EMERGENT SUBCONTRACTING MODELS AND OWNER INVOLVEMENT IN SELECTING SUBCONTRACTING STRATEGIES AND PARTICIPANTS IN THE U.S. CONSTRUCTION INDUSTRY

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Abstract

Emergent Subcontracting Models and Owner Involvement in Selecting Subcontracting Strategies and Participants in the US Construction Industry

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Numerous articles and reports have been published on the prime contracting models used under project delivery methods that range from traditional to innovative. These previous studies have identified contractual relationships among owners, lead designers, and general contractors, and have determined the principal characteristics of each contractual scheme. However, because specialty contractors have become increasingly involved in early projects phases and have begun to play a more critical role in accomplishing project objectives—especially on building projects—it has become necessary to widen the scope of this type of research beyond prime contracts, and to incorporate contractual relationships with specialty contractors. Evaluating the contractual relationships between general and specialty contractors can increase the industry's understanding of how novel subcontracting approaches are changing the landscape of project delivery; and such an evaluation can uncover collaborative practices that are currently being generated and adopted in the industry.

The objective of this research was to identify and describe new subcontracting models, owner involvement scenarios, and variations of models used across the United States. The study is built upon a previous pilot study that identified and evaluated subcontracting approaches used by contractors within Washington State. This paper identifies the properties of the subcontracting approaches currently used in the U.S., the differences among them, and the likelihood of their deployment by region. The research used two data collection instruments to obtain information from construction project participants about the subcontracting models studied, as well as the most common levels of owner involvement in each of the subcontracting practices. The study was divided into two stages: first, the authors conducted an online survey, which gathered information about participants' common practices, profiles, and company size; second, the study conducted telephone interviews of a subset of subjects identified through the online survey. The interview questions focused on obtaining a greater understanding of the respondents' familiarity with and use of the methods investigated, with particular emphasis on their advantages, disadvantages, and variations, and the extent of owner influence on each one. In addition, the participants were given the opportunity to further contribute to the research by describing any other new models they had used but that were outside the research scope.

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Chapter 1. INTRODUCTION

1.1 OVERVIEW

Construction projects of all types involve many different contractors, with general contractors and subcontractors sharing responsibilities and objectives. The relationships between a general contractor and its subcontractors are defined by the contracts both parties sign. Given the importance of contractual obligations between construction parties, this thesis will explore the nature of current subcontracting practices, and their potential impacts on collaboration. In addition, this study will evaluate the role of the owner in selecting certain subcontracting practices over others.

These subcontracting practices might vary depending on whether the project delivery method (PDM) and procurement policies selected allow for participants to be added to the project within a wide range of contractual options. Selecting the right subcontracting practice may promote integration of the process deployed by contracting parties, increase reciprocal trust and achieve better project performance. Another possible improvement is the development of long-term associations between general contractors and subcontractors, once they have contractually established the precise hierarchical structures for successful project performance.

Construction contracts aim to transfer project risk to lower tiers, where responsibilities such as insurance, bonds, safety, planning, quality, time, and cost are shifted from general contractors to subcontractors. The responsibilities these subcontractors acquire have a huge impact on construction objectives, since subcontractor's have such a high rate of participation executing around 60 to 70 percent of total project activity (Maturana et al. 2007). It is worthwhile to note

that this proportion of the total project budget is seldom carried out by a sole subcontractor. Indeed, many different subcontractors work on the numerous specific tasks of a construction project. However, if the relationships between parties are adversarial, the addition of more parties is likely to increase project management complexity.

1.2 BACKGROUND

Over time, the role of subcontractors on building projects has increased its importance. As a result, the role of the general contractor has shifted from performance of large amount of construction activities to a focus on managerial activities, e.g. administration, control of resources, cost and schedule. For example, to execute productive and effective construction strategies, general contractors seek special external trades for highly specialized tasks that they themselves cannot perform without large investments in equipment and new employees (Arditi and Chotibhongs 2005). Furthermore, general contractors believe that the horizontal type of subcontracting partnership creates more complexity and uncertainty in any managerial plan. Within this partnership model, all subcontractors share the same horizontal contractual level, while each subcontractor team defines the vertical scheme of their activities. Although horizontal partnership concepts are present in the literature, they should be studied at operational stages to determine their performance, frequency, and effects on coordination between project parties (Javanmardi et al. 2018).

As administrators of resources, general contractors cannot ignore the needs of the stakeholders and owners with whom they share direct contractual links. Here, interdependence among contractual parties can generate a synergy that enables better economic results. Timely decisions, on a project's delivery method and procurement practices can help participants better comprehend their specific

roles within the construction process. For example, the Design-Bid-Build project delivery method will limit the procurement options to low-bid standards with contractual models like lump sum that entail the strictly consecutive execution of construction milestones, which will in turn limit the ability of designers and construction contractors to share their knowledge and information. In contrast, innovative delivery methods like Design-Build (DB) can offer project team members opportunities for integrating design and construction processes, procuring contracts through best value selection, and implementing collaborative contractual mechanisms.

Long-term agreements can facilitate the application and positive reception of innovative project delivery methods. Using innovative technologies in costing and time efficiency in the development of such agreements will enhance better business connections with reliable contracts for all involved parties (Cao and Wang 2014). Nonetheless, the current construction contract templates from the American Institute of Architects (AIA) and ConsensusDOCS for the DBB, DB, and Construction Manager/General Contractor (CMGC) delivery methods all lack collaborative language in their clauses. This absence of collaborative wording, ultimately produces fissures among teams that prevent the identification of common goals (Harper and Molenaar. 2014).

Feedback constitutes an important component of project success when it is made in both directions. Conversely, only evaluating subcontractors would generate incomplete data that will not predict the complete context of the partnership. Some companies have developed methods of evaluating subcontractor performance using general contractor criteria only, instead of adding subcontractor opinions about the project process (Maturana et al. 2007). To investigate these evaluations practices this research involved interviews of general contractors and subcontractors.

1.3 STUDY OBJECTIVE

The current thesis objective is the better comprehension of subcontracting practices by reaching out through surveys and interviews to participants from all over the United States. The results from data collection and analysis phases are evaluated to identify the correlations between samples, the detection of subcontracting patterns across the US, and potential new subcontracting practices. The next list shows the key research questions.

- Are the participants familiar with the five subcontracting practices that have been identified by Osmanbhoy (2015)?
- Do the participants identify any owner's role in selecting subcontracting practices?
- Is there any possibility of identifying any new subcontracting variation? Or do the participants are aware with new subcontracting practices?

In addition, some of the research questions from the Osmanbhoy (2015) study were included in this research due to the similarities between both studies, including the following:

- What are the current and new subcontracting practices in the US construction industry?
- Do the subcontractors share multiple contractual relationships in a project?
- How is the involvement between general and specialty contractors? Do they have specific times and situations to use such methods?
- What are the opportunities and challenges?

This study used the US Census Bureau Economic Regions to organize and classify the information from the online surveys into specific geographical areas.

1.4 Study Limitations

The research only gathered data from general and specialty contractors, which meant that owner, designer, and supplier opinions were not included in the results. Although these responses could have yielded meaningful insight, their inclusion could have introduced too much complexity into the research, given its many variables.

1.5 Research Summary

The principal goal of this research was to increase the scope of the earlier study that evaluated the contractual practices between general and specialty contractors in in the greater Seattle area. In this study, Osmanbhoy (2015) established a detailed subcontracting structure between general and specialty contractors, and identified the most common project delivery methods and procurement practices used in the construction industry in Washington. Although these findings were representative of the Northwest region of the U.S., they could not be inferred to the country as a whole. Given this limitation, this research aimed to identify and evaluate the most common subcontracting practices across the United States. Since the Osmanbhoy data and the new information were gathered through similar research methodologies, the results of both studies cohere closely.

The research methodology had two phases: online surveys and telephone interviews. The first phase created distinct online survey question groups for general and specialty contractors. The online survey focused on obtaining information related to the participant's company type, size, construction market experience, yearly average contracting amount, role, professional contracting experience in the company, and common contract practices. The second phase involved follow-up

phone interviews after which the survey participants were invited to participate in one future interview. To guarantee objectivity and efficiency during the interviews, each participant received an interview packet explaining all the subcontracting models addressed in the research. This introductory packet was developed to help the interviewees understand the details and structure of the subcontracting models under study, e.g., traditional subcontracting (TS), traditional subcontracting with design assist (TS-DA), Design-Build subcontracting (DBS), Integrated Design Construction subcontracting (IDCS), and Integrated Specialty Work subcontracting (ISWS).

Among the participants, the research identified two different roles: general contractors and specialty contractors. To select these candidates, the researchers extracted contact information from highly recognized construction associations such as the American Subcontractors Association (ASA) and the Associated General Contractors of America (AGC). In addition, members of the thesis committee shared selected contacts from their own contact lists. The research selected these databases to guarantee the professional expertise of the participants and the meaningfulness of their answers.

After receiving all the data from the online surveys and follow-up interviews, it was organized in charts, conceptual maps, and written conclusions, according to common construction contractual requirements, practices, uses, and biases. These outputs were evaluated to improve comprehension of the subcontracting practices and the participants' zoning characteristics. Even more, the analysis can help researchers deduce contractor tiers, expectations, and the ability to detect similar subcontracting models around the United States.

1.6 READER'S GUIDE THESIS

The five chapters of the current study include this introduction to the background information on the common subcontracting relationships between general and specialty contractors. This section also introduced the data collection methodology throughout the study. Finally, it also summarized the study objectives and limitations, and the expected results.

Chapter 2 presents the literature review in three sections on the following topics: 1) the contractual basis and relationships; and 2) current subcontracting models. The first section briefly explains the most common PDMs used in the construction industry. It also discusses the actual collaborative attitudes held by industry members who strive to achieve less adversarial relationships. The second section summarizes the current literature on the five subcontracting models under study. This section also tracks the constant change and various combinations of these subcontracting models throughout the studied timeline. The third section presents the methodology and references to track and categorize all the data collected during the first part of the study.

Chapter 3 delineates the process sequence of the research methodology, explaining the structure of the online survey, the objectives of the follow-up interviews, and the process of their development. Also, this section describes the principal tools used to determine the correlation between the different samples.

Chapter 4 concentrates on all the results obtained in the online surveys and follow-up interviews. By offering a cumulative data information overview and an analysis of the data in the different regions, this section identifies a diversity of patterns, practices, and characteristics to be discussed in the last chapter.

Finally, Chapter 5 summarizes the research, addressing the discussions, conclusions, limitations, opportunities for future research, and practical applications of the complete picture of the subcontracting models that the study has yielded.

Chapter 2. LITERATURE REVIEW

2.1 PROJECT DELIVERY METHODS AND THEIR CURRENT COLLABORATIVE PROPERTIES

2.1.1 Introduction

The hierarchical organization between general contractors and subcontractors is defined by the selected Project Delivery Methods (PDM). Each PDM establishes the roles for each contractor during the project where the roles can be defined as those activities that fall under the responsibility of discrete members (Harper and Molenaar 2014). For this reason, choosing the right contractual language may facilitate team collaboration and support the creation of partnerships. Although the selection of members with high technical skills might help to accomplish the project goals, choosing a collaborative PDM can give to the construction members a framework to solve potential conflictive situations between general contractors and subcontractors. El Asmar et al. (2013) stated the perceived benefits of using collaborative methods, such as Integrated Project Delivery (IPD), provide construction members the opportunity to collaborate and participate in earlier stages, which generate a better comprehension of the project responsibilities and ideas between general contractors and subcontractors. In addition, these PDM collaborative theories are not only directed to top contractual tiers such as lead designers and general contractors. Subcontractors earlier involvement in construction projects improves communication, comprehension, and long-term associations, that create the basis to avoid project failures (Kumaraswamy and Matthews 2000).

The existence of concepts such as social embeddedness and risk allocation confirm the importance of executing collaborative PDM. The first concept refers to the authentic and professional

improvement of construction partnerships. Under a two-step process which starts to the information sharing and finishes with the correct organization of each construction member. The results of applying more collaborative strategies direct to create strong coordination links, overcome antagonistic relationships and lead to better economic, and technique performance (Kale and Arditi 2001). The second concept relies on the correct risk identification and common agreement of the risk distribution for all construction parties. The main objective of risk management strategies is shifting the responsibilities to capable parties based on the consensus of opinions. These agreements help to avoid responsibility gaps and potential disputes caused by the project risk discrepancies (Loosemore and McCarthy 2008). These collaborative concepts establish the common ground where associative techniques are worthily solutions for the construction industry to improve its processes. In other words, adversarial behaviors need to be removed for all projects or businesses interactions between general contractors and subcontractors in order to achieve better construction outputs.

To cover all points of view inside the construction organizational hierarchy, the Work Plan Reliability (WPR) and Contribution-based Benefit Allocation Model (CBBA) are two examples of subcontractors' collaborative models. These collaborative models help to develop better schedules among multiple specialty trades with the detection of critical tasks assures the correct amount of effort, participation, and resources in each construction activity for every construction participant. Its application allows the existence of terms like reliability and contribution which generate revenue rewards that can be shared among team members under the WPR concept (Javanmardi et al. 2018).

2.1.2 Brief Project Delivery Methods Summary

During the past decades, the construction industry has been slow to adopt remarkable PDM changes. The various construction team members had specific segregate activities without the participation of external parties; only the owners could act as the common link between construction and design members. However, this static mentality has been changing in recent years supported by the creation of new project delivery methodologies with more collaborative processes among construction team members.

In the following paragraphs, some of the most used PDM's will be explained based on The American Institute of Architects and the Associated General Contractors of America (2011) definitions. The definitions from these professional associations provide the theoretical ground for each PDM, generating a better comprehension of the distinct construction member interactions in each PDM.

Design-Bid-Build

The Design-Bid-Build (DBB) is commonly identified as the traditional method. This method has three parties under different contractual arrangements with any collaborative clause. In other words, the owner hires a designer and contractor separately. The principal procurement and contractual characteristics of the DBB process are based on competitive bid and lump sum contracts. The bidding process can start only with fully developed drawings and specifications that have been made by the designers without any contractor involvement.

Construction Management at Risk

Construction Management At-Risk (CM@Risk) is a method that has distinct contracts for designers and contractors. The difference between DBB and CM@Risk is focused on contractor participation in pre-construction activities. This early contractor involvement provides a more collaborative approach because the contractor's insights might be included in the final design and no later than the schematic design stage. Also, the contractor has two-step contractual phases, the first for pre-construction activities and the second for on-site construction activities.

Design-Build

Design-Build (DB) is a method different from the previously mentioned PDM because the owner has only a contract with the design-build entity. This entity has various contractual arrangements with other entities, including arrangements with design firms and specialty contractors. It is not uncommon for the design-build entity to be a joint venture among other entities, such as general contractors and designers. The use of DB has significantly grown over the last decades as public and private owners are adopting to relieve themselves from the risk of implied warranty design.

Integrated Project Delivery

The Integrated Project Delivery (IPD) method is a collaborative contractual arrangement where the early engagement with reliable communication practices from all project members is the key to success. Also, the team agreements describe scenarios in which all the participants share project gains, losses, and risks.

The importance of understanding how PDMs work in the prime contractual structures will facilitate the comprehension of the subcontracting practices because of their flow-down

characteristics. The next chapters document the common relationship between general contractors and subcontractors, their characteristics, activities, contractual improvements, and potential issues.

2.1.3 Negative Factors in the Construction Industry

The potential for general contractors and subcontractors to have negative attitudes and adversarial positions during the project execution is high. Listing all the hostile practices might be unpractical because inside these belligerent attitudes there are some key factors which establish the common characteristics of those uncollaborative situations. Vaux and Kirk (2018) identified key conflict factors among construction project participants, including lack of communication, old-school attitude, and lump sum contracts. In the same context, Schaufelberger (2000) used questionnaire answers from owners, designers, general contractor, and subcontractors to list five non-collaborative attitudes that match those found by Vaux and Kirk. These factors are the (1) lack of commitment, (2) lack of trust, (3) lack of communication, (4) lack of goal's understanding, and (5) non-involvement of subcontractors.

To exemplify these aforementioned factors, the normal relationships between general contractors' superintendent and subcontractors inside a DBB contractual arrangement usually seems conflictive because the subcontractor had not been consulted for design improvement and he is only asked to build based on incomplete drawings and specifications without any possibility to improve the output and process. In addition, uncollaborative practices such as bid shopping, lack of communication between the general contractor and the subcontractor, payment delays, and general contractor's incapacity to coordinate activities increase the risk of failure during the project execution (Hinze and Tracey 1994).

These traditional practices under the DBB working environment invite subcontractors to work in their path, trying to generate savings or allocating the misleading scope through change orders. The result of these actions can generate claims, over budget, schedule delays, and quality deficiencies. Here, owners and general contractors instead of negotiating any possible solution, they may reject any potential change that could affect the original schedule and budget.

2.1.4. Measures to Achieve Collaborative Structures

The acceptance of developing better contractual relationships suggest to construction members create a new contractual evaluation process where they can address innovative solutions for collaborative issues. On this regard, El-adaway et al. (2017) explained a contractual framework that consists of eight factors based on reviewing IPD contracts and case studies in the U.S. and in the U.K. which may facilitate contractual relationships. These factors are (1) Project Environment, (2) Project Management, (3) Partnering advisor, (4) Design process, (5) Partnering and project schedules, (6) Suppliers and manufactures, (7) Prices and profits, and (8) Incentives.

In addition to these IPD contractual factors, the inclusion of relational contracting concepts described by Harper et al. (2016) helps to bring more collaborative contracting theories, avoiding plain contractual contexts which are focused on one-time projects. These relational contracting concepts are Role Integrity, Reciprocity, Flexibility, Propriety of means, Reliance and Expectations, Restraint of Power, Contractual Solidarity, and Harmonization of Conflict. The IPD framework factors and the relational contracting concepts are correlated because both norms provide the guidelines to establish a fair risk allocation that facilitates the transition from the old construction framework to new associative practices.

However, to achieve the objectives of any collaborative practice, the payment method should be modified by the members to generate an attractive policy for everyone. The new efforts and cost expenditures to support the new collaborative practices must be traduced in profit for all the organizations to keep incentivizing the creation and continuous improvement of experienced construction organizations. The development of more than one cashflow will avoid dependency or economic risk under only one revenue source. The different revenue sources such as equity participation, royalties or lump sum payment with incentives can provide better performance with minimum economic risk (Contractor and Ra 2000).

2.1.5. Actual Relationships between General Contractors and Subcontractors

Based on the potential controversy that generates the subcontractors' major incorporation in construction projects, probably, some construction members may think that subcontractors have taken more power than general contractors might give to specialty contractors. However, the need of sharing information and resources produces the integration of distinct work forces, improving construction organizations. The transfer of knowledge and the adoption of collaborative practices help to accomplish the project objectives (Shafaat et al. 2014). This specialized knowledge and techniques that subcontractors provide to the project are the result of constant design and construction partnerships with different construction firms. These multi-project experiences create solutions for the newly assigned tasks, where the use of specifications from reliable suppliers with the subcontractors' expertise in design and fabrication stages generates the expected project outcomes in time, cost, and quality (Gil et al. 2000).

The situation mentioned above reflects the new path for construction projects where general contractors are facing new coordination paradigms. This challenge is focused on connecting the

fragmented activities of each subcontractor into a more collaborative and efficient method where the profit analysis is required to understand which services need to be hired and under which conditions (Kim and Ballard 2005).

Feedback and collaborative attitudes constitute important components of project success when they are made in both directions. In other words, general contractors cannot accomplish the project objectives by themselves, and there is no subcontractor capable of administrating a complete project without the general contractor guidance either (Associated General Contractors of America et al. 2008).

2.2. Current Subcontracting Models

2.2.1 Neoclassical Economic Theory and Transaction Cost Economic (TCE)

Before starting any subcontracting method discussion, procurement is one concept that must be approached by this study because it is part of the process which defines the best candidate to develop the project objectives under the selected contractual specifications. To define the procurement process Standford and Molenaar (2018) explained two competition types from economic theories which have a direct impact in the procurement processes; the neoclassical economic theory and Transaction Cost Economics (TCE). The main difference between these two options is related to the number of participants during the bidding process where the neoclassical focus establishes that more participants can accomplish price, schedule, and quality requirements easily. In contrast, TCE refers that few participants instead of reducing the project completion chances, it will be beneficial for the objective accomplishments. Both theories can be used in the construction industry, but project time constraints and long-term business relationships are the decision drivers that define which is the best option for the project.

The neoclassical and TCE economic theories define the competition driver for the procurement methodology, and those theories commonly resemble the two principal selection processes in the construction industry; one and two-step procurement. The one-step procurement process has the characteristics to develop a neoclassical approach because this system allows all the potential offerors to participate without previous filters or qualifications whereas the two-step procurement methodology promotes a narrow competition among few participants reducing time and cost during the procurement stage, resembling TCE statements (Ramsey et al. 2016).

These selection processes generate several questions about their efficiency and accuracy in designating the right contractor. For this reason, Alleman et al. (2017) identified the contractor and owner's previous construction experience as one factor which provides an advantage in the bidding accuracy for transportation projects using CM-GC project delivery. Besides the competitive approaches that were evaluated during the process, the selection of the successful procurement methodology depends on the owner's confidence in the statutes and potential participant expertise to track each process. Another factor is the learning capacity during multiple-step procurement process. The participants might have more chances of correcting their errors while the process is running. In contrast, under one-step procurement the participants have the risk of overestimating due to their limited information and learning time, generating uncertainty during the bidding (Ahmed et al. 2016).

2.2.2. Introduction to Subcontracting Models

The previous subchapter has explained the procurement processes for any contractual arrangement to understand the contractual framework and strategies between owners and general contractors in order to buy construction services. Following this hierarchical order, the next paragraphs will summarize all the available literature sources of subcontracting methodologies. Although there is not a full research development for these subcontracting structures, this thesis will centralize its efforts in giving as many insights as possible for the mentioned subcontracting models in the introduction chapter. The subcontracting methodologies will be shown in the following order: Traditional Subcontracting (TS), Traditional Subcontracting with Design Assist (TS-DA), Design-Build Subcontracting (DBS), Integrated Design Construction Subcontracting (IDCS), and Integrated Specialty Work Subcontracting (ISWS).

Traditional Subcontracting (TS)

This subcontracting practice is based on the Design-Bid-Build method where the segregation of activities is defined by the lack of collaboration between general contractors and designers. The isolation between construction and design activities is enforced by the owner's convenience of generating two linear phases where the first phase is the development of drawings and specifications in charge of the architect or engineer without the support of the contractor. The second phase is based on getting the lowest bid in the procurement process to guarantee a competitive price with all the contractual clauses which transfer the risk to the prime contractor for construction activities (American Institute of Architects 2007; American Institute of Architects and Associated General Contractors of America 2011). As a result of these practices, the subcontractors on each side (design and construction) work in isolated conditions where the direct

link is their prime. Instead of sharing or generating information among parties using multi-party communication channels, they would use their prime as a link for any claim to the owner or another construction party. Also, general contractors select specialty contractors under a competitive bidding process where drawings and specifications are already done by designers, avoiding any opportunity for design collaboration. Sometimes, the specialty contractor's selection is made by the owners early in the project, but this selection doesn't mean that specialty contractors would participate in the design stage under TS environment. In this situation, general contractors must control and administrate the construction stage using these "nominated contractors," without the opportunity to select them under competitive bid (Gil et al. 2001).

Traditional Subcontracting with Design Assist (TS-DA)

This subcontracting structure defines design and construction activities differently from traditional subcontracting practices. In comparison to the traditional methodology, Design-Assist (DA) brings a new collaboration path between designers and specialty contractors. The Arizona Board of Regents/Alliance for Construction Excellence [ABR/ACE] (2007) explained this new collaboration path as the improvement of design and constructability concerns throughout the early involvement of specialty contractors in design activities where this practice is not based on transferring design liabilities to specialty contractors. Although Kelly (2014) corroborated the benefits of using DA in terms of having better specifications, drawings and communication channels in wide-ranging projects where the designers and general contractors are aware of their inability to develop a detailed specification for each construction trade, the specialty contractors who are participating in DA practices might not be excluded of design liabilities completely due to their participation during the design development.

Currently, the DA subcontracting model has not been supported by any contractual clause or legal model which specifies the specialty contractor obligations in design activities. This situation generates a misallocation of design liabilities because any clause describes exactly the responsibilities and roles of each party under DA development (Rangel 2017). To summarize this situation, Kelly (2014) suggests that the lack of contractual responsibilities between specialty contractors and designers in DA processes might produce future disputes because it's not clear where the specialty contractors responsibilities start and finish, producing potential disputes if design and construction objectives are not achieved. Figure 1 shows a decision tree which synthetized the DA process and issues.

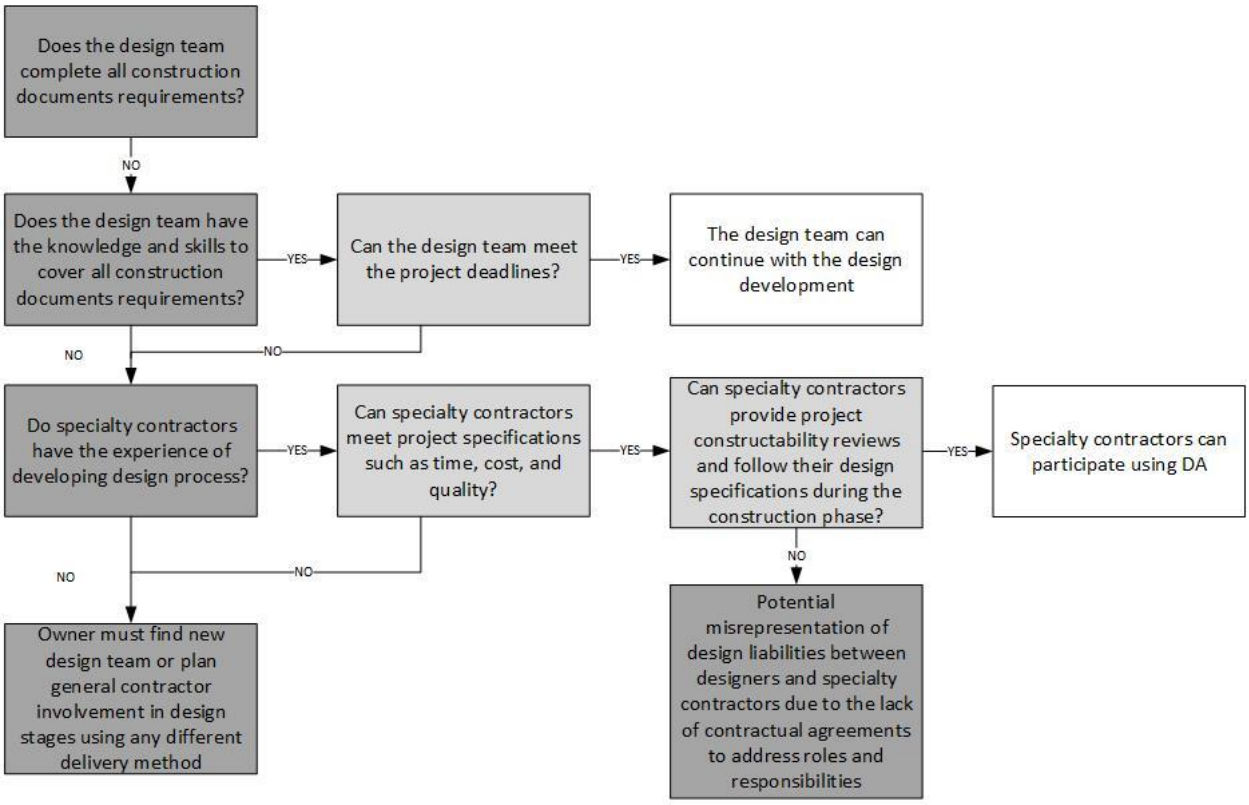


Figure 1. Design Assist Decision Tree (Developed from Andre 2012; Arizona Board of Regents/Alliance for Construction Excellence 2007; Kelly 2014).

One solution to avoid the misrepresentation of design liabilities between designers and specialty contractors is described by the ABR/ACE (2007) which suggested to select specialty contractors early on under two-party agreements with design services. This approach was designed to provided well-defined proceess boundaries that can mitigate the risk of future claims. Confirming the ABR/ACE solution, Andre (2012) states that DA helps designers to solve design complexities usign specialty contractor knowledge early in the project but this help will not reduce the ultimate design responsibility of the architect/engineer during the process. To clarify responsibilites associated with design liability, all participants must set the responsibilities and liabilities of specialty contractors during the design and construction phases to avoid unsettled situations throughout the project. In contrast, if ABR/ACE and Andre comments will not be followed by the stakeholders, two more factors would affect DA performance. The first factor is the uncertainty of getting projects after the specialty contractor collaboration in the design stages. This situation produces a strong disinterest in the complete improvement of the project where specialty contractors should bear the risk of joining the project without reserve and understanding the transfer of knowledge to third parties (Gil et al. 2001). The second factor refers to the potential restriction for specialty contractors where they could be constrained to develop reduced pre-construction services instead of participating in the complete project solution with all the stakeholders. In other words, the specialty contractor participation in design stages doesn't guarantee the total inclusion of their solutions in the final design package (Franz et al. 2013).

Design-Build Subcontracting (DBS)

Design-Build as a project delivery method has two different processes to involve specialty contractors during the project stages. Gil et al. (2001) explain both methodologies where the first scenario is centered in the joint-venture comprised of architects/engineers and general contractors

where this business association will maintain the duty to coordinate the specialty design work when it is allocated to specialty contractors. The second scenario focuses on the selection of multiple specialty contractors for design stages where all the design proposals will be based on a specialty contractor's knowledge and solutions. Also, inside this second methodology, the process can have many subcontracting model variances. For example, the owner can establish nominated contractors to the design-build entity or multiply the design-build structures for each special trade.

Gil et al. (2004) confirmed the benefits of stopping design activities until the selection of specialty contractors who would help in future design stages. This early specialty contractor involvement reduces the total project time with a low probability of cost overruns during the project. Consequently, with the specialty contractor knowledge, many of the prefabrication process and the delivery of critical elements can be scheduled with enough time avoiding future delays and quality claims. Given both theory frameworks inside the Design-Build environment, the construction industry can identify many options inside the Design-Build method.

Integrated Specialty Work Subcontracting (ISWS)

Independently of the new design role that specialty contractors can play during the project lifecycle, their evaluation relies on the accomplishment of normal on-site construction parameters such as time, cost, and performance. Although specialty contractors can develop their scope alone, they are not working in isolated conditions. The number of concurrent activities plus the interaction between subcontractors define the execution schedule which creates the necessity of generating on-site associations. These arrangements can follow vertical and horizontal subcontracting structures where the most common approach for this subcontracting model is the horizontal one.

Javanmardi et al. (2018) explain processes and models used by subcontractors such as the Work-Plan Reliability (WPR), the High Reliable Planning (HRP), and the Contribution-Based Benefit-Allocation (CBBA) to achieve and encourage these horizontal collaborative practices where the distribution of benefits plays an important role in guaranteeing the application of these collaborative practices. The WPR model is defined as a planning process based on the subcontractor knowledge on scheduling on-site tasks according to the current status of the resources and the activities which need to be performed in future project stages. The WPR model needs to achieve HRP levels to produce enough benefits for all subcontractors where HRP is defined as the complete commitment from upper and lower subcontracting tiers to guarantee the correct coordination and execution of the project activities generating benefits for both subcontracting tiers. The benefits reached by the WPR and HRP models are distributed using two different benefit-allocation strategies, the traditional and CBBA model. The traditional benefit-allocation model distributes the benefits using a uniform dispersal of the benefits between upstream and downstream subcontractors. The CBBA model distributes the benefits based on each subcontractor contribution to generate these benefits detecting all the different levels of collaboration between subcontracting tiers. To confirm the last statement, Abbasian-Hosseini et al. (2016) explain this correlation between the time used in planning activities with the time savings during the project execution. As a result, subcontractors who use less time for planning activities are proportionally affected by time delays and schedule variation during the project.

In conclusion, the general contractor understanding about the subcontractor's economic stimulus and long-term relationships would help to maintain positive WPR with these specialized teams. Even if the project conditions are not the best, the positive environment between trades may improve the construction development (Abbasian-Hosseini et al. 2017).

Integrated Design Construction Subcontracting (IDCS)

Under TS, TS-DA, and ISWS subcontracting models, specialty contractors are in the lowest hierarchy levels without a well-defined contractual clause for collaborative activities. Although some collaborative activities could be executed, those are not regulated appropriately by the construction members provoking organizational issues. Looking for one contractual solution that can merge with the new tendency of adding specialty contractors to the earliest design stages and provide them of rights and responsibilities, the Associated General Contractors of America (2010) states three different levels of associative practices which differentiates the real collaborative practices from the well-intentioned attempts. The first collaboration level describes any method or PDM where collaboration is not specified in contractual clauses. The second collaboration level is represented by a better application of IPD principles where the incentive & risk sharing, the productivity incentives for on-site activities, and the official subcontractor involvement in the design performance are part of team agreements. The third, and the final, collaborative level specifies the use of multi-party contracts that include the major parties such as owners, designers, prime contractors, key specialty contractors, and suppliers.

These multi-party contracts migrate from transactional arrangements to relational drivers, in other words, the IPD contracts define the incentives, risk sharing, responsibilities, and collaborative roles for the key members during the project development. Using this contractual model, subcontractors can maintain a direct channel with designers, contractors, and owners. Given these characteristics, PDM's such as CM@Risk, and Design-Build are classified to lower collaboration levels, losing their high collaborative status (Associated General Contractors of America 2010). To strengthen the relationship among general contractors, designers, and subcontractors for the project execution, the American Institute of Architects (2007) listed the new responsibilities for

subcontractors during the project where the activities' outputs are reported to all stakeholders instead of sending the information to their prime only. Those activities are the costing and scheduling of the work scope, developing shop drawings, designing reviews & compatibility, coordinating & executing on-site activities, and providing maintenance & operation information.

