IMPACT OF PRE-CONSTRUCTION PROJECT PLANNING ON COST SAVINGS

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN BUILDING CONSTRUCTION

UNIVERSITY OF FLORIDA

2010

ACKNOWLEDGMENTS

I would like to thank my family for believing in me. I would also like to show my appreciation to the professors in King Fahd University of Petroleum and Minerals for guiding me through my undergraduate years and for still supporting me after graduation. My deepest gratitude goes to the management team in Samba Financial Group; the two years I worked there have been very exciting and full of knowledge. Last but not least, I would like to thank the professors in M.E. Rinker, Sr. School of Building Construction at the University of Florida for setting my mind free to gain all the knowledge I could grasp. Go Gators!

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LIST OF ABBREVIATIONS

BIM	Building Information Modeling is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition.
CAD	Computer Aided Design
PDRI	Project Definition Rating Index
ROI	Return on Investment

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December 2010

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Major: Building Construction

Construction projects are a mix of very complex processes that seldom go according to plan. Many construction related firms used construction scheduling for many years but that process has proven to be undependable. There are many factors that can cause delays in a regular construction schedule including weather conditions and productivity decline. Several pre-construction planning methods emerged in the last century and made their way in projects. These methods include design phase construction planning, building information modeling, project control systems and using past projects' data to improve performance.

Different planning methods cost different rates and have different effects on the overall project's cost savings. The main objective of this research is to find the optimum percentage that can be spent on pre-construction planning, using any method, that would save the highest amount of both money and time. Additional objectives are to find which method is most widely used in the industry today and how much each method costs. The data for the research will be collected using an online survey since such information cannot be easily found. The survey will ensure anonymity of the

respondents since some information about profit and spending are often considered confidential. In addition, the survey will focus on percentages and ballpark figures of past projects to encourage more responses.

The response rate for the survey was 6% and the data collected helped answer the objective questions. Using data from past projects to improve performance was determined to be the most used method. Moreover, many other methods were mentioned in the survey by the respondents who had a high return on investment and acted as a time saver. The optimum percentage to be spent on pre-construction planning was found to be about 12% of the total project cost. Understanding how pre-construction planning affects the project savings and duration can encourage many construction firms to adopt them and push the industry even further to achieve better results.

CHAPTER 1
INTRODUCTION

A construction project can vary from extremely profitable to barely worth it and sometimes end up costing the contractor more than what he or she is getting paid to complete it. The profitability of a project depends heavily on the ability of the general contractor to anticipate potential problems and avoid them. Usually, a construction project will not proceed as planned due to various factors. These factors include, but are not limited to, weather conditions, city regulations and codes, differing site conditions, change in construction materials prices and most importantly workers productivity.

Weather conditions can cause various problems on the jobsite. Rain will stop any concrete pouring and lightning alerts can stop the entire work completely in accordance with the OSHA regulations. Many other weather related issues can either delay or stop construction work on the jobsite. However, many of those issues can be anticipated months ahead if the contractor knew where to find historic data and good forecasts.

Every construction site lies in a different location that has different and unique conditions. A jobsite in one state would allow the freedom for materials delivery trucks to get in and out at any time while another state would not. In addition, the building code can vary significantly from one county to another or from one state to another or from one country to another. Moreover, the soil conditions of every site are different. Contractors would rely on change orders to cover that issue, but a competent contractor would check the conditions of the site before starting any work.

Construction materials change constantly and both designers and contractors try to keep up with the new materials emerging every day. When a contractor orders a sample of a certain material to be approved by the designer or consultant, the price of

that material might soar substantially over a short period of time. Asking for a change order at that time would most probably be rejected. In addition, a contractor might submit a price for a new material and find out later that the price for installing the material is way more expensive than the price for the material itself.

Because construction is almost always conducted by humans, the productivity rate of workers will have a major impact on the project's budget and schedule. The productivity rate is the amount of work output completed in a certain period of time. There are many factors that affect the productivity rate of workers such as thermal comfort, safety issues, availability of tools and materials, length of work hours and availability of supporting facilities such as toilets and proper waste containers. The site layout and safety coordination play the major roles in controlling the productivity rate.

Most of the factors affecting the project's profitability can be controlled through pre-construction project planning. The general contractor is usually the one responsible about meeting all the requirements that affect these factors. However, the planning responsibility can lie on another party depending on the type of project and contract.

There are several types of construction projects in terms of how the project is handled and what the relationship between the owner and the contractor is. The general contractor's role in the pre-construction planning dilemma depends on what type of contract the project is on. On the traditional project type, where an architect is on one side of the owner and a contractor is on the other, the general contractor has to submit a bid. Very limited time is usually given to the contractor to submit a bid stating the total cost and time required to complete the project. That is why some of the pre-construction planning would be on the owner and designer's shoulders.

Another type of project contracts involves a consultant that oversees the bid and construction processes. However, the more parties the owner has to deal with, the less control he or she has on the project in terms of budget and delivery time. On the other hand, the pre-construction planning concern is shared among all the parties and will be relatively easier for each to perform his or her part of it. Many conflicts will occur in this type of contract if the controlling party did not do a good job to maintain the project.

Other types of construction project delivery systems, such as design-build offer the owner a single point of responsibility. In this type of projects, the contractor is solely responsible for planning the project to achieve the lowest cost possible to the owner while maintaining an acceptable profit rate. There is always an ethical issue in these types of projects that make the owner worry. The contractor's business is to make more profit on the project, and the more the project costs to the owner, the bigger the profit for the contractor. However, there are ways to overcome these issues by establishing a guaranteed maximum price that cannot be exceeded.

Depending on which type of contract the owner is involved in, the general contractor has to adjust accordingly in order to make the highest profit possible. Many contractors limit their planning phase to scheduling the tasks in a logical sequence and try to commit to that schedule without taking in consideration the other factors that can cause delays. Scheduling is only a part of the much broader aspect of project's planning since scheduling usually just factors how long it will take to complete a certain task based on previous experiences. Failing to complete a comprehensive project plan may lead to delays and to lost profit. On the other hand, composing an inclusive plan for the entire project before setting foot on the jobsite will pay the contractor back in terms of

savings and potential additional profit. In addition, taking in consideration the productivity rate of the workers will prove to be useful and time saving.

This study will show the various planning methods used today in the industry. In addition, the study will compare the different profitability results achieved by some of the newer methods to indicate the most successful ones. The main objective of the research is to show what the optimum percentage of the total project cost that can be spent on pre-construction planning to achieve the highest possible profit is. The profitability achieved by each method will also be compared based on the cost and time consumed for successfully implementing that specific technique. Other factors that will also be considered are the size, location and complexity of the project. This will ensure a fair comparison between the various planning methods.

In order to achieve that objective, several questions have to first be answered. These questions are as follows:

- Which sector of the construction industry mostly utilizes pre-construction planning?
- How does the size of a construction firm affect the frequency of pre-construction planning for their projects? How about the size of the project?
- Does the geographical location of such a firm have an effect on using pre-construction planning?
- What methods are used for pre-construction project planning?
- How widely is each method used?
- How much does each method cost in terms of the percentage of the project's total budget?
- How much did each method save from the budgeted project's total cost when used on actual projects?
- How much time did each method save on actual projects?

The methods for pre-construction planning are categorized in four main types; namely: design-phase construction planning, building information modeling (BIM) and 4D-CAD, establishing a project control system or unit and using past projects data to improve productivity. Each method will have several techniques to be accomplished. The advantages and difficulties of each method will be indicated as well as the effectiveness of implementing the method.

Moreover, data will be collected that will reflect the profitability of various projects that used some of the previously mentioned planning methods. Comparing these data will reflect the effectiveness of each method. The main goal is to indicate the return value of investing so much time and money on pre-construction planning.

There are some limitations on the conclusions of the research. The principle limitation is the sample size. Small sample sizes may not necessarily reflect the true conditions of the business.

CHAPTER 2
LITERATURE REVIEW

Publications regarding the various methods of pre-construction planning were reviewed for background information. Many studies have indicated the importance of pre-construction planning and the effect it has on the project's cost and profitability.

Project Scheduling

The traditional project scheduling approach is not considered the best pre-construction planning method. It has been used for a long time and has proved to be very unpredictable. Determining the length of each task depends on several factors that the developer might not have full grasp of at the pre-construction phase.

Project Scheduling seems to be purely used to determine the total length of the project without paying much attention to the individual tasks. However, Chassiakos and Sakellaropoulos (2005) re-evaluated the scheduling process in a promising way to produce more accurate schedules that can shorten the duration of the project. The way the authors proposed to achieve that was to run a linear-integer program that analyzes the time-cost of the schedule to find the shortest possible project duration. The authors developed two different methods; an exact and an approximate method. Each method used different linear equations that calculate the possible crushing time for each task in the schedule. These methods can be implemented in current project scheduling software.

