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Renovation Markup Factors for Public and Private Campus Construction

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RENOVATION MARKUP FACTORS FOR PUBLIC AND PRIVATE CAMPUS CONSTRUCTION

By

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Abstract

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Renovation Markup Factors for Public and Private Campus Construction

Thesis directed by Professor Keith Molenaar

Construction estimates are an important part of the construction industry. Both owners and contractors require accurate estimates. Owners of both public and private institutional campuses require accurate estimates to plan resources and efficiently allocate funds. Contractors require accurate estimates to win projects and generate profits. Markup is a factor that estimators apply to certain items, systems, or to the total cost of a bid to cover overhead, profit, and other indirect costs. To understand why contractors markup prices, a two-part questionnaire was established to first explore the price difference on renovation projects and then explore the factors that affect construction markup. A comparison was sought between two location, one a public institutional campus and the other a private institutional campus. This research identifies the benefits of how this pricing and the established factors can help owners, contractors, and consultants alike. Similarly, the research looks at the barriers of the study and how the study can be improved and implemented by others. The results found in this research established two new factors and ranked 19 factors that affect markup. The top five factors established from this research affecting markup on the public institutional campus is: profitability, risk, subcontractor market conditions, market conditions, and need for work. The top five factors established from this research affecting markup on the private institutional campus is: profitability, market conditions, need for work, contractor markup, and complexity of project.

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Chapter 1

Introduction

Observed Problem

The University of Colorado Boulder designs and constructs an average of $300M+ in projects each year. The majority of the projects that the university constructs are renovations to keep the school up to date. Typical projects range from $25,000 to $2,000,000 and include office, classroom, technology, medical, and laboratory renovations. An understanding of cost estimates is essential for projects because it gives owners the proper tools to allocate funds and to achieve maximum client satisfaction. Since the University of Colorado is seeking to better understand how and why contractors markup their prices on estimates, a more accurate estimating system can be created at the university. This understanding of estimates and markup may also help Facilities Management reduce factors that cause contractors to provide a higher markup on projects.

Estimating construction projects in general is a complex task and requires an understanding of pricing, factors, and terminology to produce accurate estimates. Smaller projects such as campus renovations may cause the contractor to provide a higher markup compared to larger projects, which may be because contractors can't recover their overhead and profit as easily as they can on projects over $2,000,000. Factors such as location, time of year, economic environment, and others affect the contractor's estimates and sometimes cause the owner's estimate to differ from the contractor's because of the lack of understanding for markup on the owner's side.

Markup is a factor that estimators apply to certain items, systems, or to the total cost of a bid to cover overhead, profit, and other indirect costs (AACE International, 2013). Markup is affected by many factors within the construction industry that makes the cost of the project or line items to go up or down. An example of one of these factors is a contractor's need for work. A busy contractor bidding on a job is more likely to markup the bid price higher than a contractor who is in desperate need of work.

The objective of this thesis is to better understand the industry practices in applying markups on renovation projects and thereby better understand the factors that affect construction pricing, specifically between public institutional campuses and private institutional campuses. To achieve this, a thorough review of industry standard guides and academic journals was conducted to understand the current practices. To explore what factors affect construction pricing, a questionnaire was issued to estimators asking them to compare pricing on the same project in two different locations and rate factors affecting construction markup.

The results presented in this thesis are derived from the literature and 22 contractors/consultants within the Denver metro area that completed the two part questionnaire. The first questionnaire asked the respondents to price line items for a renovation project on both the public University of Colorado Boulder campus and the private Oracle Broomfield campus. To generate consistency and remove outliers, the second part of the questionnaire allowed the participants an opportunity to change their original pricing based on the responses of the other participants. The final part of the questionnaire asked respondents to rate construction markup factors. The results found in this research were then benchmarked against the published RSMeans costs for each line items (Reed Construction Data Inc., 2014) to establish a factor that an owner can use to understand markups on these types of renovation projects. Similarly, the results found in this research

established a ranking of the already identified factors affecting construction markup as well contributing to the body of knowledge by establishing new factors. These results were then compared to the factors established by literature and the factors established by the university facilities management for external validity.

Research Statement

Public and private institutional campuses have many different projects that are constructed each year. These projects may range from renovation projects to new construction. The estimates for these projects require an immense amount of effort and understanding of both the estimates and the markup provided in the estimates. There are many different factors that affect the outcome of estimates and how contractors markup their pricing for each project. These factors can be separated into five different categories: project characteristics, project documents, company characteristics, bidding situation, and economic situation (Shash & Abdul-Hadi, 1992). To better understand the reason behind contractors' markups and why they chose to price an item the way they do, the research question below was asked.

1. What factors contribute to why contractors markup their prices when bidding on public or private institutional campus renovation projects?

With the aging buildings on these campuses it is important for renovation projects to be accurately estimated and planned in a prioritized program by both public and private facilities managers. The necessity of this research is to help individuals and companies understand the reasons behind price changes and what factors affect prices. The understanding of the factors that affect pricing, an opportunity to complete more projects on these campuses as well as provide the campuses with a better way to produce initial owner estimates may be created.

Similarly, this research will allow for necessary projects to be approved and constructed, keeping the campuses updated.

Research Objectives

The main goal of this research is to better understand why contractors provide specific markups depending on certain factors. As mentioned by the Association for the Advancement of Cost Engineering International's (AACE), markup is a factor that estimators apply to certain items, systems, or to the total cost of a bid to cover overhead, profit, and other indirect costs (AACE International, 2013). Similar to the AACE definition, markup can also be defined as the sum of the contingencies and profits applied to the bid by the contractor (Liu & Ling, 2005). The markup applied to the bid or individual prices is decided by the contractor bidding the project and can make or break a contractor's chance to win a project. Each contractor differs when deciding markup and how to split it up. Even though markup is difficult to quantify, many factors such as job and project overheads, contingencies, and profit are always included in contractor's markups (Tenah & Coulter III, 1999).

By understanding the markup on an estimate, one can better produce estimates and allocate funds for the project. This understanding of markup, can be used as a tool by anyone to understand the factors affecting public and private institutional projects, specifically the differences in the factors that affect construction markup. To achieve this understanding of the markup factors a questionnaire was used to collect construction pricing and to rate markup factors on how much they affect pricing. This questionnaire helped provide insight on if the factors affecting the construction markup differed between public and private institutional campus pricing.

Why this Research is Important

Given that estimates are an integral part of the construction industry, it is essential that estimates are accurate. Along with estimates being accurate, understanding estimates is an important piece for owners, consultants, and contractors. This research helps close the gap on why owner estimates are not in line with contractor's estimates. Similarly, the research allows for owners to use pricing provided by standard published sources such as RSMeans to help price small renovation projects; allowing for the owner's estimates to be better in line with the contractors at the time of bidding, permitting more "go" decisions for projects.

Although pricing is an important piece to estimates, understanding estimates and why they are priced the way they are vital. This research is important to contributing and validating factors that affect construction markup. Specifically this research will go more in-depth than previous studies by looking at both private and public institutional projects. Finally, this research looks to add to both academia and the industry by providing new factors affecting construction markup.

Thesis Format

This thesis provides a wrapper to an original "journal paper" that is presented in Chapter 3. Chapter 2 is a complete literature review of the sources that were used in understanding the point of departure, performing the research experiment and writing the journal paper. Chapter 3 is a stand-alone journal paper that will be submitted to an academic journal and contains all of the elements of an academic journal such as its own abstract, introduction, research method, and conclusion. Due to this layout some of the information presented in the wrapper may overlap the journal paper in Chapter 3. The final chapter in this thesis discusses the contributions from this research, its limitations and potential future research.

Chapter 2

Literature Review

Construction project "overhead," which covers items such as shared equipment, project administrative supplies, home office employees, computers, insurance, etc. can be broken into two main sections, job and home. Job overhead accounts for items and costs that are directly related to the jobsite but not found in the physical project after the completion of construction. These items which are directly related to the jobsite, include but are not limited to, job supervision, trailers, phones, internet, insurance, equipment, temporary utilities, and bonding. Similar to job overhead, home overhead costs are costs that do not directly relate to the jobsite. Home overhead can include items such as benefits, supervision, office material, administrative, marketing, and other costs needed for doing business (Norfleet, 2007).

While overhead does account for the majority of the costs in markup, both contingencies and profits make an impact on the bid. Contingencies account for items such as estimation errors, errors and omissions by the engineer, and price changes in materials (Tenah & Coulter III, 1999). These contingencies as well as other markup factors such as the size of the project, the type of project, the market condition, and the number of bidders (Bevacqua & Elias, 1992) are some of the factors that drive contractors to markup the line item prices in their bids. When looking at profit, there are three main types of profit that a company can use; gross profit, net profit, and operating profit. AACEI states that gross profit is, "Earnings from an on-going business after direct and project indirect costs of goods sold have been deducted from sales revenue for a given period." Net profit is stated by AACEI as, "Earnings or income after subtracting miscellaneous income and expenses (patent royalties, interest, capital gains) and federal income tax from

operating profit." Finally, AACEI states that earning profit is, "Earnings or income after all expenses (selling, administrative, depreciation) have been deducted from gross profit" (AACE International, 2013).

As one can see, current construction estimating practices use many terms to define costs in the construction industry. Oftentimes estimators use the same language to define these costs but other estimators choose to define them differently. For the purpose of consistency, the definitions in Table 1 were used when performing the research.