Summarizing, the collaborative principles that have been exposed in this subcontracting method are the basis to comprehend the IDCS model. The IDCS methodology is one example of collaborative contracts and practices where the lead designer and general contractor have distinct contracts with the same specialty contractor who develops design documents and controls construction activities. This methodology resembles the team flexibility concept in Cross-Functional Project Team Composition and Evolution (CFPT) for IPD projects developed by Laurent and Leicht (2017) which explain the necessity to provide project flexibility from early stages. Under this concept, the common acknowledgment of objectives helps all contractual members understand specific constraints, which in turn enables, all members to adjust their roles to achieve project objectives. Matching Laurent and Leicht team flexibility concept, Clevenger and Khan (2014) explained in one case study the time benefits that could be reached by using design-to-fabrication methodology for structural rebar designing, detailing, and fabrication applying building information modeling (BIM) tools under CM-GC strategies that resemble IDCS practices.

2.3 Potential Changes, Combinations, or Restructure of Contracting Models

The previous subchapters showed the principal characteristics of PDM's, procurement processes, competitive theories, and the most common subcontracting models. All the literature statements

could infer that all these models have static characteristics with well-defined boundaries where the requirements and characteristics dictated by specific model are final. However, the construction industry has developed many PDM's based on the combination of factors such as early design involvement, collaborative clauses, procurement practices, and contractual arrangements. The contrast between the robust literature and the practical frame provided by the industry invites all researchers to create better categorization parameters where all PDM can be included regardless of their multiple approaches.

Franz and Leicht (2016) defend this multi-factor characteristic around the construction delivery methods. The authors developed a categorization method which contains five classes. These classes range from low levels of collaborative project delivery method (class 1) to the highest collaborative process inside the construction structure (class 5). To determine the collaboration rate and potential combination of factors, the authors used four different evaluation drivers: (1) Timing of Involvement, (2) Procurement Practice, (3) Selection Criteria, and (4) Payment Terms. Strictly speaking, the decision of using classes instead of the common PDM's names facilitates the correct identification of the processes without the generalization of procedures that might provoke uncertainty during the PDM selection or evaluation.

Following the efforts to categorize every construction process from the PDM selection to the contractual final arrangements, many organizations such as the International Organization for Standardization (ISO) in the procurement construction section (10845), NEC3 contracts, and the International Federation of Consulting Engineers (FIDIC) have started developing the framework to identify the characteristics of each arrangement. The standardization of these processes will provide the construction industry a good understanding of the boundaries and how they can apply

each procurement processes without limiting the possibility of merging different solutions (Watermeyer 2012).

2.4 Different Participant Characteristics throughout the United States

The distinct characteristics of participants represent a complex organization process where the results cannot be expected as uniform or well-defined because of the variety of economic, political, cultural, and geographical factors across the United States. Therefore, some government agencies develop data structures to classify information for all regions. The US Census Bureau (2010) created a classification system that divides the United States in 4 regions (Northeast, Midwest, South, and west) with 9 divisions (New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific) in order to organize nationwide data.

The construction industry like the vast majority of economic activities has this fluctuation phenomenon for each distinct area. Specifically, the samples can have different information from nearest cities to opposite regions, where the construction methods, construction costs, construction regulations, and procurement policies are examples of the factors which might reflect these differences. Abkarian et al. (2017) experienced this phenomenon when they evaluated the pavement performance through its lifecycle using a wide range of projects across the United States. Their conclusions are based on the comparison between the final pavement performance and the PDM used during the project process; the results show a clear tendency of data dispersion when PDMs were compared, generating different conclusions and correlations in the pavement performance.

Another factor that has been identified as one which contributes to the data variability is the current normativity regulation. For this reason, Ghavamifar and Touran (2008) stated that regulation is one of the decision makers to select which contractual and PDM arrangement should be used.

Chapter 3. RESEARCH METHODOLOGY

3.1 RESEARCH OBJECTIVE

This research expands upon a previous study that identified and evaluated subcontracting practices in the state of Washington (Osmanbhoy 2015). Osmanbhoy relied on a survey and follow-up interviews of participants from the greater Seattle region. The conclusions of this previous study, while compelling, were constrained by this regional focus. The current research set out to survey and interview participants from all over the United States, to determine any similarities, differences, or new patterns in subcontracting. Figure 2 shows the following five subcontracting models found by Osmanbhoy: 1) traditional subcontracting (TS); 2) traditional subcontracting with design assist (TS-DA); 3) design-build subcontracting (DBS); 4) integrated design-construction subcontracting (IDCS); 5) integrated specialty work subcontracting (ISWS).

The limited amount of research on subcontracting practices is another factor prompting the current research. Moreover, after reviewing the available literature, this thesis found significant gaps in some of the subcontracting practices studied. While practices such as TS and DBS were found to have well-defined and thoroughly scrutinized processes, the literature rarely referenced the newer subcontracting models, such as TS-DA, ISWS, and IDCS. For example, only a few authors have identified the TS-DA and ISWS practices with limited data to discuss initial applications only. In addition, this thesis was unable to identify IDCS practices in the available literature sources.

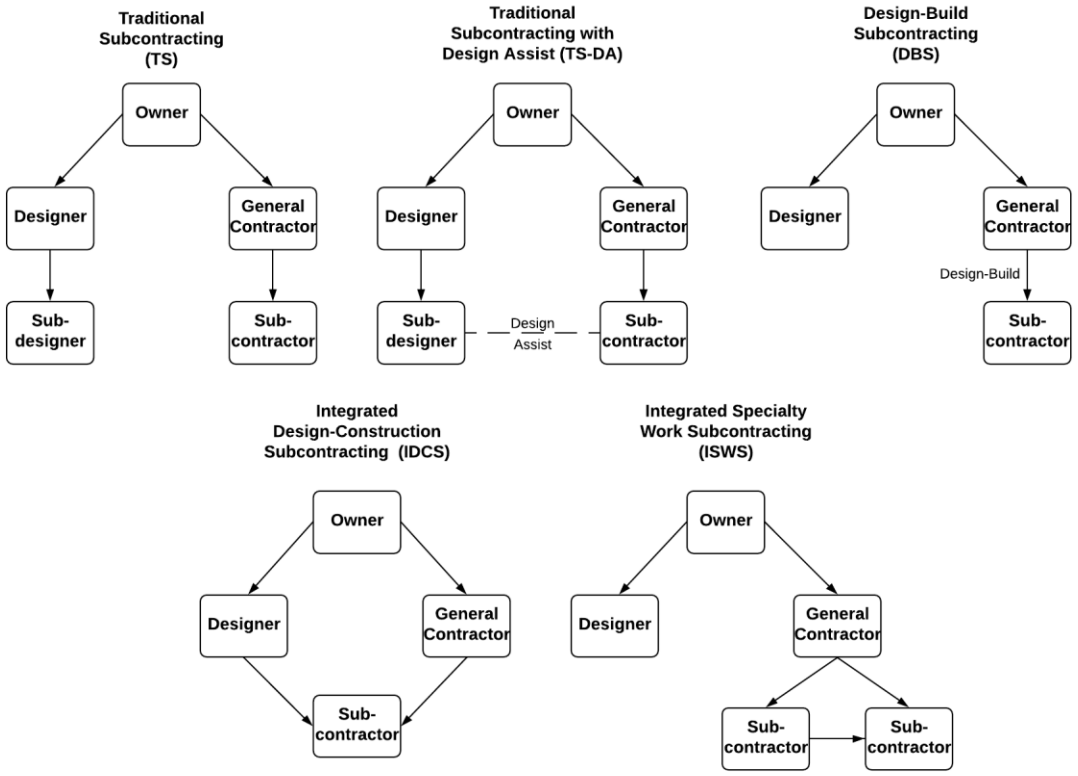


Figure 2. Subcontracting Models (Adapted from Osmanbhoy 2015)

To eliminate the regional constraints of the Osmanbhoy study, the nationwide research scope of this study was aimed at generating broader conclusions about the all the subcontracting practices. Also, the evaluation of the subcontracting practices by general contractors and subcontractors in all US regions was expected to yield different points of view, identifying areas of agreement or disagreement with the models. All this data was expected to provide meaningful information for future literature.

3.2 Research Process

This study comprised nine different research phases, aimed at identifying and better understanding the subcontracting practices now commonly deployed across the United States. The first phase

involved topic identification, the expansion of the Osmanbhoy research scope to gather more comprehensive data, and an exploration of the various subcontracting practices currently in use. This exploration helped the research team identify an industry-wide need for better conceptualization and standardization of these practices.

In the second phase, the team performed a literature review of all available sources, to explain and localize the industry's principal PDMs, procurement methodologies, and contractual processes and attitudes. The researchers also sought to identify any data variability and/or any differences in categorizing contracting methods between the Osmanbhoy findings and the information reviewed.

The third research phase focused on detecting all potential gaps between the subcontracting practices studied by Osmanbhoy and those found in the literature review. Identifying these discrepancies helped the team develop the questions and hypotheses of a research framework that could establish more connections among all current subcontracting practices, theories, and practice.

The research team developed its methodology during the fourth phase of this research, selecting and elucidating its survey and interview strategies. Data were to be collected from members of the American Subcontractor Association (ASA), the Associated General Contractors of America (AGC), and from appropriate research team member contacts.

The steps of the research methodology were as follows:

- **Online survey:** To recruit participants for the online survey, the researchers obtained email addresses from the public databases of the two targeted construction associations.

- The online survey had two formats, one for general contractors and the other for specialty contractors. Based on each participant's answers in the introduction, the survey system determined which format was appropriate.

- The survey focused on obtaining general company information (i.e., type, size, market experience, and value), respondent position, professional contracting experience, and common contracting practices between general and specialty contractors.

- **Interviews:** Survey participants who accepted the team's invitation to participate in a phone interview were contacted to set their interview times.
  - The main objective of the interview was to understand contractual practices, advantages & constraints, and interviewees' knowledge or application of the following subcontracting models:
    - Traditional Subcontracting (TS)
    - Traditional Subcontracting with Design Assist (TS-DA)
    - Design-Build Subcontracting (DBS)
    - Integrated Design Construction Subcontracting (IDCS)
    - Integrated Specialty Work Subcontracting (ISWS).

Following federal requirements, the University of Washington Institutional Review Board (IRB) reviewed and approved this study. IRB staff members are charged with guaranteeing the mitigation of any potential risk to participants. In this case, the research qualified for exempt status because it was found to pose minimal risk to any potential research population.

The fifth and sixth research phases consisted of survey data collection and analysis. After collecting all the survey responses, the team first categorized them by region, and then aggregated them. Participants were not tracked to their answers, and were only differentiated on the basis of their geographical regions and contracting roles.

The seventh and eighth research phases consisted of interview collection and analysis. Once the analysis of all survey results had been completed, the team selected the most experienced participants from among those who had accepted the Interview invitation. The team then emailed these participants to confirm their availability. Throughout the telephone interviews, the participants commented on the subcontracting practices studied by Osmanbhoy and potential owner involvement in the subcontracting process. All interviews were recorded for later analysis, with the aim of detecting any similarities or differences between participants from all the different regions. To guarantee participant privacy, the team deleted the recordings after drafting its conclusions.

The team reported results and formulated its conclusions during the ninth research phase. The findings from the data collection and analysis phases were evaluated to identify the correlations between samples, to detect the subcontracting patterns across the country, and to discover potential new subcontracting practices.

The diagram in Figure 3 summarizes all ten phases of this research.

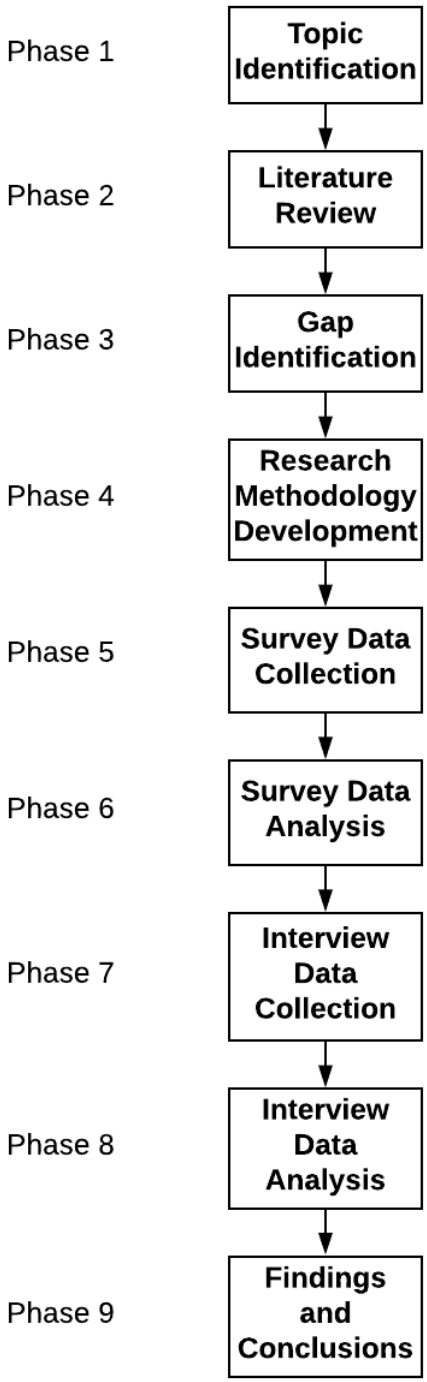


Figure 3. Research Process.

3.3 Participant Selection, Databases, and Participation Rate in Online Surveys

The researchers obtained contact information of general and specialty contractors from the American Subcontractor Association (ASA) and the Associated General Contractors of America (AGC) in the first part of the recruitment procedure. The databases are part of the public directory released by these associations, providing basic contractor information by specialty and geographic location.

The research team filtered and organized the contact information drawn from these public databases into the following categories to make future email invitations easier.

- Company
- Specialty
- Address
- City
- State
- Region (Census Categorization)
- Division (Census Categorization)
- Secondary Contact Phone
- Phone
- Website
- Primary Contact Name
- Primary Contact Email
- Secondary Contact Name
- Secondary Contact Email

When the databases did not provide a member's information in any number of these categories, the corresponding fields were filled with "N/A." For members who had neither email addresses nor telephone numbers and, thus, could not be invited, the researcher team deleted all their information. The database samples were developed in June 2018, following the most recent updates of the association databases at that point in time. A total of 696 participants were gathered for the sample, of which 662 professional practitioners came from the ASA database and 34 came from AGC. The survey invitations were sent in the second half of July, after research team review of the data, which had been codified to protect participants' personal privacy. During this first recruitment process, the research sent an invitation email and two reminders. The first reminder was sent in late July 2018, and the second reminder went out in the middle of August 2018. Fifty-five invitations were rejected because the email addresses were no longer available, since 52 had been deleted from the ASA database and three had been struck from the AGC database.

Because of the relatively small sub-sample of general contractor contact information drawn from the two databases, the researchers used their own contact information to add 151 more participants to the study. After the information gained from this second phase of recruitment had been categorized, the invitations were sent in early August 2018 following the same parameters used in the first phase, with only one reminder going out in the middle of August 2018. Only five of the research team sample invitations were undeliverable due to outdated email addresses.

The online survey was closed on August 17, 2018, to commence the follow-up interview selection and application process. To protect the confidentiality of all the data collected, the researchers assigned codes to all survey participants and maintained a separate database linking these codes to this confidential information immediately after the online survey had closed. This coding system

guaranteed that all answers could only be viewed as part of the aggregated sample. The flowchart in Figure 4 illustrates the survey participant selection process.

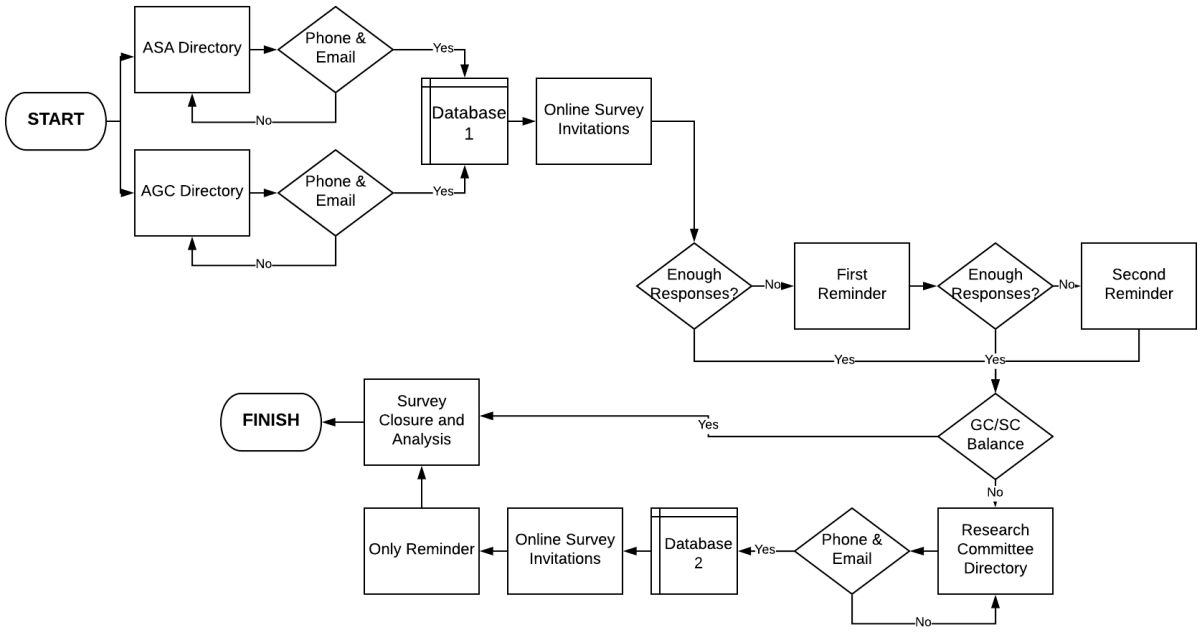


Figure 4. Survey Participant's Selection Process

3.4 Online Survey

The main goal of the online survey was to establish contact with individuals in the dataset and to identify their key characteristics. The survey was administered using a popular online survey platform, Survey Monkey, which allows users to categorize, distribute, and invite subjects to participate in surveys. Although, this study used some aspects of the Osmanbhoy (2015) pilot survey research, the research team made a few modifications to the format. These modifications did not cause any changes in the expected outputs, but rather focused on gleaning more insights from participants and, thus, provided more confidence in the data collected.

The online survey was directed at two different participant populations, general, and specialty contractors. The survey system distributed two different survey types that gathered enough information to elucidate contractual approaches for each participant type. Each survey questions had multiple options, to limit the variance of concepts and to obtain unified data on current construction contractual practices.

The survey for general and specialty contractors both was divided into two parts; the first part focused on obtaining general company information (i.e., type, size, market experience, and value), interviewee position, and professional contracting experience. The following are questions in the survey's introductory questionnaire:

- In which of the following US regions does your organization have more presence?
- How long have you worked in the construction industry?
- Which position do you presently hold in your company?
- How long have you been in this position with your company?
- What is the approximate value of the largest construction contract you have worked on personally in the last three years?
- Does your company mostly work as a general contractor or as a specialty contractor?
- Does your company mostly act as a prime contractor or as a subcontractor?
- To what extent are you involved in the administration of work subcontracted out by your company?
- To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past three years?

The survey was automatically responsive to respondent type after each participant had answered the same initial nine questions. Then, depending on his or her answer to the seventh question, "Does your company mostly act as a Prime Contractor or as a Subcontractor?," the respondent was prompted to proceed with questions from either the general contractor or the specialty contractor branches of the questionnaire. In this more targeted part of the survey, the participants were asked to answer four questions about their common relationships with higher or lower organizational tiers. These questions shed light on their current levels of collaboration inside their contractual links.

For prime contractors the questions were:

- Over the last three years, which delivery methods were commonly used in the projects for which your company acted as a prime contractor?
- Over the last three years, your company selected subcontractors based on:
- Over the last three years, have any of your subcontractors signed contracts with any other project team members?
- Which of the following parties has a direct functional relationship with any of your subcontractors?

For specialty contractors the questions were:

- How do you select your lower-tier subcontractors?
- How is your company usually selected as a subcontractor?
- Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project? Please refer only to projects for which your company acted as a subcontractor.
- Over the last three years, did your company sign more than one contract on a single project?

Figure 5 shows the online survey process followed by this study.

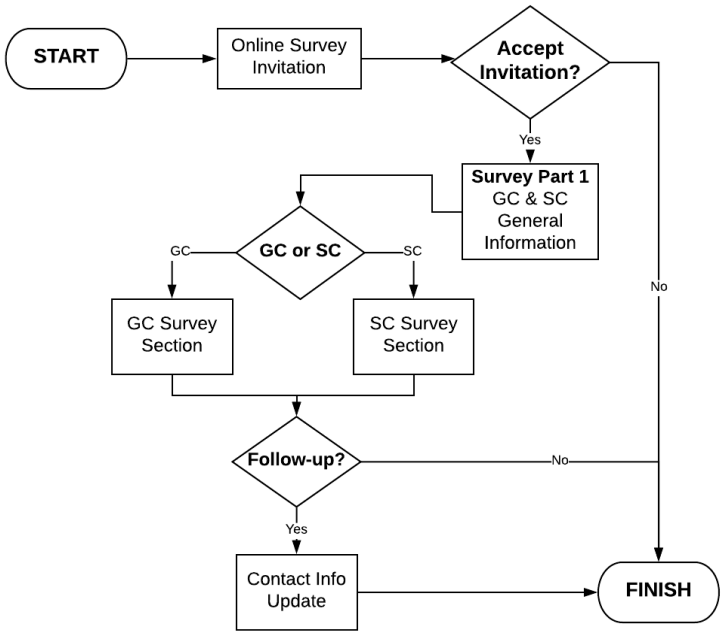


Figure 5. Online Survey Process.

3.5 Follow-up Interviews

The participants indicated on the survey whether they would like to be interviewed, providing their updated contact information. Before contacting the interested participants to set a time for these follow-up telephone interviews, the research team evaluated their survey responses to assure that they had the required experience in and knowledge of the subcontracting practices and models. The interviewee's professional experience and complete administrative involvement in his or her company were the principal criteria for participation. In addition, the research team worked to balance the type of participant type (i.e., general or specialty contractor) and the regions represented.

The follow-up interview packet included questions about subcontracting practices that allowed participants to provide their comments and insights. To collect information not captured by the survey, the packet also had two extra sections, the first of which focused on potential combinations of subcontracting models or any novel or emerging approaches. The second section provided participants an open-ended opportunity to discuss any experiences they had had of owner interference on projects. Figure 6 shows the process and topics covered in the follow-up interview for all the selected participants.

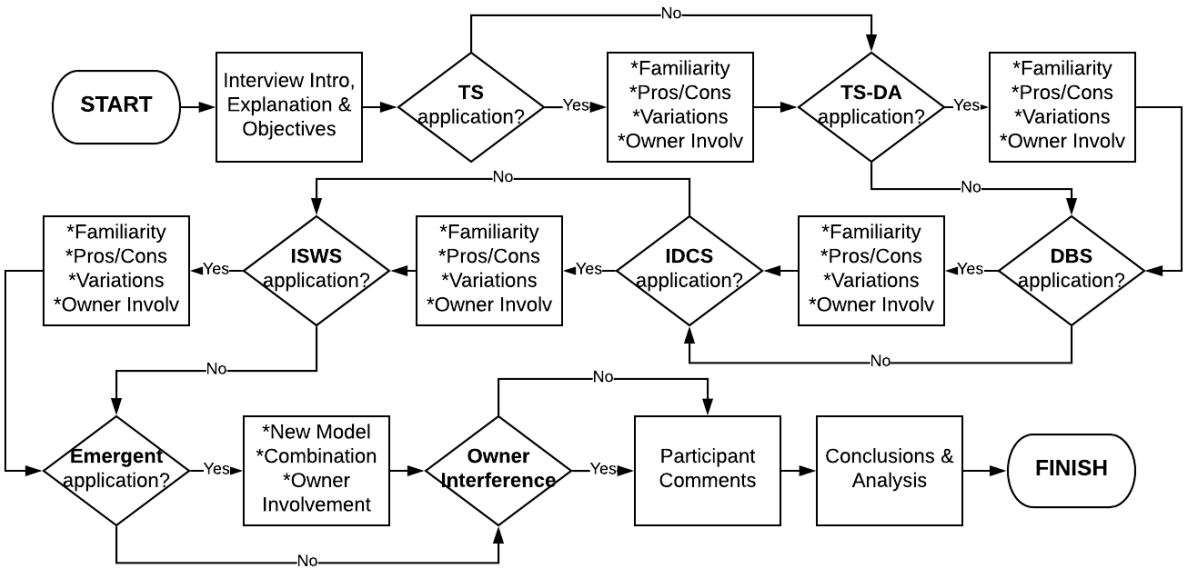


Figure 6. Follow-up Interview Process

3.5.1 Follow-up Interviews Participant Criteria Selection

The online survey results showed that 108 participants had an interest in the follow-up interview process. Of these, 41 were from general contracting organizations, and 67 came from specialty contractors' companies. To obtain meaningful information about their subcontracting practices, the research team selected the most experienced and administratively involved candidates from

among them. Their answers to Question 2 “How long have you worked in the construction industry?” and Question 8 “To what extent are you involved in the administration of work subcontracted out by your company?” determined their qualification for the interviews. The response range to the question about construction experience was as follows:

- Less than two years
- Between two and five years
- Between five and 15 years
- More than 15 years.

Likewise, the question about administrative experience had four possible responses:

- Fully involved
- Somewhat involved
- Aware but non-involved
- Non-involved.

The survey participants who reported having more than five years of construction experience and who were at least “somewhat involved” in their company’s administrative process were put on a new list for the second phase of data collection. The goal was to generate the most representative sample possible for all regions. Figure 7 presents a flowchart of the selection process for all the participants interested in the follow-up interviews.

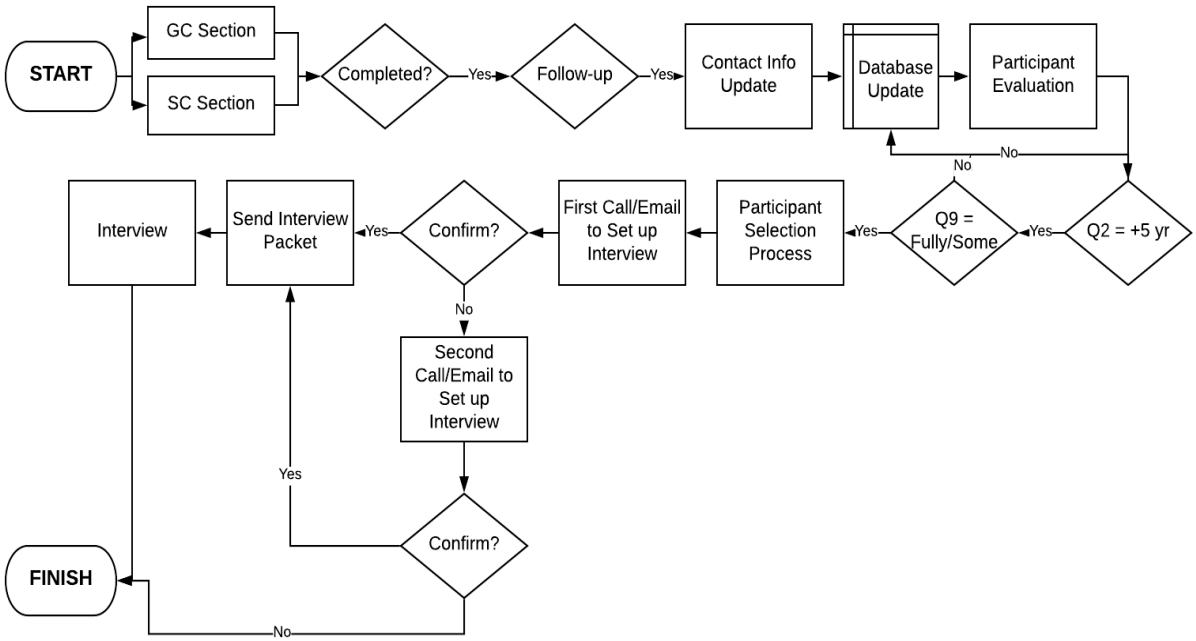


Figure 7. Follow-up Interview Participant Selection.

Before proceeding with the detailed process of selecting participants for the final directory, the researchers used the regions delineated by US Census Bureau to create five regional divisions for the study. The purpose of creating this new system is focused on merging divisions with similar contracting practices which facilitates the identification of all participants. Table 1 explains the new regions for the follow-up analysis process, and Figures 8 and 9 show the US Census Bureau regions and the proposed regions, respectively.

Table 1. Follow-up Interviews Modified Regions

NEW REGION		CONTAINS
R1	Northeast	• East North Central • Middle Atlantic • New England
R2	Southeast	• East South Central • South Atlantic
R3	Central	• West North Central • West South Central
R4	Mountain	• Mountain
R5	Pacific	• Pacific

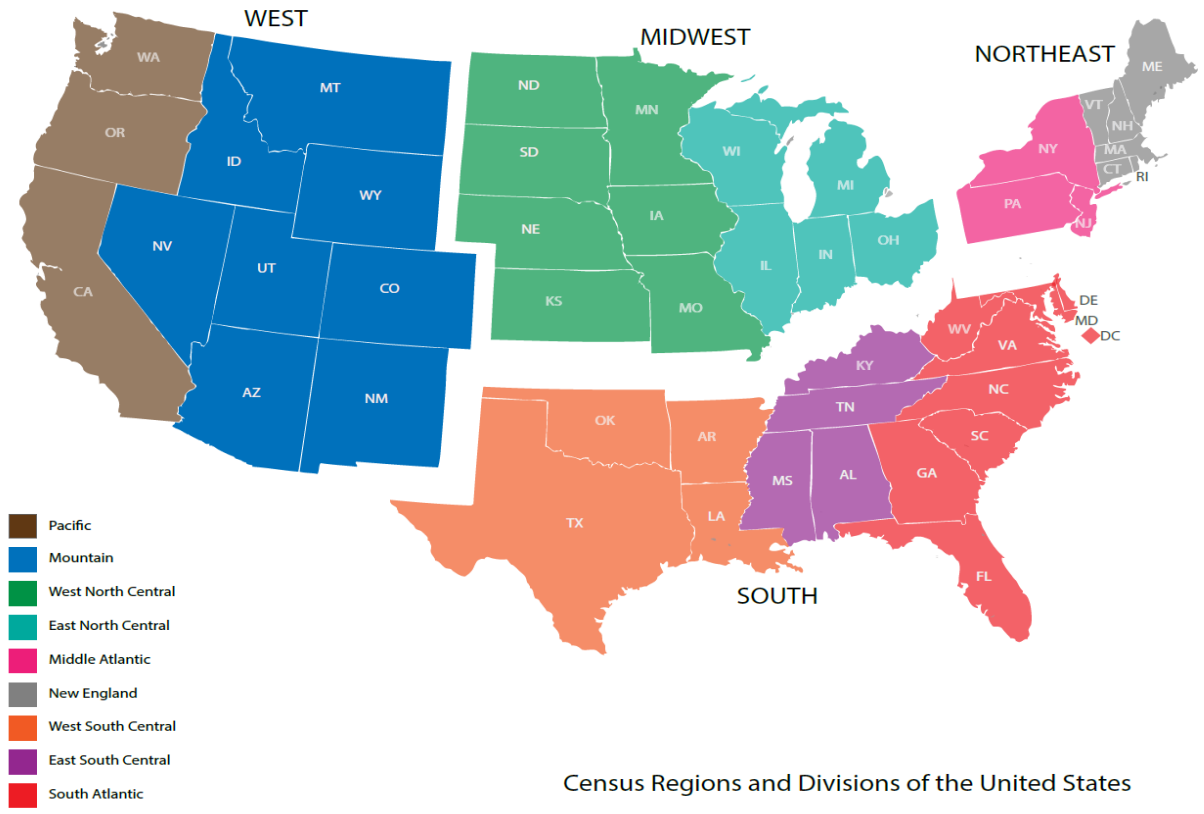


Figure 8. US Census Regions and Divisions of the United States (Adapted from US Census Bureau 2010).

