MANAGING SUBCONTRACTOR PRODUCTIVITY: OBTAINING EXCEPTIONAL PERFORMANCE WITHOUT THE ABILITY TO DIRECT PERFORMANCE

By

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To my grandparents and the rest of my family and friends

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The US construction industry of today is renowned for being an industry of low productivity. For this reason, there has been an increase in research seeking to identify and quantify the factors that affect construction productivity, and opportunities and methods to improve productivity. Contractors subcontract 80-90% of the work performed on a typical construction project to specialty contractors (subcontractors), and can often have 20-30 subcontractors working on one project (Hinze and Tracey 1994). Therefore, any attempt to improve construction productivity must give attention to the effect subcontracting has on productivity. This study sought to establish US contractors' perceptions of labor productivity factors as they relate to subcontracting and the actions contractors take to mitigate the impact of subcontracting on project performance. To do this a survey was developed and disseminated to a random selection of contractors listed on the AGC's membership list and the ENR Top 400.

Three hypotheses were developed,

- H_1: Contractors will rank subcontractor management-related factors of productivity with the highest level of importance,

- H_2: Contractors who rank subcontractor management-related factors with a high level of importance will have aggressive provisions in their subcontracts to compel performance, and
- H_3: Contractors who rank subcontractor management-related factors with a high level of importance will also require their prospective subcontractors to demonstrate competency in management techniques proven in the literature to be advantageous to productivity.

It was found that contractors do, in fact, feel that subcontractor management-related factors are of the highest importance to construction productivity. However, discrepancies found between contractors' perceptions of factors and their use of contractual provisions which stand to mitigate the impact of such factors, suggest that contractors' project performance could be improved by the implementation of contractual clauses that seek to compel subcontractors to utilize specific management techniques suggested in the literature and incentivize them to perform.

CHAPTER 1
INTRODUCTION

The Nature of the US Construction Industry

The US economy is divided into 12 industry supersectors by the North American Industry Classification System (NAICS). These supersectors are grouped into goods-producing or services-producing sectors—construction is one of four goods-producing sectors and the largest, accompanied by manufacturing, mining and natural resources. In 2005, the US economy had approximately 131.6 million workers. According to the US Department of Labor Statistics, the goods-producing sectors, as a whole, accounted for 17.6% of the total workers (23.2 million) while the construction industry accounted for 31.3% of those workers. The US Bureau of Economic Analysis reports that in 2005, the construction industry claimed 3.7% of the US Real GDP, which was $11,134.8 billion (in 2000 dollars). In short the US construction industry, with approximately 7.3 million employees and 444.7 billion real dollars produced, is an enormous industry. However, it is a highly institutionally fragmented industry—accounting for 5.52% of the total workers in the US, but 9.86% of the business organizations in the US economy.

"In one study of industry productivity, a Federal Price Commission concluded that an industry's ability to increase productivity is directly dependent on the degree to which it can set productivity standards" The U.S. construction industry is widely regarded as one of the worst industries in the nation with respect to productivity increases—regularly increasing at a rate approximately one-third the national average (Adrian 2004).

Construction involves labor-intensive work; for most building projects there is a one-to-one ratio of labor to materials cost resulting in direct labor costs of 35-40% of the total project costs (Adrian 2004). The improvement of labor productivity can obviously be seen as an effective means of improving productivity, therefore throughout this paper the term productivity

will be used to refer to labor productivity. Given the small-but-many firm environment of the construction industry, competition is fierce to deliver the lowest bid, and rising construction costs leave the improvement of project productivity as one of the most effective ways to compete. The reality is that most construction firms, due to lack of resources, know-how or short-term outlooks, do not actively measure productivity or the causes of low productivity, which leaves them ill-equipped to improve it. The obvious need for productivity improvement in the construction industry has led to many research endeavors that seek to quantify the factors that affect labor productivity.

Subcontracting in the US Construction Industry

Historically, the construction industry consisted of "master builders," a business entity that was responsible for the design, management and construction of a project from start to finish employing their own labor forces. With the industrial revolution, came a societal shift from manual labor to the mechanization of work processes as new technologies were developed and adopted. In turn, construction projects became larger and more complex giving way to specialized building firms (specialty contractors or subcontractors) that could increase profitability by maintaining a comparative advantage through specialization and economies of scale thereby antiquating the master builder. As construction projects became more complex and shifted away from trade-based building products toward technology-based products, a need was created to increase subcontractor involvement (Humphreys et al. 2003).

Today, more than ever, complex projects taking place in a geographically and institutionally dispersed global economy present construction owners with the need to expeditiously ensure quality and cost-control. This has led to the development of delivery methods that can more easily meet such needs—Design-Build and Construction Management (CM). Design-Build and CM force the issue of collaboration between design and construction

experts in the design and pre-construction phases of the project, which fast-tracks the overall construction process and facilitates more cost-effective, constructible, pro-safety, quality building designs. Ultimately, regardless of the method employed by the construction owner, the majority of the actual construction work is subcontracted to specialty contractors. Today it is common for a general contractor to subcontract 80-90% of the work on a building project—utilizing 20-30 specialty contractors (subcontractors) on a single project (Hinze and Tracey 1994). Additionally, any one of the delivery methods used may result in the subcontracting of the entirety of the construction work.

Research Objective

Given the extent of subcontracting in the construction industry, the labor force of a building project is at least once removed from the immediate control of the main contractor project management (PM) team; in fact the labor force may be several times removed. It has been established that labor productivity should be a central concern of the PM team, but how does the contractor PM team control a labor force over which they do not have direct control?

Given productivity trends and subcontracting in the US construction industry, the purpose of this study was to establish US contractors' perceptions of labor productivity factors as they relate to subcontracting and the actions they take to mitigate the impact of subcontracting on project performance.

CHAPTER 2
METHODOLOGY

Introduction

In recent years, there has been increased research on construction productivity; the factors that affect it and the methods used to measure and improve productivity. While extensive in today's construction industry, the practice of subcontracting has largely been overlooked as a factor with an effect on productivity. The primary focus of this study was to update the work of Rojas and Aramvareekul (2003) by making a distinction between contractor and subcontractor management-related factors in exploring US contractors' perceptions of the factors that affect construction productivity and the contractor-subcontractor relationship. A survey was developed (See Appendix A) and reviewed by the Institutional Review Board office of the University of Florida. Once approved, the survey was disseminated to 450 contractors chosen at random from the AGC membership list of general contractors and 100 from the ENR Top 400 General Contractors, with no regard to the size of the firm.

The survey was divided into four parts: contractors' perceptions of factors that affect labor productivity, contractors' perceptions of opportunities to improve subcontractor labor productivity, the contractor-subcontractor contractual relationship, and the contractor-subcontractor behavior relationship. It was designed to obtain quantitative data necessary for statistical analysis. The survey was designed using concepts discussed in the literature to statistically prove a relationship between contractors' perceptions of productivity factors and their actions to mitigate negative factors and bolster positive factors.

Derivation of Anticipated Findings

The review of literature found several factors that have been researched as to their relative importance to, and effect on, productivity. It also pointed out that the practice of subcontracting

has become a way of life in today's construction industry—citing that 80-90% of the work completed on a typical project is subcontracted (Hinze and Tracey 1994). The literature was consistent with regards to management and labor-related factors being the factors with the greatest effect on productivity. Given that 80-90% of the work on a typical project is completed by labor employed and managed by a subcontracting firm, it would be reasonable to believe that any attempt to improve productivity must be heavily rooted in the practice of subcontracting.

Therefore, the following hypotheses were developed:

Hypothesis 1: Contractors will rank subcontractor management-related factors of productivity with the highest level of importance.

Hypothesis 2: Contractors who rank subcontractor management-related factors with a high level of importance will have aggressive provisions in their subcontracts to compel performance.

Hypothesis 3: Contractors that rank subcontractor management-related factors with a high level of importance will require their prospective subcontractors to demonstrate competency in management techniques that are advantageous to productivity.

Research Design

The objectives of this research were to explore the relative level of importance that contractor's put on subcontractor-related productivity factors and the degree to which they utilize contractual clauses recommended in the literature to compel subcontractors to perform.

Factors that Affect Productivity and Opportunities for Improvement

First, survey questions could be answered with a "yes" or a "no" response, regarding the respondents overall opinion of the effects of subcontractor productivity on their firm. Second, respondents were asked to rate the level of importance various factors have on labor productivity and the level of the perceived benefit various strategies have on improving productivity using a 10-point Likert scale. The factors were divided into four major categories: industry-related,

contractor management-related, subcontractor management-related and crew-related factors (see Table 2-1). The factors were taken from the literature; however, those defined as management-related factors in the literature were further stratified into contractor and subcontractor management-related factors to facilitate differentiation of the two management teams' effect on productivity. Third, using a 10-point Likert scale the respondents were asked to rate the level of perceived potential a particular strategy had to improve subcontractor productivity (see Table 2-2).

The Contractor-Subcontractor Relationship

Survey participants were asked to rate various contractual clauses based on their frequency of inclusion in the subcontract using a 5-point Likert scale. A response of "1" on the scale indicated they never use the clause, while a response of "5" indicated the contractors always use the clause. Contractual clauses were chosen for inclusion in the survey based on the literature review. The survey inquired about clauses that are meant to transfer associated construction risks to the subcontractor; require subcontractors to adhere to a certain level of formal planning, safety, and communication; and clauses that give incentive to subcontractors to perform.

The survey was furthermore designed to explore the behavior relationship between contractors and subcontractors. Respondents were asked to use the 5-point Likert scale to rate how often their firm required certain competency demonstrations prior to signing a contract.

A correlation table was developed to associate each of the clauses with the factor it sought to mitigate, those highlighted were used to indicate the level of management required by subcontractors, and therefore, used in the correlations shown in Table 2-3.

Correlations between Subcontractor Management-Related Factors and the Nature of the Contractor-Subcontractor Relationship

The second hypothesis of this study was that there would be a correlation between contractors that perceived subcontractor management-related factors as having a high level of effect on productivity and contractors that took an aggressive approach with subcontractors in their subcontracts. A regression analysis was performed on subcontractor management-related factors and the clauses contained in the contract. To perform the regression analysis, the sum of the responses each contractor gave to subcontractor management-related factors was paired with the sum of the contractor's responses to the clauses in the contract related to subcontractor control. Those contract clauses included in the regression analysis are highlighted in Table 2-3.

Hypothesis 3 stated that there would be a correlation between contractors that rank subcontractor-related factors with a high level of importance and those that require their prospective subcontractors to demonstrate competency in management techniques proven in the literature to be advantageous to productivity. Therefore, a second regression analysis was performed between subcontractor management-related factors and required competency demonstrations (Table 2-4).