Table 1: Standard Definitions

Terminology	Definition
Contingency	An amount added to an estimate to account for items, conditions, or events that will most likely cause a fluctuation in the price of the project. Contingency does exclude items such as scope changes, strikes, natural disasters, and currency effects (AACE International, 2013).
Direct Costs	Costs of activities or items that directly the attribute to the project's completion. Examples of direct costs are material, labor, equipment, and direct supervision (AACE International, 2013).
Indirect Costs	Costs of activities or items that do not directly attribute to the project's completion. Examples of indirect costs are startup costs, contractor's fees, insurance, taxes, and administration costs (AACE International, 2013).
Mark-Up	Term used in construction estimating that consists of overhead, profit, and other indirect costs. Most of the time mark-up is applied to certain items, systems, or the total costs of the estimated project (AACE International, 2013).
Overhead	Costs or expenses such as operating expenses that cannot be charged to a specific task on the project. These costs are assumed to be a business expense that is independent of the direct work (AACE International, 2013).
Overhead Burden	A percentage markup that is applied to the estimated direct costs of a project to cover all necessary indirect costs and overhead (Holm, Schaufelberger, Griffin, & Cole, 2005).
Jobsite Overhead	Indirect field costs that cannot be associated with a specific task but are necessary for the project such as cost of work such as construction tools and equipment, administrative costs, and facilities (Holm, Schaufelberger, Griffin, & Cole, 2005).
Home Office Cost	The necessary costs to continue everyday business. Home office costs are directly assigned to projects, processes, and end products; this can include estimating, telephones, computers, inspections, procurement, staffing, etc. (Humphreys & Wellman, 1996).
Gross Profit	Earnings from on-going business ventures after direct and indirect costs have been subtracted from sales revenue for a given period of time (AACE International, 2013).
Operating Profit	Earnings or income after all expenses have been subtracted from gross profit (AACE International, 2013).
Net Profit	Earnings or income after subtracting miscellaneous income, expenses, and taxes from operating profit (AACE International, 2013).

Current Types of Estimates

The Association for the Advancement of Cost Engineering International (AACE) provides five different classes of estimates. These estimates are based upon the maturity level of the project design, which can range from 0% to 100% complete. The five different classes cover estimates from conceptual screening in which the estimate uses parametric modeling to a final bid where there are unit costs for a detailed takeoff. Table 2, taken from the AACE recommended practice 18R-97, shows the classification of the different estimation classification (AACE International, 2011).

Table 2: Cost Estimation Classification (Adapted from AACE)

Estimation Class	% Complete	End Usage	Estimating Method	Accuracy Range[1]
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, or judgment	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed takeoff	L: -5% to -10% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed takeoff	L: -3% to -10% H: +3% to +15%

By understanding the classification types, one can see that there are many different types of estimates used in the industry today. These estimates allow for discrepancy because some estimates are more accurate than others, creating uncertainty when deciding what contractor to pick in a bidding scenario. One approach that was used to model new state funded construction projects was using a parametric estimate (Phaobunjong, 2002). Parametric estimating is an

[1] Accuracy Range includes how accurate the estimate may be. An example is the estimate may be 20% to 50% lower (L) than the final estimate. Also, the estimate may be 30% to 100% higher (H) than the final estimate.

estimate that uses previous data from past projects to predict the cost of the upcoming project (Sonmez, 2008). By looking at different types of estimates such as conceptual and detailed estimates, Kan Phaobunjong established that conceptual estimates could be used for go/no-go situations in an organization such as a university. The data that was used in creating this database was both current and historical costs from the Texas Higher Education Coordinating Board's (THECB) Construction Application Forms, which included construction costs, gross square footage, location, and type of building. Using this data, three tables were created in Microsoft Access for the past project data set, historical cost index, and city cost index. Next, using the database and its data, which was exported to Excel, multiple regression analysis (SPSS v. 10.1) was applied to the data to analyze the independent variables to predict the dependent value ($/SF). This model was then tested against the historical projects that were not used to develop the model. This research shows how conceptual estimates are important and can help an owner make go/no-go decision based on the accuracy of the estimates (Phaobunjong, 2002).

Similar to the conceptual estimates established by Phaobunjong, other estimates are used in the industry. One type of estimate that is becoming more prevalent in the construction industry is probabilistic estimates which model the project cost by considering the cost as a random variable. Once this variable is established a probability distribution function is applied to the costs giving the estimator a range for the final cost (Sonmez, 2008). While probabilistic estimates are valuable they do require some level of detail to perform and usually are used for go/no-go scenarios. Other estimates within the construction industry are factored estimates. Factored estimates are extensively used in the industrial industry because it takes the main equipment costs and multiplies it by a ratio to achieve the final cost. The theory behind a

factored estimate is that the majority of the cost in a major facility is within the equipment, especially in the industrial industry that relies heavily on its equipment (Diekmann, 1983).

Finally, the most useful and accurate estimate within the construction industry is detailed estimates. These estimates are generally used for bidding situations and included all items within the plans and specifications. Detailed estimates do require the most amount of effort to prepare because of the amount of detail included within the estimate. While the effort to prepare detailed estimates is much more than other types of estimates, this type of estimate is used for bidding projects and cost management (AACE International, 2013).

Factors Affecting Estimates

When bidding for a construction project there are many reasons why prices may change between contractors. These reasons that affect pricing are called "factors" in this thesis. These factors affect bids such that contractors could get or not get a project, so it is important to wholly understand the factors that estimators take in to account when bidding a job. To achieve this, forty sources were found that mentioned and discussed factors affecting bid markup, bid go/no-go decisions, and profit margins. From these forty sources, a total of four seminal articles appeared to be the basis for most of the factors.

The research approaches that the forty papers applied to study markup and bid go/no-go decisions varied. The earliest seminal article that states factors in a bidding scenario was an article written in 1956 by Lawrence Friedman. The article states how and what factors can affect optimum bids in a competitive bidding environment. Friedman states that in a bidding scenario, the main objective is to maximize one's expected profit and to minimize one's expected loss. To do this Friedman states that previous bids must be taken into account as well as factors that apply

to the bidding situation. Lawrence Friedman discusses five different factors that affect pricing; size of the contract, probability of winning the bid, number of bidders, is the contract a full or split contract, and what is the bidding situation (Friedman, 1956). Similar to Friedman, Marvin Gates wrote about bidding strategies and probabilities and how the markup is related to the probability of winning. Gates states that when competitively bidding there are many factors that motivate the bidder to win the project, but these factors can also affect the markup related to the costs. One of the most influential factors that Gates explores is profit. Along with profit and the probability of winning, Gates states other factors that affect markup are the number of bidders, the previous experience the bidder has, the quality of the bid documents, and the rate of return the return the bidder is looking for (Gates, 1967).

Along with Friedman and Gates, one of the most common approaches was issuing surveys to companies within the industry. Many of these companies were contactors, civil engineering companies, or general design firms. These questionnaires frequently generated responses and results that had 20 or more factors affecting markup or go/no-go decisions (Ahmad & Minkarah, 1988) (Ling & Liu, 2005) (Bageis & Fortune, 2009). These studies also used the questionnaire to find the difference in level of importance to the respondents. Irtishad Ahmad and Issam Minkarah issued a questionnaire to ENR's top 400 general contractors that established 31 factors for the respondents to rate on a scale of one to six in regards to the factor's importance when making decisions to bid or the percent markup (Ahmad & Minkarah, 1988).

Since Ahmad and Minkarah published the paper, many other papers have been published that establish factors affecting markup and go/no-go decisions. In 1993, Ali Shash provided a survey to the top 300 contractors within the United Kingdom market. This questionnaire was based and modified from Ahmad and Minkarah's questionnaire. The result from the questionnaire was 55

factors identified for both go/no-go decisions and markup decision makings. These 55 factors were rated upon by the respondents previous work experience and how influential the factors were (Shash, 1993). Other researchers have asked contractors to complete questionnaires resulting in similar amounts of factors (Akintoye, 2000) (Dulaimi & Shan, 2002). One of the more applicable papers written on this subject is by Ali Shash and Nader Husni Abdul-Hadi. Shash and Abdul-Hadi looked at the differences in factors affecting construction markup between small, medium, and large contractors. Shash and Abdul-Hadi found that out of the 37 factors presented to the contractors, nine factors contributed to the differing responses of small, medium, and large contractors (Shash & Abdul-Hadi, 1992).

The factors established in the literature review often have different naming conventions. While the naming conventions do differ between papers, there was overlap in certain factors due to the similarly of the factor's definitions. Similar to the terminology throughout the literature, the categories that the factors were separated into was different. Some of the papers categorize the factors as fixed or operating factors (Ringwald, 1986), others internal and external factors (Fayek, 1998), but the majority of papers grouped the factors into specific categories such as project characteristics, project documents, company characteristics, bidding situation, and economic situation (Shash & Abdul-Hadi, 1992).

A Summary of Previous Works Addressing the Problem

Previous studies on the topic of factors affecting construction markup exist. The factors established were usually from questionnaires relating to the seminal work of Irtishad Ahmad and Issam Minkarah (Ahmad & Minkarah, 1988) or from in depth literature reviews.