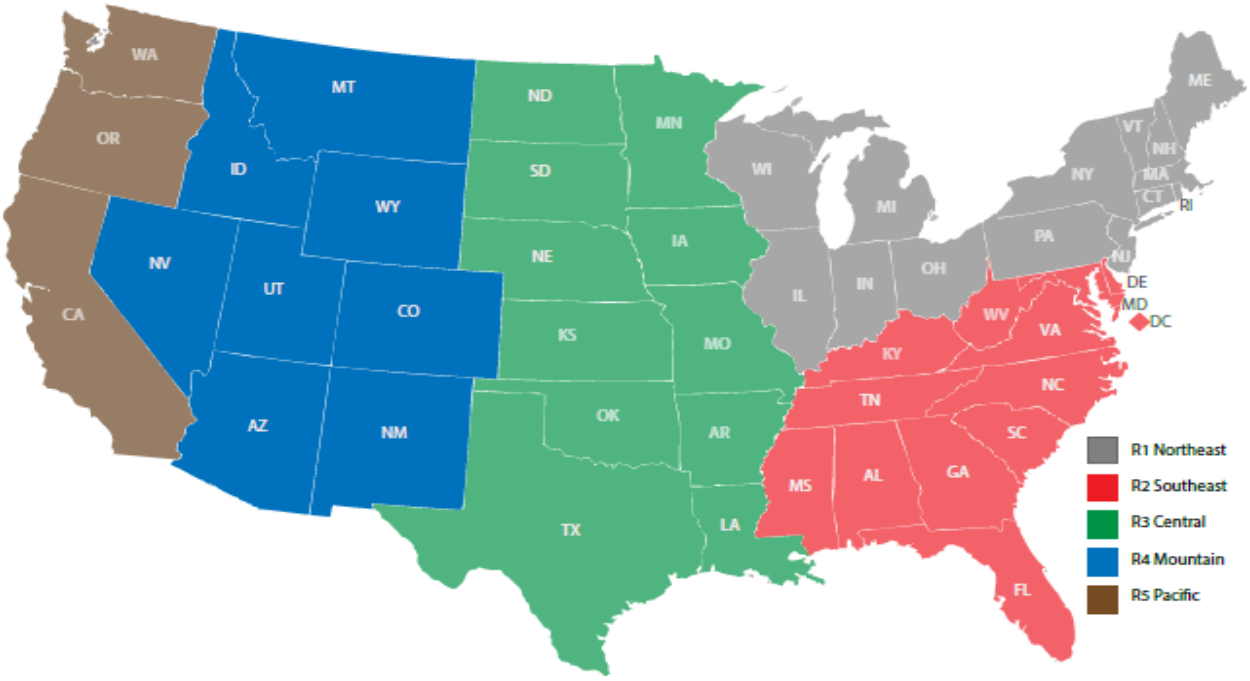


Figure 9. Research New Regions

Given this regional schema, the research team focused its efforts on including the most experienced and involved participants on the final list of interviewees. For this selection process, the team considered the candidates' construction experience first and then their administrative involvement. These filtered parameters resulted in four different tiers, with the first tier being the most reliable sample population. Table 2 shows the final number of participants per tier and the research divisions in each tier.

Table 2. Tiers' Groups

SUMMARY TABLE												
Type	**Accept Follow-Up**		***Construction Experience***		***Involvement in Administering Subcontractors***							
			YR>5	**YR>15**	**Fully & Somewhat**				**Full**			
					YR>5		*YR>15*		*YR>5*		*YR>15*	
GC	41	R1 - R4*	26	13	25	R1 - R3	13	R2, R3	19	R1 - R3	10	R2, R3
SC	67	R1 - R5	63	55	56	R1 - R5	49	R1 - R5	28	R1 - R5	24	R1, - R4
Totals	**108**		**89**	**68**	**81**		**62**		**47**		**34**	
*R4 with less 2 yr					***Tier 4***		***Tier 3***		***Tier 2***		***Tier 1***	

Finally, the flowchart in Figure 10 presents the tier categorization process for all follow-up participants.

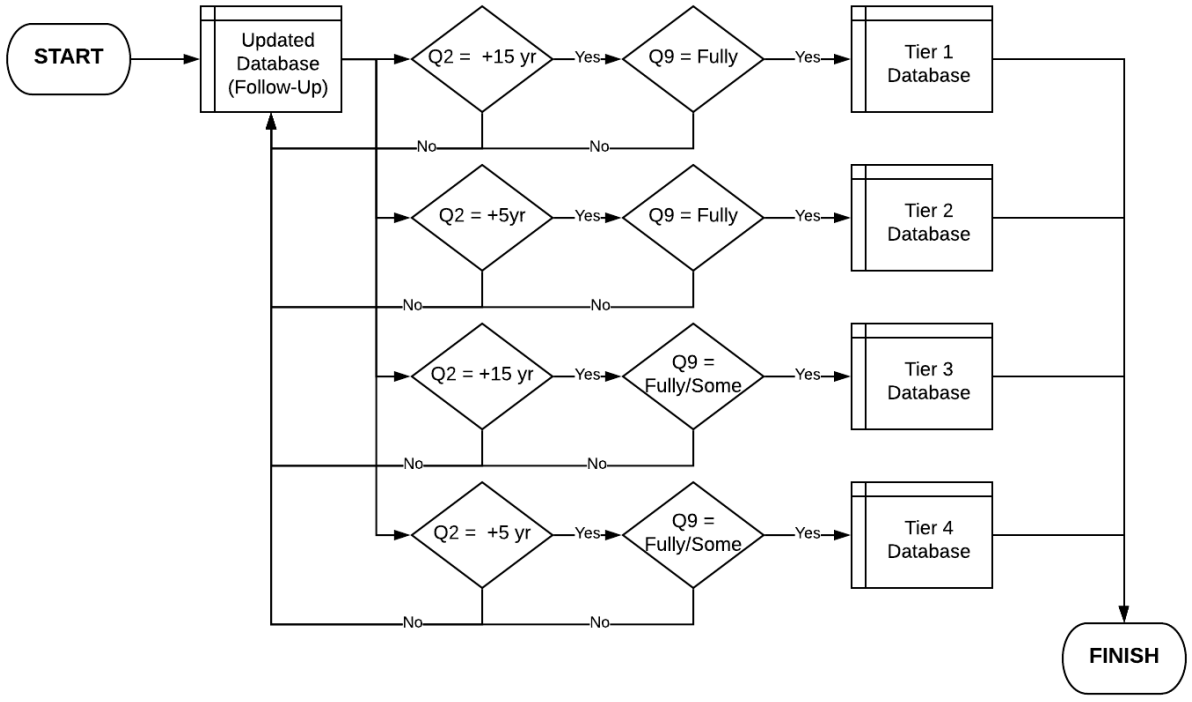


Figure 10. Tier Categorization Process.

The final directory of interviewees comprises 100 percent of the filtered GC and SC participants in Tier 1, plus three GC participants and one SC participant from Tier 2. In this regard, there were a total of 13 GC and 25 SC candidates for the follow-up interview process. The research team added the four Tier 2 participants to achieve the objective of having at least one participant for each region. Contact information and survey answers were codified to guarantee the confidentiality for all the participants in both the online survey and follow-up interview processes.

Chapter 4. DATA COLLECTION, ANALYSIS, AND RESULTS

4.1 Survey Data Collection and Analysis

The data explained in this section follows the process described in the Research Methodology chapter. The survey was sent to 847 participants from 598 different companies, a total of 170 participants completed the survey representing a 20.07% participation rate. We excluded from the analysis seven survey response sets because they were incomplete. The following sub-chapters show the survey information highlights from all the participants in three different sections: general industry data, general contractor characteristics, and specialty contractor properties.

The geographical categorization (regional and divisional) follows the Census Bureau geographical parameters, thus the research will organize information using as follows:

- All United States of America
- By Regions (Northeast, Midwest, South, and West)
- By Divisions (Pacific [PA], Mountain [MN], West North Central [WNC], West South Central [WSC], East North Central [ENC], East South Central [ESC], Middle Atlantic [MA], South Atlantic [SA], and New England [NE])

The next figure 11 provides a better comprehension of the geographical divisions stated by US Census Bureau where the reader can see the participant's location in every division. For regional and divisional survey analysis, the research places this information in the appendixes B and C.

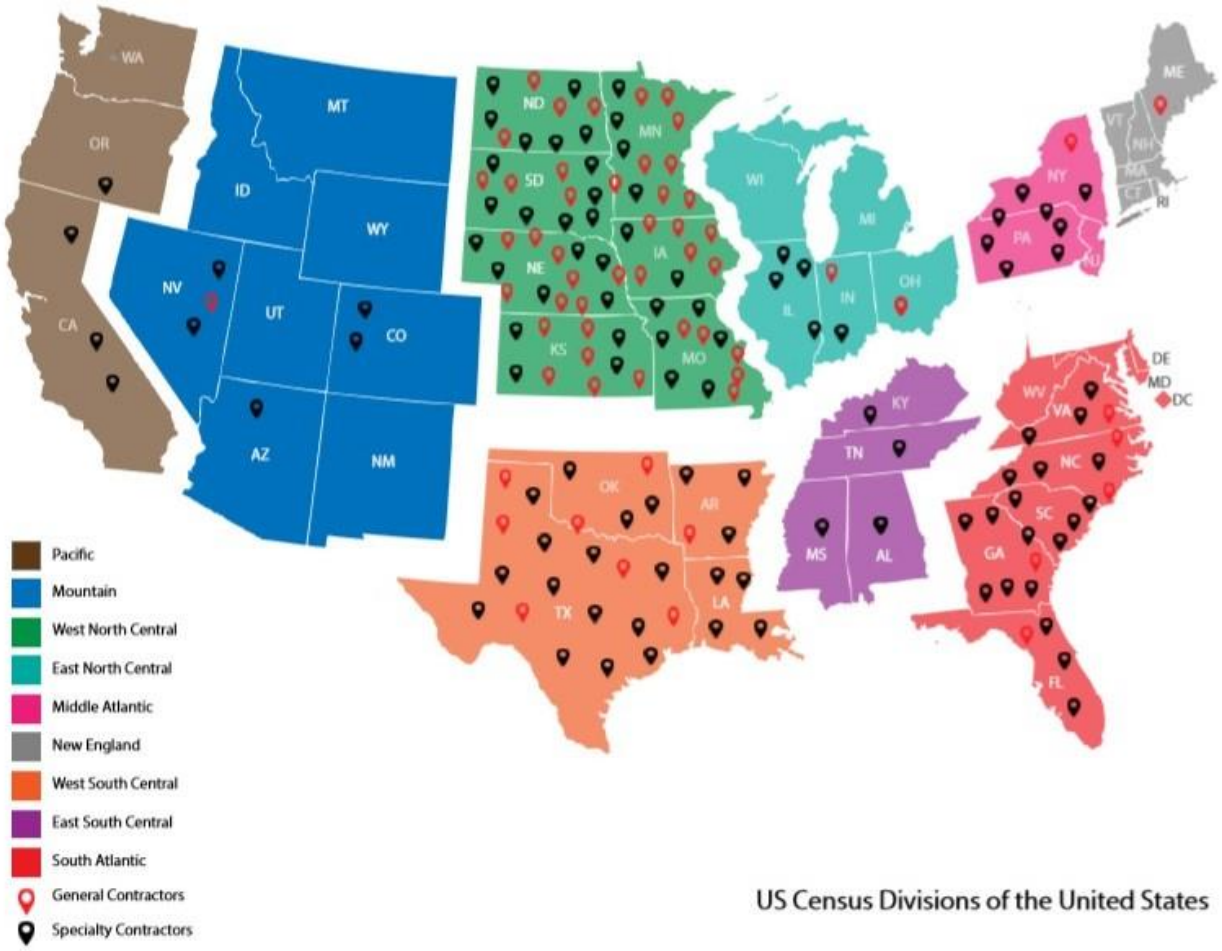
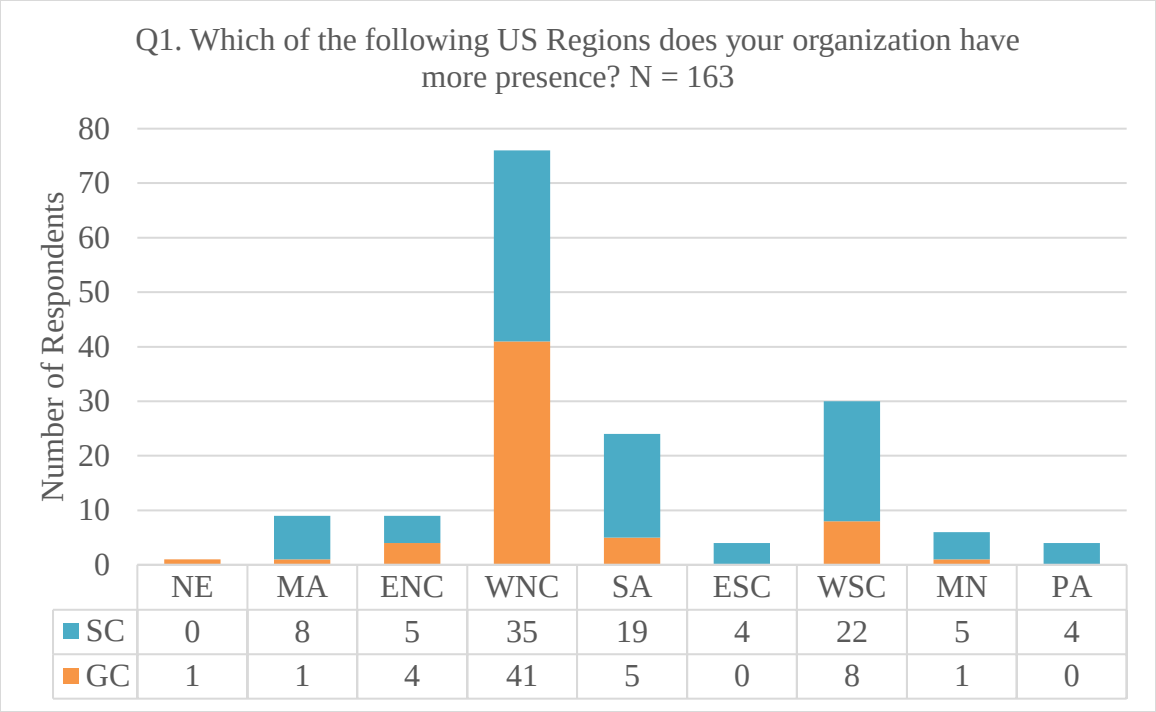


Figure 11. Online Survey Participant's Location.

4.1.1 Participants General Information Segment

Economic Location

The first survey question identifies the economic division where the participants' organization have more business presence across the country. The results show the greatest number of respondents who pursue business in the West North Central region (46.63%), followed by the West South Central region (18.40%), and the South Atlantic region (14.72%). Among the 847 individuals invited to participated, a higher response rate was obtained among specialty contractors than general contractors where 62.57% of the individuals are specialty contractors.



Graph 1. Detailed Economic Location

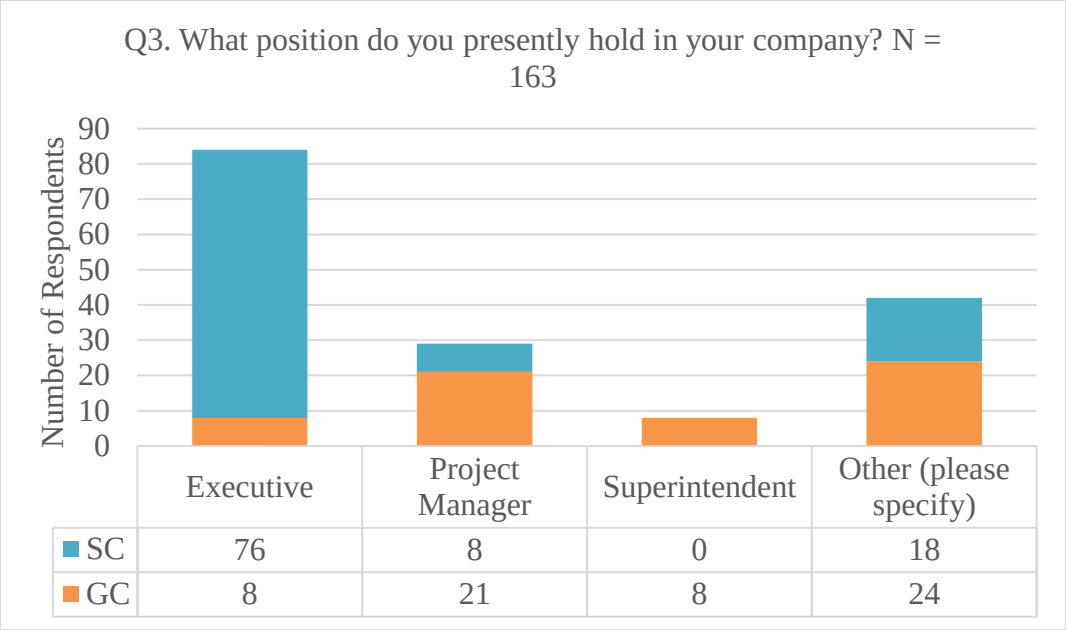
Company Industry Experience

This sample shows, in Graph 2, a high expertise level among participants, 61.96% has more than 15 years in the construction industry while 18.40% has between 5 and 15 years of experience. Moreover, 54% of general contractors and 93% of specialty contractors are concentrated in those experience categories.

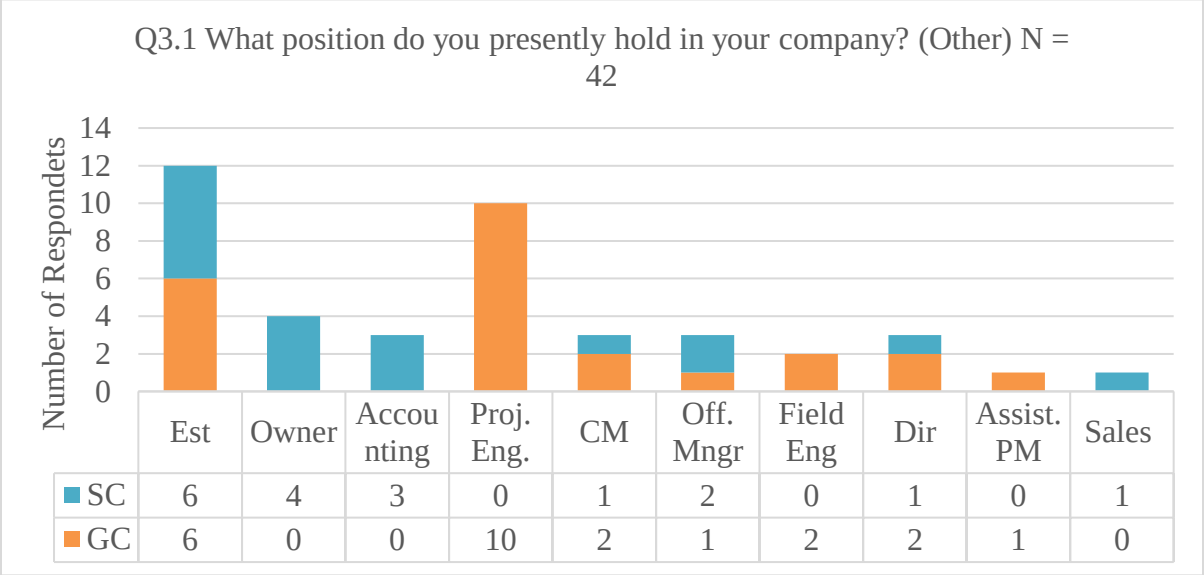
Graph 2. Detailed Company Industry Experience

Participants' Job Title

The participant's principal activities vary depending on their contractual approach (general or specialty contractors). General contractors' respondents were commonly project managers, project engineers, and estimators. On the other hand, specialty contractors' participants were executives, owners, and estimators. These factors can be observed in Graph 3 and 4.



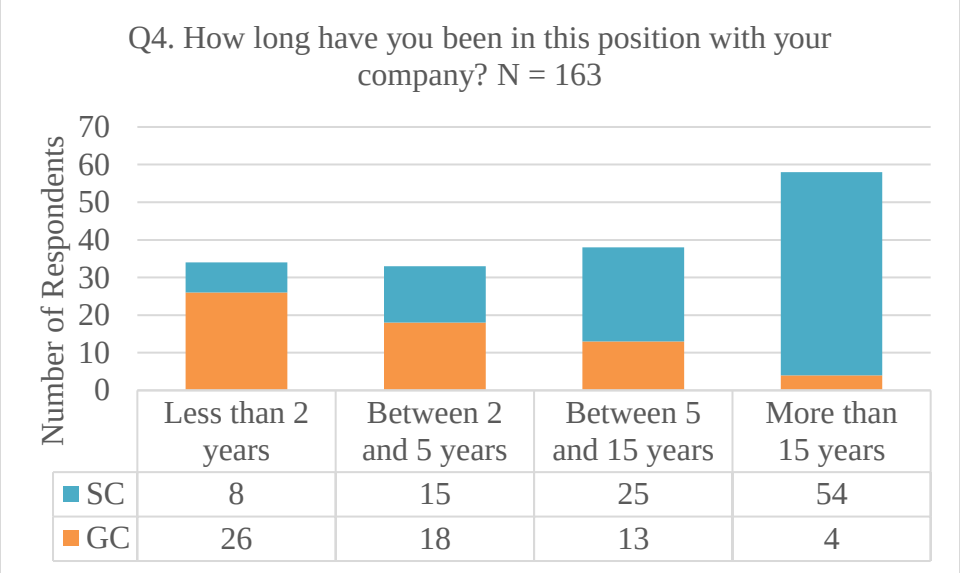
Graph 3. Detailed Participants' Job Title



Graph 4. Detailed "Other" Participants' Job Title

Experience in Current Position

Here, participants stated the time elapsed at their current company. In analyzing responses to this question, we can distinguish two groups of respondents. On one side, about 41% of respondents had less than five years of experience. This group was dominated by employees with general contractors. The second group included individuals with more than five years of experience with the current employer. This group made for about 59% of the respondents and its composition was dominated by employees with specialty contractors. Especially the most experienced respondents, those having more than 15 years of experience, were almost totally employees with specialty contractors.

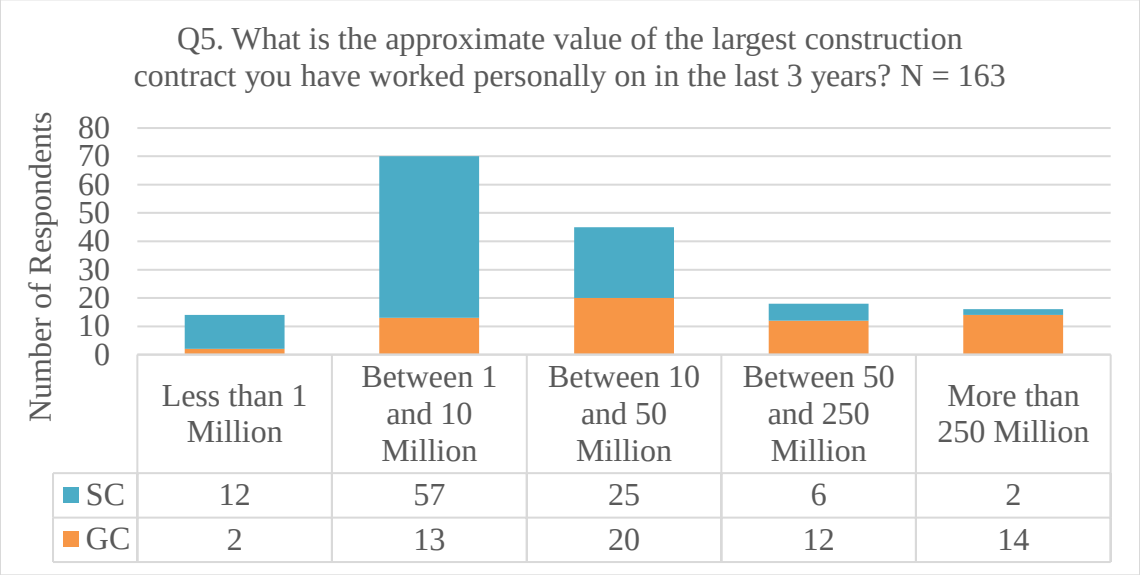


Graph 5. Detailed Experience in Current Position

Size of Recent Contracts

The most representative contract amount is between 1 and 10 million dollars (42.94%), while the contracts between 10 and 50 million (27.61%) are the second most used amounts. Contracts of less

than 1 million dollars represents only 8.59%, in other words, the companies who responded the survey have participated in large-scale projects, and they may provide interesting comments. Finally, general contractors hold contracts with the biggest amounts; specialty contractors have a clear tendency to deal with contracts between 1 and 10 million dollars.

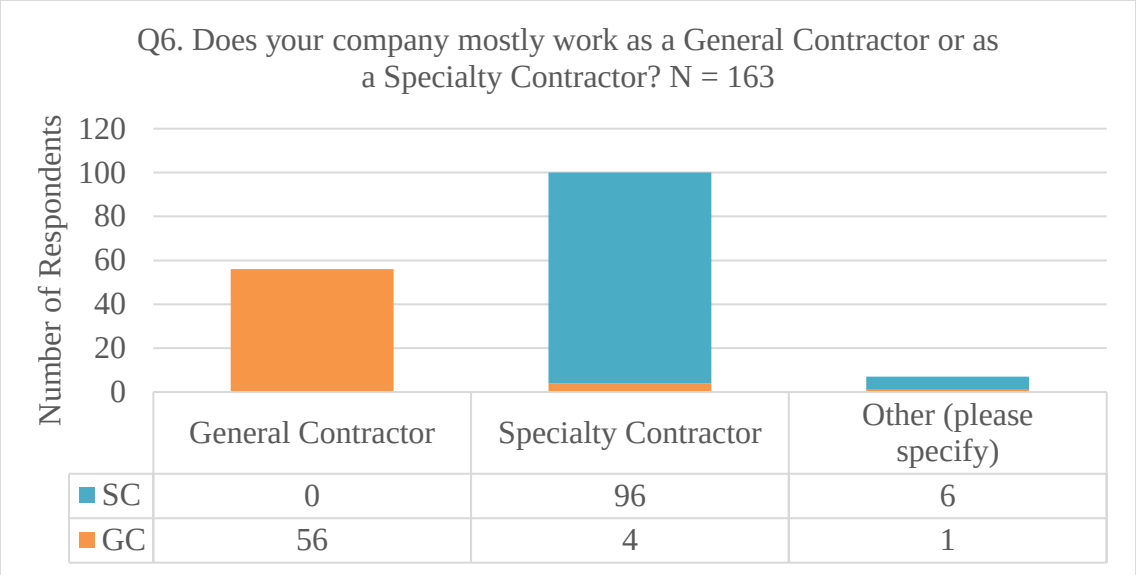


	Less than 1 Million	Between 1 and 10 Million	Between 10 and 50 Million	Between 50 and 250 Million	More than 250 Million
SC	12	57	25	6	2
GC	2	13	20	12	14

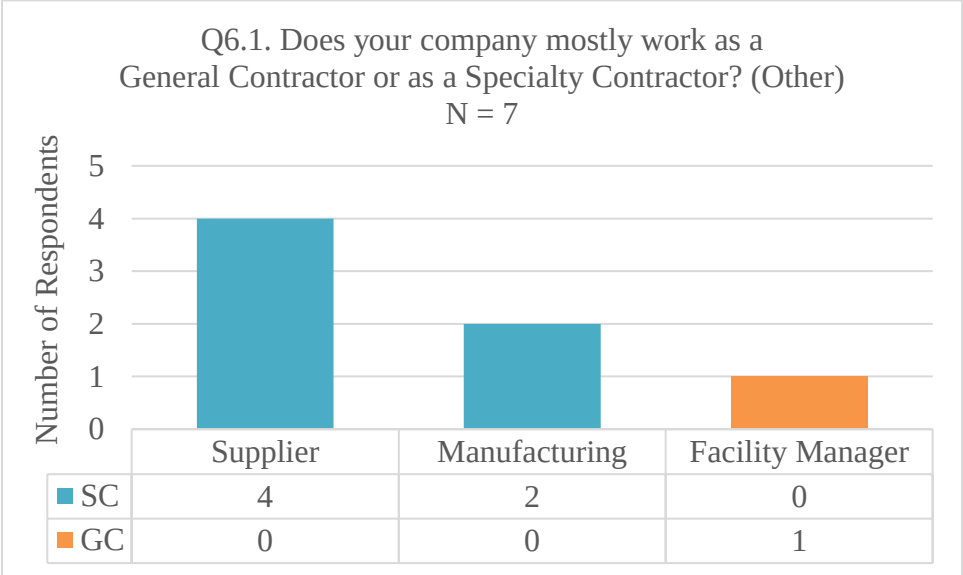
Graph 6. Detailed Overall Size of Recent Contracts

Functional Role

This question distinguishes the construction company contracting type for each participant; general contractors or specialty contractors. Using Graph 7, and 8, the survey shows that 34.36% of the respondents act as general contractors while 61.35% works as specialty contractors. Only seven participants are classified as “Other” where the researchers identified 6 of them as a specialty contractor with manufacturing and supplying scope, and one general contractor with facility manager profile.



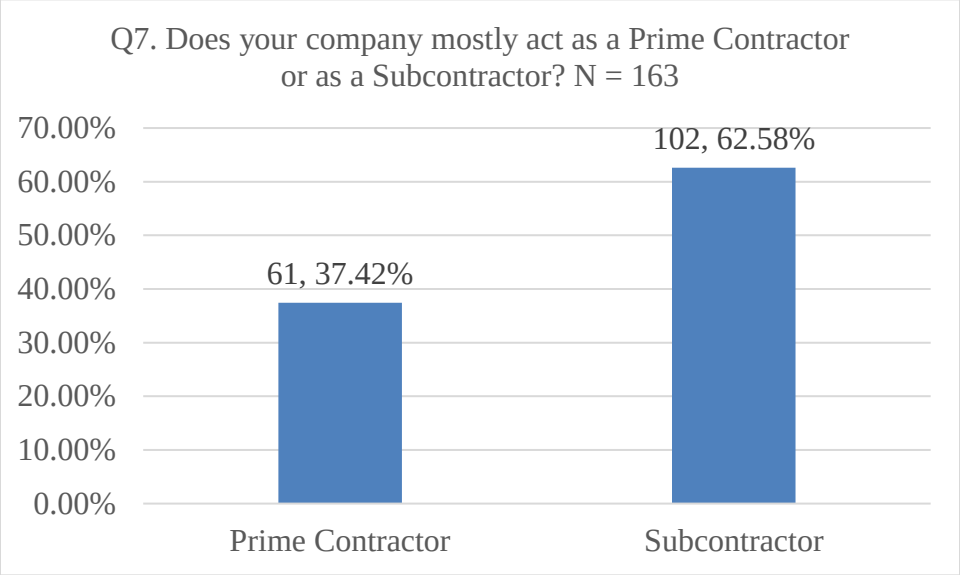
Graph 7. Detailed Functional Role



Graph 8. Detailed "Other" Functional Role

Contractual Role

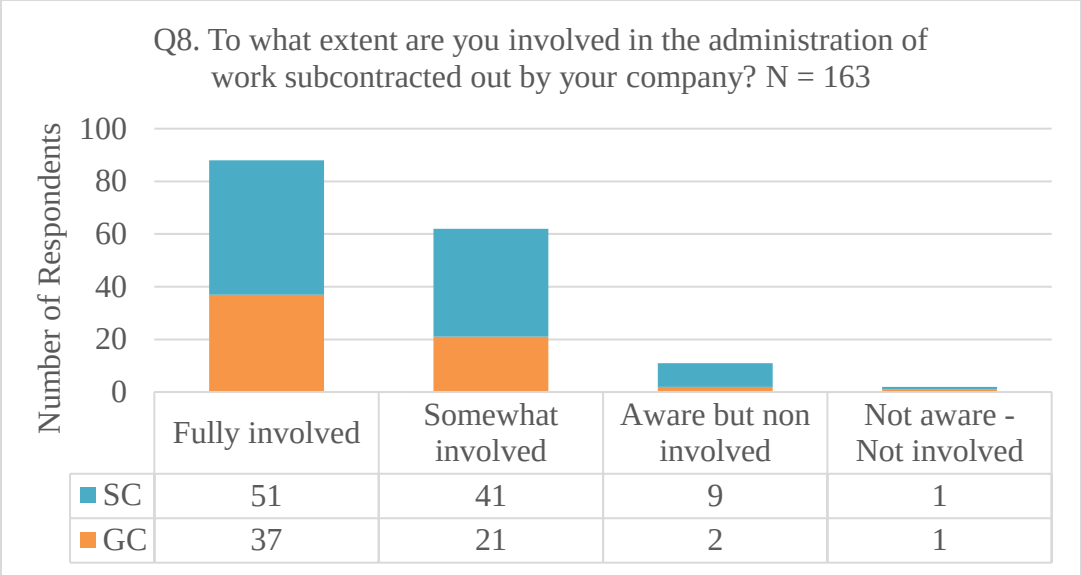
Based on the common contractual relationship established by the owners, the participants were asked about their normal contract arrangement. Graph 9 shows that general contractors represent 37.42% and specialty contractors 62.58% of the participants.



Graph 9. Overall Contractual Role

Respondents' Involvement in Subcontracting

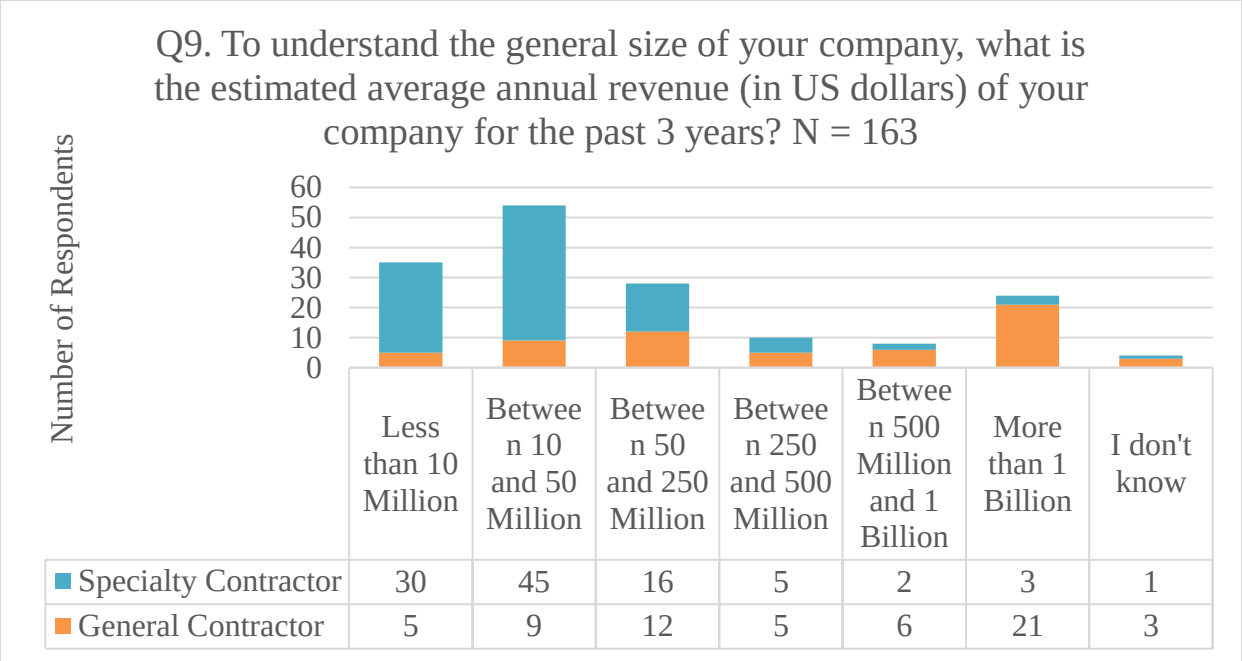
This question determines the participants' knowledge about the administrative process in their companies. As shown in Graph 10, about 54% of the respondents are fully involved in the administration of subcontracted work with an additional 38% of respondents being somewhat involved.