Table 2-1 Productivity factors by category

Subcontractor Management-Related Factors	Crew-Related Factors
Subcontractor's Management Skills	Education
Scheduling	Activity Training
Resource Management	Experience
Safety Management	Motivation
Quality Control	Morale
Communication	Tenure with Firm

Contractor Management-Related Factors	Industry-Related Factors
Contractor's Management Skills	Change Orders
Management of Subcontractors	Weather
Scheduling	Uniqueness
Safety Management	Subcontractor Integration
Quality Control	Size of Firms
Communication	Building Codes
	Economy
	R&D
	Interdependence of Activities
	IT Infrastructure (e.g. PM software, ability to communicate through multiple channels)

Table 2-2 Opportunities to improve productivity

Partnering	
Incentive programs	Contractually compelled record keeping
Labor motivation programs	Contractually compelled attendance of meetings
Training extended to subcontractor management	
Training extended to subcontractor labor	Contractually compelled safety programs
Collaborative goal setting	

Table 2-3 Correlation of the survey to productivity factors

CLAUSES	PRODUCTIVITY FACTOR
Pay-if-paid	These clauses give indication of the distribution of risk between contractor and subcontractor—an unfair distribution can result in an unwillingness to cooperate. Some "make it clear that the general contractor wants to maximize profits and that fair play is not part of the agreement" (Hinze and Tracey 1994).
Pay-when-paid	
Clauses that:	
Bind the subcontractor to the terms of the owner contractor contract.	
State the reduction of contractor retainage does not entitle the sub to a reduction in subcontractor retainage.	
State that interest accrued on contractor retainage does not entitle the sub to any interest accrued on subcontractor retainage.	
Require the subcontractor to:	
Provide detailed or resource-loaded schedules	Management techniques, scheduling, sequencing, resource management
Commit to milestone dates	
Provide updated schedules as needed	
Commit to attending project meetings	Communication
Commit to stipulated record keeping procedures (i.e. daily timecards, “Work Planned for Tomorrow” or “Work Completed Today” forms.	Management techniques, scheduling, sequencing, resource management
Maintain safety programs	Safety Management
Provide training as needed	Motivation, activity training, education, experience, morale
Pass-down a percentage of any monetary incentive payments made to the subcontractor to the labor force of the subcontractor	Motivation, activity training, education, experience
Incentive Clauses that:	
Provide monetary incentive to the subcontractor for:	
Early completion of the project	Motivation, Safety, Communication, Management Techniques, Scheduling, Resource Management
Early completion of milestone dates	
Zero-injury completion of project	
100% Attendance of project meetings	
On-time and regular completion of required record keeping procedures	

Table 2-4 Required competency demonstrations

Management skills:

Knowledge of modern management techniques:

Scheduling:

Ability to break down work into detailed work activities

Set milestone dates

Resource-loaded scheduling

Cost control

Short-Term Planning:

"Work Planned for Tomorrow" form

"Work Completed Today" form

Accurate record keeping

Resource management (labor, materials and equipment)

Productivity Management Techniques:

Productivity personnel

Understanding of factors affecting Productivity

Knowledge of productivity management techniques (i.e. methods of quantifying productivity)

Commitment to productivity improvement

Communication:

Commitment to attend project meetings:

Regularly scheduled reporting/informational meetings

Training meetings

Problem solving/brainstorming meetings (as necessary)

Commitment to timely responsiveness

CHAPTER 3
LITERATURE REVIEW

Construction Productivity

This section presents a review of current literature on the factors that affect construction productivity—specifically, as they relate to the practice of subcontracting in the US construction industry. There is no disagreement in the literature that building construction is a highly laborious process. The typical building construction project may attribute 40%, or more, of its total costs to labor. For this reason, the term "productivity" is used to refer specifically to construction labor productivity throughout this paper.

Productivity's Effect on the Bottom Line

Adrian (2004) asserts the typical construction project includes about 40-50% nonproductive time, and about 2/3 of that time can be attributed to management and labor-related factors. In other words, theoretically, a firm could reduce its total costs on a typical project 26-33% by decreasing nonproductive time, which could be attributed to management and the labor force by 66%. A typical million dollar building project could double its profits by improving labor productivity by only five percent (see Adrian, p. 88, 2004), or quadruple its profits if the project supervisor was able to eliminate the nonproductive time attributable to management (see Adrian, p. 89, 2004).

Factors that Affect Productivity

The factors that affect productivity fall into very different broad categories. Researchers classify them differently but largely study the same factors. The factors that have an effect on productivity are many, including weather, design, change orders, management, worker training, resource management, etc., but only a few are discussed below. Thomas and Napolitan (1995) developed a factor model to depict that the transfer of inputs to outputs as a function of the work

method (see Thomas and Napolitan, p.291, 1995). Adrian (2004) classified them as: industry-related, labor-related, and management-related factors; he asserted that each of the categories contributes equally to nonproductive time on a construction project. Rojas and Aramvareekul (2003) further stratified Adrian's industry-related factors by classifying them as "industry environment" or "external conditions." Industry environment includes such factors as weather, uniqueness of construction projects, subcontractor integration, etc., while external conditions include the economy, IT, R&D, and scope changes. Rojas and Aramvareekul (2003) sought to determine construction professionals' perceptions of the significance of various factors on construction productivity—limiting the factors to those heavily discussed in the literature. It was determined that factors related to "management systems and strategies," including management skills, scheduling, material and equipment management and quality control, and "manpower," including experience, activity training, education, motivation and seniority, are the most important in project productivity.

The combination of: shrinking profit margins in the construction industry; construction professionals' perception that they have the ability to affect management and labor-related productivity factors—the majority influence on productivity; and the prospect that improved productivity can lead to increased profit margins, have led most research efforts in construction productivity to focus on the determination and quantification of those particular factors with the goal of developing models to improve labor and management techniques. Research by Thomas and Raynar (1997), Thomas and Napolitan (1995), Thomas et al. (1999), and Christian and Hachey (1995) have sought to quantify the affects of such labor productivity factors as overtime, change orders, materials delivery practices, and delay times.

Disruptions

Throughout the literature, the term "Disruption" is used frequently and is defined by Thomas and Napolitan (1995), Thomas and Raynar (1997), Thomas and Zavrski (1999), Thomas (2000), and Adrian (2004) as a known event that has an adverse affect on labor productivity, e.g. lack of materials or equipment, bad weather, congestion or accidents. Most of the productivity factors discussed in the literature are actually found to cause disruptions (including rework); in turn, leading to productivity losses. Thomas and Napolitan (1995) reported a productivity loss between 25-50% when a project experiences disruptions. Thomas and Raynar (1997) found an efficiency loss of about 73% when disruptions are experienced.

Thomas et al. (1995) established a project performance parameter they called the management disruption index (MDI), which is "a measure of the ability of site management to control the work environment" or management's responsibility for disruptions. It is the ratio of the number of disruptions to total workhours expressed as a percentage and normalized to represent the number of disruptions per 100 workhours. They exclude weather disruptions from the index because weather is outside the control of management, and include sequencing, congestion, rework, and insufficient supervision, information, equipment, materials, and tools. The smaller the MDI the better control management has over the project. Their study involved data from 19 international projects and found that on "reasonably good projects (defined by a low frequency of disruptions), the average weekly labor performance is reduced by about 9 percent for every disrupted workday. For abnormal projects, the cumulative labor performance can be affected by an average of 1:2.5. Individual projects can be affected by as much as 1:5."

Effects of change orders on productivity

Thomas and Napolitan (1995) collected data on three different construction projects over 128 weeks, excluding the early and startup phases of the projects because of those phases' relatively high level of change. Their work found a highly significant relationship between changes and the performance ratio—the ratio of actual productivity to a baseline productivity. The baseline productivity was measured as the average productivity seen on days that were absent change, disruptions, rework and bad weather. They found a 30% average decrease in labor efficiency when there were changes to the scope of construction—more importantly, they saw four times as many days spent on rework and more than 2.33 times as many days with disruptions when changes were integrated into the work than when they were not.

Change orders were classified by Rojas and Aramvareekul (2003) as part of "external conditions," which was perceived by construction professionals in their study as the category with the least relative importance regarding productivity—less than half as important as management or manpower. However, it is interesting to note that the productivity loss reported in the study by Thomas and Napolitan (1995) was actually a consequence of increased disruptions and rework, which were caused by change orders. They further reported that the number one cause of disruptions was lack of materials and that accordingly the underlying cause of productivity loss related to change orders was actually related to materials management.

Understanding the root cause of productivity losses because of change orders illuminates management's opportunity to improve productivity. Adrian (2004) elaborated on the collateral effects that change orders can have on a construction project, e.g. congestion, concurrent operations, etc., which in turn cause further disruption (see Adrian, p.304, 2004). These will be discussed in later parts of this literature review.

Effects of overtime on productivity

In a study of the effects of overtime on productivity by Thomas and Raynar (1997), it was stated that independent of fatigue, overtime in and of itself does not lead to productivity losses because if it did losses would be felt immediately, and construction professionals agree they are not. Their study found that the causes of overtime-related productivity losses could largely be reduced to those within the control of management. When the hours in a work week are increased by 50% all input resources must be doubled as well—labor and materials must be available 50% more often; "equipment will be used 50% more; and the project staff must respond to 50% more questions" (Thomas and Raynar 1997). Their research actually concluded that "the inability to provide resources at an accelerated rate" is the main cause of productivity loss during prolonged scheduled overtime—in other words, resource management. Disruptions caused by lack of resources are the root cause of productivity losses associated with overtime.

In a list of "40 construction productivity facts" Adrian (2004) stated that every hour's productivity is adversely affected when a worker is required to work more than eight hours in a day. Furthermore:

> When a worker is required to work five 10-hour days, the productivity of each hour is negatively affected by approximately 9%. The end result is that if a worker is paid double-time for the added 2 hours each day, the impact of the overtime (both the wage premium and inefficient productivity) result in a 30% decrease in cost-effective work every hour. A worker required to work seven 10-hour days will show an hourly decrease in productivity of approximately 40%. This, coupled with double-time for overtime hours, may actually result in negative productivity relative to a 40-hour work week.

Effects of delivery methods on construction productivity

Thomas et al. (1999) used a multiple regression analysis to compare the effects of different delivery methods on productivity. Three projects were studied—the first had daily steel deliveries and the material was erected directly off the truck, the second had daily deliveries and

the steel was unloaded, sorted and then erected, and the third had three bulk deliveries where the steel was stored in any available space and sorted when it was erected. Double-handling and indiscriminate deliveries resulted in a loss of productivity; specifically, 9% and 16% respectively. The three projects showed a 22% crew productivity loss related to material management practices and other issues as measured by the MDI.

Effects of motivation on construction productivity

Cox, Issa, and Frey (2006) developed a model to meet the motivational needs of labor forces, i.e. the subcontractor's crew. They investigated the factors that affect motivation, which is widely accepted as a factor of productivity. The study concluded that:

> The supervisor should first create positive motivation based on confidence, which originates from worker competence and/or by the use of incentives. Next the supervisor should set goals in reference to quality of work and or safety performance and also the needs of the worker. Finally, once goals are reached the worker should be rewarded with an incentive. Based on the analysis, money was suggested to be the incentive of choice.

Quantitative Management and Measurement of Productivity

Historical data should be maintained to more accurately estimate future work—the data can be formatted on a productivity (person-hours per unit installed) or unit-cost basis (price per unit installed). Unit-costs may reflect crews comprised of different individual wages which are staged in an inflationary environment; for that matter, it may be better to structure historical data on a productivity basis, which is less sensitive to change.