While most papers discussing construction markup identify or acknowledge factors affecting construction pricing, there are papers that create models to try to obtain the optimum bid markup (Tavakoli & Utomo, 1989) (Hegazy & Moselhi, 1994) (Christodoulou, 2004). One of the commonly cited source is Bid Markup Assistant by Amir Tavokoli and J. Juliana Lano Utomo. Tavokoli and Utomo created a system to determine bid markup based upon parameters entered in by the user. These parameters included items such as project name, type of contractor, type of contract, size of project, location of project, and many more. The optimum markup was determined by adding two components together: overhead and profit (Tavakoli & Utomo, 1989).

Another commonly referenced source was written in 1994 by Tarek Hegazy and Osama Moselhi. Hegazy and Moselhi stated that in the construction and civil industry, complicated and unstructured decisions are made within a relatively short amount of time. Hegazy and Moselhi designed an artificial neural network (ANN) model based on Ahmad's and Minkarah's questionnaire to help with markup estimating problems. An ANN is a structure for processing information based upon human biological neural systems and solves problems by learning patterns and giving outputs based upon patterns (Hegazy & Moselhi, 1994).

From the existing literature relating to bidding markup, a final list of 48 factors was created for this research (reference appendix: Factor Table). The 48 factors were found throughout the articles and reduced to a list of the top nineteen factors that showed up in the literature review. These factors were reduced by eliminating irrelevant factors to this study and combining similar factors. These nineteen factors were then broken into their categories, which are explained below and used in the construction of the questionnaires.

Categories

The factors were grouped into categories following a seminal paper written by Ali Shash Ali and Nader Husni Abdul-Hadi, which states that markup factors are broken out into project characteristics, project documents, company characteristics, bidding situation, and economic situation (Shash & Abdul-Hadi, 1992).

- **Project Characteristics:** Includes factors that describe the project. These factors may include size, owner, location, etc.
- **Company's Characteristics:** Constitutes all factors that are applicable to the company. These factors include current work load, previous experience, need for work, etc.
- **Bidding Situation:** Includes factors that are relevant to the award of the contract such as number of bidders, bidding requirements, risks associated to the project, etc.
- **Economic Environment:** Involves factors that indicate the economic environment of the project. The factors that can be included in market conditions, labor market conditions, etc.
- **Project Documentation:** Consist of factors that are relevant to the bidding documents such as type of contract, level of detail on plans and specifications, etc.

Table 3: Factors

Category	Factor	Definition
Project Characteristics	Size of Project	The size of the project both in square feet and
	Location of Project/Site Access	The location of the project and how restrictive is the site (e.g. no material laydown, little material availability, etc.)
	Type of Project	The type of projects can be small, medium, and large projects as well as renovations, technology, lab projects, etc.
	Capital Requirements/Cash Flow	The cash required to start the project and keep it going
	Complexity of Project	The level of difficulty to construct the project
	Time Span of Project	The time allotted to complete the project
	Owner Sophistication	The construction knowledge of the owner
Company Characteristics	Need for Work	The need for work at the time of bidding
	Previous Experience	Previous experience with similar projects
	Profitability	The amount of profit the company is looking to achieve on a given project
Bidding Situation	Number of Bidders	The number of bidders bidding on the project
	Availability of Work	The availability of work, both company and employee
	Client Relationship	The relationship with the client. Has the company previously worked with the client
	Risk	The amount of risk associated with the project
Economic Environment	Market Conditions	The overall market conditions (e.g. recession, boom)
	Labor Market Conditions	The current labor market conditions (e.g. qualified crafts are available)
	Subcontractor Market Conditions	The current subcontractor market conditions (e.g. qualified crafts are available)
Project Documentation	Quality of Drawings and Specifications	The amount of detail for the drawings and specifications
	Contract Type	The contract type (e.g. Design bid build, design build, Construction manager at risk, etc.)

Point of Departure

After a complete understanding of the terms in construction estimating and the different types of estimates used in today's industry, markup factors were studied. These factors which were established from a literature review of 40 articles including 4 seminal articles, a total of 48 markup factors were found. These 48 factors were then reduced into 19 factors by combining similar factors and eliminating those not applicable to the research question. Once the 19 factors were reduced, the factors were defined and broken into five different categories as shown in Table 3.

By understanding the terms used in construction estimating, the different types of estimates, and the different markup factors that affect bids, a lack of information was established in the body of knowledge. Since the previous studies took into account national construction firms and didn't focus on smaller sized projects, this research will generate new knowledge on construction markup based upon the factors established from the literature review. Unlike the previous research this research will focus on understand markup and the factors associated with markup for renovation projects using public and private institutional campuses as case studies.

Chapter 3

Renovation Markup Factors on Public and Private Campus Projects

Abstract

Construction estimates are an important part of the construction industry. Both owners and contractors require accurate estimates. Owners of both public and private institutional campuses require accurate estimates to plan resources and efficiently allocate funds. Contractors require accurate estimates to win projects and generate profits. Markup is a factor that estimators apply to certain items, systems, or to the total cost of a bid to cover overhead, profit, and other indirect costs. To understand why contractors markup prices, a two-part questionnaire was established to first explore the price difference on renovation projects and then explore the factors that affect construction markup. A comparison was sought between two location, one a public institutional campus and the other a private institutional campus. This research identifies the benefits of how this pricing and the established factors can help owners, contractors, and consultants alike. Similarly, the research looks at the barriers of the study and how the study can be improved and implemented by others. The results found in this research established two new factors and ranked 19 factors that affect markup. The top five factors established from this research affecting markup on the public institutional campus is: profitability, risk, subcontractor market conditions, market conditions, and need for work. The top five factors established from this research affecting markup on the private institutional campus is: profitability, market conditions, need for work, contractor markup, and complexity of project.

Introduction

In the initial stages of a project, specifically the bidding stages, contractors make important financial decisions. Perhaps the most important financial decisions relates to how much of a markup to include in their bid. Markup is important to a contractor. If done correctly, it sets the company up for long-term success. If the markup is incorrect, it could cause the contractor to lose jobs (Kim & Reinschmidt, 2006). These markup factors such as need for work, economic environment, etc. are a constant challenge for owners to understand because contractors do not have a model on establishing the optimum markup. Estimators make these decisions based on previous experience, heuristics, and gut feelings (Dikmen, Birgonul, & Gur, 2007).

Due to these markup factors, estimating construction projects in general is a complex task. By understanding markup and the factors associated with markup, an owner can understand the bids better and minimize markup on projects. In particular smaller projects such as campus renovations may cause the contractor to provide a higher markup compared to larger projects, which may be because contractors can't recover their overhead and profit as easily as they can on new construction projects. These factors affect the estimates and sometimes cause the owner's estimate to differ from the contractors because of the lack of understanding for markup on the owner's side.

Many of the papers studied in the literature review dealt with contractor markup for larger contractors and looked at new construction projects over $2,000,000. This paper looks at the factors actually affecting the pricing using small public and private institutional campus renovation projects. While the factors may be applicable for bigger projects, the goal of this paper is to focus on projects under $2,000,000.

Markup Factors

Many factors affect construction pricing and can play a role in if a contractor is awarded a job or not. A literature review was done and 40 academic journals were found to discuss factors that affect construction pricing, bid markup, and go/no-go decisions. This review showed four key articles that were cited in nearly all the articles reviewed. One of these articles, written in 1988 by Irtishad Ahmad and Issam Minkarah looked at how bid and markup decisions are affected. Similar to this research paper, Ahmad and Minkarah submitted a questionnaire to 378 general contracting companies, of which 278 were from the 1978 top 400 contractors established by Engineering News Record. Ahmad and Minkarah's questionnaire's goal was to establish factors that affect bid and markup decisions. The recipients of the questionnaire were contractors from the building, the engineering, and the industrial sectors. One part of the questionnaire asked the contractors to score 31 factors on a one to six scale in regards to the factors importance when making decisions to bid and decisions of percent markup. Similar to scoring the factors the contractors were asked to also include any other factors that may affect their decision making in regards to bidding and markup (Ahmad & Minkarah, 1988).

Another key article that states factors in a bidding scenario was an article written in 1956 by Lawrence Friedman. The article states how and what factors can affect optimum bids in a competitive bidding environment. Friedman states that in a bidding scenario, the main objective is to maximize one's expected profit and to minimize one's expected loss. To do this Friedman states that previous bids must be taken into account as well as factors that apply to the bidding situation. Lawrence Friedman discusses five different factors that affect pricing; size of the contract, probability of winning the bid, number of bidders, is the contract a full or split contract, and what is the bidding situation (Friedman, 1956). Similar to Friedman, Marvin Gates wrote

about bidding strategies and probabilities and how the markup is related to the probability of winning. Gates states that when competitively bidding there are many factors that motivate the bidder to win the project, but these factors can also affect the markup related to the costs. One of the most influential factors that Gates explores is profit. Along with profit and the probability of winning, Gates states other factors that affect markup are the number of bidders, the previous experience the bidder has, the quality of the bid documents, and the rate of return the return the bidder is looking for (Gates, 1967).

The final key source was an article written by Amir Tavakoli and J. Juliana Lano Utomo in 1989 to help determine what the optimum bid markup should be for contractors. Tavakoli and Utomo create a program that takes into account many factors to determine the optimum bid markup. These factors included in the program are the client relationship, the project completion date and possible penalties, the current labor and subcontractor market conditions, the number of bidders, the need for work, the quality of the drawings and specifications, and the risk associated with the project (Tavakoli & Utomo, 1989).