Graph 10. Detailed Respondents' Involvement Subcontracting

Company Size

This question is focused on understanding the company revenue size of the respondents during the last three years. Graph 11 shows that most common revenue is between 10 and 50 million of dollars (33.13%), while the contracts for less than 10 million (21.47%) represent the second most used revenue amount. In contrast, revenues of more than 1 billion dollars represent 14.72%, these revenues show a good parameter due to the survey has all the company sizes, from small to huge companies. Again, general contractors hold the contracts with the biggest amounts. Specialty contractors keep the revenues from 10 to 50 million dollars.

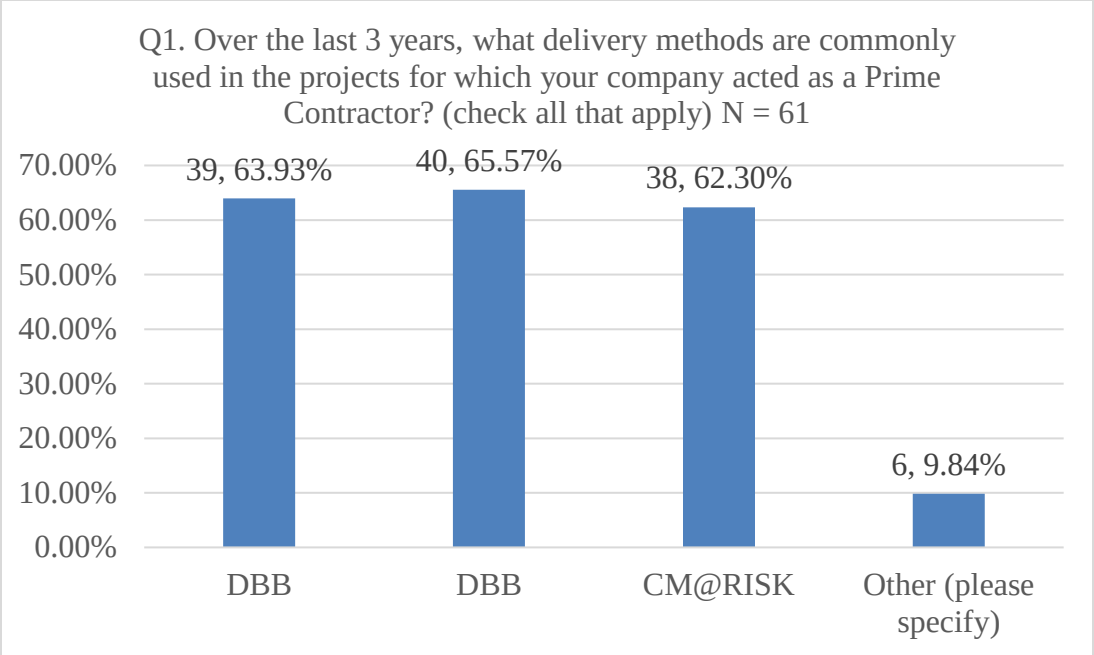


Graph 11. Detailed Company Size

4.1.2 General Contractor Survey Segment

Adopted Project Delivery Methods

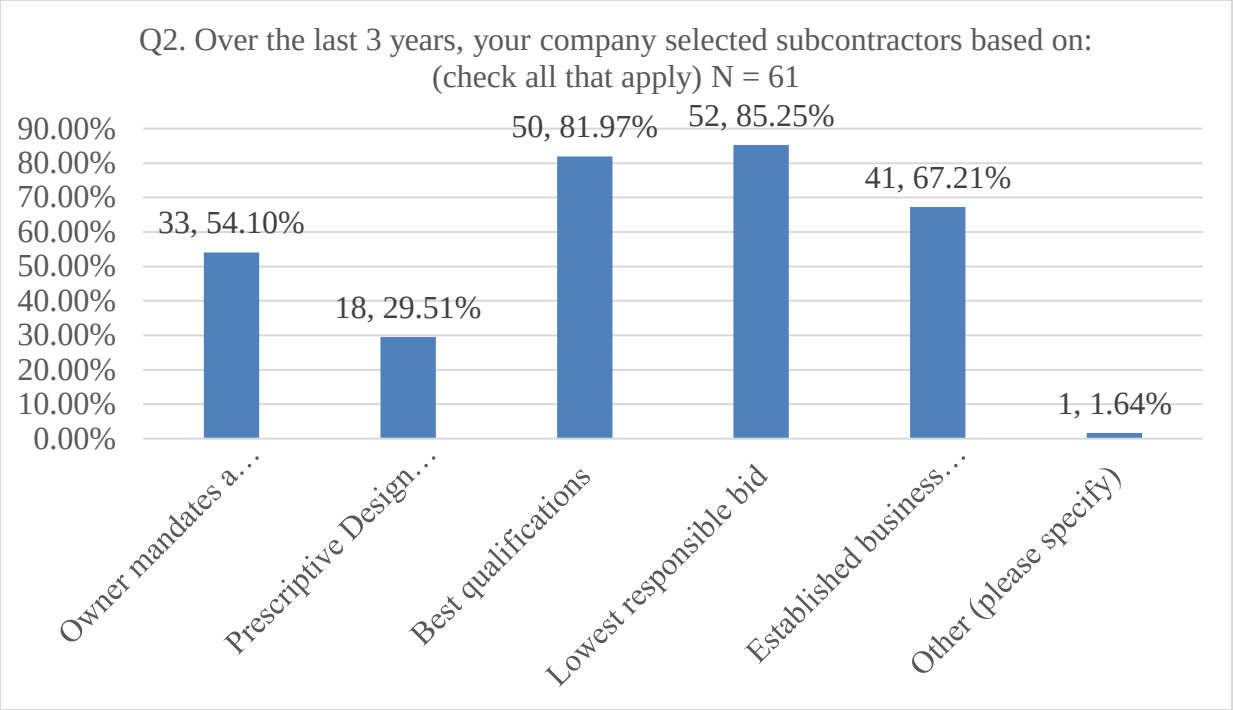
To get a better understanding of the most used PDM between prime contractors, the following Graph 12 shows that Design-Bid-Build (39%), Design-Build (40%), and Construction Management at Risk (38%) share similar percentages. These percentages show that GC respondents are about equally involved on projects delivered with the three major PDMs. However, one of the participants also included P3 as one of the other PDM.



Graph 12. Adopted Project Delivery Methods

Subcontracting Selection Criteria

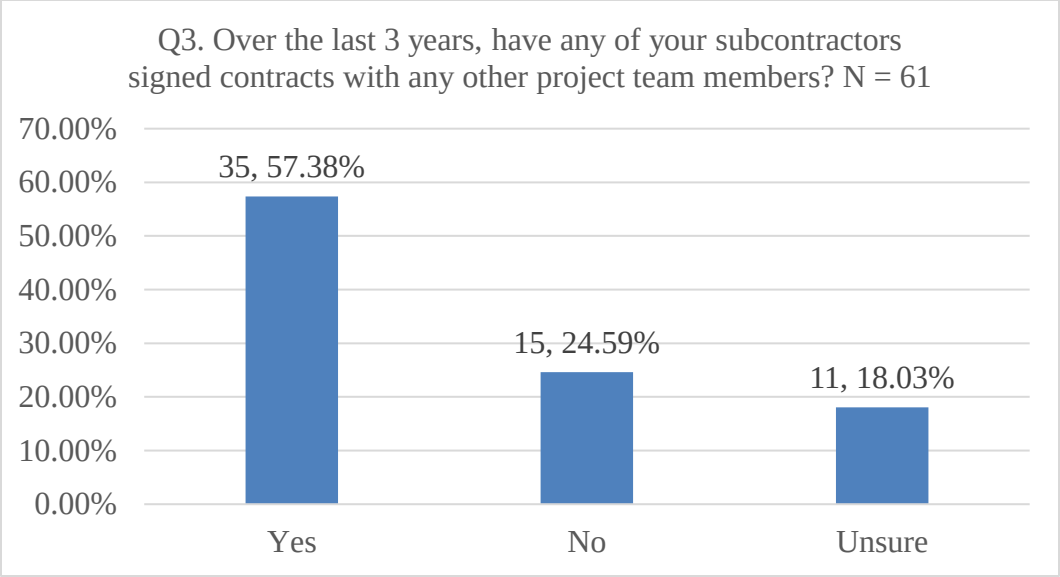
GC respondents were also inquired about what criteria they used to select their subcontractors. Graph 13 shows that best qualifications (81.97%) and lowest responsible bid (85.25%) are the most typical methods. These results show a clear tendency where general contractors may evaluate their prospects using qualifications, but the economic factor plays an important role. The remaining options such as owner mandate a contractor or list of subcontractors (54.10%) and established business relationships with project team members (67.21%) can be cataloged as real options because of their high percentage rate. Prescriptive design requirements (29.51%) and other methodologies (1.64%) like minority business enterprises (MBE) and women's business enterprises (WBE) are not preponderant decision drivers but those describe potential prescriptive requirements for the procurement process.



Graph 13. Subcontracting Selection Criteria

The Occurrence of Subcontractors with Multiple Contractual Relationships on the Same Project

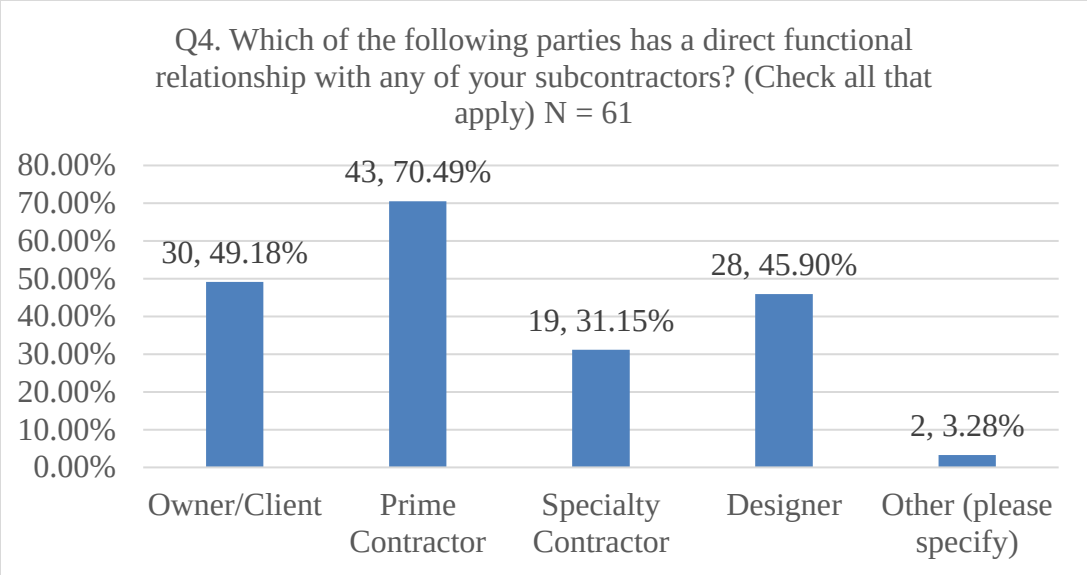
The participants were asked about potential multiple contractual relationships among specialty contractors where one (or multiple) special trades have established contractual arrangements with more construction parties inside the project. Graph 14 shows that it is a common practice with 57.38%, with the uncertainty of 18.03%. Only 24.59% assures that their subcontractors have not shared any contractual relationship with another construction member.



Graph 14. Multiple Contractual Relationships on the Same Project.

Other Contractual Parties with Contractual Relationship with Subcontractors

The respondents were asked about their direct contractual relationships to understand which construction parties share links with their subcontractors. Graph 15 identifies three principal construction members where general contractors (70.49%) are the most common construction partners to specialty contractors. Owner (49.19%) and designers (45.90%) represent the second and third option. According to subcontracting horizontal structures, the association between specialty contractors only shows 31.15%. The others' category (3.28%) states that these other contractual parties relationships depend on the project characteristics.

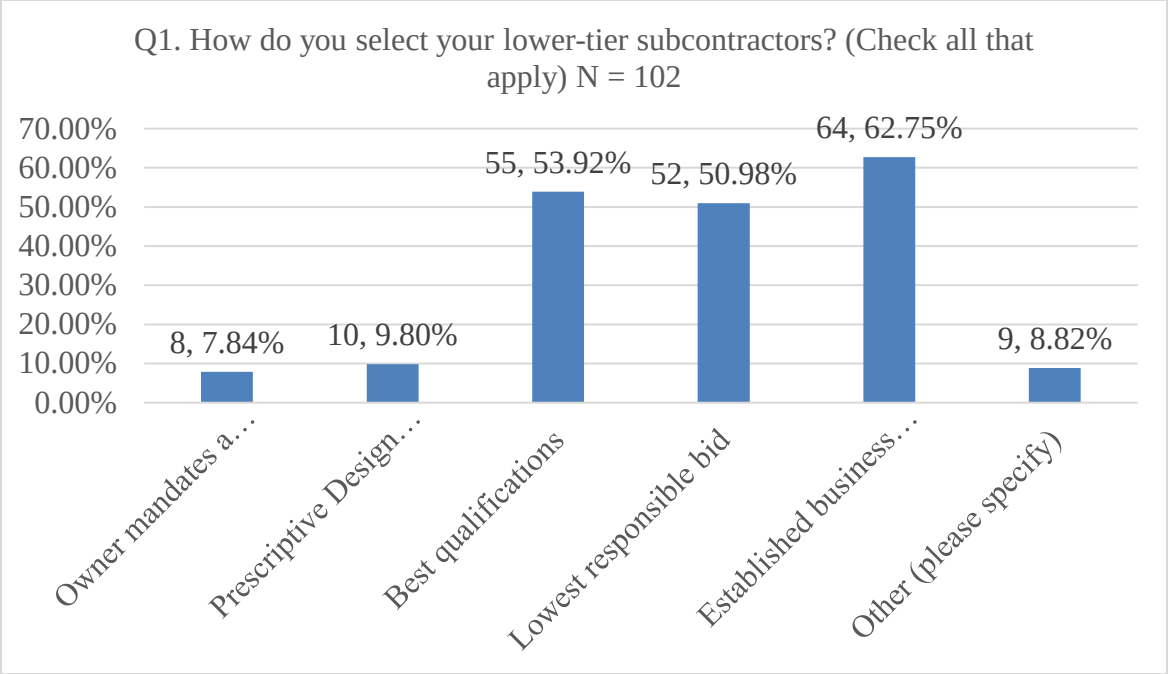


Graph 15. Other Contractual Parties

4.1.3 Specialty Contractor Survey Segment

Subcontractor Selection Criteria

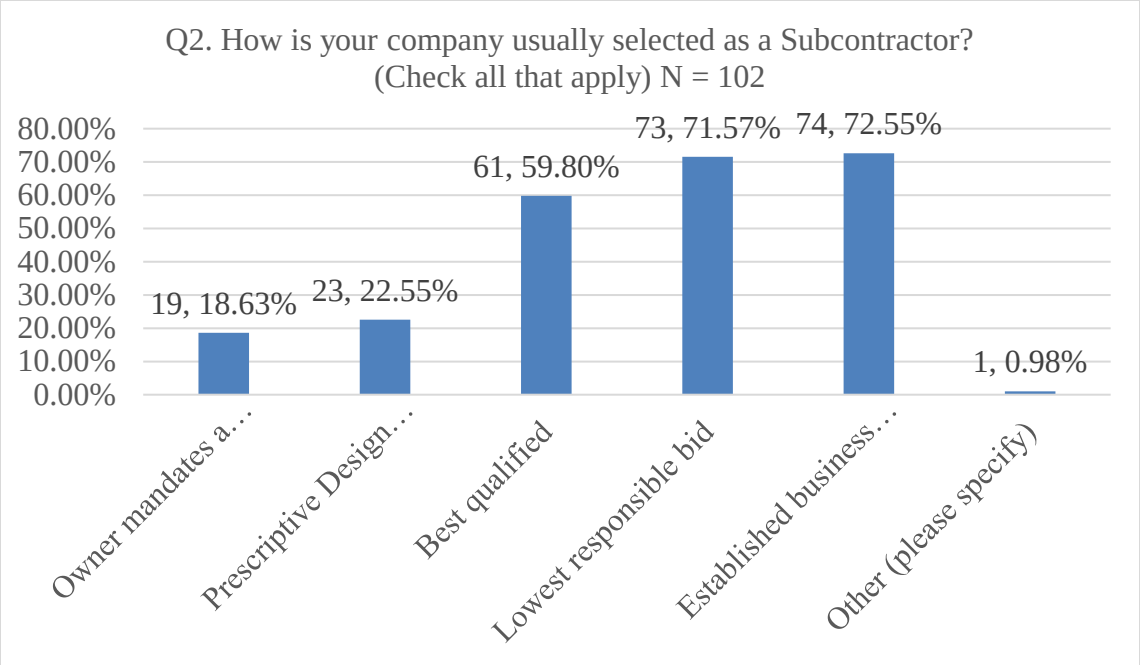
The specialty contractors were asked for their common procurement practices. Graph 16 shows that the common selection process to lower tiers is business relationships (62.75%) that differs completely from the general contractor's criteria. However, best qualifications (53.92%) and lowest responsible bid (50.98%) still represent common options in the construction market. Finally, owner interference (7.84%), design requirements (9.80%), and Other – No subcontracting practices (8.82%) are not decisive factors.



Graph 16. Subcontractor Selection Criteria

Procurement Approach

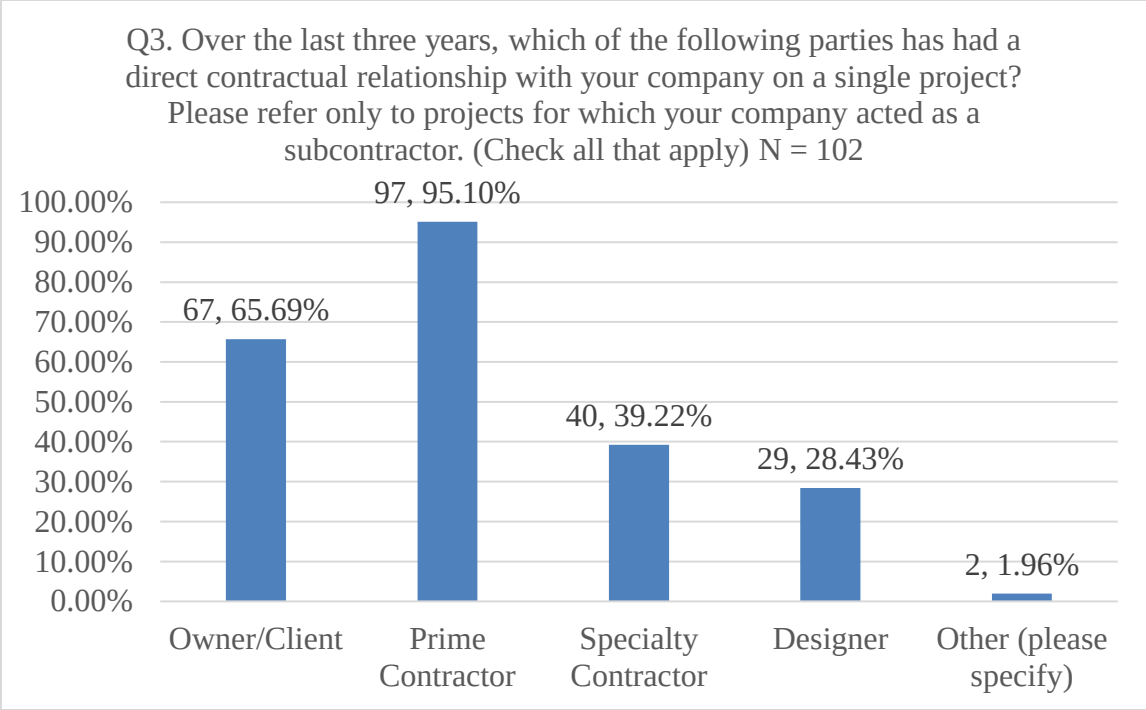
This question provides information about the specialty contractor's insights on how they are selected from general contractors. The comparison between general and specialty contractor's procurement focuses detect gaps among participants' criteria. Graph 17 identifies the typical procurement methodologies where business relationships (72.55%), lowest responsible bid (71.57%), and best qualified (59.80%) are the most used processes. Owners interference (18.63%), design requirements (22.55%), and Other – MBE/WBE (0.98%) are not important options.



Graph 17. Procurement Approach

Contractual Bounded Parties

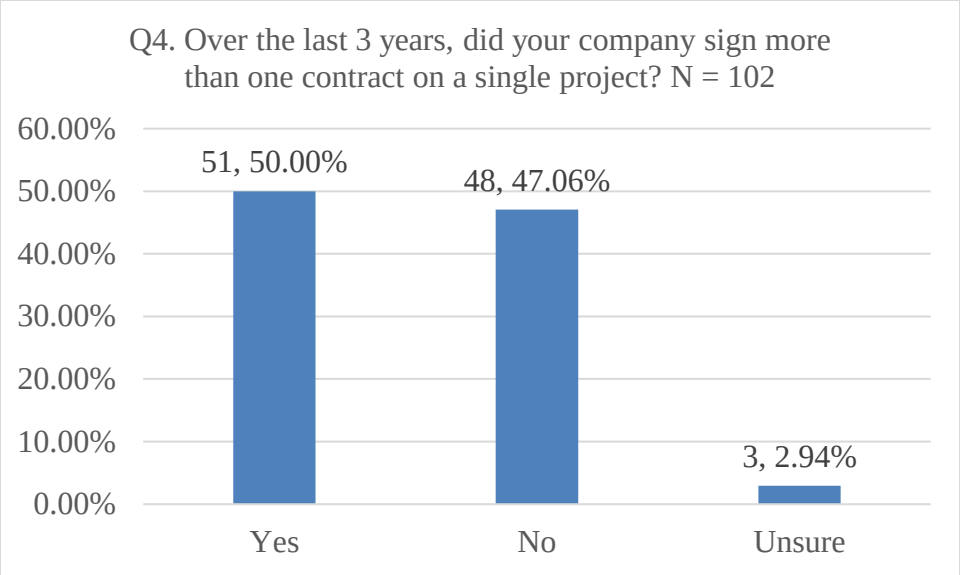
The question looks to identify how subcontractors share contractual relationships with their higher tiers and trade partners. Graph 18 shows that the common contractual link for specialty contractors is the general contractors (95.10%) followed by owners (65.69%), specialty contractors (39.22%), and designers (28.43%). The others' category (1.96%) states an important factor which confirms the lack of supplier's involvement during the project process, avoiding collaborative supplier's chains.



Graph 18. Contractual Boundaries

The occurrence of Subcontractors with Multiple Contractual Relationships on the Same Project

Following the same criteria as General Contractors Survey, the specialty contractors were asked about the possibility of multiple contracting arrangements in the same project. Graph 19 shows that this practice is common among specialty contractors (50%) while almost the same participant's proportion has not used this contract practices (47.06%), uncertainty represents only 2.94%.



Graph 19. Multiple Contractual Relationships on the Same Project.

To facilitate the comprehension and potential conclusions of the survey results, Table 3 comprises all questions and the top three answers from all participants. The answers were divided according to the survey structure; general information, general contractor, and specialty contractor sections.

Table 3. Survey Results Overview

QUESTION	FIRST RESPONSE	SECOND RESPONSE	THIRD RESPONSE
GENERAL INFORMATION (N=163)			
Location	West North Central (46%)	West South Central (18%)	South Atlantic (14%)
Participants' Experience	More than 15 years (61%)	Between 5 and 15 years (18%)	Between 2 and 5 years (13%)
Participants' Position	Executive (51%)	Project Manager (17%)	Estimator/Proj. Engineer (13%)
Current Position Experience	From 0 to 5 years (41%)	More than 15 years (35%)[S]	Between 5 and 15 years (23%)
Largest Contract Size	Between 1 and 10 M (43%)	Between 10 and 50 M (27%)	Between 50 and 250 M (11%)[G]
Contractual Role	Prime Contractor (61,37%)	Subcontractor (102, 63%)	N/A
Participants' Involvement	Fully (54%)	Somewhat (38%)	Aware (6%)
Participants' Company Size	Between 10 and 50 M (33%)[S]	Less than 10 M (21%)[S]	Between 50 and 250 M (17%)
GENERAL CONTRACTOR SURVEY SEGMENT (N=61)			
Adopted PDM[M]	Design-Build (65%)	Design-Bid-Build (63%)	CM at Risk (62%)
Subcontracting Selection Criteria[M]	Lowest Responsible Bid (85%)	Best Qualifications (82%)	Business Relationships (67%)
Multiple Contractual-Relationship	Yes (57%)	No (24%)	Unsure (19%)
Other Contractual Parties[M]	Prime Contractor (70%)	Owner/Client (49%)	Designer (45%)
SPECIALTY CONTRACTOR SURVEY SEGMENT (N=102)			
Subcontractor Selection Criteria[M]	Business Relationships (62%)	Best Qualifications (54%)	Lowest Responsible Bid (51%)
Procurement Approach from GC[M]	Business Relationships (72%)	Lowest Responsible Bid (71%)	Best Qualifications (60%)
Contractual Bounded Parties[M]	Prime Contractor (95%)	Owner/Client (65%)	Specialty Contractor (39%)
Multiple Contractual-Relationship	Yes (50%)	No (47%)	Unsure (3%)

S = SC represents the biggest sample; G = GC represents the biggest sample; M = Participants could select all options that may apply to them.

4.2 Follow-up Interview Analysis

4.2.1 Introduction

Using the approach described in Chapter 3, survey respondents were screened and selected for the interview phase. As a result, a sample of 38 individuals was invited for the interview phase. This sample included 13 GCs and 25 SCs. Twenty individuals accepted the invitation and participated to the interview phase. As practitioners are usually busy, the initial email invitation was sent in the first half of October 2018 and was followed by two email reminders throughout the end of November 2018. Interviews were conducted between October 11, 2018 and November 28, 2018. Out of the 38 individuals invited to participate to the interview, two declined the invitation. One sent an email where the invitee explained his incapacity to answer the questions adequately; another explained over the phone that he could not allocate time due to heavy workload. A total of 16 invitees did not answer to the invitation and its reminders. Given the factors, the final response rate for the interviews is 52.63% with 13 General Contractors (10 of them fall within tier 1) and 7 Specialty Contractors (6 of them fall within the tier 1).

Geographic localization by region for each participant who completed the follow-up interview is described graphically in Figure 12. The localization purpose is not based on the accuracy of the participant's offices or headquarters; the objective relies on understanding which regions the interview process covered, and then, the research can create adequate correlations to the current construction normativity on those regions.

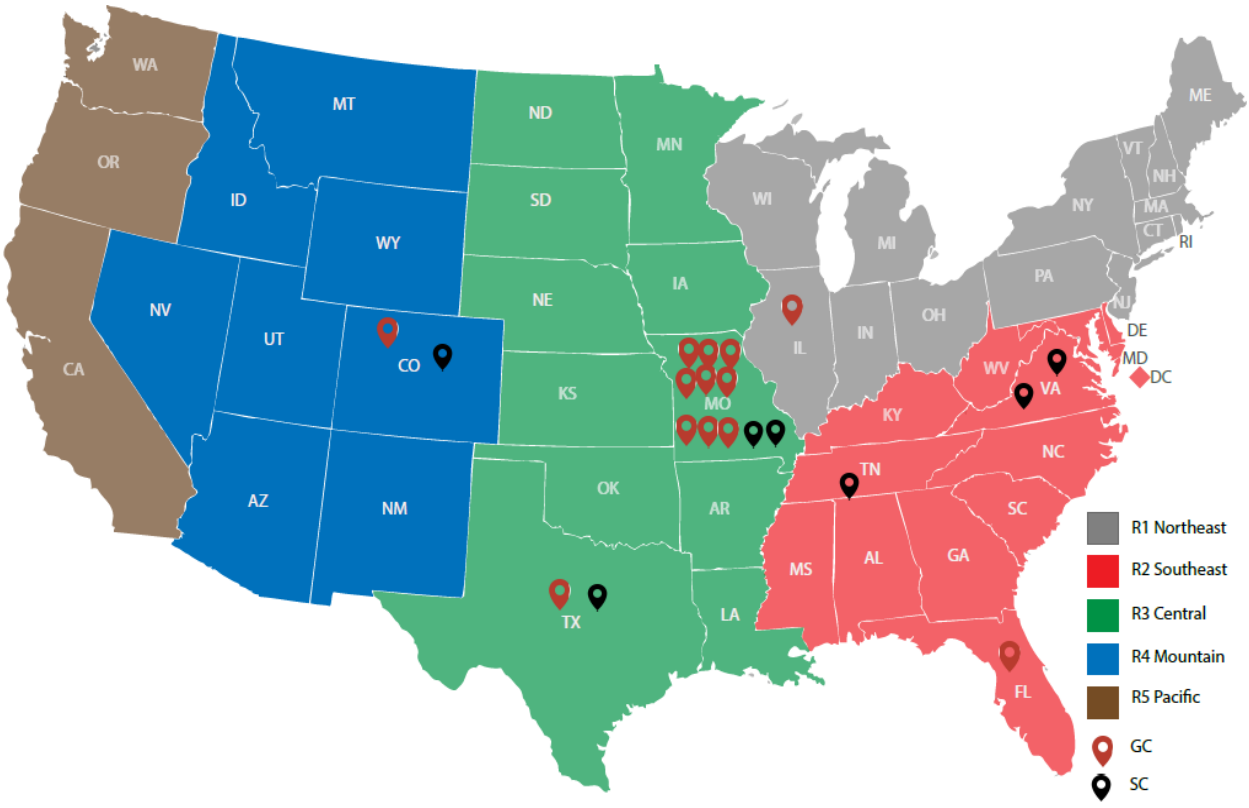


Figure 12. Follow-up Participant's Location

Some participant's point of view and explanations matched the literature review findings. Given this situation, the next subchapters underline all matched findings to facilitate their identification and comprehension.

4.2.2. Traditional Subcontracting (TS) Model

CODING OVERVIEW

After analyzing the recordings and transcripts of each participant that contributed during the interview process, the following crosstab and word cloud have been created using NVIVO 12 to provide information about which participants (GC or SC) and regions (R1 to R5) had better participation rates and shared meaningful details.

General Contractors from regions R1, R2 and R3 provided interesting comments for TS subcontracting model while Subcontractors from regions R2, R3, R4, and R5 contributed to this section with important feedback. Summarizing, both participant's types covered 100% of the regions without gaps among the geographical zones. Table 4 shows the participation rate of each category and region while Figure 13 exhibits the key words of the participants.

Table 4. Traditional Subcontracting Crosstab

Participants Information	Contractual Status = General Contractor (13)					Contractual Status = Subcontractor (7)					Total (20)
	R1 Northeast (3)	R2 Southeast (1)	R3 Central (9)	R4 Mountain (0)	R5 Pacific (0)	R1 Northeast (0)	R2 Southeast (3)	R3 Central (2)	R4 Mountain (1)	R5 Pacific (1)	
Cons (TS)	15.38%	7.69%	46.15%	0%	0%	0%	0%	15.38%	7.69%	7.69%	100%
Familiarity (TS)	0%	0%	33.33%	0%	0%	0%	0%	33.33%	33.33%	0%	100%
Owner Involvement (TS)	15.38%	7.69%	38.46%	0%	0%	0%	23.08%	0%	7.69%	7.69%	100%
Pros (TS)	18.18%	0%	54.55%	0%	0%	0%	0%	9.09%	9.09%	9.09%	100%
Use (TS)	16.67%	5.56%	44.44%	0%	0%	0%	16.67%	5.56%	5.56%	5.56%	100%
Variations (TS)	0%	0%	40%	0%	0%	0%	20%	20%	20%	0%	100%
Total (unique)	15.79%	5.26%	42.11%	0%	0%	0%	15.79%	10.53%	5.26%	5.26%	100%

The crosstab shows the spread of comments from the interviewees in each TS interview section. The percentage is defined by NVIVO 12 software.

Figure 13. Traditional Subcontracting Word Cloud

USE

General Contractor

The use of this subcontracting model may vary according to the type of client/owner that the general contractor is related to start any commercial relationship. For public owners, the TS model is the most common. Thus, participants referred to this method as highly used with constant percentages about 80 to 100%. On the other hand, participants who have contractual relationships with private owners experienced a drastic reduction in the percentage of using TS method where they have identified a reduction from 80-90% to 40-50% in average in the last five to ten years. This situation is not particular from one region, all regions identified this reduction pattern.