Regardless of the type of historical data firms choose to utilize they can collect it using accounting or scientific methods. Accounting methods are used more frequently than scientific methods because of the relative ease with which they can be developed—accounting methods simply compile as much data from timecards and work in place as possible making the resultant productivity measurements more accurate with every new data set entered. There have been

many scientific methods developed to measure productivity, however they may seem tedious to the average construction firm.

Scientific methods, heavily rooted in industrial engineering methods, include the baseline productivity measures (Thomas and Zavrski 1999), regression models, the Method Productivity Delay Model (Adrian 2004), and motion studies. Regardless of the method chosen, they involve significant observation and data collection of narrowly defined construction tasks. The observations (data) can then be used to identify causes of productivity losses, better construction methods, and better management techniques. These productivity measurement methods may be extremely time consuming and the limited resources of the average construction firm may make the use of these methods impractical.

The fragmented nature of the construction industry combined with factors exclusive to the industry, i.e. the uniqueness of each building project, the outdoor environment, the transient nature of workers, etc., have left the industry far behind its manufacturing counterpart in terms of blanket productivity improvements. The degree to which labor affects the total cost of a building project requires a project management (PM) team to utilize management techniques that optimize labor productivity in effect, control labor workers. Most often the PM team is employed by a contracting firm that does not employ the actual labor workers—the direction of the labor is left to the subcontractor.

The Contractor-Subcontractor Relationship

Today, "subcontractors play a vital role in the construction industry…on many projects, particularly building projects, it is common for 80-90% of the work to be performed by subcontractors" (Hinze and Tracey 1994). It may be common for 20 to 30 subcontractors to work together on one project, and those subcontractors will need to work synchronously towards a common goal but may or may not have ever worked with each other in the past. With little

known about the actual relationship between a contractor and subcontractor, Hinze and Tracey did an exploratory study in 1994 to better understand the relationship of the two entities as seen by the subcontractor. Their work was expanded upon by Arditi and Chotibhongs (2005), who had several findings particularly relevant to this study involving issues that may have a major effect on the level of cooperation, communication and collaboration in a relationship between the contractor and subcontractor, and therefore labor productivity, such as bidding, payment, safety, productivity and partnering issues.

The Subcontract Award System

Hinze and Tracey (1994) found that the competitive nature of the "low bid" award may result in contentious practices by both parties such as "bid shopping" pre- and postaward, or"bid peddling" and "bid chopping" respectively, when the relationship between the two parties is first being formed. In a survey of owners, general contractors, and subcontractors, Arditi and Chotibhongs (2005) found that only 15.15%, 1.61%, and 3.03% of general contractors, subcontractors, and owners, respectively, believed that there was "no need for improvement" of bid award practices. Hinze and Tracey (1994) and Arditi and Chotibhongs (2005) are in agreement that preaward bid shopping is a regular occurrence in the construction industry. Hinze and Tracey (1994) found that subcontractors utilize the practice of submitting their bids as late as possible or inflating their bids to general contractors to protect themselves from being underbid by subcontractors with "insider information" or being asked by the contractor to lower their bid post award, respectively.

Disturbingly, over half of the subcontractors surveyed by Hinze and Tracey (1994) felt they had no similar way to protect themselves from postaward bid shopping, and three-fourths of them stated that they knew at one time or another they had submitted the lowest bid and yet were not awarded the contract. According to those surveyed by Arditi and Chotibhongs (2005),

owners and subcontractors believe that general contractors employ postaward bid shopping with a frequency between "sometimes" and "often," while general contractors reported a frequency very close to "never." This discrepancy may be due to the idea that subcontractors and owners will loose, while general contractors may gain when this practice is used. In fact, postaward bid shopping may result in an unqualified subcontractor being awarded the contract, "consequently, postaward bid shopping may promote lower standards of work performance, reduce overall project quality, create an adversarial relationship between the parties, provoke legal disputes, foster unfair competition, be conducive to subcontractor insolvencies, and reduce overall jobsite safety" (Arditi and Chotibhongs 2005). Each of these possible consequences of postaward bid shopping fosters productivity losses Hinze and Tracey (1994) point to owners requiring subcontractor listings in bids from general contractors as a means to reducing or eliminating the practice. The distribution of responses to the survey question, "what can be done to improve general contractor's selection practice of subcontractors?" was shown on Arditi and Chotibhongs, p. 871 (2005), but the overwhelming majority of owners and subcontractors believe that owners should require subcontractor listing.

The Contractual Relationship

When a contract is formed between the general contractor and subcontractor, it often includes provisions that shift as much risk as possible to the subcontractor Pay-when-paid clauses seemed to be a universal example of these provisions. When the bid is awarded to a subcontractor, 46% of subcontractors indicated they were bound by the provisions of the owner-contractor contract, which is incorporated by reference in their subcontract, without being given the opportunity to review that contract. Some subcontractors reported clauses in their contracts that made it "clear that the general contractor wants to maximize profits and that fair play is not part of the agreement" (Hinze and Tracey 1994).

While the practice of withholding payment from subcontractors until after the general contractors are paid by the owner is common, there is disagreement between subcontractors and contractors as to the timeliness of payment to the subcontractor. Arditi and Chotibhongs (2005) found significant difference between the perception of payment timeliness by subcontractors and general contractors—89% of subcontractors indicated they received payment for their work at least 45 days after completion, while only 23% of general contractors agreed. Both studies found that the best ways to improve payment issues are that the owner should pay the contractor promptly, subcontractors should not work with GCs who pay late, and subcontractors should negotiate payment terms prior to signing a contract (Hinze and Tracey 1994; Arditi and Chotibhongs 2005). Another option not discussed in these studies is to allow the owner to pay the subcontractor directly thus solving both this problem and that of potential liens.

Assigning Responsibility for Safety on the Jobsite Between Contractor and Subcontractor

The safety of a project has a direct impact on the productivity of a project because accidents can lead to slow-downs, closures and lower morale. Contractors generally review subcontractor's safety policies and history before contracting with them, but the extent to which they weigh these policies precontract is undefined (Hinze and Tracey 1994; Arditi and Chotibhongs 2005). Differing perceptions of project safety responsibility could lead to unsafe projects as each party defers to the other to create a safe working environment, leaving no party specifically tasked with handling this important aspect.

Arditi and Chotibhongs (2005) found that while GCs believe subcontractors should have a sound safety program; subcontractors do not believe that GCs give consideration to subcontractor safety programs, presumably because the GC views safety as their own responsibility. The majority of subcontractors and contractors surveyed did agree that subcontractor-provided on-the-job safety programs should be an effective means of reducing

accident rates. Furthermore, nearly half of subcontractors, and more than half of contractors, believe the responsibility for creating a safe project should be assigned to the subcontractor's.

The Behavior Relationship

The behavior relationship between general contractor and subcontractor begins in the bidding stage of a project and continues through close-out; sometimes it is cultivated over multiple projects and years of business transactions. It is advantageous to the productivity of the project to have a highly collaborative and cooperative relationship between general contractor and subcontractor, Hsieh (1998) analyzed each party's willingness to cooperate. In situations where both parties are willing to cooperate towards productivity improvement, both are motivated by foreseeable gains—this can be achieved through partnering agreements. If one party sees a potential gain while the other perceives no gain or loss, the party perceiving a gain can motivate the other with speculated gains such as work on future projects. In situations where one party perceives a potential gain while the other perceives a definite loss, the party perceiving gain must motivate the other with compensation schemes. Scenarios in which neither party perceives a gain are unlikely to work (Hsieh 1998).

One of the most startling aspects of Hinze and Tracey's (1994) research concerned the project involvement of subcontractors—or lack thereof. "Many subcontracts are awarded without any formal discussion taking place between the contractor and the subcontractor," which could lead to potential conflict during the construction phase (Hinze and Tracey 1994). While 86% of subcontractors indicated frequent or occasional involvement in planning and scheduling, during construction only 43% were informed of when their services would be needed and the rest were left to monitor progress on their own. In fact, there seemed to be little communication or collaboration between contractor and subcontractor. The study concluded that subcontractors

appear to be at a disadvantage when contracting with general contractors—leaving little room for effective labor control by the contractor PM team.

Since subcontractors actually employ the labor force they are largely responsible for site productivity. Arditi and Chotibhongs (2005) found that all parties agree with similar intensity that subcontractors should be familiar with modern construction/production methods and modern management techniques, as well as play a role in accident reduction and worker motivation.

Partnering

According to the Construction Industry Institute (2006), partnering requires "companies to cooperate to an unusually high degree to achieve separate yet complementary objectives." The institute specifically defines partnering as

> a long-term commitment between two or more organizations for the purpose of achieving specific business objectives by maximizing the effectiveness of each participant's resources. This requires changing traditional relationships to a shared culture without regard to organizational boundaries. The relationship is based upon trust, dedication to common goals, and an understanding of each other's individual expectations and values.

Humphreys et al. (2003) concluded that "the adoption of partnering into the construction industries of the USA, Australia and the UK can be attributed to the fact that relationships in these industries were commonly lacking trust, respect and honesty" between owners, contractors, and subcontractors. Hsieh (1998) found that "within the scope of a contract, the more friction that exists between the parties, the lesser is the chance of success." Subcontractors being such an integral part of today's construction industry, partnering between contractors and subcontractors can be seen as an opportunity to promote innovation and performance improvement amongst parties. Partnering relationships can be on a project or strategic basis, the latter being one of longer duration perhaps over several years or projects. In deed with little capital investment needed to start a subcontracting firm, a surge of subcontractors have entered the market without

the capability to proficiently meet the needs of the contractor or owner—this may further the argument for partnering relationships (Humphreys et al. 2003). Humphreys et al. (2003) also reported on a case study developed by a major construction firm in the UK to initiate partnering agreements with key subcontractors. The results of that study were staggering, subcontractors (both successful and unsuccessful in partnering with the contractor) reported knowingly reducing their bids by 10% in anticipation of the improved working relationship; it was also perceived that the relationship made it "much easier to control time and cost performance levels and achieve higher quality levels given the close co-operation and openness/transparency that facilitated earlier anticipation and minimization of potential problems."

Arditi and Chotibhongs (2005) inquired of contractors, subcontractors, and owners their perceptions of partnering relationships (see Arditi and Chotibhongs, p. 874, 2005). Almost all respondents believed that partnering benefits everyone involved, citing that "earlier involvement in the precontract phase…is the major benefit…because it develops mutual understanding of the project, reduces constructability problems, and improves construction planning and project scheduling." Regardless, there was a significant difference between the perceptions of subcontractors and contractors of how frequently they would characterize their relationship with each other as "partnering"—close to "sometimes" versus close to "often," respectively. This discrepancy may have been because the distribution of costs associated with forming a partnering relationship are often biased towards the supplier while the benefits are largely biased towards the contractor (Humphrey et al. 2003). Nonetheless, more than half of contractors and subcontractors believed that partnering leads to better construction management, in turn reducing the time and costs associated with a project.

Subcontracting and Productivity

Given the integral role that subcontractors play in the US construction industry today, any attempt to improve productivity must take the practice of subcontracting into consideration—to dismiss it as a significant factor to productivity does a disservice to productivity improvement strategies. "The project performance to include the project time, budget, quality, and safety is only as good as the weakest link…[and] any one builder's performance at a project typically affects the other contractors at the project"—a ripple effect (Adrian 2004). Nevertheless, there has not been a lot of research attention devoted to the effect that subcontracting has on construction productivity.