Finding a better way to develop a precise project schedule has the potential to change the entire view of pre-construction planning. A schedule that can incorporate and account for weather conditions, productivity rate and resources allocation would be

an irreplaceable tool. However, such a technology is still in its early stages and will take more time and development to reach the optimum stage.

Glenwright (2004) discussed the problems facing contractors in developing a good project schedule in the bidding stage. Contractors are not given a sufficient time to establish a good plan to execute the project. Therefore, contractors need to apply a good strategy in completing project plans as accurately as possible before the bid period is over. The author explained the phases of forming the project's schedule; the phases are: planning, development and management. The planning phase being the most important one and consume 60% of the effort in developing the schedule. The author also discussed the problems that contractors face when developing a schedule. These problems include untrained staff, bad scheduling routines and insufficient time given. These problems will lead to a poor schedule that will eventually cause problems to the contractor in terms of project delays. Contractors can overcome these problems by training their schedulers and developing a better scheduling practice. A procedure consisting of several steps to be taken while developing the project's schedule was suggested.

Developing a detailed and a comprehensive schedule for construction projects can save the contractor a lot of time and money during the construction phase. However, construction project scheduling remains a two dimensional process that excludes several factors that would cause delays. Several authors came up with different procedures and outlines to ensure the schedule covers most of the projects' aspects but the processes remain mainly subjective. Project scheduling has to include at least one other pre-construction planning method to be efficient.

Design-Phase Construction Planning

Thinking about the constructability of the design is something almost every architect does. However, not every architect thinks about how smoothly the construction phase will go based on the design especially when he or she has nothing to do with the project after the bidding stage. Therefore, design-build firms might have a better understanding of this pre-construction planning method.

Including the stakeholders early in the design stage will ensure a smoother run of the project and avoid many changes after starting the construction (Heywood and Smith 2006). It will also ensure the commitments of the higher management in implementing the agreed upon schedule and requirements. The stakeholders play a major role in the required project's outcome. When all the points of views of the stakeholders are gathered in the design stage, the project would face fewer obstacles in the construction phase. The stakeholders will also be in the spot light when changes are required in terms of duration and cost.

Including the stakeholders in the design stage is an important step to ensuring that the design covers all the required aspects. Although this pre-construction planning method does more for the design phase than the construction phase, including the stakeholders can help achieve a smoother construction phase.

Establishing good communication at the beginning of any project is very essential in making it a success. Kumaraswamy et al. (2004) proposed a web-based management system that can help achieve better communication between all the involved parties of the project. The proposed management support system's main objective is to help make better decisions throughout the various project stages. These

decisions are critical in the development of the project especially in the early pre-construction phase. In addition, establishing a supply chain that can be monitored and controlled through the system will improve the overall productivity rate of the project. Setting such a system in the early stage of the project is way more effective than trying to force it later on.

Applying the proposed web-based management system in a project is a positive step that can introduce a good investment for all parties involved. The design phase construction planning method is yet another way of achieving more control over the project. Good communication is always a positive thing and in construction projects it can be the difference between a successful project and a litigious one.

Building Information Modeling (BIM) and 4D-CAD

Needless to say, Building Information Modeling and 4D-CAD models have been the main attraction of the construction industry in the last five years. The technology is an essential tool in establishing a good pre-construction plan. These models give the planner a whole new dimension in predicting the projects course and potential problems. The applications of such models in pre-construction planning are abundant and will help achieve better projects' planning.

Dixit (2007) explained how the 3D computer aided design and the traditional project schedule are combined to form the 4D application. The author also described the benefits of 4D-CAD and how they can help pinpoint potential problems and solve them before construction starts. In addition, 4D-CAD can give the contractor an overall look of the progress and tasks in the construction prior to starting on site. That will help the contractor tremendously in establishing a more accurate project schedule. A more

subtle benefit of BIM and 4D-CAD is to give the owners a clearer look of the project since they probably do not have experience in interpreting the conventional 2D drawings and project schedules.

In another research paper, Heesom and Mahdjoubi (2004) hinted at the idea of including the cost of each task in the schedule to form a 5D-CAD model. Implementing that idea would help the contractor in further determining the needed cash flow for each stage of the project. The authors also discussed some additional benefits of implementing BIM and 4D-CAD. These benefits include sharing information on a live model with the different design teams in the project to avoid conflicts. In addition, the 4D-CAD model can be used to extract various data such as geotechnical information, cost estimating and safety issues.

Building information modeling is indeed the future of construction projects. The more architects and contractors get comfortable with it, the faster it is going to grow and become even more effective. The industry is slowly, but surely, taking advantage of this technology. It will be the major pre-construction planning method in the industry very soon, if it is not already.

Project Control System

Al-Reshaid et al. (2005) explain how problems arise in construction projects in terms of time and budget. They proposed another pre-construction planning technique called “Project Control System.” The system can be implemented in three phases in a project: the planning phase, the design phase and the tender and award phase which are all considered pre-construction phases.

In the planning, or pre-design, phase the system has to incorporate three steps. The first step is in estimating the budget, the contractor, or construction management group, has to set up an exclusive budget for this phase to be included in the overall project budget. The second step lies in the preliminary scheduling where the project manager has to identify and monitor all the pre-construction planning tasks. The last step in this phase is what they referred to as “control program updating,” which is establishing a special reporting system for the owner. This system will ensure that the construction phase will go as smoothly as possible by anticipating the problems that might arise and solving them before starting the project.

In the design phase of the proposed control system, the project manager should establish a detailed design schedule while updating and monitoring the set schedule of the previous phase. The authors explained how the preliminary and detailed design of the project should be carried out while maintaining the established control system. In addition, they recommended that a value engineering process should be implemented in this phase.

In the last phase of the pre-construction project control system, which is the tender and awarding phase, the project management team is to come up with yet another schedule for the phase while updating and monitoring the older ones. Moreover, the authors emphasized the importance of implementing a web-based management information system to keep all the involved parties updated.

The authors also introduced a very promising system that can save both time and cost if implemented correctly in constructions projects. The system is purely a pre-construction planning method that can be very effective. However, establishing the right

methodology for applying such a system is very hard. On the other hand, generalizing the system would create confusion on how effective the system is. Every management firm or contractor can implement essentially the same system but in many different ways.

In another study, Bradshaw (2008) takes the project control system to a whole other level. He noted that in order to control a large and complex project, simple pre-construction planning will not do the job. An organization within the construction company has to be formed and be in charge of controlling the project from start to finish. This organization will be responsible for planning the project and monitoring it throughout the construction phase while keeping control of the plan.

The important factors cited by the author that would ensure the success of this method are the owner's commitment and the decision making authority. The owners of the construction company have to show the commitment to this system by giving all the needed resources for the organization. Moreover, the authorities of the project control organization have to be established from the start and be utterly indisputable. This will give the organization the much needed power to stay on top of all aspects in their plan to control the project without undermining the project management team.

The project control organization, as described by Bradshaw (2008), has to be formed before the start of the project, making it a pre-construction planning method. The organization has to be present and have an input on all phases of the project starting from the preliminary scheduling to the final handing over of the project. In addition, the organization has to form project scopes and contingency plans while reporting on the progress of the project in a weekly or monthly basis.

The presented method has a very major conflict issue which is the role of the project management group. It is very hard for project managers to keep the pace of the project when kept under a constant auditing. On the other hand, it seems as if the project management team has been stripped of some of its responsibilities to control the project. Many conflicts will arise throughout the project even after establishing the roles of each department since project managers are used to managing the project the good old fashioned way. However, the method will be considered as part of the project control system pre-construction planning.

In another research conducted by Gibson and Gebken (2003), the Project Definition Rating Index (PDRI) is used to determine the adequacy of the pre-construction planning for a company. The PDRI is a weighted score sheet that reflects the level of scope definition of construction projects during the pre-construction planning. Determining how good the PDRI score is helps the contractors to understand how well they interpreted the project's scope. The more the scope is defined, the better the results would be in the actual site. The authors related the delays and changes in the construction process to a scope that is not well defined. Understanding how well the project's scope is defined can help tackle the issues that might arise later on the construction phase. This way, companies will have a physical scale of how good their planning is and work on improving it to achieve better results. In addition, the importance of implementing planning "charrettes" is indicated in the research. Planning "charrettes" are a way of planning the project out from several points of views.