Specialty Contractor

Similar to the General Contractor's opinion, Specialty Contractors showed a high use of the TS method. The percentages are between 80 and 90% for all types of projects. However, some interviewees agreed with General Contractors idea about the reduction in this subcontracting practice in private projects.

ADVANTAGES

General Contractor

During the interviews, all participants shared similar points of view, such as the low upfront cost due to the lack of pre-construction activities, the complete control to subcontractors, the transfer of design risk to the lead architect/designer, the straightforward methodology, and so on. To cover all the explained points, one of the participants describe the simplicity of the method as "It's pretty

much an industry standard. Everyone's familiar with this approach. There are the documents [, and those are] generally generated in that way by the design team." Although TS is a method with many collaborative issues, the industry accepted it because of its familiarity among the industry professionals.

Specialty Contractor

Although the interviewees shared many of the points that have been explained by General Contractors, they highlighted that the TS model might help the upper tiers predominately. The only advantage detected by them relies on the change orders authorization explained in the following quote; "if [the] designer makes a mistake, I get to bill for it. [For] any error in the drawings or something I get to bill for [it]."

DISADVANTAGES

General Contractor

As described by one interviewee, "The downside to this type of project [method] is that because we don't get involved with the designers until the job is bid out or priced, it doesn't give us a chance to come up with as much value engineering for the owner to help you and get a better product or saving money."

Considering the cost efficiency evaluation, the participants made valid points where they showed negative comments to this method. (1) "[When] All the numbers coming over budget […] it's very difficult at that time to your value engineering gives the project down within the budget, and takes a lot of time […] redoing design work and it's not very effective." (2) "The lowest contracts doesn't

[don’t] always mean they're the most qualified contractor. So, that also can lead to quality and safety concerns of the project.”

The common negative factor is based on the lack of communication between general contractor and designer from the earliest project phases where they can provide a better scope and solutions to the project. Considering the adversarial environment as the principal result that generates TS method among the construction professionals, all efforts are directed to avoid it using more collaborative methods.

Specialty Contractor

Specialty Contractors detected cost, time, quality, and safety as the principal factors that might be affected for using TS model. However, this subcontracting model does not provide room for specialty contractors to be involved on overall project decisions; instead, they are simply tasked on their portion of scope, and usually selected on a competitive basis. Then, the Specialty Contractor has “to stay at arm's length [in] some discussions with the designer until we're already engaged and their contract is underway.” So, the inability to create collaborative relationships might create the idea between designers that any contribution from lower tiers would be “perceived as a challenge or threat to the designer.”

TS VARIATIONS

Under this section, General and Specialty Contractors shared the same points of view. Both participants described the unequivocal necessity to jump to more collaborative methods where the design stage would be improved by all parties; from designers to contractors. Although the owner may keep separate contracts between his primes, participation and team working are factors that

should be linked. Another point where interviewees have had a consensus is related to the new General Contractor roles.

(1) “It is that the job [of a general] contractor is becoming [more of] a construction manager. It's not really doing its job as a general contractor anymore it's getting more and more closer to be a construction manager” (2) “[Now] you're responsible for that, but what's happening is a lot of general contractors no longer there used to be involved in their own carpentry and stuff like thirty years ago. […] and [they] switched to [being] management firms.”

OWNER INVOLVEMENT

The participants’ comments pointed to make the distinction between competitive and negotiated environments. Inside the competitive procurement method, “the owner has no input in the subcontracting model. Unless [the owner] has a subcontractor that they just do not want to work with”. In contrast, for negotiated contracts “the owner contracts [the subcontractor] directly outside the general contractor administration due to the high specialization of the scope or past positive experiences” or “if the owner would prefer [the subcontractor] and it's more expensive, the owner would like to pay the difference.”

4.2.3 Traditional Subcontracting Design Assist (TS-DA) Model

CODING OVERVIEW

The following crosstab and word cloud have been created using NVIVO 12 to provide information about which participants (GC or SC) and regions (R1 to R5) had better participation rates and shared meaningful details as showed in the past subcontracting model.

General Contractors from regions R1, R2 and R3 gave information about TS-DA, but R3 has the largest percentage due to the bigger number of participants. On the other hand, Subcontractors from regions R2, R3, R4, and R5 have a more balanced coding participation between their regions where R2 and R3 represent the greatest percentages in contributing information. Table 5 shows the participation rate of each category and region while Figure 14 exhibits the key words of the participants.

Table 5. Traditional Subcontracting Design Assist Crosstab

Participants Information	Contractual Status = General Contractor (13)					Contractual Status = Subcontractor (7)					Total (20)
	R1 Northeast (3)	R2 Southeast (1)	R3 Central (9)	R4 Mountain (0)	R5 Pacific (0)	R1 Northeast (0)	R2 Southeast (3)	R3 Central (2)	R4 Mountain (1)	R5 Pacific (1)	
Cons (TS-DA)	9.09%	9.09%	54.55%	0%	0%	0%	0%	18.18%	0%	9.09%	100%
Familiarity (TS-DA)	9.09%	0%	45.45%	0%	0%	0%	9.09%	18.18%	9.09%	9.09%	100%
Owner Involvement	20%	20%	40%	0%	0%	0%	0%	0%	0%	20%	100%
Pros (TS-DA)	13.33%	6.67%	40%	0%	0%	0%	20%	13.33%	0%	6.67%	100%
Use (TS-DA)	15.38%	7.69%	38.46%	0%	0%	0%	15.38%	7.69%	7.69%	7.69%	100%
Variations (TS-DA)	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%
Total (unique)	**17.65%**	**5.88%**	**35.29%**	**0%**	**0%**	**0%**	**17.65%**	**11.76%**	**5.88%**	**5.88%**	**100%**

The crosstab shows the spread of comments from the interviewees in each TS-DA interview section. The percentage is defined by NVIVO 12 software.

Figure 14. Traditional Subcontracting Design Assist Word Cloud

USE

In general, this method represents the second or third most used method for both participants. The design component starts to be part of the tasks and objectives among general and specialty contractors where the later has a greater opportunity to provide some design insights outside any contractual requirement. Although the design involvement is something that specialty contractors are looking for, the construction industry began to use TS-DA model in the last 15 years. For this reason, the research identifies in average 10 to 15% use for General and Specialty Contractors. There are some exceptions where the clients allow it and encourage its implementation. Examples of the exceptions were provided by the participants, such as equipment manufacturers where "they will have […] a pre-selected piece of equipment […]. They [Equipment Manufacturers] would still be under our [General Contractor] contract, but they have been working on the design with the engineers and owners too", and Specialty Contractors getting clarification from the lead

designer for any misunderstanding in the contract documents; “we [Specialty Contractors] are going to say something because we will never do something is not structural sound.”

ADVANTAGES

Analyzing the word cloud at the introduction of this subchapter, the concepts which appeared repeatedly are design, specialty contractor, constructability, consultant, and owner. Then, reading between the lines, one of the principal paradigms across the construction professionals is based on the full participation in design stages where they can contribute to the project constructability that generate advantageous scenarios. The positive results that could be obtained through the process rely on the situation when, “the general contractor chooses a specialty subcontractor [that] can influence the design, which allows that specialty subcontractor as well as a general contractor to have some input regarding constructability, and ultimately constructability can affect cost and schedule.” As a result of this design collaboration, all the constructive building coordination and reduction of change orders would be possible due to the close communication. In contrast to the TS model, this subcontracting approach summarizes all the opinions and determines who “has more experience with the products,” where specialty contractors are the best element to help out design consultants and create a smoother project from “reactive to proactive mode.”

DISADVANTAGES

Similar to TS-DA Advantages, General and Specialty Contractors had a consensus about the potential disadvantages that special trades might face during the design performance, and the collateral effect that general contractor would experience. Although the design risks of TS-DA are not shared by both parties, general contractors need to be worried about selecting the right specialty

contractors with design capacity and remind the lead designers and owners “of the chain of command” where all information comes through the prime.

Now, considering the negative points that affect to Specialty Contractors under TS-DA approach, the lack of guarantees inside the design phase plays an important role. The specialty contractor who participates in the design phase would experience the possibility of being unpaid for their design services. Also, there is no assurance to specialty contractors to be awarded with the projects where they participated during the design phase.

Finally, if the specialty contractor received the award to execute the construction phase but all his design efforts aren’t captured correctly by the designer due to “designer didn’t do a good job of [on] integrating the [TS-DA] designs into their overall documents”, the specialty contractor could have lost time, effort, and resources invested during the design stage.

TS-DA VARIATIONS

Interviewees didn’t provide any variations of this subcontracting method. All the responses were directed to Design Build Subcontracting.

OWNER INVOLVEMENT

Under TS-DA subcontracting model, owners can participate in selecting specific contractors or services. They may choose between competitive and negotiated processes, following their specific type as private or public owner. Some interviewees described owner participation using cases where owners were looking for pre-selected equipment. One example is based on the selection of subcontractors for a wastewater plant which “it is designed around a certain piece of equipment- a certain process. So, the owner it's heavily involved in that specifying several different types of

grey removal systems. This decision depends on […] the building and if everything is going to look like [as planned]. So, I would say the owner is heavily involved in that aspect".

4.2.4 Design Build Subcontracting (DBS) Model

CODING OVERVIEW

The following crosstab and word cloud have been created using NVIVO 12 to provide information about which participants (GC or SC) and regions (R1 to R5) had better participation rates and shared meaningful details as showed in the pasts subcontracting model.

General Contractors from regions R1, R2 and R3 gave information about DBS, but R3 has the largest percentage due to the bigger number of participants. On the other hand, Subcontractors from regions R3, R4, and R5 have a more balanced coding participation among them. Only region R2 showed an increase in the participation for this specific subcontracting method. Table 6 shows the participation rate of each category and region while Figure 15 exhibits the key words of the participants.

Table 6. Design Build Subcontracting Crosstab

Participants Information	Contractual Status = General Contractor (13)					Contractual Status = Subcontractor (7)					Total (20)
	R1 Northeast (3)	R2 Southeast (1)	R3 Central (9)	R4 Mountain (0)	R5 Pacific (0)	R1 Northeast (0)	R2 Southeast (3)	R3 Central (2)	R4 Mountain (1)	R5 Pacific (1)	
Cons (DBS)	21.43%	7.14%	35.71%	0%	0%	0%	14.29%	7.14%	7.14%	7.14%	100%
Familiarity (DBS)	10%	0%	60%	0%	0%	0%	10%	10%	0%	10%	100%
Owner Involvement	33.33%	0%	33.33%	0%	0%	0%	0%	0%	16.67%	16.67%	100%
Pros (DBS)	25%	8.33%	41.67%	0%	0%	0%	8.33%	8.33%	8.33%	0%	100%
Use (DBS)	18.18%	9.09%	36.36%	0%	0%	0%	18.18%	9.09%	0%	9.09%	100%
Variations (DBS)	11.11%	11.11%	55.56%	0%	0%	0%	11.11%	11.11%	0%	0%	100%
Total (unique)	16.67%	5.56%	44.44%	0%	0%	0%	16.67%	5.56%	5.56%	5.56%	100%

The crosstab shows the spread of comments from the interviewees in each DBS interview section. The percentage is defined by NVIVO 12 software.

Figure 15. Design Build Subcontracting Word Cloud

USE

The DBS model keeps many characteristics from TS-DA where design and collaboration activities are the factors that define these methods. However, the key difference is that under TS-DA specialty designer and contractor only have a functional relationship; under DBS, specialty design and contractor belong to the same contractual entity either an organization or a joint-venture between organizations. The use rate for DBS is similar to TS-DA which has a range from 10 to 15% for both contractor types. The percentage is focused on the DBS model without modification or variation, but some participants made meaningful arguments on regard to the differences between this subcontracting method and the traditional design-build where the probable use may rise to 30%. Probably, the traditional design-build might produce more followers within the construction professionals, but both design-build models share the property where the specialty

contractors have the expertise of designing and building specific products and services such as landmark tanks, containers, fire protection codes, and highly specialized electrical products.

ADVANTAGES

The more in-depth elaborated team environment where "trade partners and specialty contractors are fully committed to the project," helps to achieve the collaborative objectives such as early contractor involvement, better communication, and "good design criteria to start the construction process without delivering full drawings and specifications." This design flexibility provides the opportunity to start construction faster, so the specialty contractors are not waiting for the full design from the lead architects.

Unless something else may be specified in the contracts, the specialty contractor has to follow only performance requirements that allow him to keep his own cost and design control. For this reason, there are some practices where the specialty trade is the only party who keeps "the standard practices that can be implemented in specific construction activities […], and allow the contractor to think out of the box for better solutions."

In summary, DBS advantages can be described using one of the close-out statements for one of the interviewees who believed that "everybody's got an incentive to work together to find a solution. It doesn't prevent it [adversarial situations], [but] lessens the finger pointing out. […] it helps [to] spread liability to everybody."

DISADVANTAGES

Surprisingly, participants described some negative aspects from the DBS method. Factors like cost and time appear to be the principal concerns of all contractor types. In factors such as cost, general

contractors are afraid to create accurate estimates when they need to sign Guaranteed Maximum Price (GMP) contracts with the owner. So, every design iteration is an implied risk of overdesigning some package that may increase the bottom line. In addition, the potential attachment of contingencies that specialty contractors probably include in the design will worsen the situation. Time is another factor and it is focused on the "time-consuming process because a lot of times you [general contractor] have a conceptual bid that you [design-build entity] have to go from conceptual bid to a detailed bid or detailed design and try to get approval [award] from the owner." Finally, the last factor that general contractors try to avoid is getting along with bad partners because the process "it's going to be pretty miserable for all the parties," without achieving the project objectives.

On the other hand, specialty contractors' disadvantages are based on the risk of missing concepts in the design and the bad performance requirements from the owner's designer. Although only seasoned specialty contractors are the ones who can develop DBS correctly, the design liabilities represent a real risk that they must avoid. The only way to establish solid foundations and reduce the risk of performing DBS is achieving the objectives of time, cost, quality, and safety as a team without segregating responsibilities.

DBS VARIATIONS

The only variation on this method is focused on the distinction between DBS and traditional Design Build. Some interviewees recognized DBS in the construction market and described it as "[Specialty Contractors] are working together with the lead designer. […] there would be a narrow back and forth between the lead designer and the design-build subcontractors [with] several variations when it comes to design-build". Even though this method works for some participants,

the second part of the sample argues its functionality without an in-house designer or designers that were hired by the design-build entity. So, basically "the general contractor will hire an architect […] to finish the drawings and specialty contractors to do the design-build scenario for special trades". Using the traditional approach, the design-build entity may save time avoiding the back and forth with the lead designer, and only be aware of the performance requirements that were established at the start of the procurement and award processes.

OWNER INVOLVEMENT

In the DBS method, the owners influence the creation of performance specifications with their lead designers for the future bidding and award negotiation processes throughout the design-build entities. During the award stage, the owner may have a say or input regarding the specialty contractors that are part of the awarded joint venture. He might come back and ask for more qualifications if some of the specialty contractors provided bad services in the past or the selection of specific services and products.

4.2.5 Integrated Design-Construction Subcontracting (IDCS) Model

CODING OVERVIEW

The following crosstab and word cloud have been created using NVIVO 12 to provide information about which participants (GC or SC) and regions (R1 to R5) had better participation rates and shared meaningful details as showed in the past subcontracting models.

General Contractors from regions R1, R2 and R3 gave information about IDCS where the first two regions have a balanced sample and R3 have the largest percentage due to the bigger number of participants. Subcontractors only have two regions (R2 and R4) with some coding participation.

In comparison to the past subcontracting methods, this one shows a region coding decrease. Table 7 shows the participation rate of each category and region while Figure 16 exhibits the key words of the participants.

Table 7. Integrated Design-Construction Subcontracting Crosstab

Participants Information	Contractual Status = General Contractor (13)					Contractual Status = Subcontractor (7)					Total (20)
	R1 Northeast (3)	R2 Southeast (1)	R3 Central (9)	R4 Mountain (0)	R5 Pacific (0)	R1 Northeast (0)	R2 Southeast (3)	R3 Central (2)	R4 Mountain (1)	R5 Pacific (1)	
Cons (IDCS)	25%	25%	25%	0%	0%	0%	0%	0%	25%	0%	100%
Familiarity (IDCS)	25%	25%	25%	0%	0%	0%	0%	0%	25%	0%	100%
Owner Involvement	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%
Pros (IDCS)	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%
Use (IDCS)	20%	0%	60%	0%	0%	0%	20%	0%	0%	0%	100%
Variations (IDCS)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total (unique)	14.29%	14.29%	42.86%	0%	0%	0%	14.29%	0%	14.29%	0%	100%

The crosstab shows the spread of comments from the interviewees in each IDCS interview section. The percentage is defined by NVIVO 12 software.

Figure 16. Integrated Design-Construction Subcontracting Word Cloud

USE

The coding participation rates show the reduced use of IDCS among the interviewees. The industry comments about this method locate its application to less than 10%, but some participants highlighted their limited capacity and knowledge of the IDCS method because of their minimum contact. Even more, the regions which participated in this sub-chapter specified that the IDCS hottest zone could be located to the West Coast. Probably, the second IDCS zone might be the Midwest, but its numbers are far away from the West Coast.

Inside the four sample regions, participants explained the two principal scenarios where IDCS methodology can be observed. The first case falls within the scope of doors and hardware specialty contractors. “The design team, their agreement with them [specialty contractors] to assist overall design, all the interior storefront, all the doors, and hardware to the project. Then, on the general contractor side, they are the fabricator, and they install all these storefront doors and hard work”. The second case is focused on the relationship between developers, architects, general contractors, and specialty contractors at the first stages of the project where owner and architect select which contractors are the most qualified to start working with them. After choosing them, architects, consultants, and specialty contractors develop the design stage to create all contract documents. When all the design package is ready to be implemented on-site, the general contractor may act as a construction manager to administrate all the specialty contractors’ construction efforts.

ADVANTAGES

Only one positive aspect could be identified through all the participants who commented about IDCS methodology. This situation hasn’t surprised the research team because of the small number of coding references and lack of knowledge among interviewees. The potential creation of better

information “from somebody who does that [specific] trade or furnishing [services].” Releasing the lead designer to set parameters for something that he doesn’t know and hiring someone who can design and deliver the final product under the watch of both primes (designer and general contractor) would increase the chances to perform the project objectives correctly.

DISADVANTAGES

The only contractual party that detects disadvantages was the general contractor who is aware of detecting collusion between specialty contractors and designers and communication problems. In contrast, specialty contractor only agreed about the benefits to be more involved in designing tasks without specifying any disadvantage.

The first concept is easy to explain, general contractors have the suspicious that architects deal secretly with owner representatives to hire their specialty contractor options without consulting the general contractor. In this case, designers and specialty contractors are more interested in their economic welfare rather than the project benefit. The second factor is related to the communication channels among architects, general, and specialty contractors. Since the specialty contractor is the operation center for design and construction, all activities are filtered by them. As the project is progressing in design and construction schedules, general contractors felt lost in the process because they are not informed at first instance for every change, advance, or any simple quotation. General contractors expressed this feeling as follows: “a lot of the times that [the] special contractor is working farther out ahead on any potential modifications or changes to documents. And [the specialty contractor is] more aware of it than what the general contractor is. Because […] they're taking information that they know, it was forthcoming change, and working off of it and the general contractor not yet aware of it”.

IDCS VARIATIONS

The participants will not register any modification because of the novelty and lack of experience using this method.

OWNER INVOLVEMENT

Selecting IDCS as a process is an irrefutable proof that the owner had direct input in the project. Going through all the possible methodologies and choosing one of the most unknown and innovative practices; one step behind from Integrated Project Delivery (IPD), is enough insight to understand that owners want to influence the project. They can select or run the last evaluation of consultants, specialty contractors, and the deliveries during the process.

4.2.6 Integrated Specialty Work Subcontracting (ISWS) Model

CODING OVERVIEW

The following crosstab and word cloud have been created using NVIVO 12 to provide information about which participants (GC or SC) and regions (R1 to R5) had better participation rates and shared meaningful details as showed in the pasts subcontracting model.

General Contractors from regions R1, R2 and R3 gave information about ISWS where R3 has the largest percentage of coding participation due to the bigger number of participants. On the other hand, Subcontractors from regions R2, R3, R4, and R5 share meaningful comments, but the principal regions are R2 and R3. Table 8 shows the participation rate of each category and region while Figure 17 exhibits the key words of the participants.

Table 8. Integrated Specialty Work Subcontracting Crosstab

Participants Information	Contractual Status = General Contractor (13)					Contractual Status = Subcontractor (7)					Total (20)
	R1 Northeast (3)	R2 Southeast (1)	R3 Central (9)	R4 Mountain (0)	R5 Pacific (0)	R1 Northeast (0)	R2 Southeast (3)	R3 Central (2)	R4 Mountain (1)	R5 Pacific (1)	
Cons (ISWS)	27.27%	9.09%	36.36%	0%	0%	0%	9.09%	0%	9.09%	9.09%	100%
Familiarity (ISWS)	16.67%	8.33%	25%	0%	0%	0%	16.67%	16.67%	8.33%	8.33%	100%
Owner Involvement	0%	0%	50%	0%	0%	0%	0%	0%	50%	0%	100%
Pros (ISWS)	11.11%	11.11%	44.44%	0%	0%	0%	0%	11.11%	11.11%	11.11%	100%
Use (ISWS)	22.22%	0%	55.56%	0%	0%	0%	0%	11.11%	11.11%	0%	100%
Variations (ISWS)	16.67%	0%	33.33%	0%	0%	0%	0%	33.33%	0%	16.67%	100%
Total (unique)	18.75%	6.25%	37.5%	0%	0%	0%	12.5%	12.5%	6.25%	6.25%	100%

The crosstab shows the spread of comments from the interviewees in each ISWS interview section.

The percentage is defined by NVIVO 12 software.

Figure 17. Integrated Specialty Work Subcontracting Word Cloud

USE

Under this subcontracting method, all participants are aware, and they have used the method at least once on their professional practice in each project. The percentage in this section shows what ISWS percentage is used inside projects. Also, this sub-chapter may differentiate the information for general and specialty contractors due to the variation between both samples.

General Contractors

ISWS has different reactions inside the General Contractor's environment, where some interviewees accept the benefits of using this subcontracting practice. The participants who identify a benefit in applying the method on a regular basis set the percentage use in 50% of all their projects. One participant explained that this method is common when differently SC share the project space and carry overlapping scope items. For instance, this general contractor described how on a project the ISWS took a nested form. On this project, the general contractor had three specialty subcontractors: (a) an IT sub in charge of the IT room and its fire alarm, (b) a fire suppression sub in charge of fire suppression, including fire alarm and their wiring, and (c) an electrician. By taking the ISWS to nested level, the IT sub decided to subcontract the installation of the fire alarm inside the IT room to subcontractor (b) that decided to subcontract the fire alarm wiring to subcontractor (c).

On the other hand, the participants who detect a negative impact in their activities argued that each subcontractor has a specific scope of work according to their specialization. So, the potential transfer of activities among contractors might be understood as an alarm which identifies incompetent special trades and their exclusion for future projects. Another point highlighted the

probability of “stepping on everybody’s toes” because of the overlapping of schedules and scopes when ISWS occurs.

Specialty Contractors

In general, all the participants in this sample accepted the benefits of using ISWS. Although they initially alleged to rarely use this model, after understanding better what ISWS meant, recognized that most projects use it even if they adopt it for a limited portion of scope. The examples may vary from restoration projects to the common thermal insulation in houses and buildings. One participant described the ISWS process as follows: “we [the interviewee] needed to have some painting work on our scope. [then] We hire them directly for that [another specialty contractor]. So, they have a contract with the GC, and they had a contract with us”. Specialty contractors understand the worries from general contractors about the scope transfer among special trades, but they pointed to the imperfection of schedules and scopes that pushed them to find quick solutions.

ADVANTAGES

To describe this section, General and Specialty contractors who detected positive practices in ISWS showed similar insights. In contrast, the participants who had bad experience with this method jumped directly to the disadvantages. Many properties have been explained in the past paragraph, but more details may be included in this section to understand the position from some part of the sample.

The interviewees defended the efficiency point where if the project involved fewer people in on-site activities, the project is easier to manage in time, cost, safety, and quality. In other words, the

general contractor can identify few responsibility points. For example, these points are logically the largest trades such as MEP, HVAC, and so on.

Finally, participants refer to hire participants who already are performing activities in the same project to avoid bringing participants that need to learn the requirements. Also, those project contractors "usually are very specialized because they do these activities for a living, so they are the best candidates."

DISADVANTAGES

General Contractor

Describing ISWS disadvantages as isolate factors that are not correlated might be a mistake. Participants described a chain of negative events under the application of this subcontracting model. When any specialty contractor starts to provide help outside his original scope (the contractual scope with GC), usually the special trade will not add additional craft forces on site. The lack of resources to attend the increased scope provoke "another critical work that hadn't been planned for the GC." As a result, all the schedules should be modified to the new critical paths, and the administrative work of issuing change orders might increase exponentially. The bottom line can be understood as potential over-costs and delays in the project.

Specialty Contractors

In comparison to General Contractor's view, the special trades perspective is limited to the nearest activities, not the big picture. Some of their concerns are based on "don't get distracted by another contractor's scope" and "as Specialty Contractor, everyone expects that you can self-perform all your contract."

ISWS VARIATIONS

There are two variations from this method which modify the concept of horizontal support among trades to one vertical hierarchy structure. Specialty Contractors may subcontract other special trades from outside or inside the project site, generating third tiers with strict contract clauses to guarantee the right performance. Some specialty contractors refer that these practices weren't common ten years ago, but the highly specialized scopes and time constraints drive them to start dealing with this method.

Following the last statement where specialty contractors are getting used to having horizontal or vertical support, general contractors who refuse to follow ISWS practice start to implement a methodology where they hire largest special trades for specific tasks like scaffolding. They "helped to contract the scaffold for every trade on the job site where the trades could have had a contract with five different guys," and then, general contractors may have the control of the critical paths and project performance. Another methodology to control the specialty contractor's supportive agenda is based on authorizing any relationship between lower tiers. In this scenario, general contractors may authorize and ask for contractual arrangements to all specialty contractors who are interested in developing such supportive activities.

OWNER INVOLVEMENT

Inside the prime contracts between owners and general contractors, there is a conduit or flow down clauses which establish a previous authorization from the owner to contractors when they are selecting the specialty contractor for the project. So, these clauses have the objective to transfer the rights to general contractors in order to authorize any sub subcontract among specialty

contractor. Following this hierarchical sequence, owners under contractual clauses have control of any modification in the workforce planning.

4.2.7 Other Methods

CODING OVERVIEW

The following crosstab and word cloud have been created using NVIVO 12 to provide information about which participants (GC or SC) and regions (R1 to R5) had better participation rates and shared meaningful details as showed in the pasts subcontracting model.

Although the General Contractors coding regions were reduced to two (R1 and R3), the participants provided meaningful insights for Integrated Project Delivery (IPD) and other methods. Subcontractors from regions R2, R4, and R5 have important coding participation in both options, but their principal contribution is directed to other methods different from IPD. Table 9 shows the participation rate of each category and region while Figure 18 and 19 exhibit the key words of the participants.

Table 9. Other Methods Crosstab

Participants Information	Contractual Status = General Contractor (13)					Contractual Status = Subcontractor (7)					Total (20)
	R1 Northeast (3)	R2 Southeast (1)	R3 Central (9)	R4 Mountain (0)	R5 Pacific (0)	R1 Northeast (0)	R2 Southeast (3)	R3 Central (2)	R4 Mountain (1)	R5 Pacific (1)	
Different Model (Other)	14.29%	0%	28.57%	0%	0%	0%	28.57%	0%	14.29%	14.29%	100%
Integrated Project Delivery	33.33%	0%	33.33%	0%	0%	0%	0%	0%	0%	33.33%	100%
Total (unique)	22.22%	0%	33.33%	0%	0%	0%	22.22%	0%	11.11%	11.11%	100%

The crosstab shows the spread of comments from the interviewees in each Other Methods interview section. The percentage is defined by NVIVO 12 software.

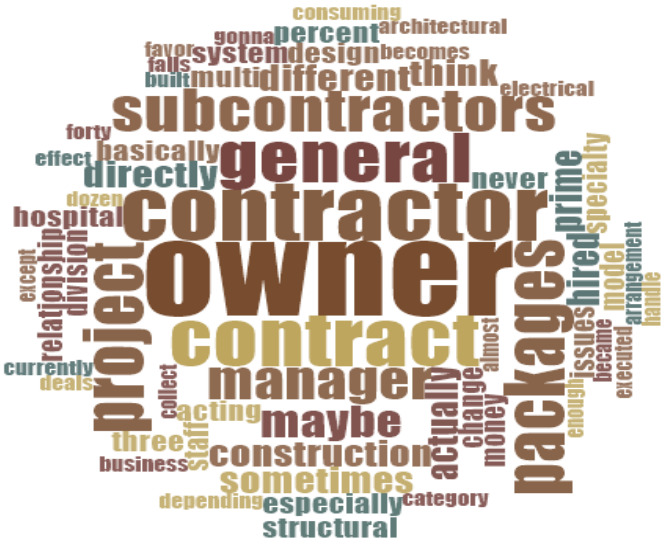


Figure 18. Other Different Subcontracting Model Word Cloud

Figure 19. Integrated Project Delivery Word Cloud

OTHER MODELS

The research identified two different methods which general and specialty contractors are aware of its occurrence in different projects. The next sub-chapters will reproduce the most important comments made by the participants to provide a clear image of these ideas. However, these

methods will not represent subcontracting methods. The models can be identified as construction administration methods for upper tiers that settle the channels to future subcontracting practices.

Multi-prime

The multi-prime method is more common among specialty contractors than general contractors for obvious reasons. Specialty Contractors have a direct link to the owners instead of working under the general contractor command. In other words, the owner acts as the general contractor and the special trades are highly specialized to complete their specific tasks without the coordination help that general contractors usually provide in the field activities. Some of the participants described benefits such as "money savings, staff reduction, and avoidance of delays." This method relies on the long-term relationships between owner and specialty contractor. So, the confidence and trust that have been created throughout the time give to the special trades the opportunity to perform their scope with more freedom.

Construction Manager at Risk

The Construction Manager profile was discussed throughout all the research when specialty contractors complained about the general contractor change from the traditional administration profile to a construction manager who only issues "change orders, payments, and the contractual relationships with the owner." This method is preferred by general contractors because they keep the control and status of the on-site project, but they delegate the contractual obligation of specialty contractors to the owner. Given this situation, the specialty contractor feels less freedom to attempt more collaborative methods. Owners have the last word about which subcontracting practices the project may pursue, but the construction manager will give some advice about how to proceed to

the subcontractors. As a result, this construction manager collaboration or advice reduces the specialty contractors' chances to get more involved in the project.

Integrated Project Delivery (IPD)

The detection of participants who used IPD in their construction projects was identified by the research as a good indicator that the construction industry is changing quickly toward more collaborative methods. As an important fact, interviewees from Missouri and Colorado were those who shared information on IPD that was based on direct experience.

The IPD characteristics detected for the participants are explained in the next paragraphs, the subchapter collected fragments of their interviewees' comments that define IPD as "working in conjunction with you and the other subs in equal circumstances." The revenue obtained for all parties are based on "sharing contingency savings on this project that gives them some incentive to coordinate with the general contractor, and it helps to save money for the project." Although these principles help to avoid adversarial relationships, IPD projects need "the right combination of people that work together as a team; it's all about picking the right team and making it work."

The IPD implementation is controlling for all the construction parties involved in the project, but owners should keep the economic factor alive. The pool administration of savings and losses must be effective and attractive for contractors. So, if the owners "remove all economic motivation and leave pride and reputation" as the only factors to keep working, the experienced contractors will run away from the IPD projects. Consequently, the industry will not have "enough people in the market to do their job right, without being babysat."

4.2.8 Project Owner Intervention

CODING OVERVIEW

The following crosstab and word cloud have been created using NVIVO 12 to provide information about which participants (GC or SC) and regions (R1 to R5) had better participation rates and shared meaningful details as showed in the pasts subcontracting model.

The General Contractors coding regions were reduced to two (R1 and R3) where the participants from R3 provided the most meaningful insights to this subchapter. Specialty Contractors covered the 100% of their coding regions (R2-R5), but the top information came from R2 and R3 regions. Table 10 shows the participation rate of each category and region while Figure 20 exhibits the key words of the participants.

Table 10. Owner Intervention Crosstab

Participants Information	Contractual Status = General Contractor (13)					Contractual Status = Subcontractor (7)					Total (20)
	R1 Northeast (3)	R2 Southeast (1)	R3 Central (9)	R4 Mountain (0)	R5 Pacific (0)	R1 Northeast (0)	R2 Southeast (3)	R3 Central (2)	R4 Mountain (1)	R5 Pacific (1)	
Owner Role (POI)	13.33%	0%	40%	0%	0%	0%	20%	13.33%	6.67%	6.67%	100%
Total (unique)	13.33%	0%	40%	0%	0%	0%	20%	13.33%	6.67%	6.67%	100%

The crosstab shows the spread of comments from the interviewees in each Owner Intervention interview section. The percentage is defined by NVIVO 12 software.

Figure 20. Owner Intervention Word Cloud

OWNER INTERVENTION OVERVIEW

The Owner Intervention in projects is based on identifying differences between participants. While specialty contractors recognized their lack of participation in the selection process, the general contractor described the scenarios which owners usually applied on their projects. The breakthrough happens when participants are hired by sophisticated owners who decide the application of innovative methods, allowing more collaboration and participation of every construction party.