Hsieh (1998) reported that the factors affecting productivity in Taiwan were the same as those reported in the US according to Thomas (1991) and Oglesby et al. (1989). He attributed management's responsibility to each of those factors, showing that subcontractors' influence on construction productivity is considerable. Hsieh further compiled the work of Arditi (1985); Koehn and Caplan (1987); and Koehn (1988) who were in agreement as to the areas that subcontractors could play a role in improving subcontracting.

Chasms Between Contractor and Subcontractor

While both contractors and subcontractors seek to maximize profits, each has a different set of drivers and strategies to achieve that goal. Contractors are driven by competition from other contractors in the market. When competition is fierce contractors may lower the markup in a bid to increase their chance of winning the contract—this strategy puts greater pressure on cost control, may decrease attention to safe practices, and increase construction risks. Subcontractors are driven by local factors such as the labor market—they are required to procure labor and materials in different localities in a timely fashion; therefore, gathering information and meeting with prospective clients is a higher priority than site work (Hsieh 1998).

When contractors are under pressure to lower markup they will in turn put pressure on subcontractors to lower costs and assume more construction risks. This mechanism may create a chasm between contractor and subcontractor making the subcontractor liable to try to escape responsibility rather than cooperate with the contractor. Furthermore, unfair distribution of the increased construction risks among the various subcontractors on a jobsite may create onsite conflict between them (Hsieh 1998). This trickle-down mechanism creates what closely resembles a "win-loose" situation between the contractor and subcontractor by lowering subcontractor profit margins while increasing their financial burden. The adversarial relationship between contractor and subcontractor usually begins here. "Without economic parity, subcontractors would not value work ethics, investment in human resources, upgrading managerial ability, and skills and technology advancement" (Hsieh 1998).

Some Perceived Setbacks to Integrating Subcontractors into Productivity Improvement Strategies

Hsieh (1998) repeatedly stumbled upon arguments against particular productivity improvement strategies for the areas described in Table 3-5 and other areas during interviews with contractors and subcontractors such as congestion, work method improvement, worker training, and housekeeping.

Regarding congestion problems—times when too many workers are onsite to have optimal productivity—advice given to the contractor's superintendent to downsize the crew may be ignored because the contractor is not concerned with potential cost saving techniques because the work is already subcontracted out at a specified unit-price. It may also be ignored by the subcontractor because the subcontractor is unsure of the number of workers that will show up to work so they over-schedule to ensure enough workers will be there to do the job (Hsieh 1998).

Subcontractors may ignore work method improvement strategies such as preplanning material usage or material and tools storage because that may require them to uphold a rigid sequencing schedule. The affects of such preplanning has the potential to cut down on materials waste and double-handling (Hsieh 1998).

Worker training can "alleviate productivity problems such as the lack of motivation or morale, fabrication errors, lack of workmanship, crew interference, and accidents" (Hsieh 1998). However, the contractor is likely hesitant to put their energies into training laborers because they are hired by the subcontractor and the contractor has no control over them and no loyalty from them. The subcontractor may be hesitant to train workers because they are more interested in hiring already skilled laborers, and/or because laborers are likely to ask for a pay increase after receiving training—that increase would be difficult to be offset in the short-run by productivity improvement. However, studies by Cox and Issa have indicated that a worker's feeling of competency, fostered by worker training, is the first step to motivating a worker, which would obviously improve worker productivity.

Housekeeping was mentioned repeatedly as one of the main causes of delays yet it is frequently under-managed because there is disagreement between contractors and subcontractors as to who is the responsible party for housekeeping. Furthermore, cleanup is often subcontracted out by the subcontractors, which leaves even less control and communication between those doing the cleaning and the contractor's management team (Hsieh 1998).

Achieving a Collaborative Effort toward Productivity Improvement

The first step in achieving a collaborative, communicative, and cooperative relationship between contractor and subcontractor is to select the right subcontractor. Adrian (2004) recommends the following practices to achieve performance:

- Be more selective in hiring subcontractors

- Encourage the subcontractors to manage themselves
- Implement performance management procedures
- Implement accurate and timely accounting and reporting procedures
- Implement a "team" approach to project management
- Serve as an advisor and aid to the subcontractor

According to Hsieh (1998), "productivity improvement measures must be implemented under the contractual framework." If one or both parties are cognizant of the need for productivity improvement, provisions can be written into the contract ex ante. Contractual compulsion of both parties to play their role in productivity improvement is the best way to make sure both parties value improvement (Hsieh 1998). Otherwise, contractors can implement strategies to motivate subcontractors to perform ex post, when construction is in progress, to perform .

Contractor's recordkeeping

To further the selection of subcontractors beyond pre-qualification Adrian (2004) suggests that the contractor design a subcontractor evaluation form. The contractor's superintendent should evaluate subcontractors' performance during and after each project using the form—the completed forms should be compiled into a database that rates a subcontractor's performance for more effective selection of subcontractors on future projects. Subcontractor selection should involve assessing their dedication to communication, collaboration, and productivity awareness.

The contractor's superintendent must also keep accurate daily records of subcontractor productivity; serving the purpose of delineating who did what and when, providing a basis for proving right from wrong in a dispute, and compiling data for other reports such as a project status report (Adrian 2004). Creating an understanding with subcontractors that they are being monitored, evaluated, and held accountable for their commitments promotes productivity. At a

minimum, Adrian (2004) suggests recording the following information on a daily basis about subcontractors:

- Number of workers
- Supervisors present
- Equipment present
- Equipment used
- Type of work performed
- Materials delivered
- Instructions given
- Instructions asked
- Construction method difficulties
- Productivity difficulties
- Safety issues
- Quality of work issues
- Conformance with contract administration requirements
- Attendance at meetings
- Compliance with scheduling requirements

Required management techniques of the subcontractor

A results oriented approach is often used by contractors to manage subcontractors—the subcontractor contractually agrees to a particular result by a specified date. This approach leaves the contractor with little recourse in the event that the subcontractor fails to produce until after the specified completion date has come and gone. According to Adrian (2004), "an approach that is more likely to achieve results is to encourage or force [contractually] the subcontractor to manage his own construction process" using specified management techniques.

According to Adrian (2004), formalized planning and scheduling "improves productivity by setting out milestone dates, drawing attention to resources needed to do the work, and by providing a means of measuring and monitoring performance" (Adrian 2004). Consensus throughout the industry on this fact is evident given the widespread adoption by contractors of formal planning and scheduling software. Subcontractors should be contractually compelled to

break down their work into a detailed list of activities, set out milestone dates in addition to a completion date, and commit to input efforts in terms of dedicated resources not just results.

The contractor can require a minimum number of work activities in the schedule or set a maximum duration for any one activity. The purpose is to force the subcontractor to think through the process, in turn, anticipating resource conflicts or problems. Requiring milestone dates forces the subcontractor to progress incrementally throughout the duration of the contract instead of potentially procrastinating until it is too late and possibly creating a ripple effect with succeeding subcontractors' work. Often subcontractors overextend themselves on multiple projects, input management forces the subcontractor to commit to a specified quantity of input resources, e.g. 14 carpenters per day for framing the first floor. The resource input the subcontractor commits to is a number they come up with based on their expected productivity and decidedly need for successful on-time completion. It is in no way a maximum number but a minimum number of resource inputs required to meet the completion date (Adrian 2004).

Communication between contractor and subcontractor

Dissemination of information on a construction jobsite is crucial to successful on-time completion of a project, as discussed earlier, especially during times of change. Positive and effective communication with subcontractors is therefore crucial. According to Adrian (2004), "construction disputes and lawsuits that are part of the construction industry could be avoided if individuals or firms would simply communicate the problem, identify the cause of the problem, and remedy the situation." Adrian (2004) asserts that the following practices should be used in communicating with subcontractors:

- Do not procrastinate—problems only get bigger if they are not communicated and addressed.
- Try to use positive communications—spend as much time commending subcontractors for their good efforts as you do implicating them for their poor efforts.

- Remember that effective communication entails both talking and LISTENING—ask them for their ideas to solve problems.
- Try to create ideas and solutions that are a win-win situation for both parties—if subcontractors believe what they are being asked to do only benefits the contractor they are unlikely to align with the contractor's recommendations.
- Maintain open communication with all subcontractors—encourage subcontractors to communicate their concerns and problems.
- When giving instructions, always try to explain why you are giving the instructions and the benefits to be gained if followed.
- Act as an advisor—not just a director.
- Communicate success as well as failure.
- Understand your subcontractors—different firms have different needs and knowledge.
- Consider new signage at job sites that communicates job status, successes, and recognition.

Hsieh (1998) suggested treating subcontractors as internal human resources, because regarding subcontractors as outsiders "prevents the contracting parties from forming a project team, or at least a coalition, and causes various productivity barriers." Furthermore, according to Hsieh (1998),

> the only differences in managing a subcontractor bound by a contract and managing site employees of the general contractor lie in the duration of employment and pay basis…if this concept becomes well understood, the general contractor would be expected to put more emphasis on the on-the-job training, project safety systems, documentation and evaluation of work ethics and performance, and team building…positive feedback from subcontractors includes the provision of more skilled workers, a lower frequency of worker switching from site to site, and, most importantly, higher commitment to the project.

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Hsieh (1998) did a study on the effects of subcontracting on construction productivity in Taiwan and this study seeks to conduct a similar study in the US construction industry.

CHAPTER 4
DATA ANALYSIS AND RESULTS

Productivity Factors

The surveys were designed to obtain quantitative data needed for statistical analysis. They were distributed by email to 550 general contractors listed on the AGC's member list and the ENR Top 400 and 14 were returned. This resulted in approximately a 3.1% return rate.

Contractors were asked two questions, which could be answered with "Yes" or "No," to determine their overall perception of the effect subcontractor productivity has on the contractor firm. When asked if they felt subcontractor productivity affected their bottom line, every single respondent said yes. When asked if the had a strategy to improve subcontractor productivity, 62% answered "Yes" and 38% answered "No" (Figure 4-1).

The average ratings for all the factors within a given category are shown in Figure 4-2. The "Subcontractor Management-Related Factors" category received the highest rating with 7.2 out of 10. Thus, Hypothesis 1 is accepted. The factors within each category were averaged to show the relative importance of each factor as perceived by the responding contractors (Figures 4-3 through 4-6).

Productivity factors were broken into four categories: "subcontractor management-related factors," "contractor management-related factors," "crew-related factors," and "industry-related factors." Examples of each of these were presented in the literature review. Subcontractor management-related factors were perceived by contractors in the US construction industry as the factors with the greatest effect on productivity with an average rating of 7.2 out of 10. Subcontractor management was followed, in order of perceived importance, by contractor management, crew, and industry-related factors (Figure 4-2).

Subcontractor Management

The factors included in the subcontractor management category were: the subcontractor's management skills, scheduling, resource management, safety management, quality control, and communication. Figure 4-3 shows the relative importance of the subcontractor management-related factors.