From these four key sources as well as the other 36 sources stating factors affecting pricing, a list of 48 factors were established. These 48 factors affecting construction markup was reduced to a list of 19 factors by combining similar factors and eliminating unnecessary factors to this study. These 19 factors that affected markup were broken out into five different categories and explained below (reference Table 4). The categories that the factors were broken out into were based off of the categories established by Ali Shash and Nader Husni Abdul-Hadi; Project Characteristics, Project Documents, Company Characteristics, Bidding Situation, and Economic Situation (Shash & Abdul-Hadi, 1992).

Table 4: Factors Affecting Pricing

Category	Factor
Project Characteristics	Size of Project
	Location of Project/Site Access
	Type of Project
	Capital Requirements/Cash Flow
	Complexity of Project
	Time Span of Project
	Owner Sophistication
Company Characteristics	Need for Work
	Previous Experience
	Profitability
Bidding Situation	Number of Bidders
	Availability of Work
	Client Relationship
	Risk
Economic Environment	Market Conditions
	Labor Market Conditions
	Subcontractor Market Conditions
Project Documentation	Quality of Drawings and Specifications
	Contract Type

- **Project Characteristics:** Includes factors that describe the project. These factors may include size, owner, location, etc.
- **Company's Characteristics:** Constitutes all factors that are applicable to the company. These factors include current work load, previous experience, need for work, etc.
- **Bidding Situation:** Includes factors that are relevant to the award of the contract such as number of bidders, bidding requirements, risks associated to the project, etc.

- **Economic Environment:** Involves factors that indicate the economic environment of the project. The factors that can be included in market conditions, labor market conditions, etc.
- **Project Documentation:** Consist of factors that are relevant to the bidding documents such as type of contract, level of detail on plans and specifications, etc.

Experimental Design

To explore what factors affect contractor markup and why contractors' prices change from project-to-project and location-to-location, an example project was developed using the University of Colorado, Boulder as a case study and priced by members of the Denver, Colorado construction market. Knowing that contractors have different methods to estimate projects, a questionnaire was created to help quantify and normalize how contractors choose their prices. After obtaining prices from multiple contractors, the prices were shown to the group to ensure validity. A second questionnaire then requested reasons for pricing markups based on the 19 factors identified in the literature. The process used was created solely for this research and has not been used in any other known academic paper and research.

Questionnaire Development and Data Collection Process

- The questionnaire consisted of two parts. The first part of the questionnaire asked the respondents to complete pricing for the same set of drawings in two different locations, a public institutional campus in Boulder, Colorado and a private institutional campus in Broomfield, Colorado (reference Table 5). The reason for comparing two different locations was to explore pricing changes between public and private institutional projects.

- The mock project consisted of plans and specifications from a small renovation project on the University of Colorado, Boulder.
- The line items specified to be priced were basic renovation items such as doors, acoustical ceilings, carpet tile, drywall, and other typical renovation items for a mock project.
- The scope was to renovate two rooms within an existing building. Both rooms were located on the first floor of the basement and had limited access in terms of material storage.
- The mock bidding scenario was such that the respondents knew how many companies they were bidding against and the two locations of the projects. To make the situation as real as possible the market conditions were set to the first quarter of 2014 in Colorado (reference Table 5).

Table 5: Questionnaire Bidding Situation

Location	**Owner**	**Construction Start Date**	**Market Conditions**	**Number of Bidders**
Boulder, Colorado	University of Colorado Boulder	March 1st, 2014	Q1 2014	Five (5)
Broomfield, Colorado	Oracle	March 1st, 2014	Q1 2014	Five (5)

Each questionnaire was assessed to see the qualifications of the respondent and the amount of work completed in the region. Upon completion of the initial pricing, values were summarized for presentation to the participants. Using the resulting data, a range, a mean, and a median for the pricing was generated for each line item specified in the questionnaire. This data also

separated the results into two different groups: pricing did change between locations and pricing didn't change between locations.

Using the range, mean, and median data of both groups from the first part of the questionnaire, the second part of the questionnaire was issued to the respondents. The second part of the questionnaire focused on why the pricing was specified, and what markup factors affected the pricing. First, the average price for each line item was sent to all of the respondents to ask if they wanted to change their original pricing provided the average of the separated results or to keep their original pricing. Using a modified Delphi method, the respondents were also asked to provide reasoning on why they would or wouldn't want to change their pricing (Hallowell & Gambatese, 2010). The results generated from this part of the questionnaire did not affect the range, mean, or median of the pricing because nearly all the respondents kept their original pricing. For the few respondents that did change their pricing, the pricing change was minimal and didn't affect the overall range, median, or mean.

In the second part of the questionnaire, the respondents were asked to rate the impact of the markup factors identified in the literature (

4) on their pricing on a scale of one to six (1 = doesn't affect pricing and 6 = dictates pricing). They were asked to do this for both locations. The questionnaire used in this study similar to the questionnaire created by Ahmad and Minkarah, asked the respondents to add any additional factors affecting construction markup (Ahmad & Minkarah, 1988). Unlike Ahmad and Minkarah, the questionnaire used in this research asked the respondents to provide new factors that affected markup that differed between the two locations.

Results

The questionnaire was sent to contractors and cost estimating consultants within the Denver Colorado area. The titles of the respondents ranged from estimator to senior preconstruction manager to president. The total number of questionnaires distributed was 33, of which 22 were returned properly filled out, giving a response rate of 67% for the first part of the questionnaire. Along with the 22 complete responses, four other responses came back partially complete in which the respondents didn't provide pricing but did discuss factors that affect markup decisions and construction pricing. When looking at the respondent's experience with bidding projects on public institutional campuses, eleven respondents said that they had previous experience bidding on the University of Colorado (CU) campus. These participants had bid on nearly 115 projects at the University of Colorado, Boulder with an average number of 10.5 projects per participant. Similar to the number of projects, the participants who had previously worked at CU Boulder had done on average $5.7 million of work with a total amount of $560 million of projects. As mentioned previously, the questionnaire was split into two different parts. The results from the first part of the questionnaire were split into two different groups: participants who provided pricing in which the prices did change between the two locations and participants who provide pricing in which the prices did not change between the two locations. Keeping these two groups in mind, 39% of the respondents claimed that there was no change in pricing, while 61% of the participants said that pricing did change from public to private.

To ensure that the data being used was a good representation, the data from all of the contractors was compared to only the data from the respondents who had previously worked on the University of Colorado, Boulder campus. This comparison showed that the data from the overall respondents was different than that from the University of Colorado campus respondents. 61%

of the overall respondents said that construction pricing did change between the two locations, while 70% of the respondents who had previously worked on the University's campus said pricing did changed. Due to the nature of this study it was expected that this separation would report similar results but it was decided to use the data from the entire group and not only the respondents who had previously worked on CU Boulder's campus. The decision to do this was because the entire group provided a more diverse set of respondents compared to only the respondents who had worked at the University's campus.

For the 61% of the participants that claimed private and public pricing did change, the cost to build on a public campus was always higher. The cost to build on a public campus for the specific line items laid out in the questionnaire ranged from 5% higher to 14% higher, with the average increase in cost of 8%. While the price of construction did cost more on public campuses than private campuses, the prices were not always higher than RSMeans Online. For example, respondents pricing one solid core wood door including hardware and a door frame, on average priced it 2% lower than RSMeans Online. Similarly, for respondents pricing gypsum board, the price provided was on average 305% higher than RSMeans Online. Table 6 and 7 show the final results from the questionnaire, which included the data gathered from the modified Delphi method.

Table 6: Mean Results & Price Comparison

Line Item	Boulder Public Institution Campus	Broomfield Private Institution Campus	No Change	RSMeans Factor
1 Solid Wood Core Door	$1,305.26/EA	$1,206.59/EA	$1,385.33/EA	0.98
1 Hollow Metal Door	$1,458.80/EA	$1,373.99/EA	$1,550.50/EA	3.62
Acoustical Ceiling System	$3.52/SF	$3.29/SF	$3.12/SF	1.03
Recessed Fluorescent Lights	$360.33/EA	$347.89/EA	$332.50/EA	2.99
Carpet Tile	$3.72/SF	$3.49/SF	$3.27/SF	0.91
3 5/8” Studs	$2.59/SF	$2.37/SF	$4.61/SF	2.32
5/8” Gypsum Board	$2.81/SF	$2.52/SF	$3.01/SF	3.05
Outlet & Atomic Clocks	$474.75/EA	$418.07/EA	$356.67/EA	3.28
Paint	$0.65/SF	$0.59/SF	$0.72/SF	1.17
Tie-in New Mechanical System	$13.13/SF	$12.05/SF	$9.17/SF	N/A

Table 7: Median Results & Price Comparison

Line Item	Boulder Public Institution Campus	Broomfield Private Institution Campus	No Change	RSMeans Factor
1 Solid Wood Core Door	$1225.50/EA	$1200.50/EA	$1100.00/EA	0.90
1 Hallow Metal Door	$1225.50/EA	$1200.00/EA	$1150.00/EA	2.97
Acoustical Ceiling System	$3.50/SF	$3.08/SF	$2.75/SF	0.96
Recessed Fluorescent Lights	$308.00/EA	$305.00/EA	$285.00/EA	2.63
Carpet Tile	$3.82/SF	$3.65/SF	$3.50/SF	0.95
3 5/8” Studs	$2.67/SF	$2.65/SF	$4.54/SF	1.94
5/8” Gypsum Board	$2.02/SF	$1.87/SF	$2.17/SF	2.21
Outlet & Atomic Clocks	$240.00/EA	$227.50/EA	$502.50/EA	1.88
Paint	$0.55/SF	$0.50/SF	$0.65/SF	0.98
Tie-in New Mechanical System	$10.75/SF	$9.75/SF	$10.75/SF	N/A

The total number of responses for the first part of the questionnaire was 22. As expected the second part of the questionnaire generated fewer results than the first (18) but did have a higher response rate of 82%. The second part of the questionnaire allowed the respondents to change their pricing based upon the averages of the group. Also, a part of the second questionnaire was asking the participants to rate factors on a scale from one to six established from the literature review and to provide any factors that they felt affected construction markup. The results from the second round questionnaire are shown in Table 8 and 9.