As previously discussed, specialty contractors tend to perform the TS model in largest percentages. The result of working under traditional subcontracting models is the lack of involvement from lower tiers. Contractual clauses which limited their participation only to inform the prime contractor increases the lower tiers risk in performing their scope. The last-minute changes like "wait a minute, we want to do this instead of that" might represent great loss to the specialty contractors due to the reduced solution margin. The only solution under this isolated environment is the direct request from the owner to select specific special trades where the long-term

relationships may give to specialty contractors more participation during the design and construction stages.

The difference between general and specialty contractors in discussing the methodologies and contractual paths with the owners rely on the close relationship during the selection process. Generally, general contractors start the procurement process knowing the requirements, owner relationships, contractual characteristics, and the project background. So, when the project follows traditional contracting methods, general contractors assume freedom to select any Specialty Contractor under any method; competitive or negotiated. Owners who select the traditional way are participants that might feel uncomfortable using innovative processes due to their inexperience or familiarity with a specific model.

Sometimes, there are owners in the market who want to be instructed in Project Delivery Methods, procurement processes, and subcontracting models. Here, general contractors explain to them what the benefits and shortcomings are for each method. After some number of projects, the owner may understand the processes and characteristics of the industry, turning on more sophisticated decisions with major eagerness to participate in all resolutions. When owners decide to be involved under this educational phase, general contractors avoid confusing requests like “I want to competitively bid the electrical package of work because I want more than one price, but I would like to work with ABC electric at all possible.”

In conclusion, all decisions will come from the owner perspective where General Contractors may guide them to select the right choice depending on the project characteristics. The owner as a client and the principal investor will retain the control of the project in all aspects. Cases which owners ask for “a better way to do this” should send contractors the clear message to start doing

"engineering value" without expecting the owner comprehension of what it means. Even more, the final decision of which specialty contractor must be contracted relies on the owner desire of interviewing, pre-listing them or giving freedom to contractors.

4.3 Interview Results

The analysis throughout the interviews has detected interesting insights of all the subcontracting methods that were discussed with the follow-up participants. Although the most important interviewees' comments have been covered and explained in the past subchapter, this subchapter has the objective to represent and describe the principal characteristics of the subcontracting variations graphically.

The subcontracting models that have been explained to the participants had a good acceptance ratio in use and descriptions. For this reason, the interviewees haven't introduced new subcontracting practices as expected in one of the thesis objectives. In contrast, the research identified a high specialization grade inside the existing subcontracting methods that can be traduced in variations or modifications of one model. The subcontracting model which contains these variations is the Integrated Specialty Work Subcontracting.

The interview analysis has identified three variations to Integrated Specialty Work Subcontracting. Traditional Subcontracting, Traditional Subcontracting Design Assist, and Integrated Design Construction Subcontracting models haven't shown any variation from the participants. Design Build Subcontracting has shown insights from the participants comments but those insights were addressed in the Literature review chapter. One important factor is that general and specialty contractors who participated during the follow-up process have confirmed the application of the five main subcontracting practices, their characteristics, and participants. Table 11 summarizes the

three new model variations that have been identified in the interview analysis subchapter with their principal characteristics. At the end of this chapter, Figure 24 shows the five Osmanbhoy subcontracting models with all variations.

Table 11. Subcontracting Method Variations

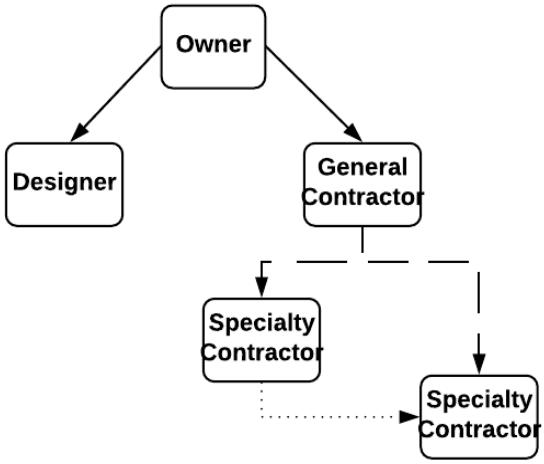
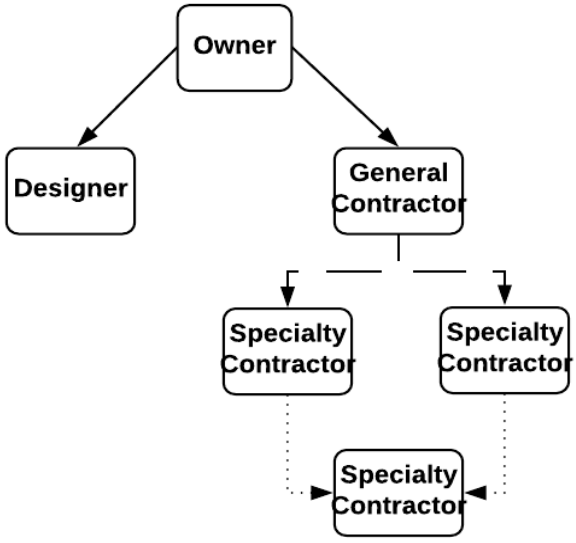
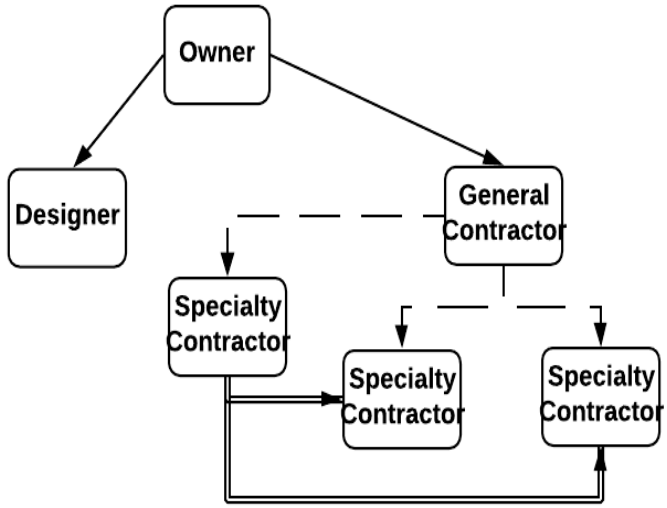
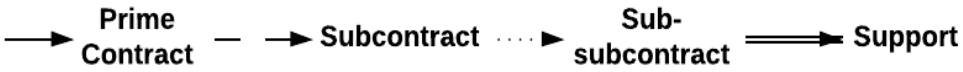
SUBCONTRACTING MODEL DIAGRAM	CHARACTERISTICS
ISWS Variation 1	
 Figure 21. ISWS Variation 1	- Strict Contractual link between Specialty Contractors. - The Specialty Contractor who hires another specialty contractor must receive the authorization from the General Contractor to share the contractual link.
ISWS Variation 2	
 Figure 22. ISWS Variation 2	- Sub-subcontractors may create more than one link between the subcontractors. - The sharing of special trades between subcontractors is based on the high task specialization. The process resembles the traditional ISWS. Now, this process comprises third tiers between subcontractors.

Table 11. Subcontracting Method Variations (continued)

SUBCONTRACTING MODEL DIAGRAM	CHARACTERISTICS
ISWS Variation 3	
 Figure 23. ISWS Variation 3	- The model is the General Contractor solution to avoid any help among lower tiers. - The General Contractor identifies repetitive activities in the project. Then, he will hire the special trade who performs these activities directly. This trade has the objective of supporting all subcontractors in those repetitive activities.



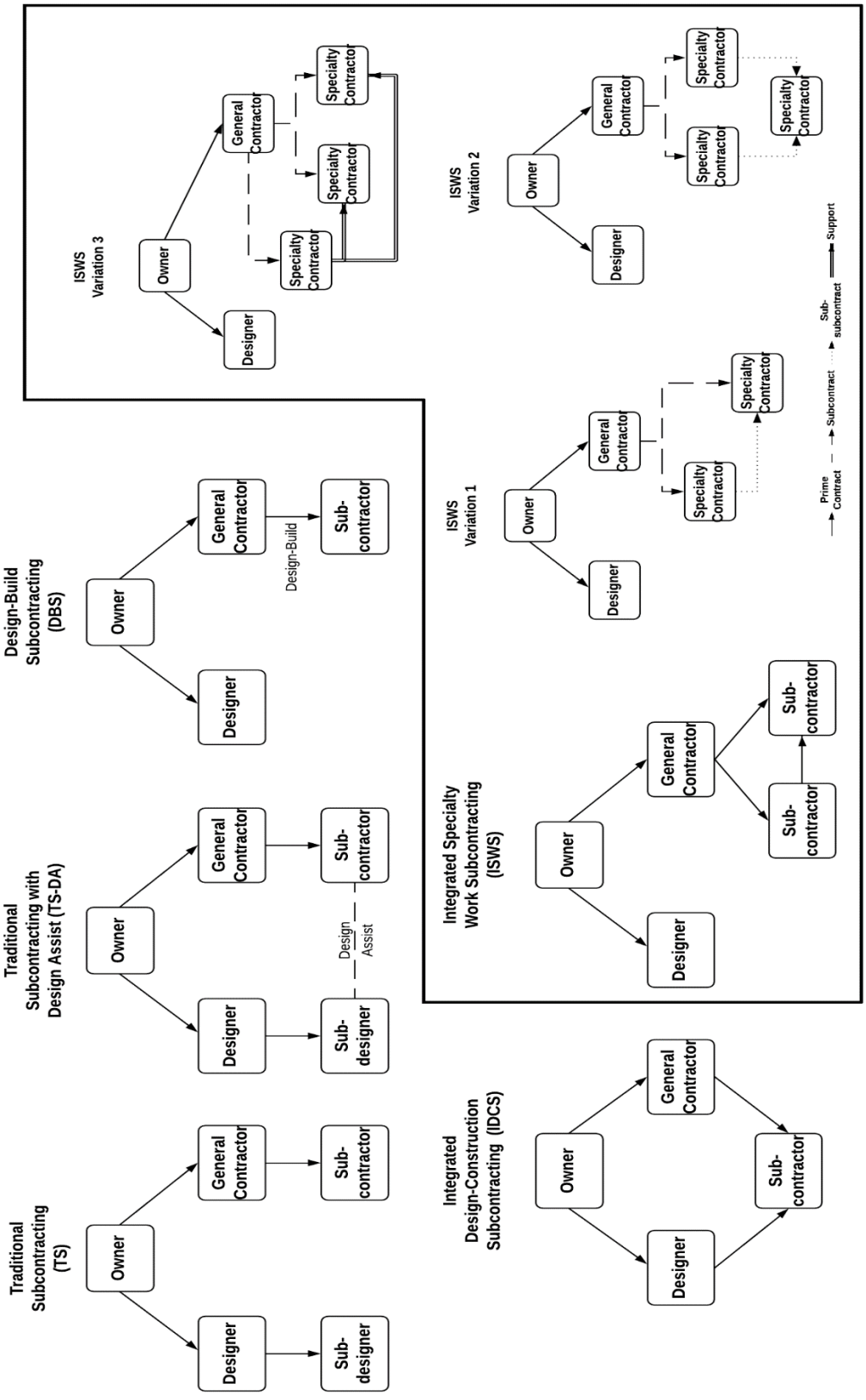


Figure 24. Subcontracting Models and Subcontracting Variations

Chapter 5. CONCLUSIONS AND FUTURE RESEARCH

5.1 CONCLUSIONS

Analysis of the online survey data showed that all nine divisions participated in the process, but the major participation numbers are in the divisions West North Central and West South Central, which provides for a bias in this study's conclusions. Overall, survey's sample included participants who had experiences with the main PDMs (e.g., DBB, DB, and CM/GC). The participants' firm grasp of the range of PDMs gave the research team confidence in the reliability of the results, since it was unlikely that respondents would change their opinions were they to discover new methodologies during the research process. On the other hand, their understanding of the procurement process was limited to only three methods: best qualifications; low responsible bid; and business relationships. The last factor evaluated in the survey was the multi-contractual arrangement, which 50 percent of participants reported to be their preference. In spite of this general preference, though, the contractual links between prime contractors and subcontractors did not vary. Owners, and prime contractors maintained their positions of power; and in only a few reported cases did the specialty contractors and designers have any influence on decisions.

The follow-up interview process worked as a complement to the survey, allowing participants to explain the qualitative factors of their use of specific subcontracting methods. Indeed, the interviewees were able to describe in detail their experiences with all five subcontracting models. The survey participants had not even been asked about these models, since the research team had decided to gather this data from the most experienced participants, all of whom had been selected for the interview phase. This second phase limited the scope only to understanding the general and specialty contractors' perspectives on sub-contractual arrangements.

The results confirmed the outputs from the online survey where the major number of participants came from central follow-up region generating a regional bias again. The results had shown a resemblance between the sub-contracting arrangements used in the modified regions and those used in the corresponding U.S. census regions. Two of the modified regions Mountain and Central were found to have the most relevant examples of collaborative subcontracting practices. The only exception was seen in Florida, where one of the participants reported performing some of the most collaborative subcontracting methods, e.g., IDCS.

Overall, the interviewees exhibited a good comprehension of the methods used and the ability to differentiate all the contractual processes. However, within each PDM and procurement type, each region showed its characteristic mix of methods used. Although there is major concentration of participants in central divisions, the divisional samples had some degree of equilibrium among traditional practices (i.e., DBB, lowest responsive bid, and no multi-contractual arrangements) and more collaborative techniques (e.g., DBB, CM/GC, business relationships, and best value), some regions were found to work with more traditional methods than others. Participants from the Pacific, Mountain, and West North Central divisions of the U.S. Census Bureau reported using more collaborative and multi-contractual practices. The other regions demonstrated a more equilibrated sample, with a tendency toward traditional methods.

The results from both the online survey and follow-up interviews confirmed that the participants still use traditional subcontracting and procurement practices to a large extent. In some regions, these traditional practices are the primary option for all project types, both public and private. Exceptions to this general finding were found in the West Coast and Midwest regions, where the use of traditional methods has lessened significantly over time, due to the upper-tier inclusion of the new subcontracting methodologies.

The continuous innovation in PDMs and subcontracting methods in Central regions was evident in the answers from both the online survey and follow-up interviews. In almost all the states in this region, PDMs such as Design-Build, Public-Private Partnerships, Integrated Project Delivery are becoming real options; and Construction Management/General Contractor (or Construction Manager at Risk) is gaining popularity even though it is not yet widely used.

The contrasts among the U.S. regions based on the follow-up participant's comments in terms of subcontracting practices were evident in the participants' eagerness or reluctance to apply collaborative methods. While contractors from Western and Central regions are comfortable experimenting with the most progressive contracting models to find the best solutions, those in the Atlantic region tend to rely on traditional methods without questioning their effectiveness. Given these results, the tendency to use collaborative methods in the regions where participants have major participation rate depended on the contractors' familiarity, confidence, and attitude toward risk. Participants from the Western and Central regions reported being motivated to take more risks to discover contracting methods that can establish new patterns among owners, companies, public entities, and trades, all to promote industry progress.

Finally, while analyses of the survey and interview data revealed variations in one of the five subcontracting practices, this research was unable to identify any completely new subcontracting practices. However, only three variations can be determined as new. The DBS insights from the interviewees confirm the models discussed in the literature review where participants may choose between the DBS practices and traditional Design-Build. Also, TS and TS-DA discussions in the literature review have gotten confirmation throughout the comments during the follow-up interviews. Although the results have a regional bias where a major part of the participants came from Central divisions, the thesis can infer two conclusions: first, all five subcontracting models

studied to address the most common scenarios and characteristics are familiar to the nationwide participant sample; second, since the need to find better contractual arrangements creates effective variations from the original models, it is clear that subcontracting practices are dynamic by nature where all five subcontracting practices can co-exist in the some project.

5.2 Future Research and Practical Applications

The current study has identified four future research directions that may be undertaken to expand this study. The first research direction would be to expand the interview sample by including both general and specialty contractors from a more widespread geographical distribution. This would reduce the hidden bias that we have previously recognized. As part of this additional interviews, it would be beneficial to hear from owners and designers. This research direction would both reduce the geographical bias and incorporate perspectives from all project participants.

To pursue this direction, a researcher could purchase access to the Engineering News-Record (ENR) membership list to acquire the latest contact information on designers, contractors, specialty contractors, design-build entities, and CM@Risk companies. The accuracy of this frequently updated and ranked list would increase the response rates for online surveys and telephone interviews. In addition, collaborative efforts with researchers at other construction-related university programs could allow for a broader list of personal contacts. In this study, conclusions were heavily grounded in responses from survey respondents and interviewees from the Central divisions thanks to the collaboration between the University of Washington and Missouri State University—both of which have well-established industry connections in their own and contiguous regions. Note: outreach to the northwestern contracting community was pursued as part of Osmanbhoy's thesis.

The second potential research direction would aim at the identification of factors that affect the decision-making among subcontracting models. The evaluation of the characteristics, differences, and risks for each region would create a matrix of properties of each subcontracting practice. The purpose of this matrix is oriented to support the decision-making process for economic players who want to initiate construction activities in different regions. The opportunity to understand specific subcontracting properties could support better planning scenarios or help companies identify whether a geographic market is ready for the use of a subcontracting model, which may be novel to it. With this information, they could prevent gaps between their expectations and the local knowledge about each subcontracting practice. Moreover, constant monitoring of this matrix would help researchers recognize the principal problems and subcontracting gaps among regions, allowing them to identify the patterns that they would need to understand theory frames. Examples of these factors are the construction investment and the public construction statutes throughout the time addressed in Appendix D.

A third research direction would be based on detecting which project stakeholders are driving the subcontracting process. In addition to other contributions, this research confirmed the familiarity with Osmanbhoy's subcontracting practices from participants all across the US and investigated the owner involvement in the process. Beyond these achievements, researchers could study in the future what is each participant's role in selecting subcontracting practices, what is the impact of taking those decisions throughout the process, what are the participant characteristics, and variations.

The fourth and last research direction would focus at understanding how requirements to apply building information modeling (BIM) tools may drive toward the use of integrated project delivery methods, and when IPD is not available, how it could drive to push down some of the IPD concepts

through innovative subcontracting. Clevenger and Kahn (2014) highlighted in their future research section the possibility of detecting specialized trades such as mechanical-electrical-plumbing (MEP) contractors with the potential of creating new frameworks to design and fabricate their project scope with the approval of the lead designer under design-to-fabrication method and BIM practices. Also, overlaps existed between comments of this study's interviewees and comments made by Clevenger and Khan. Although the interviewees didn't mention anything about BIM, one of the interviewees suggested how establishing a platform for communication is important for collaboration: "The project and the general contractors [are] hiring the mechanical, electrical, plumbing, fire protection contractors, other especially contractors directly working together with the lead designer. There would be a narrow back and forth between the lead designer record for the architect with the design build subcontractors."

BIBLIOGRAPHY

Abbasian-Hosseini S., Howell, G., and Liu, M. (2016). "Relationship between On-Site Planning Efforts and Work Plan Reliability." *Construction Research Congress 2016*, 2129-2138.

Abbasian-Hosseini, S., Liu, M., and Hsiang, S. M. (2017). "Social network conformity and construction work plan reliability." *Automation in Construction 78*, 1–12.

Abkarian, H., El Asmar, M., and Underwood, S. (2017). "Impact of Alternative Project Delivery Systems on the International Roughness Index." *Transportation Research Record: Journal of the Transportation Research Board,* 76–84.

Ahmed M. O., El-adaway I. H., Coatney K. T., and Eid M. S. (2016). "Construction Bidding and the Winner's Curse: Game Theory Approach." *Journal of Construction Engineering and Management*, 142(2), 1-9.

Alleman, D., Antoine, A., Gransberg, D. D., and Molenaar, K. R. (2017). "Comparison of Qualifications-Based Selection and Best-Value Procurement for Construction Manager–General Contractor Highway Construction." *Transportation Research Record: Journal of the Transportation Research Board*, 2630, 59–67.

American Institute of Architects. (2007). "Integrated project delivery: a guide." https://info.aia.org/SiteObjects/files/IPD_Guide_2007.pdf (July 11, 2018)

American Institute of Architects, and Associated General Contractors of America. (2011). "Primer on Project Delivery." https://www.agc.org/sites/default/files/Files/Programs%20%26%20Industry%20Relations/AIA-AGC_Primer_on_Project_Delivery_2nd_Edition-FINAL.pdf (May 27, 2018)

Andre, G. R. (2012). "Design-Assist: Getting Contractors Involved Early." *Legal Insight*. https://www.klgates.com/files/Publication/055ae3ba-ecb7-43d0-be9b-412fb235407b/Presentation/PublicationAttachment/e4e0432e-8ae0-4656-824e-48d6a7619d36/Design-Assist-Getting-Contractors-Involved-Early_091912.pdf (Feb 28, 2019)

Arditi D., and Chotibhongs R. (2005). "Issues in Subcontracting Practice." *Journal of Construction Engineering and Management*, 131(8), 866–876.

Arizona Board of Regents/Alliance for Construction Excellence. (2007). "Design Assist - Best Method Approach to Subcontracting." *Alliance for Construction Excellence*. https://studylib.net/doc/18350545/design-assist---alliance-for-construction-excellence (Feb 26, 2019)

Associated General Contractors of America. (2010). "Integrated project delivery for public and private owners." https://www.agc.org/integrated-project-delivery (July 11, 2018)

Associated General Contractors of America, American Subcontractors Association, and Associated Specialty Contractors. (2008). "Guidelines for a successful Construction Project." http://consensusdocs.org/Downloads/Index?id=72849a56-b5fe-4768-b88a-a36f00b24590&name=Guidelines_Full.pdf (May 27, 2018)

Cao, D., and Wang, G. (2014). "Contractor–Subcontractor Relationships with the Implementation of Emerging Interorganizational Technologies: Roles of Cross-Project Learning and Pre-Contractual Opportunism." *International Journal of Construction Education and Research*, 10(4), 268–284.

Clevenger C. M., and Khan R. (2014). "Impact of BIM-Enabled Design-to-Fabrication on Building Delivery." *Practice Periodical on Structural Design and Construction*, 19(1), 122–128.

Contractor, F. J., and Ra, W. (2000). "Negotiating alliance contracts: Strategy and behavioral effects of alternative compensation arrangements." *International Business Review*, 9(3), 271–299.

Design Build Institute of America. (2018). "Design-Build Authorization." *DBIA*, https://dbia.org/advocacy/state/ (Aug. 13, 2018).

El Asmar M, Hanna A. S., and Loh W. (2013). "Quantifying Performance for the Integrated Project Delivery System as Compared to Established Delivery Systems." *Journal of Construction Engineering and Management*, 139(11), 1-14.

El-adaway I., Abotaleb I., and Eteifa S. (2017). "Framework for Multiparty Relational Contracting." *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, 9(3), 1-19.

Fails Management Institute. (2017). "U.S. Markets Construction Overview 2017." *4th Quarter 2016*. https://www.fminet.com/wp-content/uploads/2018/01/Overview2018_FINAL-1.pdf (March 12, 2018)

Federal Highway Administration. (2012). "Construction Manager/General Contractor (CM/GC) Authority in Various States." *FHWA*, https://www.fhwa.dot.gov/innovation/everydaycounts/edc-2/pdfs/edc_cm_gm.pdf (Aug 13, 2018)

Franz, B. W., and Leicht, R. M. (2016). "An alternative classification of project delivery methods used in the United States building construction industry." *Construction Management & Economics*, 34(3), 160–173.

Franz B. W., Leicht R. M., and Riley D. R. (2013). "Project Impacts of Specialty Mechanical Contractor Design Involvement in the Health Care Industry: Comparative Case Study." *Journal of Construction Engineering and Management*, 139(9), 1091–1097.

Ghavamifar K., and Touran A. (2008). “Alternative Project Delivery Systems: Applications and Legal Limits in Transportation Projects.” *Journal of Professional Issues in Engineering Education and Practice,* 134(1), 106–111.

Gil, N., Tommelein, I. D., and Ballard, G. (2004). “Theoretical comparison of alternative delivery systems for projects in unpredictable environments.” *Construction Management & Economics*, 22(5), 495–508.

Gil, N., Tommelein, I. D., Kirkendall, B., and Ballard, G. (2000). "Contribution of Specialty Contractor Knowledge to Early Design." *Proc., 8th Annual Conf. Int’l. Group for Lean Constr., Univ.of Sussex, Brighton, U.K.* 1-11.

Gil, N., Tommelein, I. D., Kirkendall, R. L., and Ballard, G. (2001). "Leveraging Specialty-Contractor Knowledge in Design-Build Organizations." *Engineering, Construction and Architectural Management,* 1-25.

Harper C. M., and Molenaar K. R. (2014). “Association between Construction Contracts and Relational Contract Theory.” *Construction Research Congress 2014*, Proceedings. 1329-1338

Harper C. M., Molenaar K. R., and Cannon J. P. (2016). “Measuring Constructs of Relational Contracting in Construction Projects: The Owner’s Perspective.” *Journal of Construction Engineering and Management,* 142(10), 1-11.

Hinze J., and Tracey A. (1994). “The Contractor-Subcontractor Relationship: The Subcontractor’s View.” *Journal of Construction Engineering and Management*, 120(2), 274–287.

Javanmardi A., Abbasian-Hosseini S., Liu M., and Hsiang S. M. (2018). “Benefit of Cooperation among Subcontractors in Performing High-Reliable Planning.” *Journal of Management in Engineering*, 34(2), 1-12.

Kale, S., and Arditi, D. (2001). “General contractors’ relationships with subcontractors: a strategic asset.” *Construction Management & Economics*, 19(5), 541–549.

Kelly, D. (2014). “Examination of Design-Assist Subcontracting.” *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, 6(3), 1-7.

Kumaraswamy M. M., and Matthews J. D. (2000). “Improved Subcontractor Selection Employing Partnering Principles.” *Journal of Management in Engineering*, 16(3), 47–57.

Laurent, J. E., and Leicht, R. M. (2017). “Cross-Functional Project Teams in Construction: A Longitudinal Case Study.” *25th Annual Conference of the International Group for Lean Construction, IGLC 2017, Hersonissos, Crete, Greece*, 1–8.

Loosemore, M., and McCarthy, C. S. (2008). "Perceptions of Contractual Risk Allocation in Construction Supply Chains." *Journal of Professional Issues in Engineering Education and Practice,* 134(1), 95–105.

Maturana S., Alarcón L. F., Gazmuri P., and Vrsalovic M. (2007). "On-Site Subcontractor Evaluation Method Based on Lean Principles and Partnering Practices." *Journal of Management in Engineering*, 23(2), 67–74.

Osmanbhoy, N. M. A. (2015). "Closing The Contractual Circle: Investigating Emergent Subcontracting Approaches." M. Sc., University of Washington, Seattle, WA. United States.

Ramsey D., El Asmar M., and Gibson G. E. (2016). "Quantitative Performance Assessment of Single-Step versus Two-Step Design-Build Procurement." *Journal of Construction Engineering and Management,* 142(9), 1-14.

Rangel, C. I. (2017). "How are Contractors Defining Design Assist." M.Sc.B.C.M., Purdue University, United States -- Indiana.

Schaufelberger J. E. (2000). "Strategies for Successful Partnering Relationships." *Construction Congress VI*, Proceedings. 463-470.

Shafaat A., Mahfouz T., Jackson C., and Kandil A. (2014). "Decision-making Model by Specialty Subcontractors in Construction Projects." *Construction Research Congress 2014*, Proceedings, 867–876.

Stanford M. S., and Molenaar K. R. (2018). "Influence of Simplified Procurement Methods on Competition for Public Sector Construction." *Journal of Construction Engineering and Management,* 144(2), 1-10.

University of Minnesota. (2015). "IPD: Performance, Expectations, and Future Use." https://www.agc.org/sites/default/files/Files/Programs%20%26%20Industry%20Relations/IPD_Performance_Expectations_and_Future_Use.pdf (Aug 13, 2018)

US Census Bureau. (2010). "2010 Geographic Terms and Concepts - Census Divisions and Census Regions." https://www.census.gov/geo/reference/gtc/gtc_census_divreg.html (Jun. 27, 2018).

US Census Bureau. (2018). "US Census Bureau Construction Spending Survey." https://www.census.gov/construction/c30/historical_data.html (Aug. 12, 2018).

Vaux J. S., and Kirk W. M. (2018). "Relationship Conflict in Construction Management: Performance and Productivity Problem." *Journal of Construction Engineering and Management,* 144(6), 1-11.

Watermeyer, R. (2012). "A framework for developing construction procurement strategy." *Proceedings of the ICE - Management, Procurement and Law*, 165, 223–237.

Yong-Woo K., and Ballard, G. (2005). “Profit-point analysis: A tool for general contractors to measure and compare costs of management time expended on different subcontractors.” *Canadian Journal of Civil Engineering*, 32(4), 712–718.

APPENDIX A

1. Abbasian-Hosseini S., Howell, G., and Liu, M. (2016). "Relationship between On-Site Planning Efforts and Work Plan Reliability." ***Construction Research Congress 2016*****. 2129-2138**

This document provides information about the positive impacts of on-site activities when the previous planning activities are completely developed by designers, project managers, and all the construction staff. The information was obtained by the researches using online surveys, the participants were categorized in 4 different groups where the principal objective was based on evaluating the correlation between Work Plan Reliability (WPR) and Plan Percent Complete (PPC) in accordance of the previous planning stage development.

2. Abbasian-Hosseini, S., Liu, M., and Hsiang, S. M. (2017). "Social network conformity and construction work plan reliability." ***Automation in Construction,*** **78, 1–12.**

This study explains the subcontractors' tendency of conforming WPR structures with other subcontractors generating local structures. In other words, the task-sequence established by project managers or prime contractor staff has a low influence in the final environmental organization among subcontractors. To create meaningful links and future long-term relationships, this study shows the common characteristics of these local associations and their impact on the project completion.

3. Abkarian, H., El Asmar, M., and Underwood, S. (2017). "Impact of Alternative Project Delivery Systems on the International Roughness Index." ***Transportation Research Record: Journal of the Transportation Research Board*****, 76–84.**

This article provides information about the Alternative Project Delivery Methods (APDM) performance in highway projects where the performance evaluation is not limited to cost and schedule indicators. The objective is based on generating an evaluation of the operational phase

for the pavement's quality and durability in long-term scenarios. The state restrictions for APDM implementation play an important role in the improvement and evaluation of operational indicators among the different project delivery options in the market.

4. Ahmed M. O., El-adaway I. H., Coatney K. T., and Eid M. S. (2016). "Construction Bidding and the Winner's Curse: Game Theory Approach." ***Journal of Construction Engineering and Management,*** **142(2), 1 – 9.**

This article describes the risks contained in bidding environments where the inaccurate estimates (under or above) represents a problem for construction companies to accomplish their profit targets. Using Symmetric Risk Neutral Nash Equilibrium (SRNNE), the research evaluates one and two steps bidding process in non-cooperative environments. The results show a higher risk increase in two-step biddings than one-step bidding process for new participants. In contrast, when the experience is one factor, participants have better bidding performance in two-step biddings avoiding loses in their profits.

5. Akintan, O. A., and Morledge, R. (2013). "Improving the Collaboration between Main Contractors and Subcontractors within Traditional Construction Procurement." ***Journal of Construction Engineering,*** **1-11.**

This study detects the principal uncollaborative factors between prime and specialty contractors. The research was based on surveys where factors such as delay in payments, disruption in work planning, exclusion from decision-making processes, and the inclusion of tough contract clauses from higher tiers to lower tiers., represents the most common claims that block any possibility of collaboration. The study recommends Integrated Project Delivery practices with Lean concepts to improve these broken relationships.

6. Alleman, D., Antoine, A., Gransberg, D. D., and Molenaar, K. R. (2017). "Comparison of Qualifications-Based Selection and Best-Value Procurement for Construction Manager–General Contractor Highway Construction." ***Transportation Research Record: Journal of the Transportation Research Board*****, 2630, 59–67.**

This research evaluated the procurement performance of Best Value Selection (BVS) and Qualification Based Selection (QBS). The results show that both systems didn't represent a meaningful advantage from each other. The use of any of these procurement methods is defined by the current state's normativity where BVS is chosen by some public agencies due to the similarity with traditional Project Delivery Methods. In contrast, QBS is used by more experienced agencies which have been using both systems and they can detect the benefits of QBS process in their projects.

7. American Institute of Architects. (2007). "Integrated project delivery: a guide." https://info.aia.org/SiteObjects/files/IPD_Guide_2007.pdf (July 11, 2018).

This guide represents the Integrated Project Delivery method from AIA where establish its process, methodologies, and collaborative efforts based on AIA specific clauses under its pre-established contracts. However, their integrated design and construction phases (Conceptualization, Criteria Design, Detailed Design, Implementation Documents, Agency/Coordination, Construction, and Closeout) summarizes correctly all the new tasks and responsibilities for all construction members under collaborative practices.

8. American Institute of Architects and Associated General Contractors of America. (2011). "Primer on Project Delivery.", https://www.agc.org/sites/default/files/Files/Programs%20%26%20Industry%20Relations/AIA-AGC_Primer_on_Project_Delivery_2nd_Edition-FINAL.pdf (May 27, 2018).

This report details each Project Delivery Method in the construction industry under AIA and AGC institutional concepts. Design-Bid-Build, Construction Management at Risk, Design-Build, and Integrated Project Delivery are the methods contained on this report.

9. Andre, G. R. (2012). "Design-Assist: Getting Contractors Involved Early." ***Legal Insight.*** **https://www.klgates.com/files/Publication/055ae3ba-ecb7-43d0-be9b-412fb235407b/Presentation/PublicationAttachment/e4e0432e-8ae0-4656-824e-48d6a7619d36/Design-Assist-Getting-Contractors-Involved-Early_091912.pdf (Feb 28, 2019)**

This article explains the concepts, characteristics, advantages, and disadvantages of using Design-Assist. The author provides information about the DA scope of work and the legal contractual implications and techniques to address in order to use this subcontracting practice correctly.