Subcontractor management-related factors were perceived by respondents as the factor category with the highest level of importance to productivity. Communication received the highest rating in both contractor and subcontractor management-related factors. This should not be surprising, as communication is often cited in the literature as the cornerstone of any good relationship. Dissemination, or communication, of information is crucial to the successful completion of a project on-time (Adrian 2004).

Contractor Management

Contractor management-related factors were ranked a very close second to subcontractor management-related factors and include: contractor communication, management of subcontractors, contractor management skills, scheduling, safety management and quality control. This is consistent with previous research findings when no distinction is made between contractor and subcontractor management. Figure 4-4 depicts the relative importance of the factors included in "contractor management."

The factors of "contractor management" and "subcontractor management" were similarly ranked within the category. Again, the contractor's communication is ranked with the highest level of importance in this category at 8.2, followed closely by management of subcontractors and contractor management skills at 7.8. Scheduling was rated at 6.8, safety management was rated at 5.7, and quality control was rated as 5.3.

Crew-Related Factors

The factors inquired of, under "crew" include: experience, motivation, morale, activity training, tenure with firm, and education. Figure 4-5 shows the results for crew-related factors.

Experience was assessed by contractors as the most important factor relating to the crew with an average rating of 8.1. Motivation and morale of the crew were rated second and third, with 7.4 and 7.1 ratings, respectively. Activity training was rated an average of 6.5.

Industry-Related Factors

Industry-related factors were based on the categorization of factors by Adrian (2004), and include those listed as "industry environment" and "external conditions" by Rojas and Aramvareekul (2003). These factors include: subcontractor integration, weather, interdependence of activities, change orders, uniqueness, economy, IT infrastructure, size of firms, building codes, and research and development. Figure 4-6 shows the level of importance each of these factors were given by the contractors surveyed.

Opportunities for Productivity Improvement

The relative importance of each opportunity to improve productivity was computed following the same procedure used with the factors that affect productivity (Figure 4-7). Among opportunities for productivity improvement, "collaborative goal setting" received the highest mark with an average rating of 6.8 out of 10.

"Contractually compelled attendance of meetings" and "contractually compelled safety programs" were ranked as 6.6 and 6.3, respectively. "Incentive programs" and partnering were both considered to have a relative benefit of 5.7. "Labor motivation programs" received the lowest ranking of 4.6.

Correlations between Subcontractor Management-Related Factors and the Nature of the Contractor-Subcontractor Relationship

The second hypothesis of this study was that there would be a correlation between contractors that perceived subcontractor management-related factors as having a high level of effect on productivity and contractors that took an aggressive approach with subcontractors in their subcontracts. A regression analysis was performed; the resulting correlation coefficient was 0.1395 (Figure 4-8). A correlation coefficient is always between -1 and +1 and a coefficient close to zero represents no correlation while a value close to -1 or +1 represents a high level of negative or positive correlation. A two-tailed t test was run. Because the two-tailed t test value was computed to be 0.4880 which is less than the tabulated value of +/- 1.782 at a 90% confidence level, there is no significant relationship. Hypothesis 2 of this study was rejected.

A second regression analysis was performed to test Hypothesis 3 (Figure 4-9). The correlation coefficient was determined to be 0.4233. There appeared to be a stronger correlation than that seen between "contract clauses" and "subcontractor management-related factors." A two-tailed t test was performed to measure the significance of the correlation coefficient. The test value was 1.6185, which is less than the tabulated value of +/- 1.782 at the 90% confidence interval and Hypothesis 3 of this study was rejected.