Implementing a physical scale of how well the project is planned is an essential tool in understanding pre-construction planning. Contractors need to implement a good

project planning and the proposed index can help them determine if it is good enough or not. Although pre-construction planning is somewhat subjective, the PDRI gives contractors with different backgrounds an established bottom line of what is expected from them. There is a big difference between planning a project and proceeding to see how it progresses and understanding how good the planning is before starting the construction.

Gidado (2004) stressed the fact that pre-construction planning should focus more on the role level rather than the activity level. This approach is said to increase the planning of a project which will lead to better completion results. He noted the various phases of a construction project and when planning can be most effective. The phases described in this study are pre-project, pre-construction, construction and post-construction phases. Each of these phases consists of sub-phases to form a total of nine sub-phases for the project.

Gidado (2004) explained the two aspects of pre-construction planning, physical and financial planning. Physical planning includes the scheduling of the project's tasks in terms of time while financial planning shows the required cash flow for each time period. In addition, four main parts of construction planning; method statement, programming and scheduling, organizational and systems set up and site set up and layout were explained. The author emphasized the fact that spending on pre-construction planning has proven to be a good investment.

The author introduced a flowchart for complex project planning that covers a lot of aspects that can easily be missed when planning. Completing a comprehensive pre-construction plan while focusing on the role level will help avoid many of the problems

that might arise later on. Although the paper presented many of the deliverables in a project that has to be accounted for when planning, the method simply proposed identifying the project aspects and performing a better plan. Therefore, this method can be classified as a project control system.

Historic Data

Using past projects' data has always been associated with submitting an estimate for the project. However, materials prices are not the only factor in the project's budget. Labor and equipment can weigh more heavily than the price of the material to be installed. Knowing the base cost for the labors' wage and the equipment rental are not sufficient in establishing an estimate. The main ingredient is calculating how long each task will take to be completed and multiply the number of man-hours required by the hourly wage. Determining the duration for each task requires the productivity rate of the crew.

Slomsky (2009) explained how construction projects' cost can be controlled. The key factor in controlling the project's cost is a good pre-construction plan and attention to details. The author stressed on the fact that using historical data to produce conceptual or even final estimates can be a double-edged sword. While many projects share the same resources and crew, the productivity rate might differ based on many external factors. Contractors should take care when using past projects' data and compare the parameters of the new project to the older ones.

What was not mentioned is how to utilize the historical data to improve the productivity rate of the new project. Comparing the different productivity rates of the same crew in different project might shed a light at why the same crew performed better

or worse at some projects. Moreover, the contractor can use the resources and equipment in the new project in a manner that is better than older projects where he or she faced some problems. Predicting the pattern of how the new project will perform in comparison to older ones gives the contractor a better picture of how to handle future projects.

Finding the historical data needed to determine the duration of a task and what needs to be done to complete it is challenging. It takes years of experience to acquire all the knowledge required to understand every detail about all equipment needed to complete every task in a complex project. Tatum (2005) introduced a simple solution for this dilemma. He explained the idea of creating technical support software within the construction company. The technical support enables the project managers and estimators to access the historical data of the company for each task separately and understand what steps and equipment are needed to complete that task. The information will provide a better understanding of all the tasks in a project no matter how complex it is. Using this information will enable the estimators and project managers to develop a more comprehensive plan and budget for the project.

Establishing a good reference would give contractors a controlling edge on estimating the budget of a project especially in the short amount of time given. However, the data has to be updated regularly because the prices of everything related to construction changes constantly. Having this system will help construction firms come up with better pre-construction plans.

CHAPTER 3
METHODOLOGY

In order to understand the true relationship between pre-construction planning and the cost savings of a project, data has to be collected from construction companies. This data will show how often pre-construction planning is conducted in construction firms and what the return on investment is. In addition to understanding how pre-construction planning affects the project cost, this research will uncover which method is more effective. Several objective questions were asked in the introduction chapter. The answers to these questions and others will be found after analyzing the collected data.

The various planning techniques or methods have to be measured in dollar figures. In other words, how much does each planning method cost prior to starting the project. After that, the profitability of that specific project is measured against the cost of the planning establishing a percentage of how much was spent and how much was made. Moreover, data about the project's location and how long the project took to be completed will be collected. In order to answer all the objective questions, data about the respondent's company business type, size and project location has to be collected as well.

Getting such an abundant amount of data will indeed prove to be a challenge. Many contractors tend to refuse to share the profit they made in their projects rather than the amount they spent on planning. The best way to get more data from the contractors is to make an anonymous survey that asks for approximate figures rather than detailed information that might be considered sensitive to some. In addition, the shorter and more straight-forward the survey is, the more likely it will get more responses. The demographic of the survey is construction related companies in the

United States. It is true that construction projects vary in costs and methods from one State to another, but the percentages should be fairly similar.

As mentioned earlier, the survey will be as short as possible and right to the point which should not discourage respondents. The survey will be an online version created by one of the many sites that offer the service. An online survey was chosen because of its easiness to send and respond to while covering virtually unlimited geographic locations. The online survey will be short and easy to use to encourage more responses. The estimated response rate is expected to be an optimistic 10 percent. That said, the survey will be sent to over 1,300 e-mails for project managers, estimators, architects, construction company owners and other construction related personnel. The e-mails of those potential respondents will be collected randomly using several directory websites. In addition, most of the top 400 contractors on the Engineering News-Record magazine's list of 2010 will be included in the invitation list.

The survey questions were designed to collect all the data required to answer the objective questions. Aspects that will be covered in the survey include location, size of the company, methods of pre-construction planning, frequency of using those methods and details about a past project. The survey is designed to be simple, straight to the point and short. In addition, the survey will guide the respondent automatically based on his or her answer. That will mainly focus on the business type that the respondent is related to. When the respondent answers that he or she works as a contractor, he or she will only be asked questions from the contractor related section. The more responses that can be collected, the more conclusive the outcome of the survey will be. The survey questions can be found in Appendix A.

The average respondent will take about 5 minutes to complete the survey. This will ensure that he or she does not get bored with the questions which will encourage more completed surveys. A website called “SurveyMonkey” will be used as a service provider. The well known survey website will assure the respondents of the security and anonymity of the survey. Moreover, the website provides various helpful services including building and sending the invitation e-mails, providing live information about the number of respondents and their answers, ensures respondents anonymity and send reminders to the e-mails that did not respond. In addition, the website offers the respondent an option to opt-out of the survey and the user that chooses to do so will never receive any e-mails or reminders about future surveys.

After gathering all the survey’s responses, the numbers will be compared to see how much profit the contractors that did not use any pre-construction planning had against those who did. In addition, the various methods for project planning will be compared to see which methods led to more profits. The profit achieved for every percentage spent on pre-construction planning will be averaged out. The analysis will also show how the location of the project or the company affects the decision on pre-construction planning.

CHAPTER 4
RESULTS AND ANALYSIS

The period given to collect the survey responses was 14 business days. The online invitations were sent to 1,334 e-mails of construction related personnel that were collected randomly. A total of 180 e-mails have bounced back as either a wrong address or no longer existing. The estimated response rate of 10% was a very optimistic one. However, the survey registered a response rate of slightly over 6% with a total of 83 responses. On the other hand, only 59 respondents actually completed the survey, the rest exited the survey after answering several questions. The incomplete surveys were discarded as not useful. Moreover, out of the 59 responses, only 54 were used for the analysis as the other 5 provided what seemed as false information that did not add up correctly. The invitation e-mail gave all respondents the option of opting out of the survey and 40 persons decided to take that option.

The results and analysis of the collected data will be presented in the same order as the objective questions mentioned in the introduction chapter. This way, the analysis will maintain the flow of the objectives and lead to answering the main question.

Construction Industry Sectors

The first question asked about which sector of the construction industry mostly utilizes the use of pre-construction planning. The data was analyzed in terms of how much each sector invested in pre-construction planning in addition to how much they made as profit. Out of the 54 responses, Table 4-1 shows the number of each response related to the corresponding sector. In addition, Figure 4-1 demonstrates the percentage of responses related to each sector.