10. Arditi D., and Chotibhongs R. (2005). "Issues in Subcontracting Practice." ***Journal of Construction Engineering and Management,*** **131(8), 866–876.**

This research contains the different perceptions among owners, prime contractors, and specialty contractors based on the following contractual clauses: pay when paid clauses, retainage clause, shop bids, subcontractor's bonds and insurances, responsibility on safety practices, and actual partnering arrangements (adequate risk transfer among parties). The results show a clear tendency where prime contractors differ from specialty contractors and owner's perspectives.

11. Arizona Board of Regents/Alliance for Construction Excellence. (2007). "Design Assist - Best Method Approach to Subcontracting." Alliance for Construction Excellence. https://studylib.net/doc/18350545/design-assist---alliance-for-construction-excellence (February 26, 19).

This article explains the concept, benefits and selection process of subcontractors to develop Design-Assist (DA) practices. The article shows a project delivery method assessment where using a flowchart it evaluates the best project delivery method to execute DA. Finally, the article describes DA practices and deliverables graphically to provide better information and potential advantages in applying DA subcontracting practice.

12. Arslan, G., Kivrak, S., Birgonul, M. T., and Dikmen, I. (2008). "Improving sub-contractor selection process in construction projects: Web-based sub-contractor evaluation system (WEBSES)." *Automation in Construction,* 17(4), 480–488.

This study explains the development of one software that evaluates the subcontractor's performance for each project. This software has databases that were online codified by the company representatives at the end of every subcontractor's work package. These databases contain the historical evaluations of each subcontractor where the ranking points determines the potential subcontractor selection for future projects. The author states the following advantages of using this software: faster selection process, user-friendliness, selection under systematic approach, reduction of subjectivity, reduction in cost & training compared to another innovative process.

13. Associated General Contractors of America. (2010). "Integrated project delivery for public and private owners." https://www.agc.org/integrated-project-delivery (July 11, 18).

This article describes the concepts and statements made by AGC for IPD methodology where the most important topic describes the three levels of collaboration. The first level refers to non-required collaboration. The second level has the characteristic of having some degree of contractual collaboration requirements. The final level states a required multi-party contractual agreement where collaboration is obligatory.

14. Associated General Contractors of America, American Subcontractors Association, and Associated Specialty Contractors. (2008). "Guidelines for a Successful Construction Project.", http://consensusdocs.org/Downloads/Index?id=72849a56-b5fe-4768-b88a-a36f00b24590&name=Guidelines_Full.pdf (May 27, 2018).

This article explains the general guidelines for prime and specialty contractors during the project execution based on AGC statements. The process includes stages such as bidding, pre-construction planning, execution, insurances, bonds, payments policy, quality assurance/control, and project

closeout. This user-manual doesn't follow a specific PDM but it gives practical information to manage every construction project avoiding future claims among participants.

15. Biruk, S., Jaśkowski, P., and Czarnigowska, A. (2017). "Minimizing Project Cost by Integrating Subcontractor Selection Decisions with Scheduling." ***IOP Conference Series: Materials Science and Engineering*****, 245(7), 1-7.**

This study develops a mathematical model which provides the guidelines to analyze the subcontractors bidding process. Using an activity-on-mode network with precedence relations between tasks, this model generates the nodes, activities sets, and graphics that determine the correct schedule, duration, work packages per subcontractor, and final cost. Given this information, the general contractor can choose the best combination of subcontractors with a clear activity schedule. This process recommends a two-step procurement method where the first-step can follow any of the short-list's techniques, then, the second-step should use this mathematic model.

16. Cao, D., and Wang, G. (2014). "Contractor–Subcontractor Relationships with the Implementation of Emerging Interorganizational Technologies: Roles of Cross-Project Learning and Pre-Contractual Opportunism." ***International Journal of Construction Education and Research*****, 10(4), 268–284.**

This research explains the risks of using long or short-term relationships between prime and specialty contractors. Each option generates specific issues, for example, short-term relationships produce cross-project learning and long-term environments drive to specialty contractor's pre-contractual opportunism. However, the implementation of technologies for specific projects give to prime contractors the opportunity of creating long-term associations without opportunism practices. These technologies can track performance, procedures, and costs., for each specialty contractors that diminish the uncertainty derived by cross-project learning. Also, these innovative

tools provide cost-reduction because the process will gain confidence and efficiency, avoiding the resource waste.

17. Clevenger C. M., and Khan R. (2014). "Impact of BIM-Enabled Design-to-Fabrication on Building Delivery." ***Practice Periodical on Structural Design and Construction*****, 19(1), 122–128.**

This article explains the benefits of using design-to-fabrication methodologies with building information modeling (BIM) for structural rebar designing, detailing, and fabrication in foundation and structure. The article examines the impact of applying design-to-fabrication against the traditional design-detail-fabricate process using two different projects; one federal building and medical pavilion. These two projects were compared against theoretical design-detail-fabricate baselines in order to obtain the potential time and cost savings.

18. Collins W., and Parrish K. (2014). "The Need for Integrated Project Delivery in the Public Sector." ***Construction Research Congress 2014*****, 719-728.**

This research focuses on evaluating the changes in scope and cost that occur in public projects using traditional PDM. Change orders were used to evaluate the fluctuation between the original contract and project completion where indicators such as final cost and basis of the change order were categorized. The results give a clear tendency of owner's interference in the process where the scope was changed with frequency in all the evaluated projects. Given this situation, the author recommends the IPD implementation in public projects to generate data precedence for future analysis and potential change in bidding requirements.

19. Construction Users Round Table. (1987). "Contractual Arrangements.", http://mail.curt.org/pdf/141.pdf (May 5, 2018).

This report provides the planning steps for owners who want to start any construction project. This process starts with project identification and goes through contracting strategies and bidding

process recommendations. The principal objective of this documents is based on representing a correct organizational structure and risk analysis throughout the first stages of any construction project.

20. Construction Users Round Table. (1999). "Guide for Global Project Delivery.", http://mail.curt.org/pdf/283.pdf (May 5, 2018)

This study explains the common methodologies and characteristics of the construction process such as planning, bidding, contracting, executing, and operating., in the United States. Each stage contains the guidelines and literature to develop these mechanisms in overseas projects. For example, the guide summarizes the common PDM with their potential procurement methods and contract types. Also, the study provides a checklist of cultural, economic, government, and quality issues that can be detected when American companies develop projects outside their country.

21. Contractor, F. J., and Ra, W. (2000). "Negotiating alliance contracts: Strategy and behavioral effects of alternative compensation arrangements." International Business Review, 9(3), 271–299.

This study evaluates different multiple payment scenarios that generate a "non-zero-sum" tradeoffs. Looking at the financial bibliography, multiple cash flows reduce general volatility, and risk., creating strategic long-term partnerships. This financial research recommends the following cash flows to avoid dependency or economical risk under only one revenue source: (1) equity participation, (2) knowledge transfer or royalties, and (3) Lump sum fees or payments per finished unit.

22. El Asmar M., Hanna A. S., and Loh W. (2013). "Quantifying Performance for the Integrated Project Delivery System as Compared to Established Delivery Systems." ***Journal of Construction Engineering and Management*****, 139(11), 1 – 14.**

This study represents one of the first IPD researches which evaluate the performance of non-IPD projects and IPD projects that share enough characteristics to create a trustworthy comparison among the samples. This example uses nine performance areas such as cost, quality, schedule, safety, project change, communication, labor, environmental, and business performance metrics. The study states that significant differences can be identified in quality, communication, and performance from IPD to non-IPD practices.

23. El-adaway I., Abotaleb I., and Eteifa S. (2017). "Framework for Multiparty Relational Contracting." ***Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*****, 9(3), 1 – 19.**

This analysis explains the differences between traditional and relational contracts, common IPD practices in USA and UK, common IPD short-comings in USA and UK, and potential solutions to address the mentioned short-comings using the available legal frame. The analysis proposes 10 premises to improve the contractual framework based on the clause's evaluations. These premises are the project environment, project management, partnering advisor, design process, partnering and project schedules, suppliers and manufacturers, prices and profits, incentives, changes, and conflicts & disputes. To accomplish the recommendations stated in this paper, traditional contract methods should be modified to relational clauses where multi-party agreements establish the collaborative focus towards all construction parties, not only for the top of the construction supply chain.

24. Enshassi, A., and Medoukh, Z. (2008). "The contractor–subcontractor relationship: the general contractor's view.", 1520-1527.

This article explains prime and specialty contractor's relationships in Palestine. The construction industry, as a globalized economic activity, shares some characteristics around the world. One example of this statement is the similarity between subcontracting practices in Palestine and the United States traditional PDM's where bid shopping, low bid contracts, and uncollaborative practices can be identified.

25. Errasti, A., Beach, R., Oyarbide, A., and Santos, J. (2007). "A process for developing partnerships with subcontractors in the construction industry: An empirical study." *International Journal of Project Management,* 25(3), 250–256.

This study explains the process to cover all the supply chain under collaborative practices where the use of dynamic analysis can provide to prime contractors the diagnosis, deployment, change drivers' criteria, multi-party contracting strategies, and the development of clear structures for project management to their specialty contractors and suppliers. Although the theory frame is supported by IPD practices, the success of the project cannot be guaranteed because of the mentality change and future process modification that this process represents.

26. Franz, B. W., and Leicht, R. M. (2016). "An alternative classification of project delivery methods used in the United States building construction industry." *Construction Management & Economics*, 34(3), 160–173.

This study states different typologies of Project Delivery Methods (PDM) to generate a consensus among construction parties. The study categorizes five different classes where the combination of factors such as the timing of involvement, procurement practice, selection criteria, and payment terms can be mixed on each specific project generating a wide range of PDM variations. In other words, one well-defined PDM might not represent totally the contractual and administrative characteristics of the project.

27. Franz B., Esmaeili B., Leicht R., Molenaar K., and Messner J. (2014). "Exploring the Role of the Team Environment in Building Project Performance." ***Construction Research Congress 2014*****, 1997-2010.**

The objective of this study is based on evaluating the correlation between team environment practices and construction outcomes. 124 projects were evaluated where different PDM was used by each sample. The results show a strong correlation between timely communication and team chemistry, in contrast, administrative burden and staff turnover have a negative correlation with communication and team chemistry. The cases which present these positive communication factors are related to collaborative delivery methods while traditional methods show a complex administrative burden.

28. Franz B. W., Leicht R. M., and Riley D. R. (2013). "Project Impacts of Specialty Mechanical Contractor Design Involvement in the Health Care Industry: Comparative Case Study." ***Journal of Construction Engineering and Management,*** **139(9), 1091–1097.**

This study evaluates the overall & system schedule with the overall & system cost performance of specialty mechanical contractors in healthcare projects. This study shows the results based on the evaluation of two projects with some similarities, but different Project Delivery Method: Design-Build and Design-Assistance. The outputs show a better cost and schedule performance in Design-Build because of the vertical design integration (avoiding communication obstacles to high tiers), complete design access to modify pre-established parameters, and correct design appliance on-site.

29. Garcia A. J., Manata B., Mollaoglu S., and Miller V. (2016). "Key Information Sharing Behaviors for Improved Performance in IPD Project Teams." ***Construction Research Congress 2016*****, 1904-1916.**

This study confirms the positive correlation between team monitoring and team goal alignment in IPD processes which drive to better completion effectiveness. Practices such as constant objective

validation and well-defined communication channels can avoid segregating practices among the project parties that might create a collaboration disinterest.

30. Ghavamifar K., and Touran A. (2008). "Alternative Project Delivery Systems: Applications and Legal Limits in Transportation Projects." ***Journal of Professional Issues in Engineering Education and Practice,*** **134(1), 106–111.**

This study categorizes the current legal codes of all the 50 states in the United States regarding on PDM in transportation public projects. PDM's procurement limitations for Design-Build, Construction Management at Risk, and Public-Private-Partnerships are explained by the author. The study purpose is the identification of restrictions or requirements for each PDM across the United States, providing the right information and construction practices that might be followed if any company wants to develop transportation projects nationwide. Also, the criteria that authorities follow to keep traditional delivery methods or give the opportunity to alternative ones are based on the authorities fear to disclose methods that will transform their current legal frame.

31. Gil, N., Tommelein, I. D., and Ballard, G. (2004). "Theoretical comparison of alternative delivery systems for projects in unpredictable environments." ***Construction Management & Economics,*** **22(5), 495–508**.

This study shows the benefits of bringing specialty contractors to early design stages and let them work and modify technical requirements to reduce waste and reworks during the process. The project complexity can be mitigated when prime contractors adjust the bidding process to add specialty contractors before the elaboration of fab drawings, this practice allows the reduction of full design changes. The time postponement between programming and design, where specialty contractors are chosen, can lead to better performance and results because specialty contractors will develop accurate designs from the earliest project stages. In contrast, when specialty

contractors are selected after the design stage, conservative assumptions are made increasing the bid price.

32. Gil, N., Tommelein, I. D., Kirkendall, B., and Ballard, G. (2000). "Contribution of Specialty Contractor Knowledge to Early Design." Proc., *8th Annual Conf. Int'l. Group for Lean Constr., Univ.of Sussex, Brighton, U.K.,* 1-11.

The study states the importance of developing a mechanism where the specialty contractor knowledge can be processed, retained, and improved for future projects. This situation started to gain notoriety when the participation of specialty subcontractors in design activities increased. Because of the specialty contractor's constant combination of design and construction activities, their solutions show more creativity, better space constraints, trustable fabrication and construction bases, and knowledge of suppliers. For this reason, the transformation from tacit to explicit knowledge will help to create shared data structures among the organizations.

33. Gil, N., Tommelein, I. D., Kirkendall, R. L., and Ballard, G. (2001). "Leveraging Specialty-Contractor Knowledge in Design-Build Organizations.", *Engineering, Construction and Architectural Management,* 1-25

This study took the principles of specialty contractors tacit and explicit knowledge from Gil, Tommelein, Kirkendall, and Ballard research named Contribution of Specialty Contractor Knowledge to Early Design. Developing these concepts, this current study explains three different subcontracting arrangements: (1) Design-Bid-Build, (2) Design-Build with A/E-GC and (3) Design-Build with SC., where nominated contractors and Design-Assistance play an important role to define each subcontracting model. Also, the research makes emphasis on communication tools and correct design liability clauses for each subcontracting situation because of the procedure's novelty where boundaries are not specified by any contractual clause.

34. Gransberg, D. D. (2016). "Comparing Construction Manager–General Contractor and Federal Early Contractor Involvement Project Delivery Methods." *Transportation Research Record: Journal of the Transportation Research Board*, 2573, 18–25.

This study explains a CMGC variant named Early Contractor Involvement (ECI) which establishes the contractor participation since day 1. The difference between CMGC and ECI is based on how each model supports the design stage. While CMGC only gives its professional constructability comments in design activities, ECI goes further because the contractor helps the designers directly at the earliest point of the design stage. ECI procurement method is a two-step process with the low bid selection driver, however, the contract has some incentive-disincentive clauses to achieve the performance during the project.

35. Harper C. M., and Hazleton R. (2014). "New Engineer's Knowledge for Success with Subcontractors and Trade Partners." *Practice Periodical on Structural Design and Construction,* 19(1), 15–19.

This study identifies the professional profile of new construction experts. The author divides this profile into two categories, the construction engineer knowledge and the knowledge for success. The first division contains elements such as Building Information Modeling (BIM), Sustainability, and Lean Construction. The second and last division states four main elements to fulfill engineering activities correctly like Technical fundaments, Construction materials, Construction-applied resources, and Field Construction Operations.

36. Harper C. M., and Molenaar K. R. (2014). "Association between Construction Contracts and Relational Contract Theory." *Construction Research Congress 2014,* 1329-1338.

This paper analyzes the presence of collaborative clauses or language in construction contracts. The researcher evaluates standard construction contracts for IPD, DB, CMGC, and DBB., where IPD shows a more collaborative language that facilitates relational contracts. DB and CMGC have

many collaborative clauses but they cannot share the same properties as IPD contracts. DBB is the less relational in comparison to IPD, DB, and CMGC. This study should be complemented with the analysis of improved contracts which fulfill characteristics for specific situations.

37. Harper C. M., Molenaar K. R., and Cannon J. P. (2016). "Measuring Constructs of Relational Contracting in Construction Projects: The Owner's Perspective." ***Journal of Construction Engineering and Management,*** **142(10), 1 – 11.**

This study states relational contracting norms measures to evaluate the relationship integration inside construction projects. These evaluation factors cannot be taken as a rule because of the variety of project and team characteristics but it might provide a useful guide for further collaborative steps. These contracting norms are Role integrity, Reciprocity, Flexibility, Property of means, Reliance and expectations, Restraint of power, Contractual solidarity, and Harmonization of conflict.

38. Hartmann A., Ling F. Y., and Tan Jane S. H. (2009). "Relative Importance of Subcontractor Selection Criteria: Evidence from Singapore." ***Journal of Construction Engineering and Management,*** **135(9), 826–832.**

The study explains the relative importance of the criteria used by the prime contractor to select specialty contractors in Singapore. The research can identify four principal factors such as price, quality, cooperation, and technical know-how. These factors have a different weight during the evaluation process where price is the most important decision driver. However, the selection criteria might be modified depending on the complexity of the projects, in this case, technical know-how aptitudes take more importance in the process.

39. Hinze J., and Tracey A. (1994). "The Contractor-Subcontractor Relationship: The Subcontractor's View." ***Journal of Construction Engineering and Management*****, 120(2), 274–287.**

This study explains the most common uncollaborative practices between prime and specialty contractors which the author highlights the shop bidding, lack of communication, lack of comprehension in contractual clauses by specialty contractors, payment delays, and prime contractor incapacity of coordinating activities. Although specialty contractor can change these uncollaborative attitudes using their right to avoid specific contracts or clients, they are focused in only get the project without a clear contractual and economic evaluation.

40. Javanmardi A., Abbasian-Hosseini S., Liu M., and Hsiang S. M. (2018). "Benefit of Cooperation among Subcontractors in Performing High-Reliable Planning." ***Journal of Management in Engineering*****, 34(2), 1 – 12.**

This study identifies the subcontractor's benefits from cooperation and partnering with other subcontractors who share the same hierarchical level. Using Contribution-Based Benefit-Allocation (CBBA), general contractors evaluate the framework and results provided by the High-Reliable Planning (HRP). This subcontractor planning process allows schedule and cost reduction because subcontractors use more resources and time for planning stages that impact the activity order, performance, and project development inside the subcontractor's work packages. The combination of efforts and acceptance of collaborative principles generate a complete Work-Plan Reliability (WPR) that shows the performance benefits during the project.

41. Kale, S., and Arditi, D. (2001). "General contractors' relationships with subcontractors: a strategic asset." ***Construction Management & Economics*****, 19(5), 541–549.**

This study explains the importance of high-quality relationships between prime and specialty contractors where prime contractors should establish and maintain these cooperative relationships because they have an economic and contractual advantage from subcontractors. The study states

the social embeddedness premise which has two benefits (1) use of positive information based on ethical practices and (2) learning between organizations.

42. Kelly, D. (2014). "Examination of Design-Assist Subcontracting." *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, 6(3), 1 - 7

This study explains the Design-Assistance (DA) methodology and the conflicts that this subcontracting method can produce inside the design stage. Although designers and prime contractors can identify the benefits of DA in design stages, design liabilities might be confused among construction parties because there is no contractual arrangement which allocates this liability appropriately.

43. Khalfan, M. M. A., McDermott, P., and Asad, S. (2006). "Supply chain integration within construction: related theories and concepts.", 191-200.

This study summarizes the supply chain theory for the construction industry. Using a lean school which states the coordination among companies to operate and creates products instead of planning supplier logistics to the construction site. Also, this document explains the benefits of clustering construction companies to generate technological innovation with low production costs.

44. Kumaraswamy M. M., and Matthews J. D. (2000). "Improved Subcontractor Selection Employing Partnering Principles." *Journal of Management in Engineering*, 16(3), 47–57.

This study explains the benefits of creating partnership structures between prime and specialty contractors where time, performance, cost, and quality drivers are easily improved by this type of arrangements. To accomplish these objectives prime contractors must accept this new business philosophy and principles which specialty contractors are no longer an interchangeable party. However, the procurement cost increases because prime contractors should evaluate non-price

factors such as technical competency and responsiveness, previous quality ratings for long-term subcontractors, and ratings for potential new subcontractors.

45. Lahdenperä, P. (2012). "Making sense of the multi-party contractual arrangements of project partnering, project alliancing and integrated project delivery." ***Construction Management & Economics*****, 30(1), 57–79.**

This study explains the similarities and differences among Relational Project Delivery Arrangements (RPDA) which the principals multi-party contracting practices are Project Partnering (PP), Project Alliancing (PA), and Integrated Project Delivery (IPD). The evaluation was elaborated under the categorization of literature references where the author chose the following factors to compare each RPDA: (1) Cooperative Culture, (2) Team formation, (3) Administration consistency, (4) commercial unity, (5) Planning emphasis, (6) Teamwork premises, and (7) Operational Procedures. The conclusions were based on the continuous improvement of these systems where PA and IPD represent the most collaborative processes.

46. Laurent, J. E., and Leicht, R. M. (2017). "Cross-Functional Project Teams in Construction: A Longitudinal Case Study." ***25th Annual Conference of the International Group for Lean Construction, IGLC 2017, Hersonissos, Crete, Greece*****, 1–8.**

This study explains the performance of Cross-Functional Project Teams (CFPT). These collaborative teams are the result of IPD relational clauses which the principal members share risks, incentives, responsibilities, and objectives. The study concludes that the correct CFPT member selection and future flexibility to modify its team member composition according to the new project parameters is one of the most important characteristics of any IPD process due to all the project participants are working to achieve the general objectives.

47. Leicht, R., and Harty, C. (2017). "Influence of multiparty IPD contracts on construction Innovation." ***33rd Annual ARCOM Conference*****, 164–173.**

This study categorizes the innovation factors that construction industry should evaluate to develop complete relational contract clauses, these factors are (1) Team and actor willingness, (2) Innovative tools and processes, (3) Contextual and institutional barriers, and (4) Spread and management of innovation. These points can be developed using Lean techniques like Last Planner or Big Room meetings in programming stages that provides enough information about which type of framework should be defined to create the clauses of multi-party agreements.

48. Matthews, O., and Howell, G. (2005). "Integrated project delivery: An example of relational contracting.*" Lean Construction Journal***, 46-61.**

This study identifies the four major systemic problems for traditional contractual approach, these problems are (1) Good design ideas are avoided by previous design stage, (2) Cooperation and innovation are not included in contracting clauses, (3) Lack of coordination, and (4) Local optimization and self-protect practices. To solve these adversarial concepts this study lists the following collaborative examples based on previous successful projects: (1) Use of the Last Planner, (2) Shared Manpower, (3) Problem Resolution, (4) Handling Major Changes to the work, (5) Work across traditional boundaries, (6) Recovering from oversights, (7) Avoid redundant efforts and expenses, (8) Enhance Job Safety, (8) Direct more resources to design and planning stages to guarantee saves at completion stage, (9) Sharing Rental Equipment.

49. Maturana S., Alarcón L. F., Gazmuri P., and Vrsalovic M. (2007). "On-Site Subcontractor Evaluation Method Based on Lean Principles and Partnering Practices." ***Journal of Management in Engineering*****, 23(2), 67–74.**

This study explains an evaluation system where prime contractors give their weekly evaluation to specialty contractors. The score is given by qualitative answers that represent the grade of

satisfaction for specific project drivers such as quality, schedule fulfillment, safety, and cleanliness. To complement these qualitative measures, the project advance of the specialty contractors is monitoring with the percent plan complete (PPC) tool to give a complete reference of the developed performance with the planned schedule. To obtain reliable data, this analysis should be used during the complete building execution of each project to generate trustable databases.

50. Osmanbhoy, N. M. A. (2015). "Closing The Contractual Circle: Investigating Emergent Subcontracting Approaches." M. Sc., University of Washington, Seattle, WA. The United States.

This research explains the common subcontracting models that the construction industry can find in Washington State. These models are based on online surveys and following-up interviews to selected construction companies who provide all the recommendations, experiences, and insights to establish the following subcontracting models: (1) Traditional Subcontracting, (2) Design-Assistance, (3) Design-Build Subcontracting, (4) Integrated Design-Construction Subcontracting, and (5) Integrated Specialty Work Subcontracting.

51. Radziszewska-Zielina, E., and Szewczyk, B. (2017). "Examples of actions that improve partnering cooperation among the participants of construction projects." *IOP Conference Series: Materials Science and Engineering*, 251(1), 1 – 12.

This study shows nine actions that prime contractors or managers should implement in their contractual arrangement to facilitate collaborative attitudes among construction parties. Although these actions have general descriptions that can be used in any project, prime contractors must adjust them to specific goals or project characteristics. These actions are (1) Participation in organizing construction work, (2) Sharing of material and human resources, (3) Sharing of non-material resources (technologies), (4) Effective communication, (5) Behavior standards and rules,

(6) payment deadlines and amounts, (8) Dispute's frequency and time frame to solve it, and (9) Adaptability to changes.

52. Ramsey D., El Asmar M., and Gibson G. E. (2016). "Quantitative Performance Assessment of Single-Step versus Two-Step Design-Build Procurement." ***Journal of Construction Engineering and Management,*** **142(9), 1 - 14.**

This study evaluates the procurement performance of one and two-step methods where one-step procurement process has a bigger cost than the two-step process because of a large number of offerors that submit their proposal. In contrast, the procurement duration doesn't have a significant difference between one and two-step method. For innovation indicators, a two-step process can achieve better results, but it doesn't mean that the project performance will improve using this process. In other words, both processes don't represent a significant performance difference. The selection of one or two-step procurement method is based on the contractor experience and historical results using specific process.

53. Rangel, C. I. (2017). "How are Contractors Defining Design Assist." M.Sc.B.C.M., Purdue University, United States -- Indiana.

This study explores the liability gaps between specialty contractors and designers in the Design-Assistance subcontracting model. Although this method helps to manage the design complexity of great scale projects, the design liabilities and scenarios for specialty contractors are not well-defined. For this reason, this study generates the theoretical and legal scenarios where designers of record and specialty contractors can work together by assigning the right risk allocation to each party.

54. Robson, A., Boyd, D., and Thurairajah, N. (2015). "Are contractors' cost accounting practices up to the job of establishing improvement in site operations?" ***Thirty-First Annual Conference 2015*****, 823-832.**

This study explains the importance of costing supply chains under collaborative approaches where prime and specialty contractors share information regardless of the project. This information provides enough insights to develop better practices for long-term relationships. Identifying the process which generates waste, both contractor's types can improve the supply chain and keep working as an association. However, traditional costing practices lose information during the supply chain production, for this reason, better allocation cost methods should be implemented such as Activity-Based Costing method.

55. Saad Ihab M. H. (2014). "Preparing a Project Manual: A Comprehensive Project View." ***Construction Research Congress 2014, Proceedings*****. 426-435.**

This study states that project manuals are one useful tool to standardize practices, track outcomes, and evaluate the progress of specific tasks. Generating these reports, prime contractors can create robust databases to evaluate the specialty contractors' performance for future biddings where not only cost drivers might select the future contractor.

56. Sariola, R., and Martinsuo, M. (2016). "Enhancing the supplier's non-contractual project relationships with designers." ***International Journal of Project Management*****, 34(6), 923–936.**

This study explains the non-contractual relationships between designers and component suppliers. Designers, as a top contractual tier, know all the clients' requirements but they support their specifications using supplier's technical knowledge which rules the fabrication or construction processes to prime contractors. The author develops a framework that states the trust and commitment as the principal values to generate a non-contractual relationship with collaborative

characteristics such as activeness, technical capability, reputation, and cooperation beyond project boundaries.

57. Schaufelberger J. E. (2000). "Strategies for Successful Partnering Relationships." ***Construction Congress VI, Proceedings*****. 463-470**

This study explains the partnering concept in the construction industry and how it is interpreted by owners, designer, prime contractors, and specialty contractors. Based on surveys, the study identifies five major obstacles to accomplish complete partnership environments. The obstacles are (1) Lack of commitment, (2) Lack of trust, (3) Lack of communication, (4) Lack of training and understanding, and (5) Non-involvement of subcontractors.

58. Shafaat A., Mahfouz T., Jackson C., and Kandil A. (2014). "Decision-making Model by Specialty Subcontractors in Construction Projects." ***Construction Research Congress 2014, Proceedings*****, 867–876.**

This study recognizes the important role that plays specialty contractors during the execution of any construction project. Their specialized knowledge for specific activities provides them with an opportunity to show their real value inside the supply chain. Knowing this situation, this study is focused on distinguishing the specialty contractor's activities from events to routines. Routines are identified as activities with low uncertainty and complexity, in contrast, events have a high uncertainty and complexity.

59. Sinha, A. K., Davich, T., and Krishnamurthy, A. (2016). "Optimisation of production and subcontracting strategies*." International Journal of Production Research***, 54(8), 2377–2393.**

This study explains four queuing models for complex supply chains in engineered products where the customization of time, resources, and quality are deeply evaluated by project managers to avoid resource waste. All improvement practices have these four axes (1) Capital investment model, (2)

Production and subcontracting model, (3) New subcontractor qualification model, and (4) Process improvement model. The selection of specific factors depends on the company approach to satisfy the demand under defined time and cost criteria.

60. Stanford M. S., and Molenaar K. R. (2018). "Influence of Simplified Procurement Methods on Competition for Public Sector Construction." ***Journal of Construction Engineering and Management*****, 144(2), 1 - 10.**

The study explains Indefinite Delivery - Indefinite Quantity (IDIQ) in the public sector. These contracts have the characteristics of limit the number of participants in every bidding stage, and after the award, the winner contractor can revalidate their prices to execute a bigger scope than the originally contracted. The author compares two procurement frameworks such as neoclassical economic theory and Transaction Cost Economics (TCE) where the first theory defends the unlimited participants in every bid, and the latest theory defends IDIQ focus because this practice generates savings in procurement stages, and it might help for future long-term relationships.

61. Tieder, J. B., and Cox, R. K. (1983). "Construction Management and the Specialty Trade (Prime) Contractors." ***Law and Contemporary Problems*****, 46(1), 39-54.**

This article explains Design-Build and Construction Management first practices in the construction industry. The mentality changes in specialty contractor's practices impact design and construction processes because of the transformation from traditional and uncollaborative practices to collaborative clauses. Examples of these impacts can be observed in the avoidance from damages for delay, new scheduling and coordinating practices, and keep the created commitments throughout the project. To accomplish these modifications and fulfill the innovative requirements, owner, prime and specialty contractors must understand the benefits and consequences of applying these collaborative new methods.

62. Tran, D., Molenaar, K. R., and Gransberg, D. D. (2016). "Implementing Best-Value Procurement for Design–Bid–Build Highway Projects." ***Transportation Research Record: Journal of the Transportation Research Board*****, 2573, 26–33.**

This study evaluates the benefits of applying Best Value Selection (BVS) as a procurement method in Design-Bid-Build for transportation projects. The results reflect positive performance because the public owner can use more evaluation drivers, not only cost analysis, that allows the selection of better construction companies. However, the public owner identifies an increase in cost and time during the procurement stage. This situation limits BVS application only to complex project where subcontractors' expertise and technique plays an important role.

63. Ulubeyli, S., Manisali, E., and Kazaz, A. (2010). "Subcontractor selection practices in international construction projects." ***Journal of Civil Engineering and Management*****, 16(1), 47–56.**

This paper explains the current procurement practices in the subcontractor's selection in Turkey. The main selection criterium is based on traditional methods such as low-bid with non-participation in design stages. Depending on the project characteristic or owner intervention, the subcontractors are not chosen by the general contractor, generating lack of communication and poor construction outputs.

64. US Census Bureau. (2010). "2010 Geographic Terms and Concepts - Census Divisions and Census Regions." https://www.census.gov/geo/reference/gtc/gtc_census_divreg.html (June. 27, 2018).

This document provides graphical information about the Census office divisions and regions of the United States. Based on this categorization, any research can track specific information for delimited areas, generating correlations between sources.

65. Vashani H., Sullivan J., and El Asmar M. (2016). "DB 2020: Analyzing and Forecasting Design-Build Market Trends." ***Journal of Construction Engineering and Management, 142(6),*** **1 - 12**.

This analysis presents the growth of Design-Build agencies from 2003 to 2013. Also, forecasting techniques were used to show the contractual tendencies from 2014 to 2020. The results show a growth of 124% in the Design-Build agencies, this tendency will continue until 2020 but with less volatility in growth trends, unless, American states change completely the restriction to Design-Build methodologies.

66. Vaux J. S., and Kirk W. M. (2018). "Relationship Conflict in Construction Management: Performance and Productivity Problem." ***Journal of Construction Engineering and Management,*** **144(6), 1 - 11.**

This study creates a framework that describes the principal factor and participants who contribute to uncollaborative practices. The author identifies three principal contributors: (1) Lack of communication, (2) Old School attitude, and (3) Lump sum contracts., with three primary players: (1) owner, (2) prime contractors' representatives (superintendent), and (3) specialty contractors. Communication strategies such as active listening, empathy, and real interest in the project's objectives are identified as the tools to break all uncollaborative practices among the mentioned parties.

67. Watermeyer, R. (2012). "A framework for developing construction procurement strategy." ***Proceedings of the ICE - Management, Procurement, and Law,*** **165, 223–237.**

This study explains procurement practices under the ISO 10845 standards with FIDIC and NEC3 contracting formats. The combination of these standards provides to construction members a complete framework for all the potential options in contracting stages. The study describes a procurement strategy where the packaging, contracting, pricing, and targeting are the principal decision-makers to select the right procurement and tender evaluation procedures. This research

shows the potential standardization of PDM procedures with all probable combination between methods.