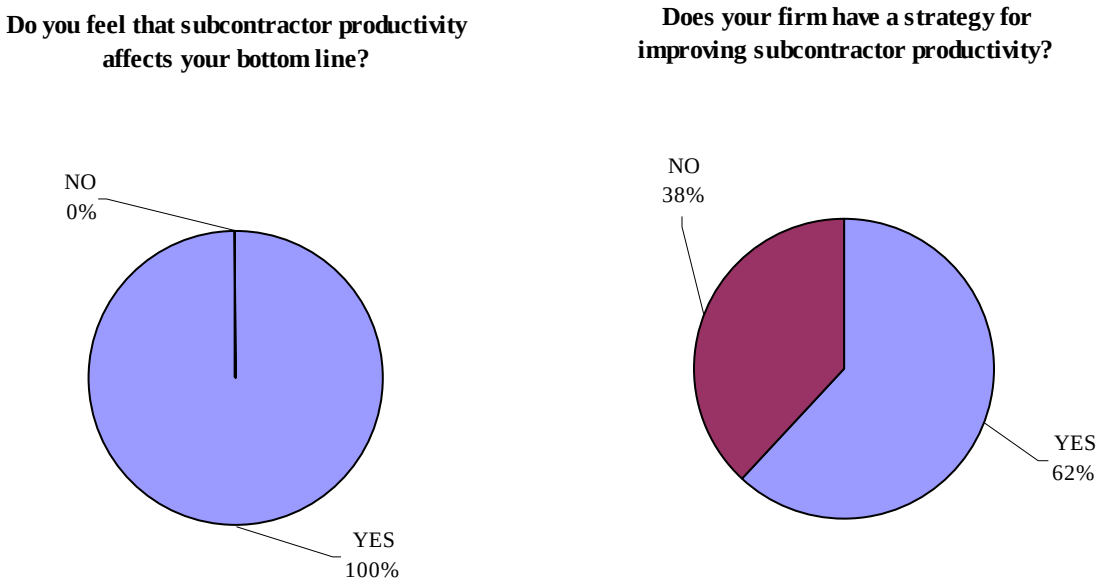

Figure 4-1 Perception of subcontractor productivity's affect on contractor firm

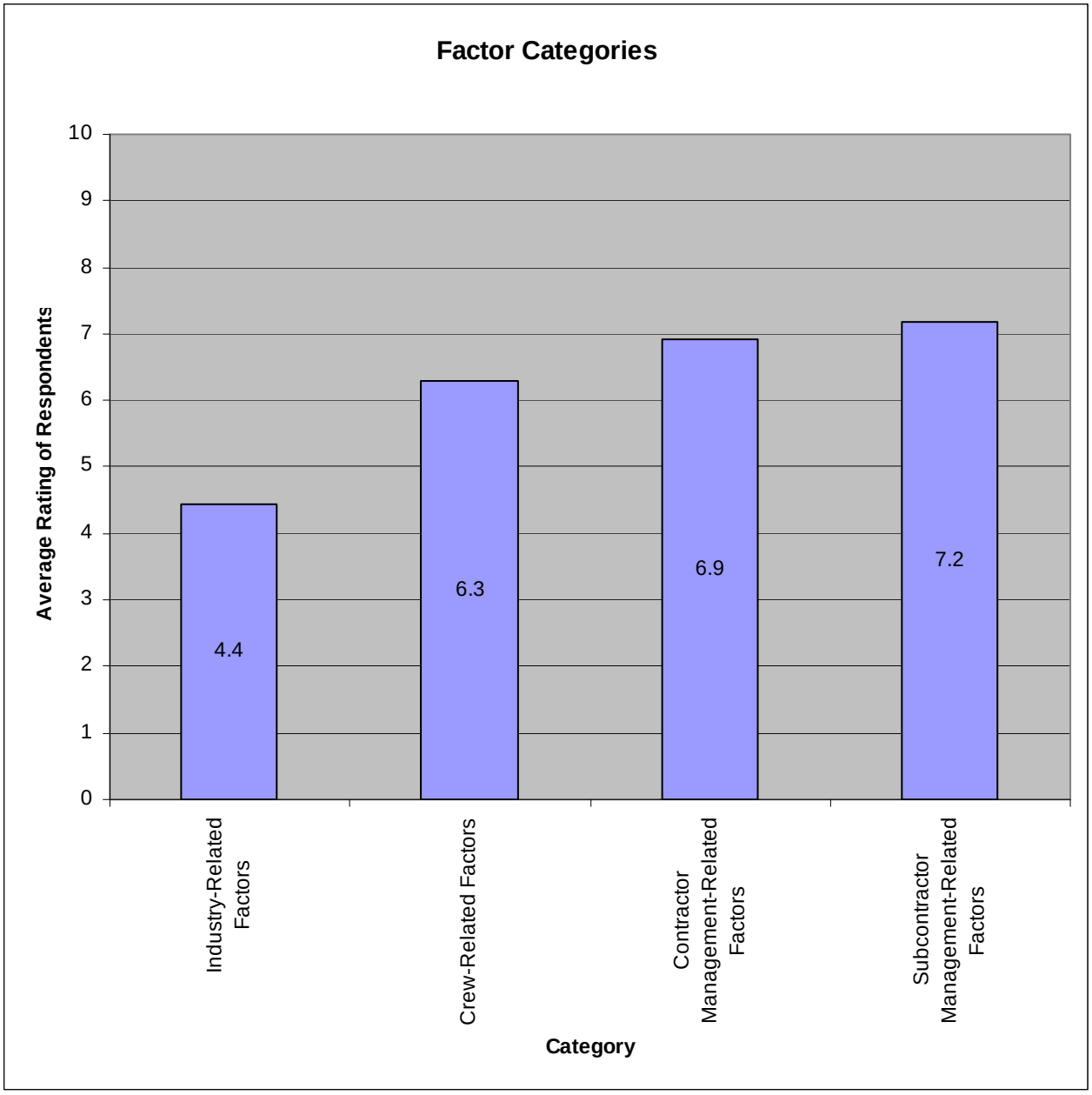

Figure 4-2 Productivity factor categories

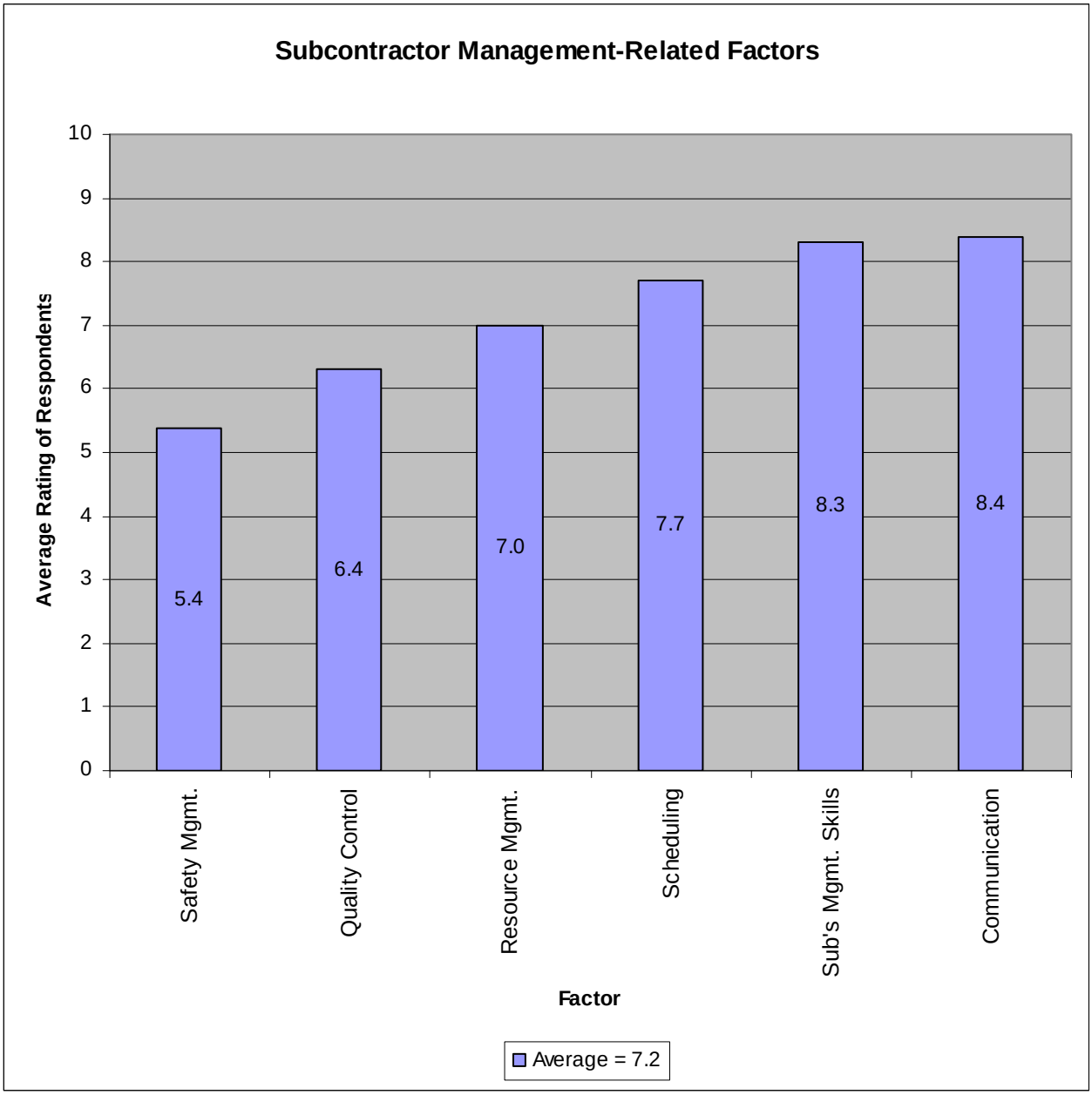

Figure 4-3 Subcontractor management-related factors

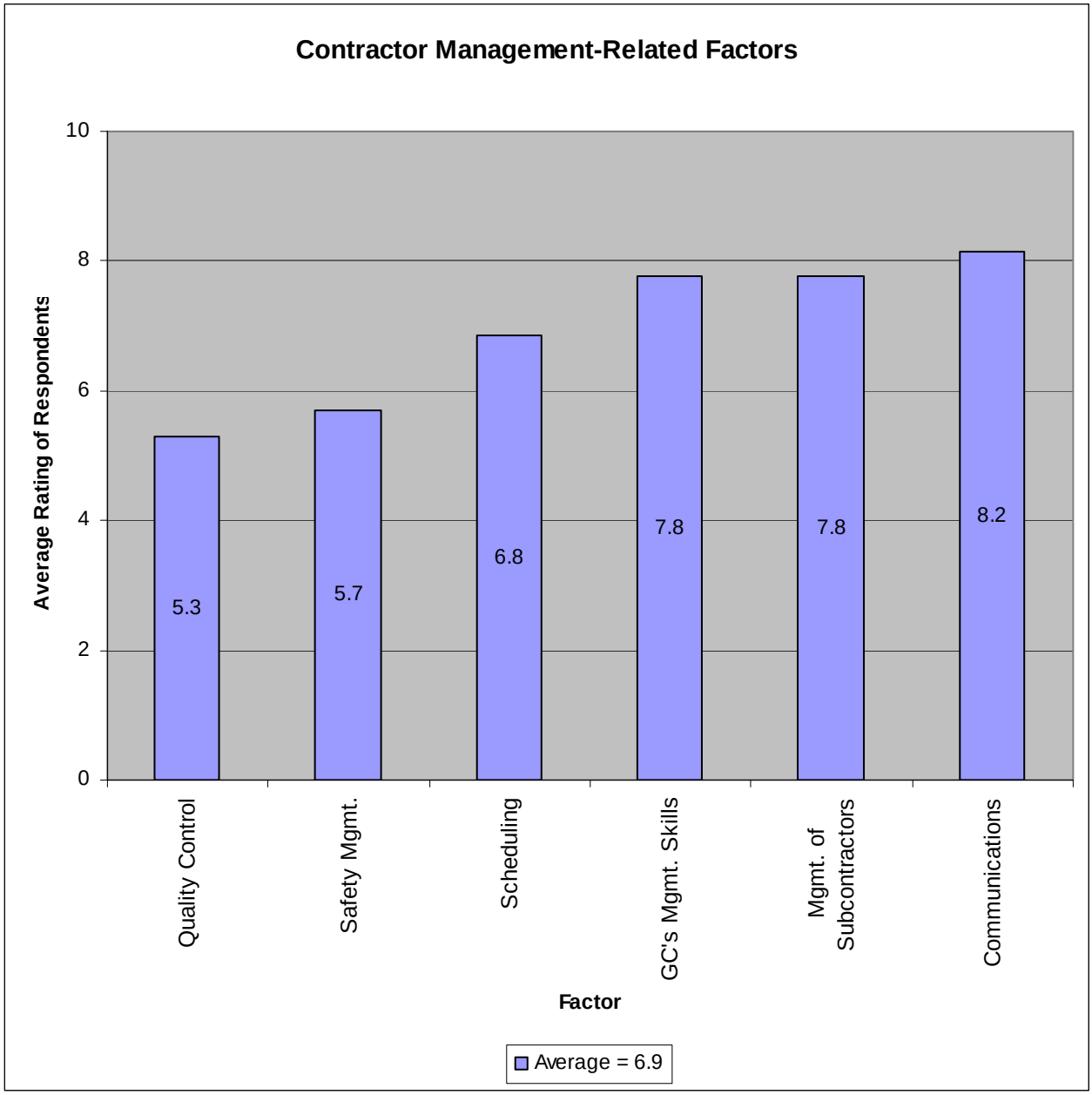

Figure 4-4 Contractor management-related factors

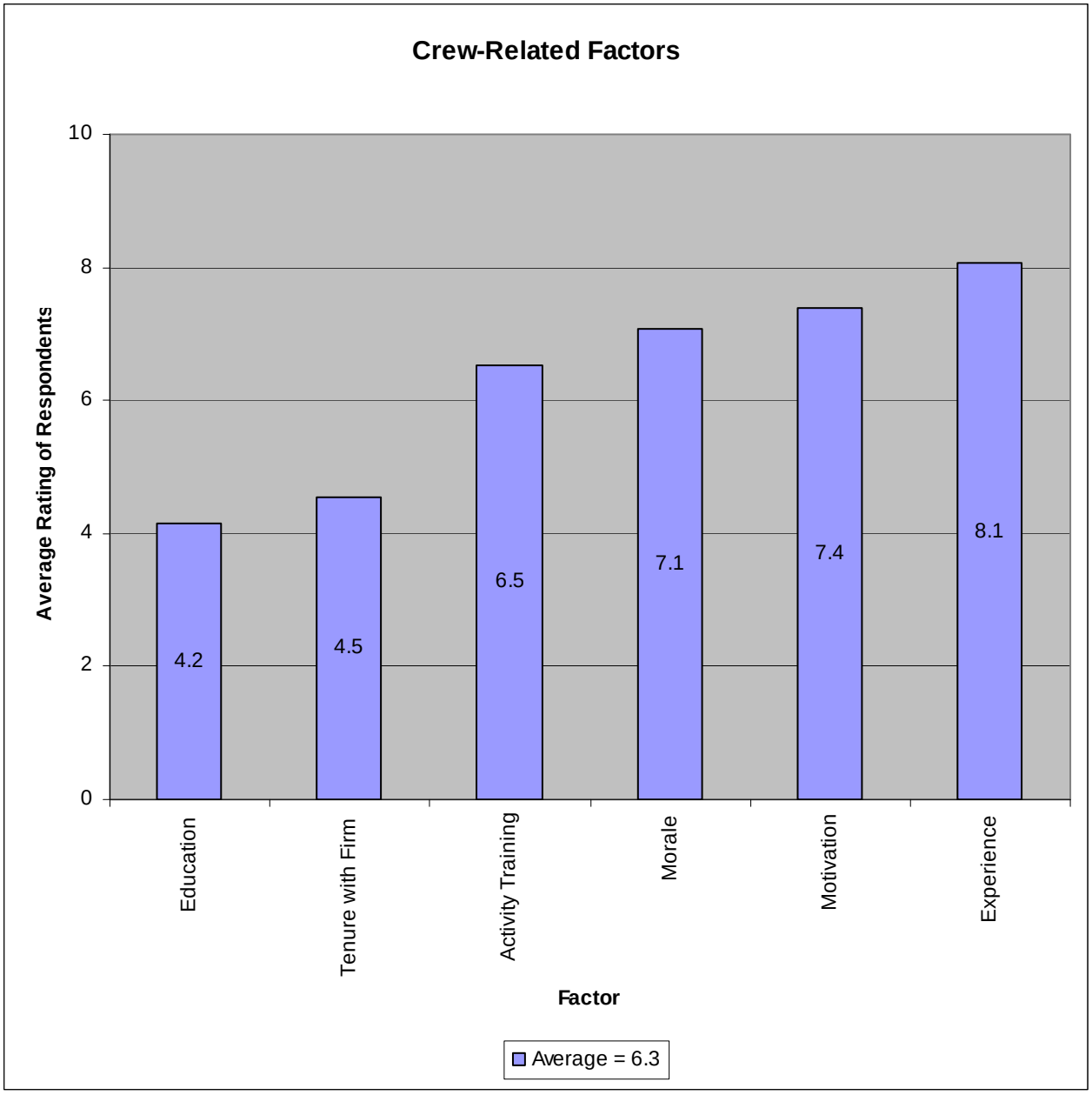