Table 4-1. Number of responses of each construction industry sector

Construction industry sector	Number of responses
Owner	2
Designer	9
Contractor	37
Consultant	0
Design-builder	6

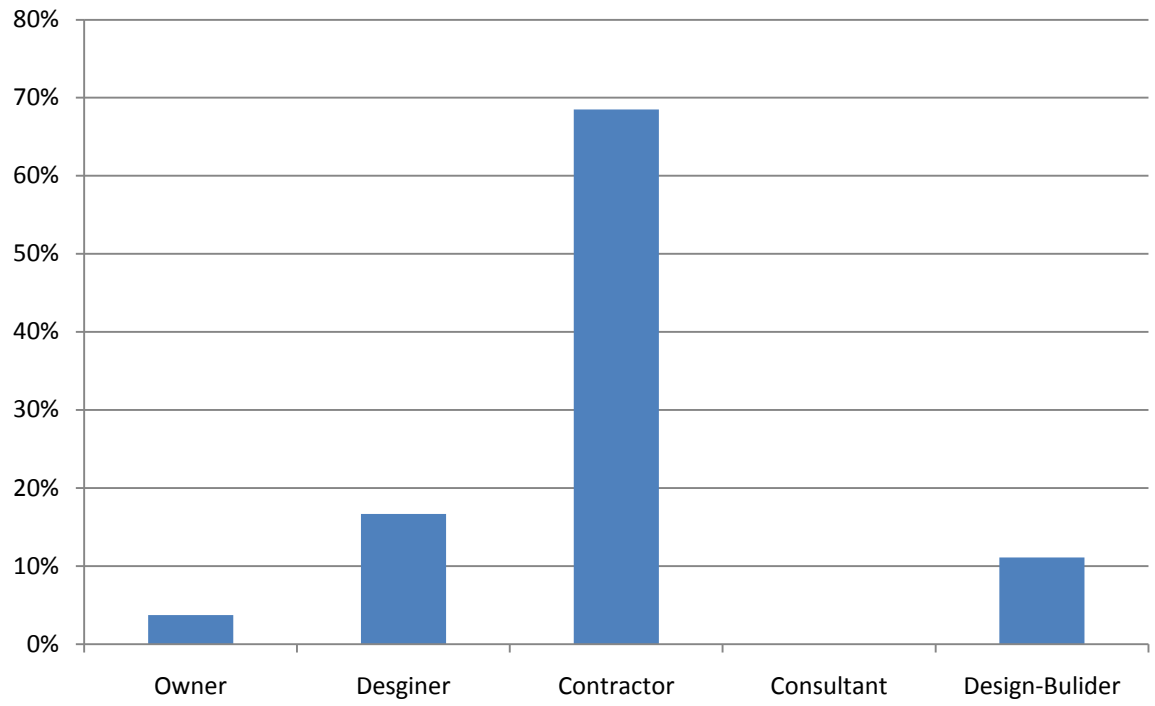

Figure 4-1. Response rate of each construction industry sector

Next, the data analyzed represented how much each sector invested in pre-construction planning and how much they made in profit. Table 4-2 shows the percentage of average actual project cost that was invested in pre-construction planning. In addition, Table 4-2 also shows the percentage of the return on investment for each sector.

Table 4-2. Investment of each sector in pre-construction planning

Sector	Average % Spent	Average % Profit	Average Project Cost	% ROI
Owner	6.5%	10.5%	$500,000	38%
Designer	4.8%	8.2%	$34,100,000	42%
Contractor	2.3%	5.1%	$70,430,000	54%
DB	3.6%	6.5%	$38,860,000	45%

The data indicates that the design sector invests the highest percentage in pre-construction planning. However, due to the lower budget of projects handled by the design sector as compared to that of the contractor's, the return on investment for the designers is lower than all the contractors and design-builders. The data also shows that the contractors spent the least percentage out of the total project cost but managed to score the highest return on investment. This is attributed mainly to the high budget projects that the contractors are completing. The survey showed that the average project cost for responding contractors is slightly below $70.5 million compared to the next highest cost for design-builders with an average total cost of about $40 million. This gives contractors an advantage in terms of how much they can save by implementing a pre-construction plan.

Size of Construction Firm and Project

The question regarding the company's size in the survey gave the respondent five options to choose from. More than two-thirds of the respondents indicated that their business has an average annual income of more than $10 million. Figure 4-2 shows the percentage of the sizes of respondent's companies. The size of the company will be compared to how much they spent on pre-construction planning in addition to how much they saved or made as additional profit.

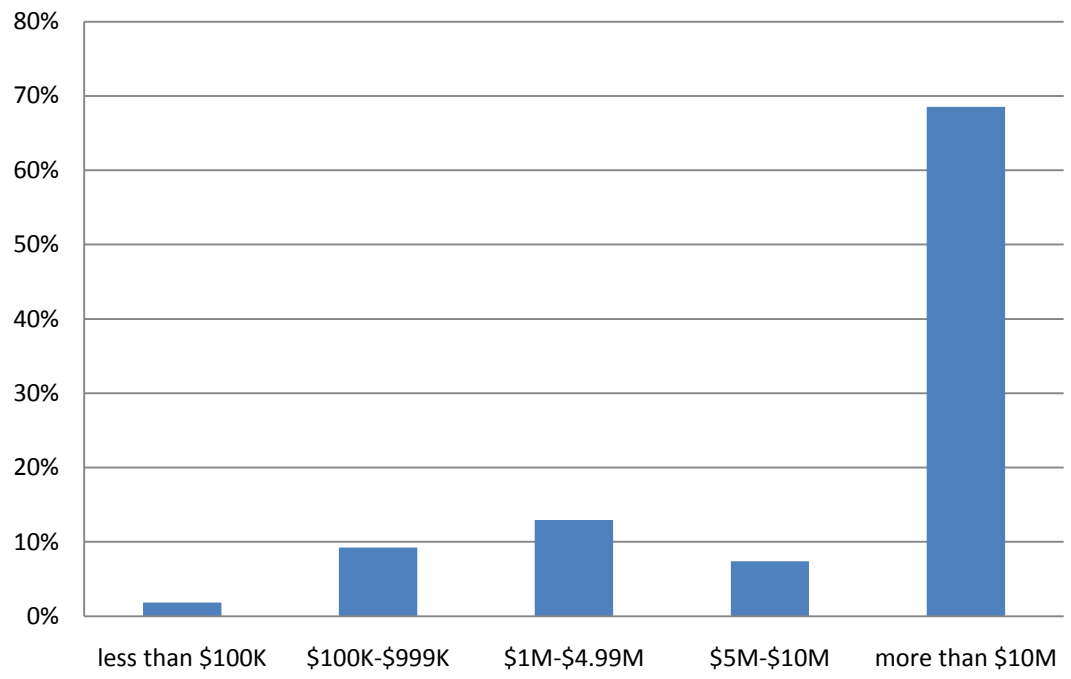

Figure 4-2. Number of respondents for each company size

The main question in this section is how does the size of the company affect the frequency of using pre-construction planning? The survey asked respondents how often they use pre-construction planning which will give a clear idea of how the size affects the decision to perform the planning. Figure 4-3 highlights the percentage of respondents from each size category that choose the frequency of performing planning.

The data indicates that companies with a size between $5 million and $10 million have the highest rate of performing pre-construction planning on a regular basis. However, companies bigger in size than $10 million, in average annual income, have the highest rate (54%) of performing pre-construction planning on all their projects. The fact that the data shows 100% of performing pre-construction planning all the time in companies less in size than $100,000 is negligible since there was only one respondent that belonged to that category.

