135	CM/GC	86	92%
114	CM/GC	87	91%
11	CM/GC	88	90%
14	CM/GC	89	90%
5	DBB	90	90%
172	CM/GC	91	90%
104	CM/GC	92	89%
89	CM/GC	93	89%
87	CM/GC	94	88%
121	CM/GC	95	88%
169	CM/GC	96	88%
3	CM/GC	97	88%
101	CM/GC	98	88%
64	CM/GC	99	87%
125	CM/GC	100	87%
4	CM/GC	101	86%
113	DBB	102	86%
107	CM/GC	103	86%
48	CM/GC	104	85%
155	CM/GC	105	85%

Property ID	Delivery Method	Cost Ranking	Percentage of Average
61	CM/GC	106	85%
28	CM/GC	107	85%
139	CM/GC	108	85%
35	DBB	109	85%
82	CM/GC	110	83%
20	DBB	111	83%
29	CM/GC	112	83%
162	CM/GC	113	82%
161	CM/GC	114	82%
136	CM/GC	115	82%
132	CM/GC	116	82%
133	CM/GC	117	82%
146	CM/GC	118	82%
144	CM/GC	119	81%
80	CM/GC	120	81%
160	CM/GC	121	81%
152	CM/GC	122	80%
99	DBB	123	80%
15	DBB	124	80%
124	DBB	125	79%
157	CM/GC	126	78%
9	CM/GC	127	78%
138	CM/GC	128	78%
42	DBB	129	77%
60	CM/GC	130	76%
145	CM/GC	131	76%
52	CM/GC	132	76%
16	DBB	133	75%
56	CM/GC	134	75%
6	CM/GC	135	75%
65	CM/GC	136	75%
13	DBB	137	75%
130	CM/GC	138	74%
59	CM/GC	139	74%
128	DBB	140	74%

SITE PREP RANKING DATA (CONT'D)

Property ID	Delivery Method	Cost Ranking	Percentage of Average
8	CM/GC	141	0.73381043
34	CM/GC	142	0.73149539
90	DBB	143	0.73105823
63	DBB	144	0.72381993
70	DBB	145	0.71832406
92	CM/GC	146	0.71825702
66	DBB	147	0.71634853
119	DBB	148	0.71632905
110	CM/GC	149	0.7099755
109	CM/GC	150	0.70685753
98	CM/GC	151	0.70674854
47	DBB	152	0.70476126
173	CM/GC	153	0.70335664
106	CM/GC	154	0.70327519
77	DBB	155	0.69971248
105	DBB	156	0.6951785
123	DBB	157	0.69346094
71	DBB	158	0.69325403
84	CM/GC	159	0.68733017
23	CM/GC	160	0.68119384
73	DBB	161	0.67275506
127	DBB	162	0.67211636
30	CM/GC	163	0.66488803
41	CM/GC	164	0.66422795
57	CM/GC	165	0.66016391
159	CM/GC	166	0.64701212
26	CM/GC	167	0.63432152
83	DBB	168	0.63307037
108	CM/GC	169	0.605714
40	DBB	170	0.59210263
93	DBB	171	0.58670097
81	DBB	172	0.5623723
38	CM/GC	173	0.54650303