Table 8: Factors Affecting Markup (Mean)

Boulder Public Institution Campus			**Broomfield Private Institution Campus**	
Factor	**Average Rating**		**Factor**	**Average Rating**
Profitability	5.18		Profitability	4.82
Risk	4.82		Market Conditions	4.71
Subcontractor Market	4.75		Need for Work	4.63
Market Conditions	4.71		Subcontractor Market	4.50
Need for Work	4.69		Complexity of Project	4.47
Client Relationship	4.65		Labor Market Conditions	4.47
Labor Market Conditions	4.65		Risk	4.41
Complexity of Project	4.59		Client Relationship	4.35
Location of Project	4.41		Time Span of Project	4.06
Time Span of Project	4.35		Number of Bidders	4.06
Previous Experience	4.35		Type of Project	3.94
Type of Project	4.18		Quality of Drawings & Specs	3.88
Quality of Drawings & Specs	4.06		Contract Type	3.88
Size of Project	3.94		Previous Experience	3.82
Number of Bidders	3.94		Size of Project	3.76
Contract Type	3.82		Availability of Work	3.75
Availability of Work	3.75		Location of Project	3.53
Owner Sophistication	3.29		Owner Sophistication	3.12
Capital Requirements/Cash Flow	2.76		Capital Requirements/Cash Flow	2.81

Table 9: Factors Affecting Markup (Median)

Boulder Public Institution Campus			**Broomfield Private Institution Campus**	
Factor	**Average Rating**		**Factor**	**Average Rating**
Complexity of Project	5		Complexity of Project	5
Time Span of Project	5		Need for Work	5
Need for Work	5		Profitability	5
Previous Experience	5		Market Conditions	5
Profitability	5		Subcontractor Market	5
Client Relationship	5		Client Relationship	4.5
Risk	5		Risk	4.5
Market Conditions	5		Size of Project	4
Labor Market	5		Location of Project/Site	4
Subcontractor Market	5		Type of Project	4
Location of Project/Site	4.5		Time Span of Project	4
Type of Project	4.5		Previous Experience	4
Size of Project	4		Number of Bidders	4
Number of Bidders	4		Availability of Work	4
Availability of Work	4		Labor Market	4
Quality of Drawings	4		Contract Type	4
Contract Type	4		Quality of Drawings	3.5
Capital	3		Owner Sophistication	3
Owner Sophistication	3		Capital	2

The results established from the second part of the questionnaire show very interesting results. First, the respondent rated profitability the highest, making it the most influential factor affecting construction markup in the situation laid out in the questionnaire. One respondent stated in the questionnaire, “profitability is one of the most important factors for us. We will not go after a job that we see as a company will not make us profitable.” As one can see from the quote contractors usually will not go after projects that they know they will lose money on most. Companies want to grow and they cannot do this if the projects they are on, are not profitable.

Risk ranked second highest for a markup factor for projects on the University of Colorado campus. Many of the respondents mentioned that the University of Colorado did have a reputation of being risky in terms of cost overruns, multiple change orders, lower productivity rates, and longer durations. While risk is the second highest rated factor on the CU Boulder campus, market conditions was ranked second for private campuses. Unlike public projects which have a promised source of funding, market conditions are more influential for private projects because the funding may be lost by a change in investors or economic shift. This market condition factor can be seen in the Great Recession when many private projects fell through and public projects continued. Opposite of the highest rated factors for both the Boulder scenario and the Broomfield scenario, the least influential factor for both Boulder and Broomfield was capital requirements/cash flow. This factor was least influential because as many of the respondents stated the companies in this study were established and had money to start a project. Once the project is started the contractor is typically paid for the work completed, so capital and cash flow is not as important as the other factors that contribute to markup.

One of the most interesting result from the study was the location of the project ranked 9th for the Boulder public institutional campus and 17th for the Broomfield private institutional campus. This difference of 8 rankings is very significant as it shows that the location of a project has a great influence on the markup of a project. Many respondents mentioned that a reasons why the University of Colorado Boulder campus costs more to build on is because the town of Boulder costs more to live and operate in than a town like Broomfield. Similarly, public campuses such as the one used in this study may have lower productivity rates and additional restrictions or requirements causing the price to be higher than the Broomfield private campus.

In addition to ranking the factors that were found in the literature, participants were asked to provide any additional factors that affect markup. One supplementary factor mentioned by the respondents was additional owner specifications. These additional specifications include specific materials and codes that cannot be changed without a length process. For example the University of Colorado Boulder has a strict mechanical system design standards and only allows certain types of equipment. While this may be very useful to the university because it allows for a longer life on the mechanical system, the price does go up. When a contractor tries to change a piece of equipment, a committee must approve this substitution. Most of the time this process takes too long or the committee comes to the conclusion to not allow the substitution. This process affects the construction pricing because it backs contractors into a corner in terms of equipment, while on a private projects owners are more susceptible to changes. Another factor that was identified by the respondents was administrative requirements. The State system takes longer to pay and there are many more requirements than the private sector. An example of this is the amount of inspections required by each trade. These inspections slow down the contractor and cause them to markup their work because of the amount of paperwork they must complete. Inspections also cause the contractor to work at a stop and go pace, reducing productivity and raising the cost of the project. Similarly, the closeout on projects can be very slow and last much longer than private projects. If the State takes a long time during closeout and doesn't return the retention to the contractor in an adequate amount of time, that contractor bidding on the next project is more likely to raise their prices because they haven't received their previous projects retention.

Limitations

While the results from this study provided adequate data for an owner or a general contractor to estimate projects or understand what factors should be looked at when estimating on a public or private institutional campus in the Denver metro area, there was limitations to the research. One of the biggest limitations with the research done in this journal article is that of location. The location of the research in terms of pricing is very specific and limited to the Denver metro area, specifically Boulder and Broomfield. This pricing data will most likely not be useful to users outside of the Denver metro area because the price of construction changes between locations across the country. While the pricing data is limited the factors are still applicable to any public and private institutional projects. For example all public institutional projects usually have more owner oversight than a private institutional project. Similar to the limitation of location, the prices asked in the first part of the questionnaire are not fully encompassing. As many know, projects are always dynamic and two projects rarely have the same scope. In this paper the key line items for renovation projects at the University of Colorado Boulder campus were specified. When it comes to other campuses or different sized projects the pricing of each line item will change.

Another limitation with this research was the population size of the respondents and the rating of the factors. The population size used in this research was limited due to the amount of time allocated for the participants to respond and the voluntary nature of the questionnaire. Since the questionnaire was voluntary, getting respondents to fill out the questionnaire presented, was a challenge. By having a limited amount of responses, there was an opportunity for the data to be skewed and not “proven”. By having more data points and more questionnaires, the data would be concrete and help create a more even bell curve for the data, making it more statistically

strong. Along with the small population size the rating of the factors does cause limitations in the research. While rating items on a scale there is always the possibility that the respondent doesn't fully understand the scale or doesn't take time to properly rate the factor. A respondent may understand the terminology differently than another, causing for discrepancy in the data. This is the case in all data collection processes like the one used in the second part of the questionnaire, but because the population size was small in this study the discrepancy may be more prominent.

Conclusions

Construction companies are constantly bidding projects with the intent to win work. Many of these projects have uncertainty in the initial stages and can cause a contractor to provide a markup factor on the estimate provided to the owner. Markup is a term used in construction estimating that consists of overhead, profit, and other indirect costs. Most of the time markup is applied to certain items, systems, or the total costs of the estimated project (AACE International, 2011). This researched analyzed the factors that affect markup to help organizations better understand and improve on how to apply or reduce markup factors. The results generated from this research showed that the most influential factors for the public institutional campus in this study were profitability, risk, need for work, client relationship, and subcontractor market conditions. For the private institutional campus in this study, the most influential factors were profitability, need for work, market conditions, complexity of project, and contractor market. These factors did differ from the top factors mentioned in the literature review, but were similar to the seminal article by Ahmad and Minkarah. The literature review showed that the top factors mentioned were number of bidders, market conditions, size of project, location of the project, and the quality of the drawings and specifications. Ahmad and Minkarah showed that the degree

of hazard, degree of difficulty, type of job, uncertainty in the estimate, and the historic profit (Ahmad & Minkarah, 1988). This difference may be due to the time and location differences between the studies in the literature reviews and the study done in this paper. The location and time of bidding do affect the bidding attitude of the respondents, which could have been the difference in results. Also, the size of the projects specified within this study is much different than the studies reviewed in the literature review in this paper. The papers reviewed in the literature review looked at projects over $2,000,000 while this paper looked at projects much smaller.