Figure 4-5 Crew-related factors

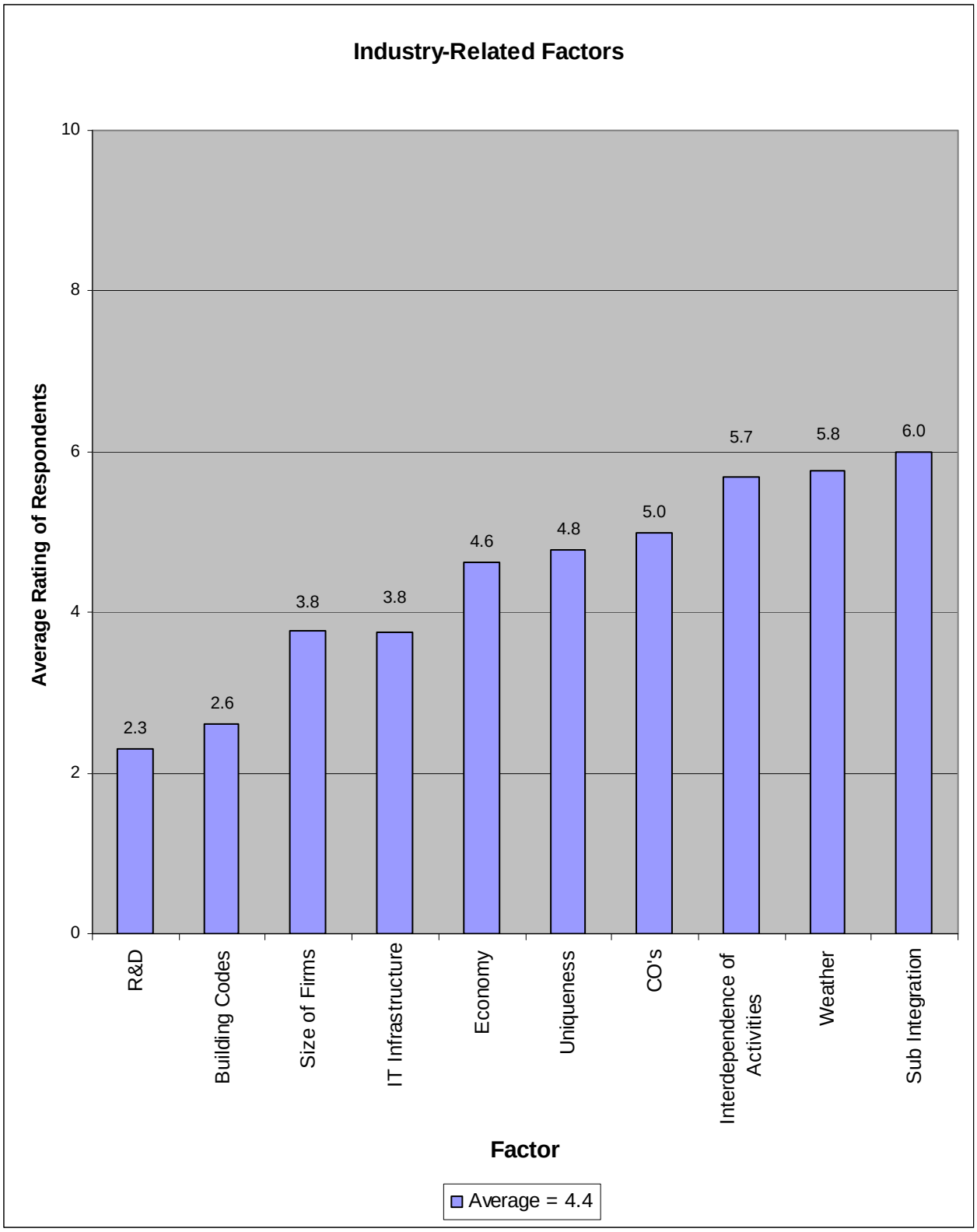

Figure 4-6 Industry-related factors

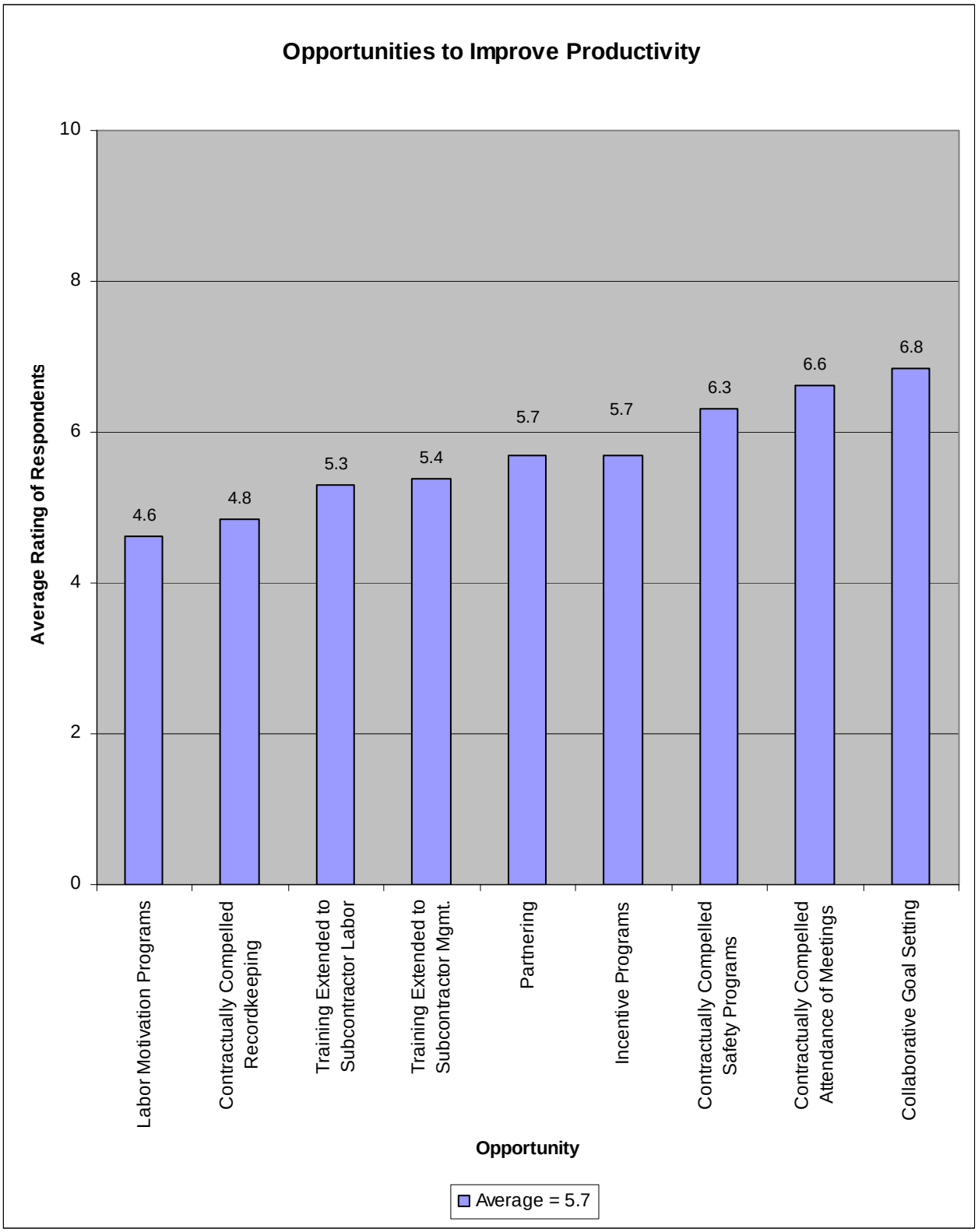

Figure 4-7 Opportunities to improve subcontractor productivity

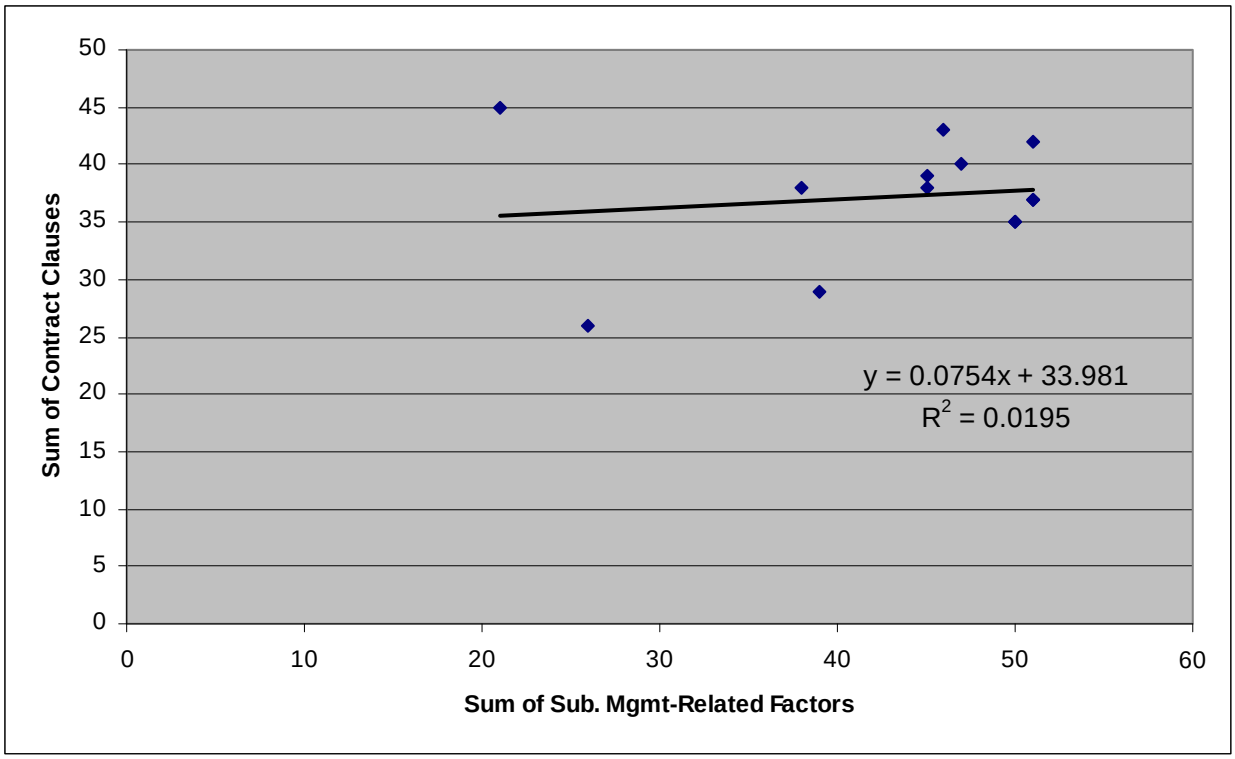

Figure 4-8 Correlation between contract clauses and sub. mgmt-related factors

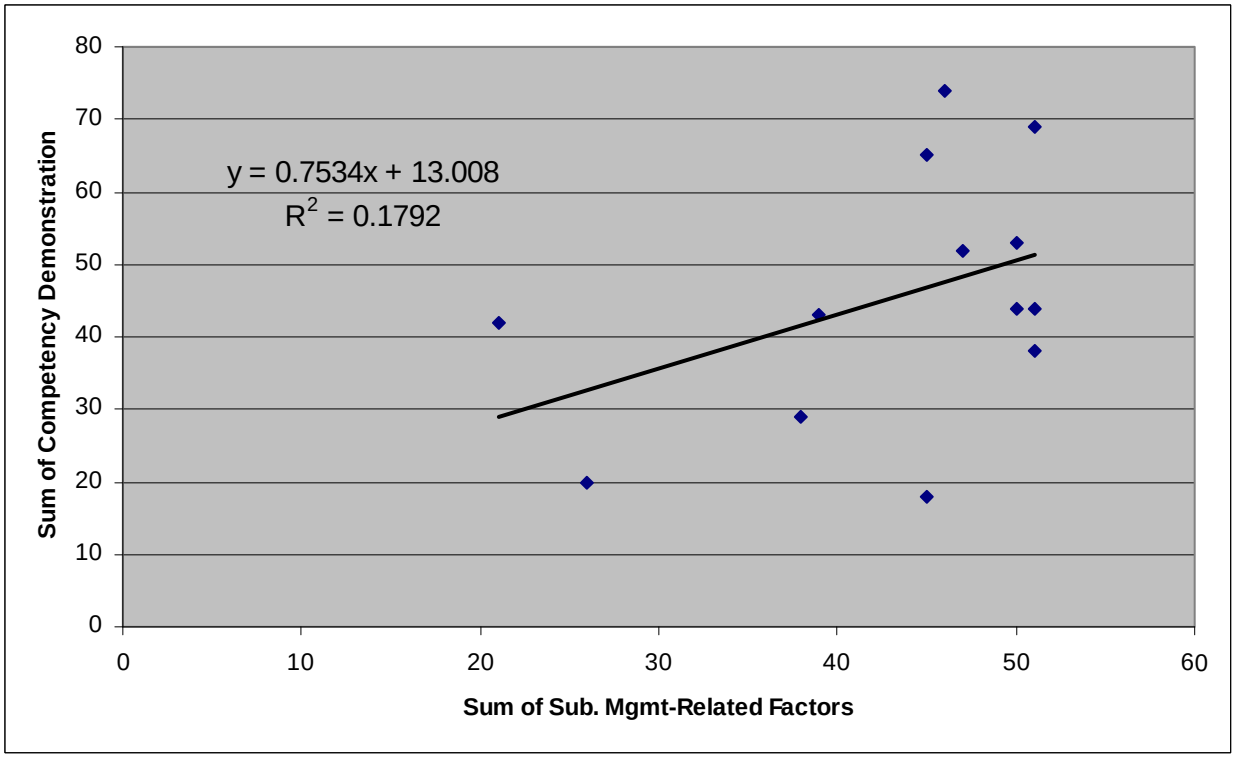

Figure 4-9 Correlation between competency demonstrations and sub. mgmt-related factors