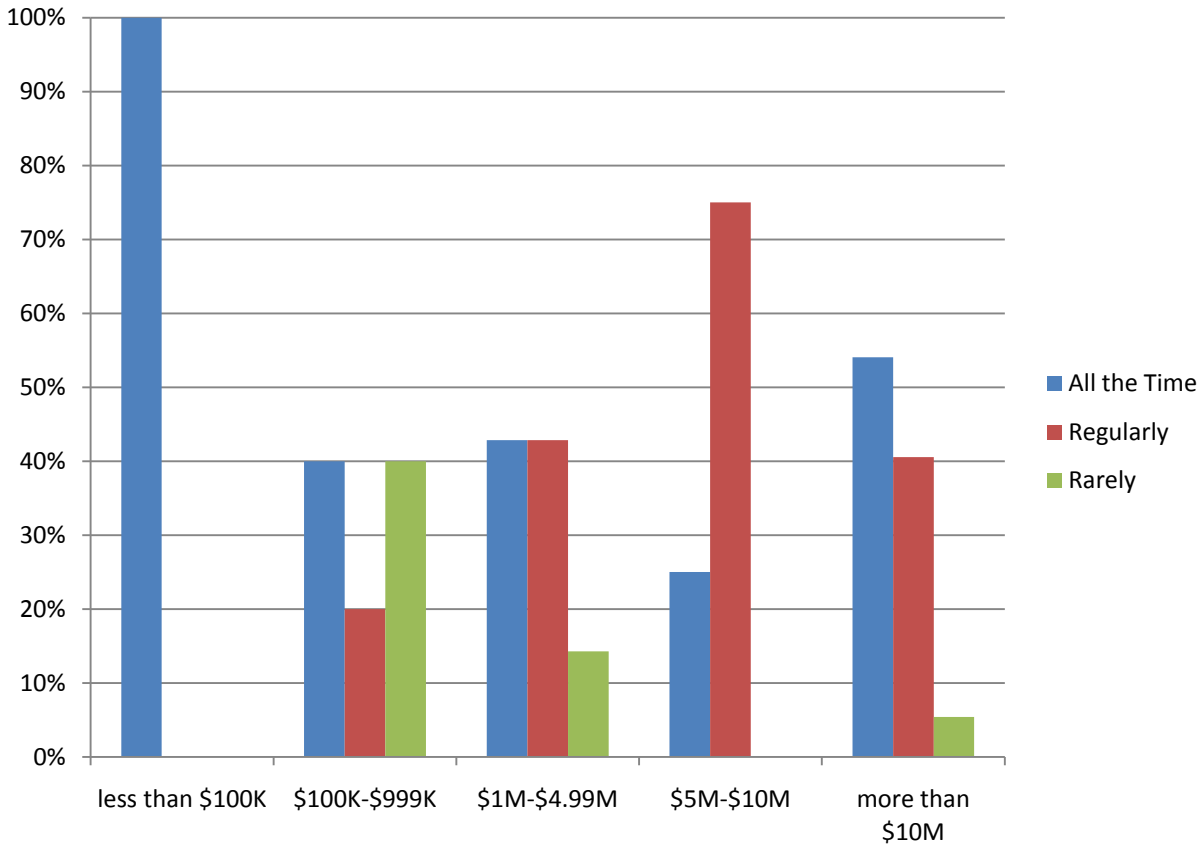

Figure 4-3. Frequency of performing preconstruction planning based on company sizes

The size of a company has an impact on how much the company is willing to spend on pre-construction planning. However, just because a company is spending more on planning does not necessarily mean that it will get a higher profit. The survey data showed that the duration of projects can have an impact on the return on investment; i.e. the profit rate in return to how much was spent on planning. Table 4-3 indicates how much was invested in pre-construction planning by company size.

The data concludes that companies with an average annual income of between $5 million and $10 million had the highest return on investment for pre-construction planning despite the fact that they spent a very small amount. This can be attributed to

having more control over the plan rather than just planning. On the other hand, it can be related to the fact that 75% of companies in that size that responded to this survey perform pre-construction planning on a regular basis while the other 25% performed it on every project. It is not very clear from the data why companies that have a size between $100,000 and $999,999 had a larger return on investment than those with a size of more than $10 million even though they reported that 40% of them rarely use pre-construction planning.

Table 4-3. Investment of each company size in pre-construction planning

Size	Average % spent	Average % profit	Average % ROI
Less than $100K	3%	6%	50%
$100K – $999K	4%	8.8%	54%
$1M – $4.99M	4.4%	9.3%	52%
$5M – $10M	0.7%	4.8%	86%
More than $10M	2.9%	5.1%	43%

Most of the projects found in the survey data had a cost of between $10 million to $50 million. However, the largest project reported a total cost of $1 billion. Figure 4-4 indicates the sizes of respondents' projects in the survey. In order to see how the project size affects the return on investment for pre-construction planning, projects need to be categorized in size groups. These groups are shown in Table 4-4 along with how much was spent on pre-construction planning and how much profit was made in terms of percentages of the total project cost.

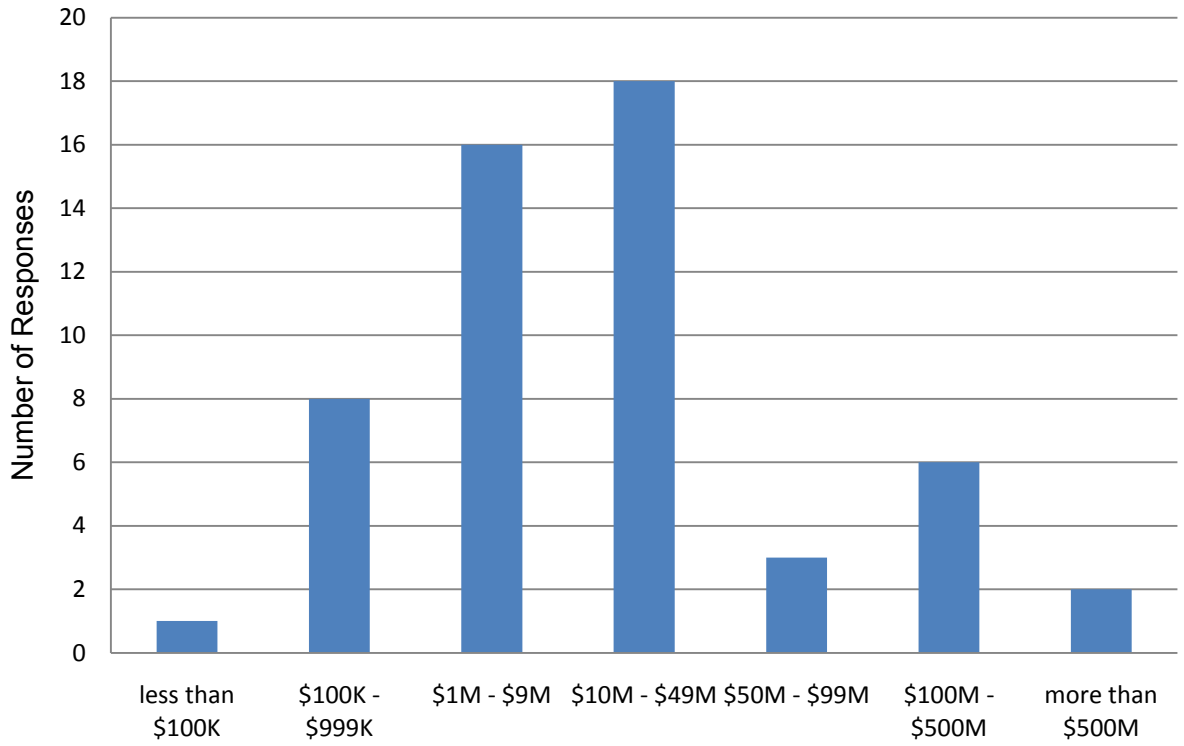

Figure 4-4. Sizes of respondents' projects

Table 4-4. Investment for project size groups in pre-construction planning

Project Size	Average % spent	Average % profit	Average % ROI
Less than $100K	8%	10%	20%
$100K – $999K	5.8%	11.8%	50%
$1M – $9.99M	2.6%	5.7%	55%
$10M – $49.9M	1.5%	4%	63%
$50M – $99.9M	4.3%	6.5%	35%
$100M – $500M	3%	4%	24%
More than $500M	4.8%	7%	33%

The data shows that projects with a total cost between $10 million and $50 million have the highest return on investment for pre-construction planning. Although projects of this size can be very complicated, when pre-construction planning is established and controlled, it will give good results. In addition, projects with higher total

cost showed a decline in the return on investment for pre-construction planning. This is supposed to be mainly due to the extreme complexity of these projects. However, projects larger than $500 million have a slight increase in the return on investment due to the huge figures that come in play.

Location of Construction Company and Project

One of the objectives of this research is to find out if the location of the company or the project affects the decision to perform pre-construction planning and if so, to what extent. However, the limited response rate affected the researcher's ability to uncover the relationship. The responses of the survey came from 24 different states while 14 of those states had as low as one response. Only 5 states had 4 responses or more; the highest state's response rate was Florida with 10 responses. The rate of which each company from a certain state performs pre-construction planning cannot be calculated based on one response. Therefore, the focus of this section will be on how much having a construction project in the same state as the company location affect pre-construction planning against projects constructed in a different state.

Table 4-5 shows the average percentages spent on and saved by pre-construction planning on projects that were conducted in the same state as the company's headquarter location and compared to those completed in a different state. The data indicates that projects performed outside the state where the company is located have a higher average total cost. Although these projects have a higher percentage for performing pre-construction planning, they had a lower average return on investment. This can be due to oversight conditions or codes of the other state. The higher percentage spent on the planning is mainly due to the higher total cost for these

projects. Construction businesses are usually more comfortable performing jobs in areas that they already know and have worked in before. This explains the higher return on investment for projects performed in the same state as the company's headquarter location.

Table 4-5. Investment for project locations from company's HQ in pre-construction pln'g

Project Location	Average % spent	Average % profit	Average total cost	Average % ROI
Same state	2.4%	5.6%	$38,930,000	58%
Different state	4.2%	6.8%	$93,915,000	38%

Pre-Construction Planning Methods

The survey respondents had to choose out of four major groups of pre-construction planning methods; namely: design-phase construction planning, building information modeling (BIM) and 4D-CAD, establishing a project control system and using past projects' data to improve performance. Each of these methods represents a category that can contain more specific planning techniques. In addition, the survey respondents had the option to input any method they used and that they did not think belonged to any of the mentioned ones. The respondent also has the option to pick "none of the above" which means he or she relies solely on the traditional project scheduling. The objective of this survey section was to find out which of these methods, or others if any, were more widely used in addition to which were more effective in terms of saving cost and time.