For both public and private institutional campuses this research helped establish new factors and brought light to factors that cause unnecessary increases in pricing. The two new factors that were found that affect markup on public institutional campuses was, additional owner specifications and administrative requirements. Additional owner specifications and administrative requirements were identified by several respondents in the questionnaire. These two new factors as well as the factors rated in the questionnaire can be used by owners to reduce markup on their projects. One great way for an owner to reduce markup is to allow and maintain a good relationship with the contractors. Establishing relationships with the contractors that allow for a good flow of information, a level of trust, and a productive environment will reduce the markup factor on projects. This relationship may lend itself to getting the owner more consistent pricing over other projects from the contractors that they have established a relationship with. Another example specific to public universities is a public owner may know that their campus has a lot of site access restrictions, so to avoid higher costs, the owner can try to ease these restrictions for the contractor.

The research involved quantitative research methods such as a questionnaire to gather data and analyze that data. The “what” and “why” were addressed in the results section by analyzing the findings from the research question. This research should encourage more in-depth case studies such as a nationwide study or to explore what policies and procedures affect construction pricing.

As noted in the results section, this research produced results that could be applied to an RSMeans value. This research also added important factors to the community on why public and private institutional campuses, specifically in the Denver metro area may cost more to build on. While the data produced was very applicable and useful to the community a more in depth data collection across a wider area and bigger participant base may be worthwhile.

Chapter 4

Conclusions

This research explored the impact of markup factors on public and private renovation projects. Although previous research has established factors that affect bid go/no-go bid decisions and how much to markup prices (Ahmad & Minkarah, 1988) (Fayek, Ghoshal, & AbouRizk, 1999) (Ling & Liu, 2005), these studies did not address public and private institutional campuses or small renovation projects. This research has provided new information and understanding in these areas for both academic researchers and industry practitioners.

Academic Contributions

The primary academic contributions of this work were (1) confirmation of established factors; (2) new factors established; and (3) a look into the difference between markup on public and private projects. This research provides validation of the work done by Irtishad Ahmad and Issam Minkarah in 1988 and other research papers that have followed. Although the research done by Ahmad and Minkarah showed that the degree of hazard, degree of difficulty, type of job, uncertainty in the estimate, and the historic profit were the top five driving factors affecting construction markup, the results produced in this thesis varied . The results established from the questionnaire used in this thesis showed that for the public institutional project the top five factors were profitability, risk, subcontractor market conditions, market conditions, need for work. For private institutional project the top five factors were profitability, need for work, market conditions, complexity of project, and subcontractor market. As one can see profit is identified as a top factor in both the seminal work and this study. Also, risk was shown as a top factor in the work by Ahmad and Minkarah and in the public sector. The difference in the results may be accountable to Ahmad and Minkarah's questionnaire being issued to ENR's top 400

contractor list (Ahmad & Minkarah, 1988), while this research contacted local firms, which only some were on ENR's top 400 contractor list. This difference allows for a new study on the factors being applied to smaller firms and smaller projects, which is evident through the differing top five factors for both public and private projects.

While there were differences in the ranking of the factors in this research compared to the ranking of the factors from the literature, the nineteen factors were validated by this study. Along with the validation of the previous factors, two new factors were established for the academic community to study. Additional owner specifications and administrative requirements were identified by several respondents in the questionnaire and should be included in any future research. The final academic contribution was looking at the difference in terms of construction markup factors between public and private projects. The differences in markup factors between public and private institutional campuses are that on public campuses, the client relationship and the risk of the project are more influential than that on private projects. On private projects the market conditions and the complexity of the project are more influential on markup than on public projects. All of the papers reviewed in the literature review did not have distinctions between public and private institutional campuses and just looked at the construction industry as a whole. This paper provided a new insight on the differences in factors and in pricing between the public and private projects.

Industry Contributions

Along with the academic contributions, many contributions were made to the construction industry as a whole. In terms of an owner, the factors established can help owners eliminate or mitigate the factors that general contractors claim to affect construction pricing. A key result that the research established was that the five main factors that affect markup on public

institutional campuses are; profitability, risk, subcontractor market conditions, market conditions, need for work. Similarly, the five main factors that affect markup on private institutional campuses are; profitability, market conditions, need for work, contractor markup, complexity of project. These factors can also help contractors establish markup factors for different projects. For example if a contractor has little to no experience bidding on public projects, they may use the factors studied in this thesis to help make decisions on why they should markup their prices.

One of the most impactful contributions from this research is the establishment of two new factors that affect construction markup for public projects. These two new factors, additional specifications and public administration, contribute to higher prices on public institutional projects. While these factors are directed towards higher education construction projects, they are also applicable to other state, federal projects.

By using the knowledge and identification of these factors an owner may be able to mitigate the factors and possibly get lower pricing on projects. As mentioned earlier in the paper the two new factors identified in this research may help owners reduce the markup provided by contractors. Additional owner specifications require more effort by the contractors and cause them to markup their prices. Also, the administrative requirements at the University of Colorado campus causes contractors to markup their prices. The administrative requirements that the University puts on contractors such as additional permitting, inspections, and closeout requirements greatly affect the pricing of a project. Many times during the questionnaire and follow up process contractors talked about how the university is slow in their administrative process with approving items or getting the projects closed out. By know these types of factors an owner can mitigate the problem and reduce their pricing. For the University, they could

reduce the amount of inspections needed or create a process that reduces the current closeout time of a project, which would most likely have an impact on the future projects pricing and reduce the markup.

Limitations & Future Research

This research had some limitations that should be addressed in future research. The first research limitation was the amount of firms completing the questionnaire. Due to the voluntary nature of this study, 33% of firms contacted did not respond. If more time was allowed to each firm to fill out the questionnaire, more results may have been produced. These additional results may have provided even more factors affecting construction markup as well as more accurate construction pricing. The research also could have looked at more contractors that had done previous work on the University of Colorado Boulder's campus. As stated previously only 50% of the respondents had done previous work at CU Boulder. While this may be an appropriate number, more firms could be found to provide better pricing and more applicable factors.

Another research limitation is the location and limited scope of the questionnaire. The research and questionnaire were focused on small renovation projects within the Denver metro region. While it is hard to properly quantify small renovation projects because each renovation is different, multiple renovation projects could have been priced out. This would allow for different pricing for different scopes of work. For example pricing of cabinets would change depending on the renovation type. If the renovation is a laboratory, the cabinets would cost much more than if the renovation is a typical office. This is also similar to the location. The location of the project was limited to the Denver metro region. While the factors and pricing are accurate to the region, they most likely are not completely accurate outside of the Denver metro area. One example of this is rural areas of Colorado such as the mountains, pricing and factors

may be different. One of the factors that may be very prominent in the mountain region of Colorado that isn't as important in the Denver metro region is location. The mountain region requires a lot more planning due to the location of the project and the limited amount of materials available. Having the study done in multiple locations would also lend itself to separating the factors into factors that affect public renovations and private renovations instead of only the two locations done in this study.

One of the biggest limitations to this study and where future research can be conducted is the factors. When looking at the factors and the way the questionnaire was designed, it was hard to conclude that the factors differed because of public vs private. Since the questionnaire only looked at two locations the factors could have differed in rankings due to location instead of the type of owner. This research could be expanded upon by looking at public institutions and comparing them to private companies that have very rigid specifications similar to the public institutional campuses. Firms such as Hyatt or other high end hospitality firms usually have specifications that require systems to last similar to public institutions such as CU Boulder. By doing this in multiple locations as mentioned above, the factors may really separate between public and private projects.

Since construction is ever changing and each project is so dynamic the amount of research that can be done in this sector can be overwhelming and endless. Both owners and contractors will need to study these factors to understand the true reasons for construction markup, either to reduce that markup or to win a project. By becoming more familiar with these factors, one can create more accurate estimates that account for pricing not usually discussed by the general public. This allows for more control when bidding projects or awarding projects.

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Appendices

Stats Test

To check the differences in the factors between the Boulder public institutional campus and the Broomfield private institutional campus a statistical test was conducted. IBM's SPSS software was used to conduct the statistical test for the differences between the factors in the two locations. SPSS has many different statistical tests that can be used to test the differences between two samples but for this research the Kruskal-Wallis test was used. The Kruskal-Wallis test compares the medians of two or more samples to see if the samples differ statistically.