CHAPTER 5
SUMMARY AND CONCLUSIONS

Summary

Contractors who responded to the survey unanimously agreed that subcontractors' productivity affects their bottom line; yet only 62% reported having a strategy to improve subcontractor productivity. They indicated subcontractor management-related factors were of the highest level of importance. Without making distinction between subcontractor and contractor management-related factors, the results are consistent with that of Rojas and Aramvareekul (2003) who found that management and crew-related factors are perceived by contractors in the industry as having the greatest effect on construction productivity. The results of this study found a divergence from contractors' acknowledgement of subcontractor productivity as a major factor to overall project performance and their actions taken to mitigate the potential impact of poor subcontractor productivity on their own bottom line.

Still 32% of contractors reported having no strategy at all to improve subcontractor productivity. The fact that both Hypothesis's 2 and 3, relating factor perception to action, were rejected leading to the conclusion that those contractors reporting they do have a strategy for improving subcontractor productivity may not being doing all they can or they may not be using the appropriate techniques as seen in the literature.

Inconsistencies abound between contractors' perceptions of the factors that affect productivity and their actions. For instance, subcontractor safety management received the lowest relative importance within the subcontractor management category, and the second lowest importance within the contractor management category. Yet it is indisputable that accidents can cause slow-downs, closures and lower morale—all having a major impact on project performance (Arditi and Chotibhongs 2005). Respondents of this study ranked the importance of

safety management factors with low regard, but ranked it with third highest potential benefit to productivity improvement with an average rating of 6.308 out of 10. Arditi and Chotibhongs (2005) and Hinze and Tracey (1994) found that both contractors and subcontractors agree that safety is paramount on a jobsite. The literature presented that almost half of contractors and subcontractors agree that the responsibility of creating a safe project should be put in the hands of the subcontractor (Arditi and Chotibhongs 2005).

Conclusion

Discrepancies found between contractors' perceptions of factors and their use of contractual provisions which stand to mitigate the impact of such factors, suggest that contractors' project performance could be improved by the implementation of contractual clauses that seek to compel subcontractors to utilize specific management techniques suggested in the literature and incentivize them to perform.

Limitations Of Study And Recommendations

This study was limited by the number of responses received. A sample must have at least twenty observations for the conclusive statistics of the sample to be considered reliable. Given that only 13 contractors responded to the survey, the statistics created may not be indicative of the population. It was thought that the length of the survey made busy professionals adverse to participating.

In the future, an online survey may facilitate a quicker response time and ensure greater participation.

APPENDIX
SUBCONTRACTOR PRODUCTIVITY SURVEY FOR GENERAL CONTRACTORS

This survey seeks to gain insight into the perceptions of General Contractors regarding factors that affect subcontractor productivity. The goal of this study is to establish a common set of "best practices" used by high performance firms, as determined by profit margin exclusive of in-house production, throughout the industry.

Part 1. Background Information

Section 1-1. Respondent's Information

Job Title: _____ Years with Current Company: _____

Years of Experience in Construction: _____ Number of projects currently supervised: _____

Section 1-2. Company's Information

1. Company Name:_____ 2. Years in business:_____

3. Estimated Annual Volume: 2004:_____ 2005: _____ 2006: _____

4. Average size of project ($): _____

5. Annual profit margin _____

6. # of permanent employees in firm:	
Field (salary)	
Field (hourly)	
Home Office	

7. Sector of Construction (as % of total business)
   - ☐ Civil construction _____ ☐ Building construction _____
   - ☐ Residential construction _____ ☐ Industrial construction _____
   - ☐ Other _____

8. Project Acquisition (% of total business)
   - ☐ Competitive bid _____ ☐ Negotiated _____
   - ☐ Other _____

9. Projects (% of total work)
   - ☐ Self-performed _____ ☐ Subcontracted _____

Part 2. Subcontractor Productivity

Section 2-1. Perception of Need to Improve Subcontractor Labor Productivity (Please circle your answer)

1. Do you feel that subcontractor productivity affects your bottom line? **Yes / No**
2. Does your company have a strategy for improving subcontractor productivity? **Yes / No**
3. Does your company believe there is a correlation between the longevity of a subcontractor? relationship and subcontractor productivity? **Yes / No**

Section 2-2. Factors that Affect Labor Productivity

Please rate the level of importance each of the following factors has on productivity as it relates to subcontractors. (1-lowest; 10-highest)

Industry-Related Factors:

	Change Orders		Size of firms		Interdependence of activities
	Weather		Building codes		IT Infrastructure (i.e. PM software, ability to communicate through multiple channels)
	Uniqueness		Economy		
	Subcontractor Integration		R&D		

Contractor Management-Related Factors:

	General Contractor's Management Skills		Safety Management
	Management of Subcontractors		Quality Control
	Scheduling		Communication

Subcontractor Management-Related Factors:

	Subcontractor's Management Skills		Safety Management
	Scheduling		Quality Control
	Resource Management		Communication

Crew-Related Factors:

	Education		Motivation
	Activity Training		Morale
	Experience		Tenure with Firm

Section 2-3. Perception of Opportunities to Improve Subcontractor Labor Productivity

1. Please rate the following strategies as to their level of perceived benefit to subcontractor Productivity (1-lowest; 10-highest):

	Partnering		Contractually compelled record keeping
	Incentive Programs		Contractually compelled attendance of meetings
	Labor Motivation Programs		Contractually compelled safety programs
	Training extended to subcontractor *management*		Other: (Please Specify)
	Training extended to subcontractor *labor*		Other: (Please Specify)
	Collaborative goal setting		Other: (Please Specify)

Part 3. Contractor-Subcontractor Relationship

Section 3-1. Contractual Relationship

1. Please rate the following clauses based on frequency of inclusion in your subcontract AND if they are never included please indicate how advantageous to subcontractor productivity you believe each would be using a scale from 1-10:

Contract Provision	Never	Seldom	Some-times	Often	Always
Pay-if-paid	☐	☐	☐	☐	☐
Pay-when-paid	☐	☐	☐	☐	☐
Clauses that: Bind the subcontractor to the terms of the owner contractor contract	☐	☐	☐	☐	☐
State the reduction of contractor retainage does not entitle the sub to a reduction in subcontractor retainage	☐	☐	☐	☐	☐
State that interest accrued on contractor retainage does not entitle the sub to any interest accrued on subcontractor retainage	☐	☐	☐	☐	☐
Require the subcontractor to: Provide detailed or resource-loaded schedules	☐	☐	☐	☐	☐
Commit to milestone dates	☐	☐	☐	☐	☐

Provide updated schedules as needed	☐	☐	☐	☐	☐
Commit to attending project meetings	☐	☐	☐	☐	☐
Commit to stipulated record keeping procedures (i.e. daily timecards, "Work Planned for Tomorrow" or "Work Completed Today" forms	☐	☐	☐	☐	☐
Maintain safety programs	☐	☐	☐	☐	☐
Provide training as needed	☐	☐	☐	☐	☐
Pass-down a percentage of any monetary incentive payments made to subcontractor to the labor force of the subcontractor	☐	☐	☐	☐	☐
Other: (Please Specify)_____	☐	☐	☐	☐	☐
Incentive Clauses that: ***Provide monetary incentive to the subcontractor for:*** Early completion of the project	☐	☐	☐	☐	☐
Early completion of milestone dates	☐	☐	☐	☐	☐
Zero-injury completion of project	☐	☐	☐	☐	☐
100% Attendance of project meetings	☐	☐	☐	☐	☐
On-time and regular completion of required record-keeping procedures	☐	☐	☐	☐	☐
Other: (Please Specify) _____	☐	☐	☐	☐	☐

Section 3-2. Behavioral Relationship

1. Does your firm make further stipulations that any of the following competencies will have to be demonstrated prior to contract signing (Please check the appropriate box)?

Qualifications	Never	Seldom	Some-times	Often	Always
Management Skills: ***Knowledge of Modern Management Techniques:*** ***Scheduling:*** Ability to break down work into detailed work activities	☐	☐	☐	☐	☐
Set milestone dates	☐	☐	☐	☐	☐
Resource-loaded scheduling	☐	☐	☐	☐	☐
Cost Control	☐	☐	☐	☐	☐
Short-Term Planning: "Work Planned for Tomorrow" form	☐	☐	☐	☐	☐
"Work Completed Today" form	☐	☐	☐	☐	☐
Accurate Record Keeping	☐	☐	☐	☐	☐
Resource Management (labor, materials and equipment)	☐	☐	☐	☐	☐
Productivity Management Techniques: Productivity Personnel	☐	☐	☐	☐	☐
Understanding of factors affecting productivity	☐	☐	☐	☐	☐
Knowledge of Productivity Management techniques (i.e. methods of quantifying productivity)	☐	☐	☐	☐	☐

Commitment to productivity improvement	☐	☐	☐	☐	☐
Communication: ***Commitment to attend project meetings:*** Regularly scheduled reporting/informational meetings	☐	☐	☐	☐	☐
Training meetings	☐	☐	☐	☐	☐
Problem solving/brainstorming meetings (as necessary)	☐	☐	☐	☐	☐
Commitment to timely responsiveness	☐	☐	☐	☐	☐
Other: (Please Specify _____)	☐	☐	☐	☐	☐

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BIOGRAPHICAL SKETCH

Courtney Jennings was born in Atlanta, GA. She grew up in Charlotte, NC and moved to Florida for her final year of high school. She began her collegiate career at a women's college in Nevada, MO. She received her associates of arts there, at Cottey College, and transferred to the University of Florida. While at the University of Florida she received her Bachelors of Science in Business Administration; Finance. She will be graduating with her Masters of Science in Building Construction in May 2007.