First of all, the survey data were analyzed to reveal which construction sector uses which method. Figure 4-5 shows the number of respondents that use each method and what sector they belonged to. Using past projects' data to improve performance is

clearly the most widely used based on the responses especially among contractors. The least was the traditional scheduling, referred to as “none.” Several designers and contractors chose “other” methods which were namely: program verification, site due-diligence, multiple design concepts, CM at-risk delivery method, detailed analysis, last-planner scheduling process and value engineering. Although many of these “other” methods can fall under one of the major categories described, they were treated as a separate method in this analysis.

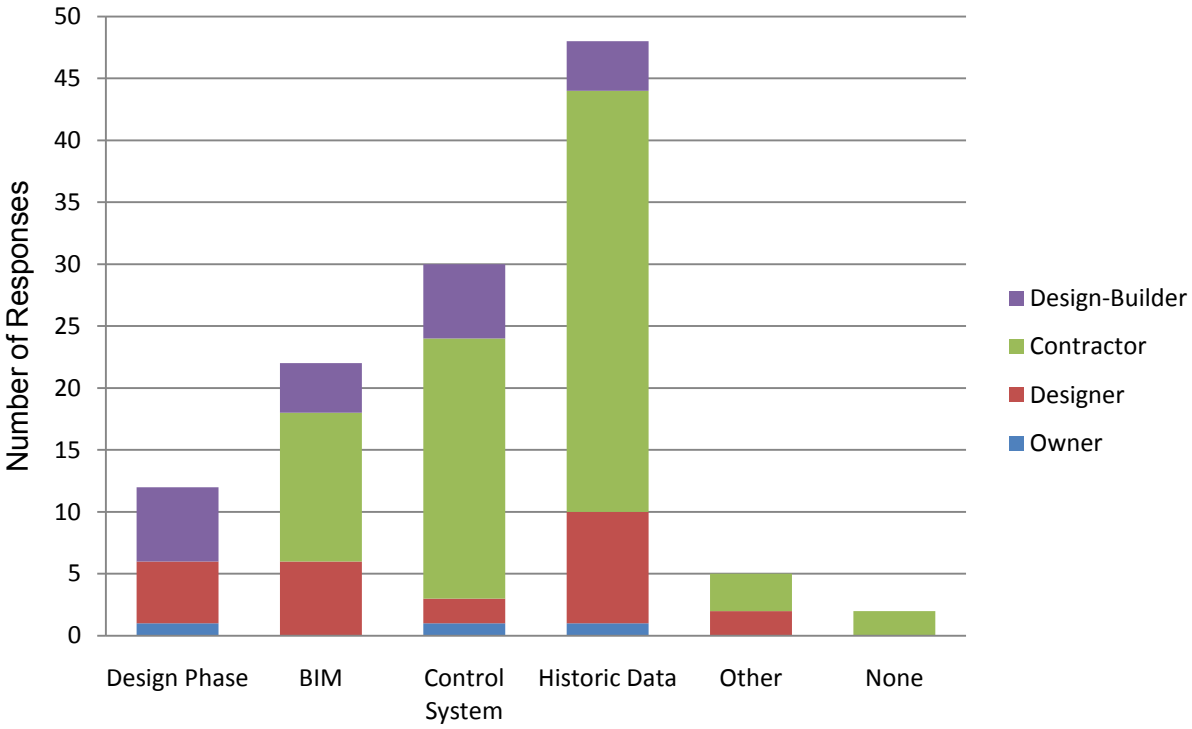

Figure 4-5. Number of respondents using each planning method

The next subject to be analyzed in this section is how effective each of these methods really is. Although respondents had the option to pick all that apply, each method will be calculated independently as if the respondent worked only with that

method. This will give a clearer big picture of how well did each method work in real jobsites. Table 4-6 shows the average percentages of spending and profiting from each of the listed methods. Please note that the method labeled as “none” is in fact the traditional scheduling approach without any pre-construction planning.

Table 4-6. Investment of each method in pre-construction planning

Method	Average % spent	Average % profit	Average % ROI
Design-phase	4%	6.7%	41%
BIM	3.4%	7%	50%
Control system	2.7%	5.3%	49%
Historic data	3%	6.3%	51%
Other	0.5%	4.7%	89%
Scheduling	4.5%	3.3%	-38%

The first thing that stands out in Table 4-6 is the negative return on investment for the traditional scheduling method. That means relying on traditional scheduling only is more likely to cost the construction firm more than it can benefit it. This can be seen in real projects as delays caused by unanticipated problems on the jobsite that end up costing more than what was spent on the scheduling process. On the other hand, the data indicates that the listed “other” methods had a very high return on investment. This is likely due to the low cost of such methods that can have a very high impact on the savings of a project. Establishing a project control system, using BIM and utilizing past projects’ data had almost the same return on investment of 49%, 50% and 51% respectively. This shows that these methods can be very effective in savings on a project but they have a fairly high cost. In addition, the design-phase construction planning had the highest cost of the methods, except for the traditional scheduling, and had a relatively lower return on investment of 41%. Figure 4-6 shows how the different

methods can be compared to each other in terms of cost and potential savings in percentages out of the total project cost.

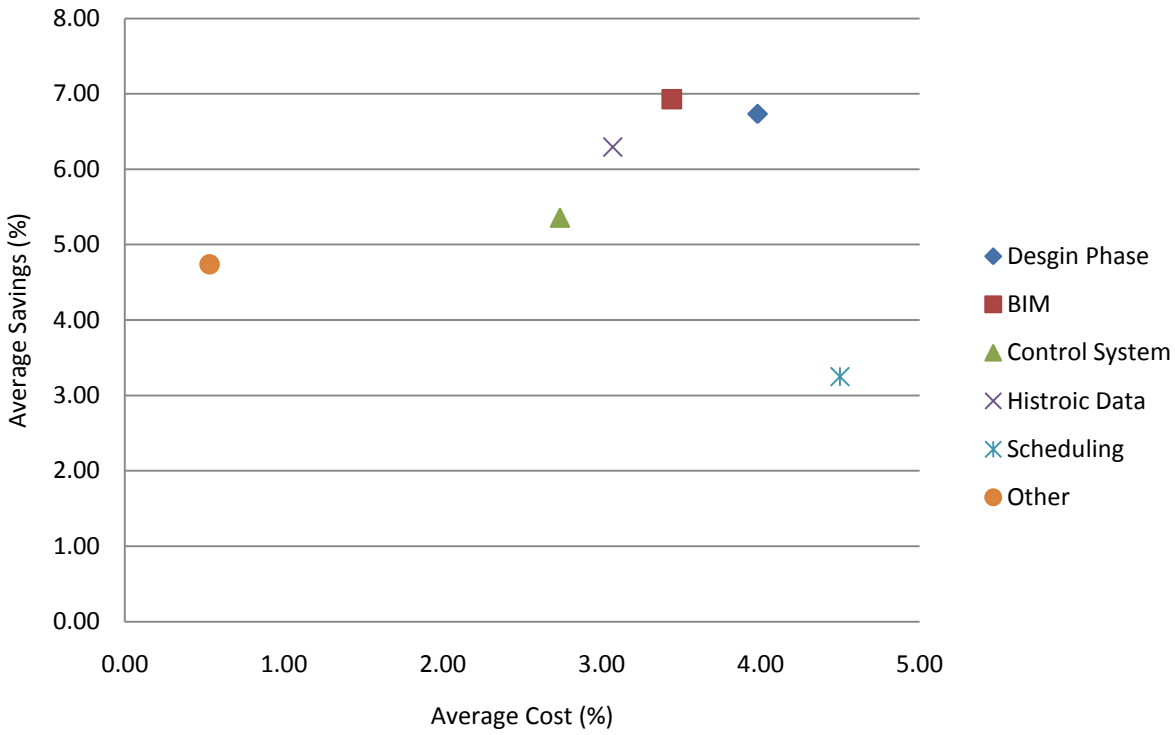

Figure 4-6. Pre-construction planning methods costs against savings

The last objective in this section was to find out how each method impacted the scheduled time for the project. The planned and final duration of projects that used the same pre-construction planning method were averaged to see how much time was saved or how many days the schedule was overrun. Table 4-7 explains the average durations of projects that used a certain pre-construction planning method.