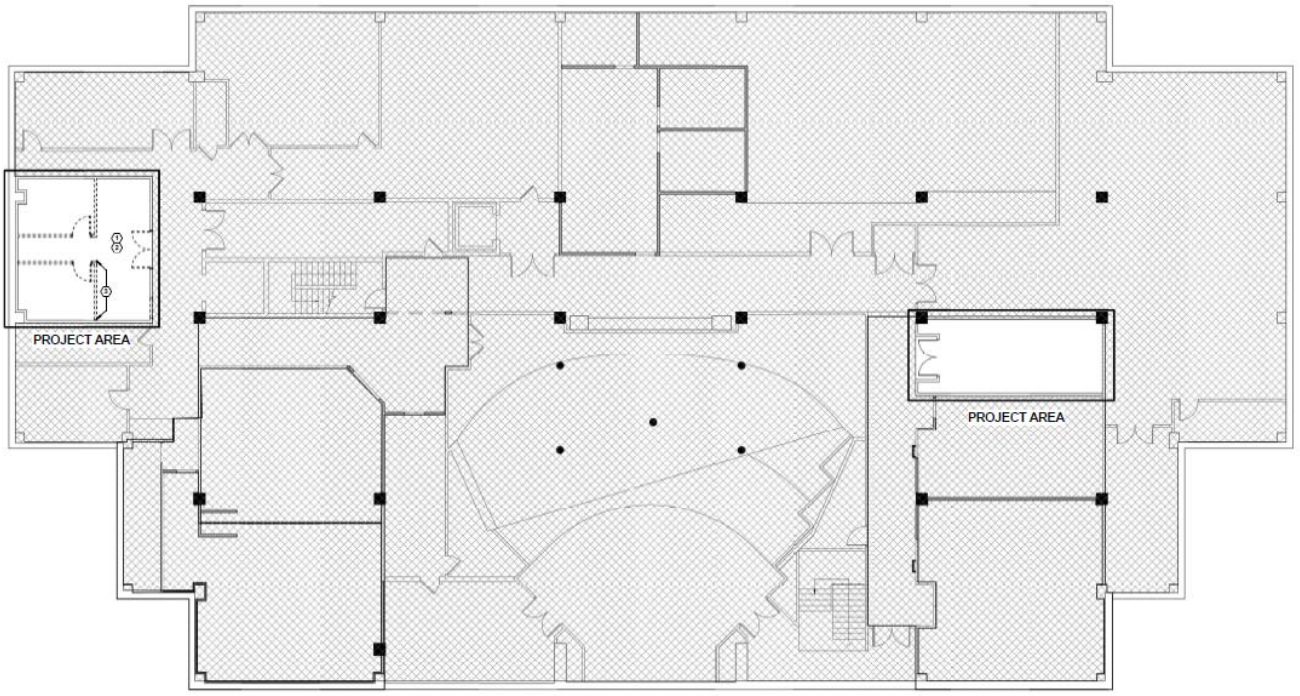
To set up the program a data table was created that housed the ratings of each markup factor separated between the two locations, Boulder and Broomfield. Assuming that each factor was separate from the others, the Kruskal-Wallis test was conducted. The test looked difference in the medians between the two locations for each factor with a significance level of 5%.

The results generated by the Kruskal-Wallis test are shown in the figures below. While all of the factors did not statistically differ between the public institutional campuses and the private institutional campuses, there was one factor that I believe did statistically differ, the location of the project. The location of the project, which had a significance level of 8.6% is the only factor that had a significance level close to 5%. I believe that this factor differs between locations even though the significance level was higher than 5% because of the lack of data points within the study. There was only 18 data points for each factor at each location, so due to the minimal data points this factor would most likely move under the significance level of 5% with an addition of more data.

Hypothesis Test Summary				
	Null Hypothesis	**Test**	**Sig**	**Decision**
1	The distribution of **Size of Project** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.660	Retain the null hypothesis
2	The distribution of **Location** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.086	Retain the null hypothesis
3	The distribution of **Type** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.651	Retain the null hypothesis
4	The distribution of **Capital** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.961	Retain the null hypothesis
5	The distribution of **Complexity** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.757	Retain the null hypothesis
6	The distribution of **Time Span** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.539	Retain the null hypothesis
7	The distribution of **Owner Sophistication** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.650	Retain the null hypothesis
8	The distribution of **Need for Work** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.813	Retain the null hypothesis
9	The distribution of **Previous Experience** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.194	Retain the null hypothesis

10	The distribution of **Profitability** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.480	Retain the null hypothesis
11	The distribution of **Number of Bidders** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.781	Retain the null hypothesis
12	The distribution of **Availability** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	1.000	Retain the null hypothesis
13	The distribution of **Client Relationship** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.388	Retain the null hypothesis
14	The distribution of **Risk** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.441	Retain the null hypothesis
15	The distribution of **Market Conditions** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	1.000	Retain the null hypothesis
16	The distribution of **Labor Market** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.671	Retain the null hypothesis
17	The distribution of **Subcontractor Market** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.568	Retain the null hypothesis
18	The distribution of **Quality of Documents** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.672	Retain the null hypothesis
19	The distribution of **Contract Type** is the same across categories of **Project Type**	Independent – Samples Kruskal – Wallis Test	.884	Retain the null hypothesis

Example Plans



1 SECOND BASEMENT DEMOLITION PLAN
D2.00 1/8" = 1'-0"

DEMOLITION NOTES

1. PRIOR TO DEMOLITION, CONTRACTOR SHALL DO A WALK-THROUGH WITH OWNER TO IDENTIFY ANY ITEMS TO BE SALVAGED AND RETURNED TO BUILDING STOCK.
2. REFER TO FLOOR PLAN FOR LOCATION OF PARTITIONS TO BE REMOVED. DEMOLITION TO INCLUDE ALL ELEMENTS WITHIN AND CONNECTED TO PARTITION. TERMINATE ALL ASSOCIATED ITEMS - I.E. ELECTRICAL, ETC., AS NECESSARY. ALL PIPING, CONDUIT, ETC. SHALL BE TERMINATED AND CAPPED IN A LOCATION THAT WILL NOT BE VISIBLE WHEN NEW CONSTRUCTION IS COMPLETE. PIPING TO BE REMOVED BACK TO MAIN LINE PER OU STANDARDS LEAVE EXISTING DRYWALL AND FURRING AT EXTERIOR WALLS, LATERAL BRACING AND COLUMNS. COORDINATE ALL DEMO EXTENTS WITH OU STANDARDS
3. PROTECT ALL SURFACES ADJACENT TO DEMO AREAS. CONTRACTOR TO BE RESPONSIBLE FOR ALL ITEMS DAMAGED DURING DEMOLITION.
4. REMOVE ALL EXISTING DASHED DOORS AND FRAMES. RETURN TO BUILDING STOCK. GC TO REMOVE ITEMS FROM SITE PER ATHLETIC DEPT.'S REQUEST. COORDINATE WITH DEPARTMENT PRIOR TO DEMO.
5. REMOVE ALL EXISTING FLOOR COVERINGS AND ADHESIVES WHERE NOTED. PREPARE FLOOR SMOOTH TO RECEIVE NEW FINISHES.
6. REMOVE AND SALVAGE FOR RE-USE ALL WALL MOUNTED WHITE BOARDS AND PROJECTION SCREENS.
7. ALL EXISTING ABANDONED TELEPHONE CABLE, DATA CABLE AND EQUIPMENT SHALL BE REMOVED BY CONTRACTOR.
8. REMOVE ALL EXISTING WALL BASE IN AREAS OF DEMOLITION. PREPARE SURFACE SMOOTH FOR NEW FINISHES.
9. ITEMS TO BE SALVAGED FOR FUTURE USE INCLUDE BUT ARE NOT LIMITED TO: HVAC DIFFUSERS, HVAC CONTROL DEVICES, LIGHT FIXTURES AS NOTED AND WIRING DEVICES, DOORS, DOOR FRAMES (DELETED FLUSH), HARDWARE, EXIT SIGNS, FIRE ALARM DEVICES
10. ITEMS TO BE SALVAGED SHALL BE CAREFULLY REMOVED IN A MANNER TO ENSURE MINIMUM DAMAGE, AND SHALL BE STORED IN A STAGING AREA DESIGNATED BY THE OWNER. ALL MATERIALS, EQUIPMENT, AND OTHER ITEMS NOT TO BE RETAINED FOR FUTURE USE SHALL BE REMOVED FROM THE SITE.
11. ERECT TEMPORARY, TIGHT-FITTING, DUST PROOF PARTITIONS AT THE PERIMETER OF THE AREA OF WORK PRIOR TO COMMENCEMENT OF DEMOLITION. DUST PROOF PARTITIONS SHALL REMAIN IN PLACE UNTIL COMPLETION OF ALL CONSTRUCTION WORK.
12. GC TO COORDINATE ALL POWER SHUT DOWNS WITH OWNER PRIOR TO EXECUTION. WORK MAY NEED TO BE DONE AFTER HOURS.

DEMOLITION KEYED NOTES

1. DEMO EXISTING CEILING TILE AND GRID.
2. REMOVE EXISTING FLOOR COVERING AND ADHESIVES. PREPARE FLOOR SMOOTH TO RECEIVE NEW FINISHES.
3. CONTRACTOR TO CUT AND PROTECT PORTION OF DRYWALL AT THIS LOCATION IF FROM FURTHEST SIGNATURES. COORDINATE WITH ATHLETIC DEPARTMENT FOR RELOCATION OR SALVAGE.

PARTITION LEGEND

EXISTING PARTITION TO BE REMOVED
EXISTING PARTITION TO BE REMAIN

Example Questionnaire Part A
Basic Information

Please provide your name and contact information (Needed for a follow up questionnaire):

Company (Optional): _____

Name: _____

Email: _____

Phone Number: _____

Have you previously bid on projects at the University of Colorado Boulder?

_____Yes _____No _____Consultant

If you answered yes, approximately how many projects have you bid on at the University of Colorado Boulder and what is the average price of those projects?