Table 4-7. Average durations of projects using pre-construction planning methods

Method	Planned duration (months)	Achieved duration (months)	Difference (months)
Design-phase	15	15	0
BIM	17	18	-1
Control system	16.5	17	-0.5
Historic data	14	15	-1
Other	17	16	1
None	7	9	-2

The data again gives the upper hand to the “other” methods mentioned earlier. Companies selecting this answer managed to save an average of 1 month. On the other hand, the design phase construction planning method managed to keep the project on track for the planned duration. BIM, project control system and using past data methods had an average overlap of 1 month. This can be due to other factors that cannot be controlled simply by pre-construction planning such as change orders or union strikes. However, the traditional scheduling showed an average overlap of 2 months which explains why the industry stopped depending on it alone.

Relationship between Pre-Construction Planning and Cost Savings

The main objective of this research can now be achieved after answering all the other objectives leading to it. It is very important to have a clear understanding of how pre-construction planning affects the cost savings of a project. The survey data showed a very scattered relationship since respondents spent different percentages on the planning. Starting with 0.1% as the lowest percentage spent to the highest of 15% which no one seems to spend more than that for the sake of planning. Figure 4-7 shows a scattered graph of all the respondents’ data.

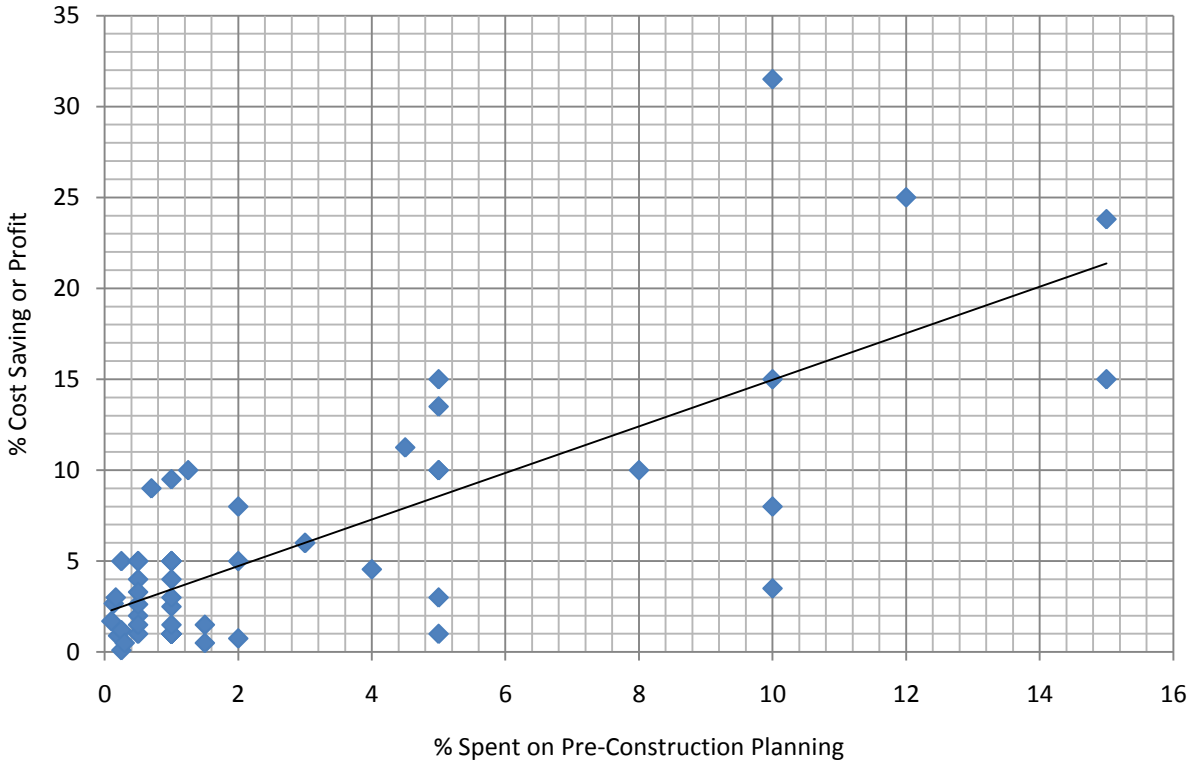

Figure 4-7. Scattered graph of all respondents' data

Averaging the similar percentages spent on pre-construction planning will give a clearer image than the scattered graph. The averaged graph is shown in Figure 4-8 which gives a big picture result of how pre-construction planning affects cost savings or profit.

Figure 4-8 shows a steady increase in cost savings with the increase of cost spent on pre-construction planning. As expected, the cost savings will start to decrease after a certain point since spending more money towards pre-construction planning will not make much more difference. The optimum percentage to be spent on pre-construction planning is shown to be around 12% of the total project cost.

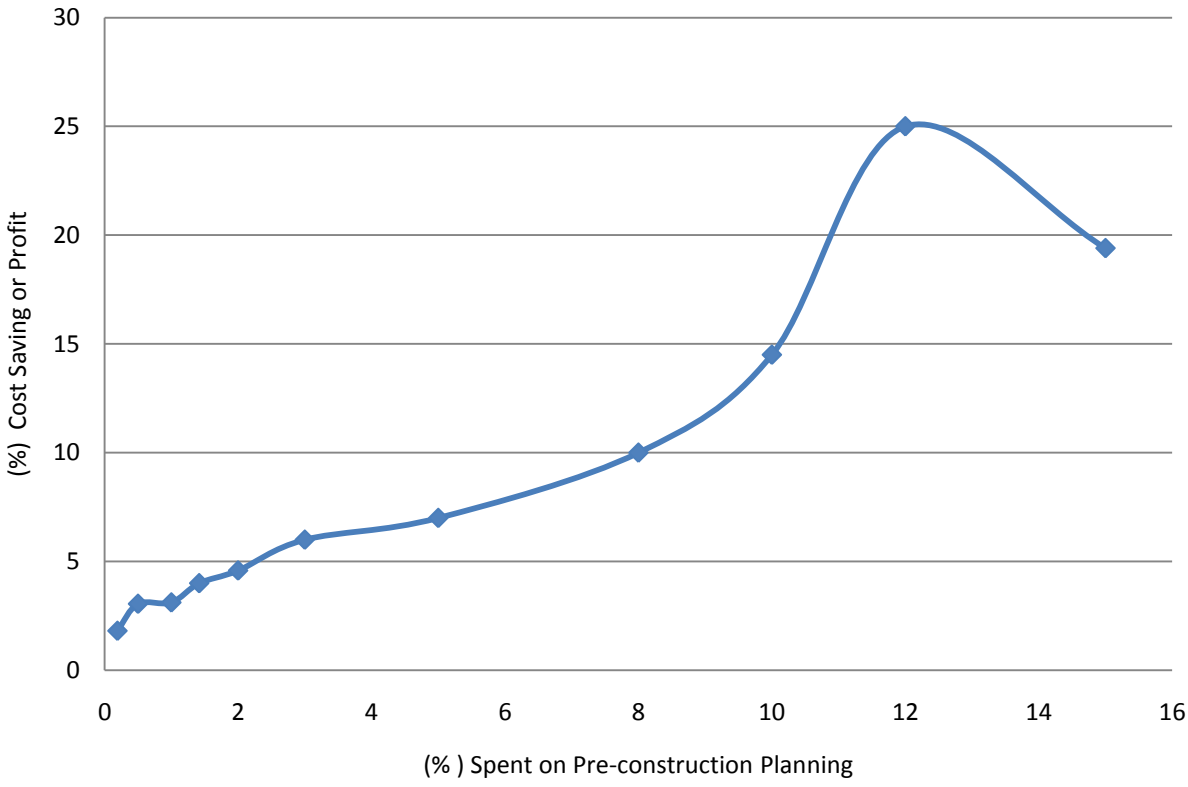

Figure 4-8. Averaged plot of survey data

CHAPTER 5
CONCLUSION AND RECOMMENDATION

Understanding how pre-construction planning really affects project cost savings or profit can be a deciding factor for many construction firms to get involved in it. It will also pave the way to developing more effective methods or at least evolve the existing ones to get a higher return on investment. After all, it all comes down to how much it costs and what the pay back is. On the other hand, pre-construction planning can be the thin line between success and failures in some projects.

The survey data presented in this research showed many aspects of pre-construction planning starting with which sector of the industry embraces it more and ending up with what is the optimum percentage that can be spent on it. This, of course, does not mean that these conclusions are objective and final. Planning in general is a very subjective matter that can be interpreted in many different ways by many different professionals. The data presented in this research reflects the current understanding of pre-construction planning in the United States.