Number of Projects (N/A for Consultants): _____

Average Size of Project (N/A for Consultants): $_____

Renovation Work

Install **1 solid core wood door (includes door frame and hardware):**

** Reference A2.00, Door Schedule, Door Notes (1-10), and Finish Notes (13, 15)*

CU Boulder *($/Unit)*	**Oracle Broomfield *($/Unit)***
Comments on Pricing:	

Install **1 hallow metal door (includes door frame and hardware):**

**Reference A2.00, Door Schedule, Door Notes (1-10), and Finish Notes (13, 15)*

CU Boulder *($/Unit)*	**Oracle Broomfield *($/Unit)***
Comments on Pricing:	

Example Questionnaire Part B

Name: _____

Renovation Work

Install **1 solid core wood door (includes door frame and hardware):**

** Reference A2.00, Door Schedule, Door Notes (1-10), and Finish Notes (13, 15)*

	CU Boulder *($/Unit)*	**Oracle Broomfield *($/Unit)***
Average Price of Item (Location Did Change Price):	$1285.49/EA	$1227.55
Average Price of Item (Location Didn't Change Price):	$1532.40/EA	$1532.40/EA
Option to Change Price:		
Comments on why you chose to keep your original pricing or change it:		

Scale

1	2	3	4	5	6
Doesn't affect Pricing					Dictates Pricing

Rating

Project Characteristics

Size of Project:

CU Boulder *($/Unit)*	**Oracle Boulder *($/Unit)***

Location of Project/Site Access:

CU Boulder *($/Unit)*	**Oracle Boulder *($/Unit)***

Type of Project:

CU Boulder *($/Unit)*	**Oracle Boulder *($/Unit)***

Factor Table

	1	2	3	4	5	6	7	8
Factors	**A Case-Based Decision Support Tool for Bid Mark-Up Estimation of International Construction Projects**	**A Competitive Bidding Strategy**	**A Dynamic Competition Model for Construction Contractors**	**A Framework for Contractors to Reach Strategically Correct Bid/No Bid and Mark-up size Decisions**	**A Risk-Sensitive Markup Decision Model**	**A Survey of the Bidding Practices of Canadian Civil Engineering Construction Contractors**	**An Examination of the Importance of Resource Considerations When Contractors Make Project Selection Decisions**	**Analogy-Based Solution to Markup Estimation Problem**
Availability of Resources	x			x	x	x	x	x
Availability of Work			x			x	x	
Bidding Situation		x			x			
Bonding Requirements								
Capital Requirements/Cash Flow	x						x	x
Client Relationship	x			x		x	x	
Company Characteristics	x			x		x		x
Completion Time & Penalty	x			x				
Complexity of Project	x			x			x	
Contract Type	x						x	x
Early Contractor Input								
Equipment Costs/Requirements					x	x		
Financial Stability	x							
Full or Split Contract	x	x				x		
Government Regulations	x							
Historic Failures								
Insurance Requirements								
Labor Market Conditions				x	x			
Location of Project/Site Access	x			x		x	x	x
Market Conditions	x			x		x		x
Need for Work	x		x	x		x		x
Number of Bidders		x		x	x	x	x	x
Overhead/Markup Components								x
Owner Requirements	x			x				
Owner Sophistication	x			x			x	x
Payment History	x							
Potential Future Projects	x							
Previous Experience	x				x	x	x	x
Probability of Winning		x	x	x	x		x	
Profitability			x	x	x	x	x	
Public/Private								x
Quality of Drawings and Specs	x			x	x			x
Rate of Return						x		
Relationship with Consultant								
Resources for Bid/Confidence							x	x
Risk				x	x	x		x
Safety								x
Size of Project	x	x				x		x
Staffing Requirements				x		x		x
Starting Time/Climate					x			x
Subcontractor Market Conditions	x			x	x	x		x
Taxes								
Third Party Stakeholders								
Time Available to Bid					x		x	
Time Span of Project	x					x	x	x
Type of Project	x			x		x	x	
Union/Open Shop								
Value of Project						x	x	x

9	10	11	12	13	14	15	16	17
Analysis of Factors Influencing Project Cost Estimating Practice	**Analyzing Construction Company Profitability**	**ANN-Based Mark-Up Estimation System With Self-Explanatory Capacities**	**Bid Markup Assistant**	**Bidding Strategies and Probabilities**	**Bid-markup Determination for Microtunneling Projects**	**Combining Rule-Based Expert Systems and Artificial Neural Networks for Mark-Up Estimation**	**Competitive Bidding Strategies**	**Competitive Bidding Strategy Model and Software System for Bid Preparation**
x								x
	x	x				x	x	
							x	
		x			x	x	x	x
			x				x	x
							x	x
	x		x					
x		x			x	x		
x	x							
					x		x	
					x			
		x	x			x	x	x
x		x			x	x	x	x
	x	x				x	x	x
			x				x	
	x	x	x	x		x	x	
						x		
	x							x
x	x				x			
							x	
					x			
x				x	x		x	
				x				
				x	x			
			x	x				x
				x				
x								
			x				x	x
x	x	x			x	x		x
x							x	
	x		x				x	x
x								
x	x							
	x	x				x		x
								x

Articles									
18	19	20	21	22	23	24	25	26	27
Controlling Overhead Costs	**Evaluating Contractor Prequalification Data: Selection Criteria and Project Success Factors**	**Factors Affecting A Contractor's Mark-Up Size Decision in Saudi Arabia**	**Factors Affecting the Bid/No Bid Decision in the Saudi Arabian Construction Contractors**	**Factors Considered by Successful and Profitable Contractors in Mark-Up Size Decision in Singapore**	**Factors Considered in Tendering Decisions by Top UK Contractors**	**General Overhead Distribution**	**Heterogeneous Approach to Modeling Contractors' Decision-to-Bid Strategies**	**Integrated Bid Preparation with Emphases on Risk Assessment Using Neural Networks**	**Key Factors Considered in Compiling Tender Prices for China's Public Works Projects**
		x	x	x	x				
		x	x	x	x			x	
		x		x	x				
		x		x	x				
		x	x	x	x				x
x	x		x	x	x				
			x	x	x			x	x
			x	x	x		x		
				x	x		x	x	
		x	x	x	x		x		
					x				
		x	x	x		x			
	x		x	x					
		x		x	x				
		x			x				
x				x	x	x			
		x	x	x	x	x			
		x		x	x		x		
x		x		x	x		x	x	x
x		x		x	x	x		x	
		x	x	x	x		x	x	x
		x	x						
		x		x	x				x
		x	x						x
x			x	x					x
	x		x	x	x				
		x	x	x	x				
				x					
	x	x	x	x	x			x	
					x				
				x					
		x	x	x					
		x	x	x	x				
	x			x					
				x	x		x		
		x	x	x	x				
		x			x	x			
				x	x				
					x				
									x
	x	x		x	x				
	x	x	x	x	x			x	
x				x	x				
					x	x			
	x	x		x					

28	29	30	31	32	33	34	35	36	37
Key Factors in Bid Reasoning Model	Modeling a Contractor's Markup Estimation	Modelling Contractors' Mark-Up Behavior in Different Construction Markets	Optimum Bid Markup Calculation Using Neurofuzzy Systems and Multidimensional Risk Analysis Algorithm	Profit	Questionnaire Survey on Bidding in Construction	Risk and Need-for-Work Premiums in Contractor Bidding	Subcontractors' Bidding Decisions	The effect of Client and Type and Size of Construction Work on a Contractor's Bidding Strategy	The Effect of Contract Type and Size on Competitiveness in Bidding
x	x	x			x	x		x	
	x				x				
x				x					
x					x		x		
	x			x	x		x	x	
	x				x	x			
x				x			x		
	x		x	x	x	x			x
		x		x			x		x
x									
x					x	x			
x							x		
x									
x				x	x	x			
x	x			x	x			x	
	x	x	x	x	x	x		x	
x	x		x	x	x	x	x		
	x	x	x	x	x	x		x	x
x			x						
	x								
x				x		x			
	x			x	x		x		
x							x		
			x	x		x	x		
			x						
x	x		x	x	x	x	x		
x					x				
	x								
x									
				x	x	x			
						x			
x	x	x		x	x	x		x	x
x						x		x	
					x		x		
x				x	x		x		
					x				
x									
			x	x	x	x			
x	x	x		x	x			x	x
				x					
								x	x

38	39	40		
The Factors Influencing Bid Mark-Up Decisions of Large and Medium-Size Contractors in Singapore	**To Bid or Not to Bid: A Parametric Solution**	**Utility-Theory Model for Bid Markup Decisions**		
	x		13	Availability of Resources
x	x	x	21	Availability of Work
x			8	Bidding Situation
x			7	Bonding Requirements
x	x	x	19	Capital Requirements/Cash Flow
x		x	19	Client Relationship
			14	Company Characteristics
x			12	Completion Time & Penalty
x		x	19	Complexity of Project
x	x		16	Contract Type
			2	Early Contractor Input
x	x		11	Equipment Costs/Requirements
			8	Financial Stability
x			7	Full or Split Contract
x			5	Government Regulations
		x	2	Historic Failures
x			5	Insurance Requirements
x	x	x	19	Labor Market Conditions
x	x	x	23	Location of Project/Site Access
x		x	25	Market Conditions
x			21	Need for Work
x	x	x	30	Number of Bidders
			6	Overhead/Markup Components
x	x	x	12	Owner Requirements
x		x	15	Owner Sophistication
	x		11	Payment History
x			3	Potential Future Projects
x	x		17	Previous Experience
			10	Probability of Winning
x	x	x	15	Profitability
			2	Public/Private
x	x		22	Quality of Drawings and Specs
x		x	7	Rate of Return
			2	Relationship with Consultant
x	x		9	Resources for Bid/Confidence
	x	x	16	Risk
x			5	Safety
x	x	x	24	Size of Project
x		x	14	Staffing Requirements
	x		8	Starting Time/Climate
	x	x	17	Subcontractor Market Conditions
x			3	Taxes
			1	Third Party Stakeholders
x	x		10	Time Available to Bid
	x	x	18	Time Span of Project
x		x	20	Type of Project
			3	Union/Open Shop
			9	Value of Project