To sum up the findings of this research, there are many different pre-construction planning methods that can fall out of the four major methods described here. There are new methods and tools that can help construction firms achieve better results in their projects. In addition, the research showed that contractors are the main construction industry sector to embrace pre-construction planning and apply it although designers spent the highest percentage on applying it. It was expected that design-builders would have the highest spending percentage and return but that was not the case. Moreover, using past projects' data was the most used method in the industry. BIM was a far third after project control system but is expected to boom even more in the coming years.

More findings revealed that construction firms' sizes affect the tendency to use pre-construction planning. Companies with an average annual income between $1 million and $5 million spent the highest percentage of project costs on planning. In addition, project sizes contribute in the decision on whether to use pre-construction planning or not. Planning was more effective in projects that cost between $10 million and $50 million while the highest spending was found in projects costing under $1 million but more than $100,000.

It has also been pointed out in the research that using past projects' data, building information modeling and project control system methods had a fairly similar return on investment of almost 50%. The category "others" was shown to be the most successful method although it contained several methods mentioned in the results and analysis chapter. The methods describes as "others" also succeeded in saving the most time in project with an average of 1 month.

The most important finding in the research was the optimum percentage to be spent on pre-construction planning. That percentage was found to be about 12% of the total project cost where the project cost saving starts to decline with higher percentages. No respondents reported using more than 15% of the total project cost which makes the even bigger picture limited. It is not yet understandable how much will be saved in a project when applying even higher percentages. The overall feel is that when spending way too much on planning it would cost the project more than save it.

Although extensive pre-construction planning remains a fairly new addition to the industry, the industry seems to be grasping its benefits. Hopefully, the methods to

achieve safer and more productive projects can continue to evolve and grow. The productivity rate of a project will continue to rise as the project plan becomes clearer.

For further research in this topic, it is recommended that a bigger sample size be collected and analyzed to get a more detailed look. Achieving a better response rate would lead to establishing a better understanding of the topic. There are several ways to get a bigger response rate of a survey. Giving the survey a longer time while sending reminder e-mails to contacts that had not responded, will increase the response rate. In addition, sending the survey to a large number of reliable contacts will also help achieve a higher number of responses.

APPENDIX A
SURVEY QUESTIONNAIRE

1. Where is your company's headquarters located: _____

2. Which of the entries below best describes your construction company's business type: (pick all that apply)
    a. Owner
    b. Designer
    c. Contractor
    d. Consultant
    e. Design-Builder

3. What is the size of your company based on the average annual income?
    a. Less than $100,000
    b. $100,000 – $999,999
    c. $1,000,000 – $4,999,999
    d. $5,000,000 - $10,000,000
    e. More than $10,000,000

On the Projects where you were the OWNER:

4. Which method(s) of pre-construction planning, other than the traditional scheduling, did you require to be used: (pick all that apply)
    a. Design-Phase Construction Planning
    b. Building Information Modeling and 4D-CAD
    c. Establishing a Project Control System or Unit
    d. Using Past Projects' Data to Improve Performance
    e. Other: _____
    f. None of the above

5. How often do your require the use of that pre-construction planning method in your projects?
    a. Rarely
    b. Regularly
    c. All the time

On the Projects where you were the DESIGNER or CONSULTANT:

6. Which method(s) of pre-construction planning was used: (pick all that apply)
    a. Design-Phase Construction Planning
    b. Building Information Modeling and 4D-CAD
    c. Establishing a Project Control System or Unit
    d. Using Past Projects' Data to Improve Performance
    e. Other: _____
    f. None of the above

7. How often did you use that pre-construction planning method in projects?
    a. Rarely
    b. Regularly
    c. All the time

On Projects where you were the CONTRACTOR:

8. Which method(s) of pre-construction planning, other than the traditional scheduling, was used: (pick all that apply)
    a. Building Information Modeling and 4D-CAD
    b. Establishing a Project Control System or Unit
    c. Using Past Projects' Data to Improve Performance
    d. Other: _____
    e. None of the above

9. How often did you use that pre-construction planning method in projects?
    a. Rarely
    b. Regularly
    c. All the time

On Projects where you were the DESIGN-BUILDER:

10. Which method(s) of pre-construction planning, other than the traditional scheduling, was used: (pick all that apply)
    a. Design-Phase Construction Planning
    b. Building Information Modeling and 4D-CAD
    c. Establishing a Project Control System or Unit
    d. Using Past Projects' Data to Improve Performance
    e. Other: _____
    f. None of the above

11. How often did you use that pre-construction planning method in projects?
    a. Rarely
    b. Regularly
    c. All the time

Previous Projects' Outcome: in this section, data of a specific project that first comes to mind is kindly requested.

12. Please indicate the approximate size of the project based on the total cost: $_____

13. Please indicate the location of the project: _____

14. Please indicate the year of the project completion: _____

15. Please indicate the approximate percentage of the total cost spent on pre-construction planning: __%

16. Please indicate the approximate percentage of the total cost project cost saving or additional profit: __%

17. How much of that cost saving or additional profit do you think was attributed to planning? __%

18. Please indicate the duration of the project: Planned: __months ; Achieved: __months

APPENDIX B
INTERNATIONAL REVIEW BOARD LETTER

UF Institutional Review Board
UNIVERSITY of FLORIDA

PO Box 112250
Gainesville, FL 32611-2250
352-392-0433 (Phone)
352-392-9234 (Fax)
irb2@ufl.edu

August 30, 2010

TO: Hamzah Alshanbari

FROM: Ira S. Fischler, PhD; Chair
University of Florida
Institutional Review Board 02

SUBJECT: **Exemption of Protocol #2010-U-778**
Effect of Pre-Construction Project Planning on Cost Savings

SPONSOR: None

The Board has determined that your protocol is exempt from review. This exemption is issued because this protocol does not involve the use of human participants in research in accordance with 45 CFR 46. Human participants are defined by the Federal Regulations as living individual(s) about whom an investigator conducting research obtains (1) data through intervention or interaction with the individual; or (2) identifiable private information.

Should the nature of your study change or if you need to revise this protocol in any manner, please contact this office before implementing the changes.

IF:dl

LIST OF REFERENCES

Al-Reshaid, K., Kartam, N., Tewari, N., & Al-Bader, H. (2005). A Project Control Process in Pre-Construction Phase: Focus on Effective Methodology. *Engineering Construction & Architectural Management , 12* (4), 351-371.

Bradshaw, G. (2008). Establishing a First Class Project Controls Organization for Managing Large Complex Projects. *AACE International Transactions* , 1-9.

Chassiakos, A., & Sakellaropoulos, S. (2005). Time-Cost Optimization of Construction Projects with Generalized Activity Constraints. *Journal of Construction Engineering & Management , 131* (10), 1115-1124.

Dixit, V. (2007). 4D Modeling: Adding a New Dimension to CPM Scheduling. *AACE International Transactions* , 10.1-10.8.

Gibson Jr, G. E., & Gebken II, R. J. (2003). Design Quality in Pre-Project Planning: Applications of the Project Definition Rating Index. *31* (5), 346-356.

Gidado, K. (2004). Enhancing the Prime Contractor's Pre-Construction Planning. *Journal of Construction Research , 5* (1), 87-106.

Glenwright, E. (2004). Contractor's Schedule Submittal: Catch-22. *AACE International Transactions , PS.10*, 10.1-10.3.

Heesom, D., & Mahdjoubi, L. (2004). Trends of 4D CAD Applications for Construction Planning. *Construction Management & Economics , 22* (2), 171-182.

Heywood, C., & Smith, J. (2006). Integrating Stakeholders During Community FM's Early Project Phase. *Facilities , 24* (7/8), 300-313.

Kumaraswamy, M. M., Ng, S. T., Ugwu, O. O., Palaneeswaran, E., & Rahman, M. M. (2004). Empowering collaborative decisions in complex construction scenarios. *Engineering, Construction and Architectural Management , 11* (2), 133-142.

Slomsky, D. (2009). Complete Cost Control. *Health Facilities Management , 22* (1), 29-32.

Tatum, C. (2005). Building Better: Technical Support for Construction. *Journal of Construction & Management , 131* (1), 23-32.

BIOGRAPHICAL SKETCH

Hamzah Alshanbari graduated from King Fahd University of Petroleum and Minerals in Dhahran, Saudi Arabia with a Bachelor of Science in Architectural Engineering in 2005. He then worked at Samba Financial Group as an owner representative in the corporate construction department. As the project manager for several new buildings and a few renovations projects, Hamzah gained enormous experience in the construction process and management. Hamzah then received a King Abdullah Scholarship to pursue his Master of Science in Building Construction from the University of Florida. He is a proud Gator now.