68. Yong-Woo K., and Ballard, G. (2005). "Profit-point analysis: A tool for general contractors to measure and compare costs of management time expended on different subcontractors." ***Canadian Journal of Civil Engineering*****, 32(4), 712–718.**

This study explains cost allocation techniques which can identify and categorize correctly the overhead cost designated to managerial activities. Knowing the managerial overhead cost for each subcontractor, general contractors can identify the best subcontractor's option for specific task package. The study is based on Activity-Based Costing (ABC) development where the two-step evaluation gives the possibility of allocating activities costs to cost objects, generating a Profit-point analysis (PPA).

APPENDIX B

This appendix explains the data highlights of each census region due to the importance of categorizing and identifying characteristics that might differentiate regions from one another. The results are shown by "Evaluation Tables" which summarize the respondents' answers for each survey section (introduction, general contractor, and specialty contractor), including all questions. West region section shows two different tables; one table shows the survey results of the current thesis and the second table summarizes the results of Osmanbhoy online survey.

Northeast

The Northeast Region is made up of the New England and Middle Atlantic divisions. As shown in the Figure 25, Northeast Region includes the states of Connecticut (CT), Maine (ME), Massachusetts (MA), New Hampshire (NH), Rhode Island (RI), Vermont (VT), New Jersey (NJ), New York (NY), and Pennsylvania (PA). The total number of respondents in this region is 10, divided into 2 General Contractors and 8 Specialty Contractors. The next Evaluation Table 12 shows the contractual characteristics of the Northeast Region, the highlight responses represent the most common practices or data relevance in each question.

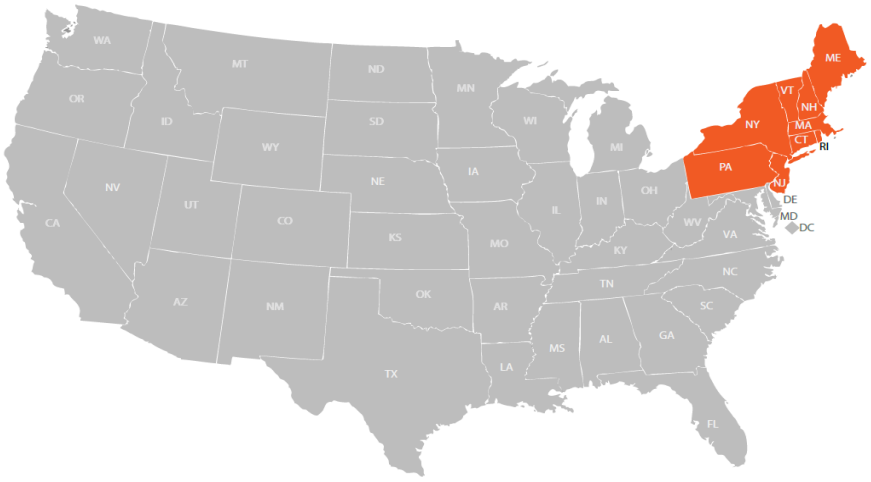


Figure 25. Northeast Region

Table 12. Northeast Survey Evaluation

OVERALL QUESTIONS N = 10	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (0) 2<x<5 years (0) 5<x<15 years (2) 15<x years (8)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (2) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (8)	PC has acceptable experience while SC has great construction experience
What position do you presently hold in your company?	Executive (8) PM (1) SI (1) Other (0)	Executive (0) PM (1) SI (1) Other (0)	Executive (8) PM (0) SI (0) Other (0)	SC has Executives in the sample, PC respondents came from on-site activities.
How long have you been in this position with your company?	x<2 years (2) 2<x<5 years (2) 5<x<15 years (2) 15<x years (4)	x<2 years (2) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (2) 5<x<15 years (2) 15<x years (4)	PC has short-term employees, in contrast, SC has long-term employees.
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (0) 1<x<10M (5) 10<x<50M (3) 50<x<250M (1) 250M<x (1)	x<1M (0) 1<x<10M (0) 10<x<50M (0) 50<x<250M (1) 250M<x (1)	x<1M (0) 1<x<10M (5) 10<x<50M (3) 50<x<250M (0) 250M<x (0)	PC has bigger contracts (50-250 M) than SC (1-50M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (2) SC (8) Other (0)	GC (2) SC (0) Other (0)	GC (0) SC (8) Other (0)	PC & SC keep their normal properties
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (2) SC (8)	N/A	N/A	GC has a smaller sample than SC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (5) Somewhat (3) Aware (2) Not Aware (0)	Fully (2) Somewhat (0) Aware (0) Not Aware (0)	Fully (3) Somewhat (3) Aware (2) Not Aware (0)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (0) 10<x<50M (6) 50<x<250M (2) 250<x<500M (0) 500<x<1B (0) 1B<x (2) Don't Know (0)	x<10M (0) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (0) 1B<x (2) Don't Know (0)	x<10M (0) 10<x<50M (6) 50<x<250M (2) 250<x<500M (0) 500<x<1B (0) 1B<x (0) Don't Know (0)	PC has the biggest revenues (1B) examples, but the average revenue amounts for SC are 10-250M

Table 12. Northeast Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 2	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (1) DB (2) CM/GC (1)	Lack of knowledge to differentiate between PDM & Contracts. DB represents the most used PDM, but DBB and CM/GC are available options for many projects.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (1) Design Reqs (1) Best Qualif (2) Low Resp Bid (1) Business Relat (1)	Best Qualifications have gained popularity, but the industry shows a wide spectrum where all options can be chosen.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (2) No (0) Unsure (0)	Multiple contract practice is a common practice where 100% of participants recognize this method.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (1) PC (2) SC (1) Designer (1) Other (0)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC & Designer

Table 12. Northeast Survey Evaluation (continued)

SPECIALTY CONTRACTORS (SC) QUESTIONS N = 8	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (1) Design Reqs (1) Best Qualif (5) Low Resp Bid (5) Business Relat (6) Other (0)	Business Relationships option is often used, but the two-steps method under hard bid selection is a common option.
How is your company usually selected as a Subcontractor?	Owner mand (3) Design Reqs (1) Best Qualif (7) Low Resp Bid (6) Business Relat (6)	Business Relationships option is often used, but the two-steps method under hard bid selection is still used by higher tiers to select subcontractors.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (7) PC (8) SC (4) Designer (4) Other (0)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC & Designer
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (4) No (4) Unsure (0)	Multiple contract practice is a common practice where 50% of participants recognize this method.

Midwest

The Midwest Region is made up of the East North Central and West North Central divisions. As shown in the Figure 26, Midwest Region includes the states of Indiana (IA), Illinois (IL), Michigan (MI), Ohio (OH), Wisconsin (WI), Iowa (IA), Kansas (KS), Minnesota (MN), Missouri (MO), Nebraska (NE), North Dakota (ND), and South Dakota (SD). The total number of respondents in this region is 85, divided into 45 General Contractors and 40 Specialty Contractors. The next Evaluation Table 13 shows the contractual characteristics of the Midwest Region, the highlight responses represent the most common practices or data relevance in each question.

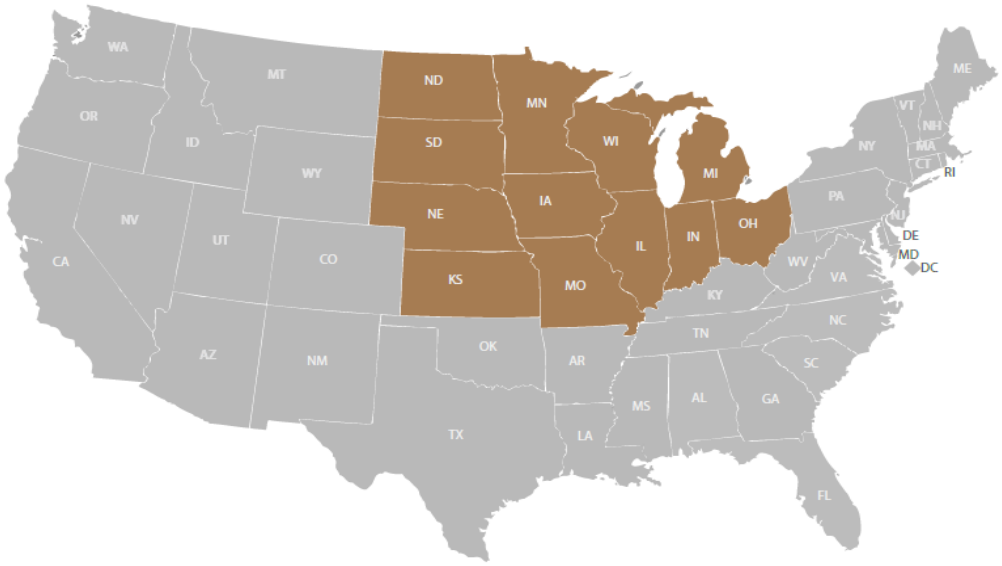


Figure 26. Midwest Region

Table 13. Midwest Survey Evaluation

OVERALL QUESTIONS N = 85	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (4) 2<x<5 years (17) 5<x<15 years (19) 15<x years (45)	x<2 years (4) 2<x<5 years (12) 5<x<15 years (14) 15<x years (15)	x<2 years (0) 2<x<5 years (5) 5<x<15 years (5) 15<x years (30)	SC have great construction experience, PC has a more balanced sample but still has representative experience
What position do you presently hold in your company?	Executive (34) PM (25) SI (5) Other (21)	Executive (6) PM (18) SI (5) Other (16)	Executive (28) PM (7) SI (0) Other (5)	Executives are the most representative participants for SC. PC has construction field participants (Est, PM, Proj. Eng.)
How long have you been in this position with your company?	x<2 years (22) 2<x<5 years (23) 5<x<15 years (18) 15<x years (22)	x<2 years (16) 2<x<5 years (17) 5<x<15 years (10) 15<x years (2)	x<2 years (6) 2<x<5 years (6) 5<x<15 years (8) 15<x years (20)	PC & SC have long/mid-term employees, but SC has more lasting relationships than PC
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (6) 1<x<10M (34) 10<x<50M (25) 50<x<250M (9) 250M<x (11)	x<1M (1) 1<x<10M (10) 10<x<50M (17) 50<x<250M (8) 250M<x (9)	x<1M (5) 1<x<10M (24) 10<x<50M (8) 50<x<250M (1) 250M<x (2)	PC & SC share the same average in contracts (1-50 M), but PC has more opportunity to bigger ones than SC (50-250M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (41) SC (42) Other (2)	GC (41) SC (3) Other (1)	GC (0) SC (39) Other (1)	PC & SC keep their normal prop. Others include: FM & manufacturer
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (45) SC (40)	N/A	N/A	GC has a bigger sample than SC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (46) Somewhat (33) Aware (4) Not Aware (2)	Fully (26) Somewhat (16) Aware (2) Not Aware (1)	Fully (20) Somewhat (17) Aware (2) Not Aware (1)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (21) 10<x<50M (21) 50<x<250M (16) 250<x<500M (6) 500<x<1B (3) 1B<x (15) Don't Know (3)	x<10M (4) 10<x<50M (8) 50<x<250M (10) 250<x<500M (5) 500<x<1B (3) 1B<x (13) Don't Know (2)	x<10M (17) 10<x<50M (13) 50<x<250M (6) 250<x<500M (1) 500<x<1B (0) 1B<x (2) Don't Know (1)	PC has the biggest revenues examples, but the average revenue amounts for PC & SC are 10-250M

Table 13. Midwest Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 45	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (29) DB (29) CM/GC (29) Other (LS, GMP, C+F) (3) Other (P3) (1) Other (CM Agency) (1)	DB, CM/GC, and DBB have the same rate. However, the inclusion of P3 shows a new PDM tendency.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (25) Design Reqs (11) Best Qualif (36) Low Resp Bid (39) Business Relat (30) Other (MBE/WBE) (1)	Business Relationships option is often used, but the two-steps method under hard bid selection is the most used.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (24) No (13) Unsure (8)	Multiple contract practice is a common practice where more than 50% of participants recognize this method.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (21) PC (30) SC (8) Designer (19) Other (2)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. Designer 4. SC (Horizontal structures)

Table 13. Midwest Survey Evaluation (continued)

SPECIALTY CONTRACTORS (PC) QUESTIONS N = 40	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (4) Design Reqs (2) Best Qualif (17) Low Resp Bid (23) Business Relat (21) Other (No Subs) (5)	Business Relationships option is often used, but the two-steps method under hard bid selection is the most used. Sometimes, the only criteria used by SC is low bid.
How is your company usually selected as a Subcontractor?	Owner mand (6) Design Reqs (7) Best Qualif (17) Low Resp Bid (32) Business Relat (25) Other (MBE/WBE) (1)	Business Relationships option is often used, but the low bid method is the most used method among PC to select lower tiers.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (25) PC (37) SC (16) Designer (13)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC (Horizontal Structures). Designers and SC's might have better relationships in designing stages.
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (19) No (18) Unsure (3)	Multiple contract practice is a common practice where almost 50% of participants recognize this method.

South

The South Region is made up of the South Atlantic, East South Central and West South Central divisions. As shown in the Figure 27, South Region includes the states of Delaware (DE), District of Columbia (DC), Florida (FL), Georgia (GA), Maryland (MD), North Carolina (NC), South Carolina (SC), Virginia (VA), West Virginia (WV), Alabama (AL), Kentucky (KY), Mississippi (MS), Tennessee (TN), Arkansas (AR), Louisiana (LA), Oklahoma (OK), and Texas (TX). The total number of respondents in this region is 58, divided into 13 General Contractors and 45 Specialty Contractors. The next Evaluation Table 14 shows the contractual characteristics of the South Region, the highlight responses represent the most common practices or data relevance in each question.

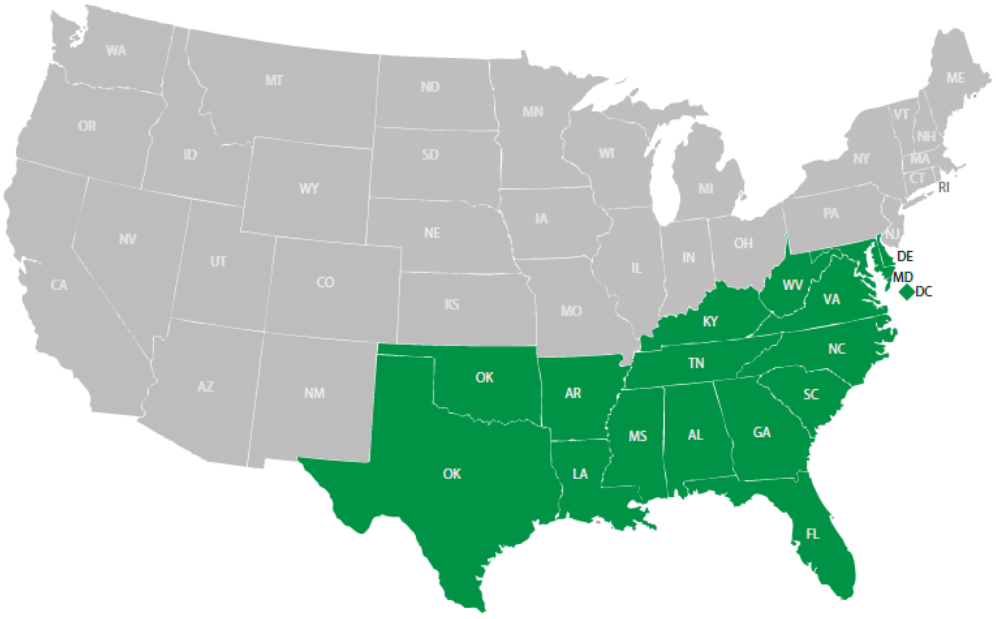


Figure 27. South Region

Table 14. South Survey Evaluation

OVERALL QUESTIONS N = 58	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (6) 2<x<5 years (4) 5<x<15 years (8) 15<x years (40)	x<2 years (5) 2<x<5 years (3) 5<x<15 years (2) 15<x years (3)	x<2 years (1) 2<x<5 years (1) 5<x<15 years (6) 15<x years (37)	SC have great construction experience, PC has a more balanced sample but still has novice respondents.
What position do you presently hold in your company?	Executive (37) PM (3) SI (2) Other (16)	Executive (2) PM (2) SI (2) Other (7)	Executive (35) PM (1) SI (0) Other (9)	Executives are the most representative participants for SC. PC has construction field participants (Est, PM, Proj. Eng.)
How long have you been in this position with your company?	x<2 years (9) 2<x<5 years (8) 5<x<15 years (16) 15<x years (25)	x<2 years (7) 2<x<5 years (1) 5<x<15 years (3) 15<x years (2)	x<2 years (2) 2<x<5 years (7) 5<x<15 years (13) 15<x years (23)	PC has short-term employees, in contrast, SC has long-term employees.
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (7) 1<x<10M (28) 10<x<50M (13) 50<x<250M (6) 250M<x (4)	x<1M (1) 1<x<10M (3) 10<x<50M (3) 50<x<250M (2) 250M<x (4)	x<1M (6) 1<x<10M (25) 10<x<50M (10) 50<x<250M (4) 250M<x (0)	PC & SC share the same average in contracts (1-50 M), but PC has more opportunity to bigger ones than SC (50-250M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (11) SC (45) Other (2)	GC (11) SC (2) Other (0)	GC (0) SC (43) Other (2)	PC & SC keep their normal prop. Others include: suppliers & Manufacturers
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (13) SC (45)	N/A	N/A	SC has a bigger sample than GC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (32) Somewhat (21) Aware (5) Not Aware (0)	Fully (9) Somewhat (4) Aware (0) Not Aware (0)	Fully (23) Somewhat (17) Aware (5) Not Aware (0)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (12) 10<x<50M (25) 50<x<250M (6) 250<x<500M (4) 500<x<1B (5) 1B<x (5) Don't Know (1)	x<10M (1) 10<x<50M (1) 50<x<250M (2) 250<x<500M (0) 500<x<1B (3) 1B<x (5) Don't Know (1)	x<10M (11) 10<x<50M (24) 50<x<250M (4) 250<x<500M (4) 500<x<1B (2) 1B<x (0) Don't Know (0)	PC has the biggest revenues (500M - 1B) examples. SC has a revenue average from 10 to 250M.

Table 14. South Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 13	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (9) DB (8) CM/GC (8) Other (LS) (1)	DBB is the most used option, DB and CM/GC are methods that are gaining popularity.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (7) Design Reqs (6) Best Qualif (11) Low Resp Bid (12) Business Relat (10)	Business Relationships option is often used, but the two-steps method under hard bid selection is the most used.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (9) No (2) Unsure (2)	Multiple contract practice is a common practice where more than 50% of participants recognize this method.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (7) PC (10) SC (9) Designer (8) Other (17)	The contractual links between higher and lower tiers are different from normal practices: 1. PC 2. SC 3. Designer 4. Owner

Table 14. South Survey Evaluation (continued)

SPECIALTY CONTRACTORS (PC) QUESTIONS N = 45	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (3) Design Reqs (4) Best Qualif (25) Low Resp Bid (20) Business Relat (30) Other (No Subs) (5)	Business Relationships option is the most used method, where two-steps method under hard bid selection is a common option, but it is losing popularity when SC's select their lower tiers.
How is your company usually selected as a Subcontractor?	Owner mand (8) Design Reqs (11) Best Qualif (32) Low Resp Bid (29) Business Relat (36)	Business Relationships option is the most used method, where two-steps method under hard bid selection is a common option. As SC example, PC's are changing their Low Bid practices.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (30) PC (44) SC (17) Designer (11) Other (2)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC (Horizontal Structures). Designers and SC's might have better relationships in designing stages.
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (24) No (21) Unsure (0)	Multiple contract practice is a common practice where almost 50% of participants recognize this method.

West

The West Region is made up of the Mountain and Pacific divisions. As shown in the Figure 28, West Region includes the states of Arizona (AZ), Colorado (CO), Idaho (ID), New Mexico (NM), Montana (MT), Utah (UT), Nevada (NV), Wyoming (WY), Alaska (AK), California (CA), Hawaii (HI), Oregon (OR), and Washington (WA). This study excluded Alaska, and Hawaii participants because of the lack of contact information available in public databases. For this Census Region, databases from Osmanbhoy's research and the current survey were separated to obtain a detailed report of the respondents' preferences. The total number of respondents between both studies is 101 (10 from the current thesis), divided between 66 General Contractors (1 from the current thesis) and 35 Specialty Contractors (9 from the current thesis). The next Evaluation Tables 15 and 16 show the contractual characteristics of the West Region, the highlight responses represent the most common practices or data relevance in each question.

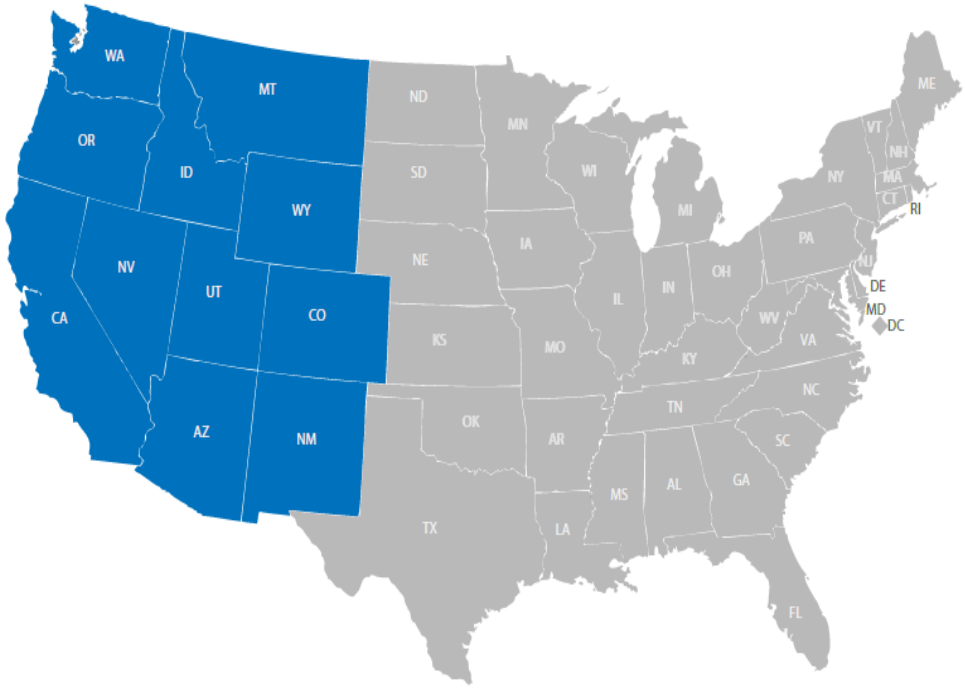


Figure 28. West Region

Table 15. West Current Survey Evaluation

OVERALL QUESTIONS N = 10	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (1) 2<x<5 years (0) 5<x<15 years (1) 15<x years (8)	x<2 years (1) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (1) 15<x years (8)	Not enough participants.
What position do you presently hold in your company?	Executive (5) PM (0) SI (0) Other (5)	Executive (0) PM (0) SI (0) Other (1)	Executive (5) PM (0) SI (0) Other (4)	Not enough participants.
How long have you been in this position with your company?	x<2 years (1) 2<x<5 years (0) 5<x<15 years (2) 15<x years (7)	x<2 years (1) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (2) 15<x years (7)	Not enough participants.
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (1) 1<x<10M (3) 10<x<50M (4) 50<x<250M (2) 250M<x (0)	x<1M (0) 1<x<10M (0) 10<x<50M (0) 50<x<250M (1) 250M<x (0)	x<1M (1) 1<x<10M (3) 10<x<50M (4) 50<x<250M (1) 250M<x (0)	Not enough participants.
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (1) SC (6) Other (3)	GC (1) SC (0) Other (0)	GC (0) SC (6) Other (3)	Not enough participants.
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (1) SC (9)	N/A	N/A	Not enough participants.
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (5) Somewhat (5) Aware (0) Not Aware (0)	Fully (0) Somewhat (1) Aware (0) Not Aware (0)	Fully (5) Somewhat (4) Aware (0) Not Aware (0)	Not enough participants.
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (2) 10<x<50M (2) 50<x<250M (4) 250<x<500M (0) 500<x<1B (0) 1B<x (2) Don't Know (0)	x<10M (0) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (0) 1B<x (1) Don't Know (0)	x<10M (2) 10<x<50M (2) 50<x<250M (4) 250<x<500M (0) 500<x<1B (0) 1B<x (1) Don't Know (0)	Not enough participants.

Table 15. West Current Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 1	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (0) DB (1) CM/GC (0) Other (LS, GMP, C+F) (0) Other (IPD) (0)	Not enough participants.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (0) Design Reqs (0) Best Qualif (1) Low Resp Bid (0) Business Relat (0)	Not enough participants.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (0) No (0) Unsure (1)	Not enough participants.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (1) PC (1) SC (1) Designer (0) Other (0)	Not enough participants.

Table 15. West Current Survey Evaluation (continued)

SPECIALTY CONTRACTORS (SC) QUESTIONS N = 9	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (0) Design Reqs (3) Best Qualif (7) Low Resp Bid (4) Business Relat (7) Other (No Subs) (0) Other (Ins/Bonds) (0)	Not enough participants.
How is your company usually selected as a Subcontractor?	Owner mand (2) Design Reqs (4) Best Qualif (5) Low Resp Bid (6) Business Relat (7)	Not enough participants.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (4) PC (8) SC (3) Designer (1) Other (1)	Not enough participants.
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (4) No (5) Unsure (0)	Not enough participants.

Table 16. West Osmanbhoy Survey Evaluation

OVERALL QUESTIONS N = 91	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (0) 2<x<5 years (3) 5<x<15 years (8) 15<x years (80)	x<2 years (0) 2<x<5 years (3) 5<x<15 years (8) 15<x years (54)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (26)	PC & SC have great construction experience
What position do you presently hold in your company?	Executive (65) PM (15) SI (2) Other (9)	Executive (44) PM (12) SI (1) Other (8)	Executive (21) PM (3) SI (1) Other (1)	Executives are the most representative participants
How long have you been in this position with your company?	x<2 years (3) 2<x<5 years (16) 5<x<15 years (36) 15<x years (36)	x<2 years (3) 2<x<5 years (14) 5<x<15 years (24) 15<x years (24)	x<2 years (0) 2<x<5 years (2) 5<x<15 years (12) 15<x years (12)	PC & SC have long-term employees
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (2) 1<x<10M (30) 10<x<50M (32) 50<x<250M (20) 250M<x (7)	x<1M (1) 1<x<10M (16) 10<x<50M (23) 50<x<250M (18) 250M<x (7)	x<1M (1) 1<x<10M (14) 10<x<50M (9) 50<x<250M (2) 250M<x (0)	PC has bigger contracts (10-250 M) than SC (1-50M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (63) SC (23) Other (5)	GC (62) SC (1) Other (2)	GC (1) SC (22) Other (3)	PC & SC keep their normal prop. Others include: suppliers & agencies
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (65) SC (26)	N/A	N/A	GC has a bigger sample than SC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (43) Somewhat (43) Aware (5) Not Aware (0)	Fully (26) Somewhat (35) Aware (4) Not Aware (0)	Fully (17) Somewhat (8) Aware (1) Not Aware (0)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (14) 10<x<50M (32) 50<x<250M (21) 250<x<500M (8) 500<x<1B (3) 1B<x (12) Don't Know (1)	x<10M (4) 10<x<50M (20) 50<x<250M (18) 250<x<500M (8) 500<x<1B (3) 1B<x (12) Don't Know (0)	x<10M (10) 10<x<50M (12) 50<x<250M (3) 250<x<500M (0) 500<x<1B (0) 1B<x (0) Don't Know (1)	PC has the biggest revenues (1B) examples, but the average revenue amounts for PC & SC are 10-250M

Table 16. West Osmanbhoy Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 65	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (38) DB (43) CM/GC (39) Other (LS, GMP, C+F) (37) Other (IPD) (1)	Lack of knowledge to differentiate PDM & Contracts. DB and CM/GC represents the most used PDM, but DBB is an available option for many projects.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (24) Design Reqs (26) Best Qualif (53) Low Resp Bid (56) Business Relat (48)	Business Relationships option is often used, but the two-steps method under hard bid selection is the most used.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (29) No (29) Unsure (7)	Multiple contract practice is a common practice where almost 50% of participants recognize this method.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (34) PC (41) SC (23) Designer (31) Other (17)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. Designer 4. SC (Horizontal structures)

Table 16. West Osmanbhoy Survey Evaluation (continued)

SPECIALTY CONTRACTORS (SC) QUESTIONS N = 26	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (1) Design Reqs (8) Best Qualif (15) Low Resp Bid (16) Business Relat (19) Other (No Subs) (1) Other (Ins/Bonds) (1)	Business Relationships option is often used, but the two-steps method under hard bid selection is the most used.
How is your company usually selected as a Subcontractor?	Owner mand (5) Design Reqs (7) Best Qualif (16) Low Resp Bid (22) Business Relat (17)	Business Relationships option is often used, but the two-steps method under hard bid selection is the most used.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (18) PC (26) SC (6) Designer (4) Other (0)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC (Horizontal Structures). Designers and SC's might have better relationships in designing stages.
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (13) No (12) Unsure (1)	Multiple contract practice is a common practice where almost 50% of participants recognize this method.

APPENDIX C

This appendix explains the data highlights of each census division due to the importance of categorizing and identifying characteristics that might differentiate divisions from one another. The results are shown by "Evaluation Tables" which summarize the respondents' answers for each survey section (introduction, general contractor, and specialty contractor), including all questions. Pacific division section shows two different tables; one table shows the survey results of the current thesis and the second table summarizes the results of Osmanbhoy online survey.

New England

The New England Division includes the states of Connecticut (CT), Maine (ME), Massachusetts (MA), New Hampshire (NH), Rhode Island (RI), and Vermont (VT) as shown in Figure 29. The total number of respondents in this region is 1, divided into 1 General Contractors and 0 Specialty Contractors. The next Evaluation Table 17 shows the contractual characteristics of the New England Division, the highlight responses represent the most common practices or data relevance in each question. For this division, the study explains the results, but it will not be considered as a meaningful sample because of the reduced number of respondents.

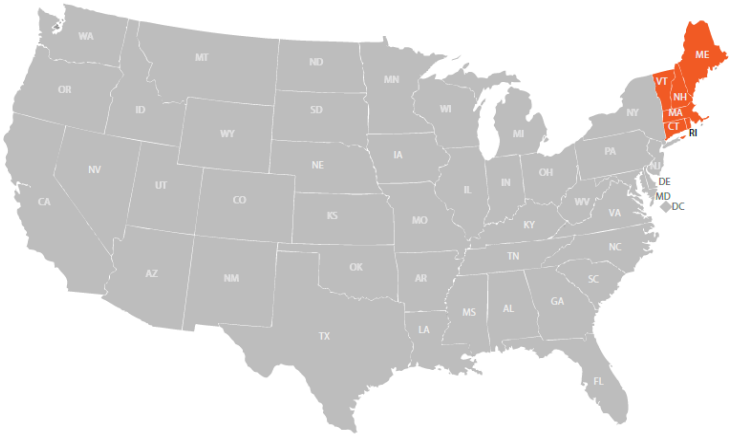


Figure 29. New England Division

Table 17. New England Survey Evaluation

OVERALL QUESTIONS N = 1	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (0) 2<x<5 years (0) 5<x<15 years (1) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (1) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	PC have a good construction experience.
What position do you presently hold in your company?	Executive (0) PM (0) SI (1) Other (0)	Executive (0) PM (0) SI (1) Other (0)	Executive (0) PM (0) SI (0) Other (0)	PC has construction field participants
How long have you been in this position with your company?	x<2 years (1) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	x<2 years (1) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	PC has short-term employees.
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (0) 1<x<10M (0) 10<x<50M (0) 50<x<250M (0) 250M<x (1)	x<1M (0) 1<x<10M (0) 10<x<50M (0) 50<x<250M (0) 250M<x (1)	x<1M (0) 1<x<10M (0) 10<x<50M (0) 50<x<250M (0) 250M<x (0)	PC has the biggest contracts amounts (+250M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (1) SC (0) Other (0)	GC (1) SC (0) Other (0)	GC (0) SC (0) Other (0)	PC keeps its normal properties
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (1) SC (0)	N/A	N/A	Only one GC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (1) Somewhat (0) Aware (0) Not Aware (0)	Fully (1) Somewhat (0) Aware (0) Not Aware (0)	Fully (0) Somewhat (0) Aware (0) Not Aware (0)	Fully involvement
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (0) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (0) 1B<x (1) Don't Know (0)	x<10M (0) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (0) 1B<x (1) Don't Know (0)	x<10M (0) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (0) 1B<x (0) Don't Know (0)	PC has the biggest revenues (+1B)

Table 17. New England Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 1	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (1) DB (1) CM/GC (1)	The three listed PDM have the same probability to be used under any project.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (1) Design Reqs (1) Best Qualif (1) Low Resp Bid (1) Business Relat (1)	Because of the company size, the respondent states that every option could be used for different projects.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (1) No (0) Unsure (0)	Multiple contract practice is a common practice.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (1) PC (1) SC (1) Designer (1) Other (0)	Real possibility for relational contracts.

Middle Atlantic

The Middle Atlantic Division includes the states of New Jersey (NJ), New York (NY), and Pennsylvania (PA) as shown in Figure 30. The total number of respondents in this region is 9, divided into 1 General Contractors and 8 Specialty Contractors. The next Evaluation Table 18 shows the contractual characteristics of the Middle Atlantic Division, the highlight responses represent the most common practices or data relevance in each question.

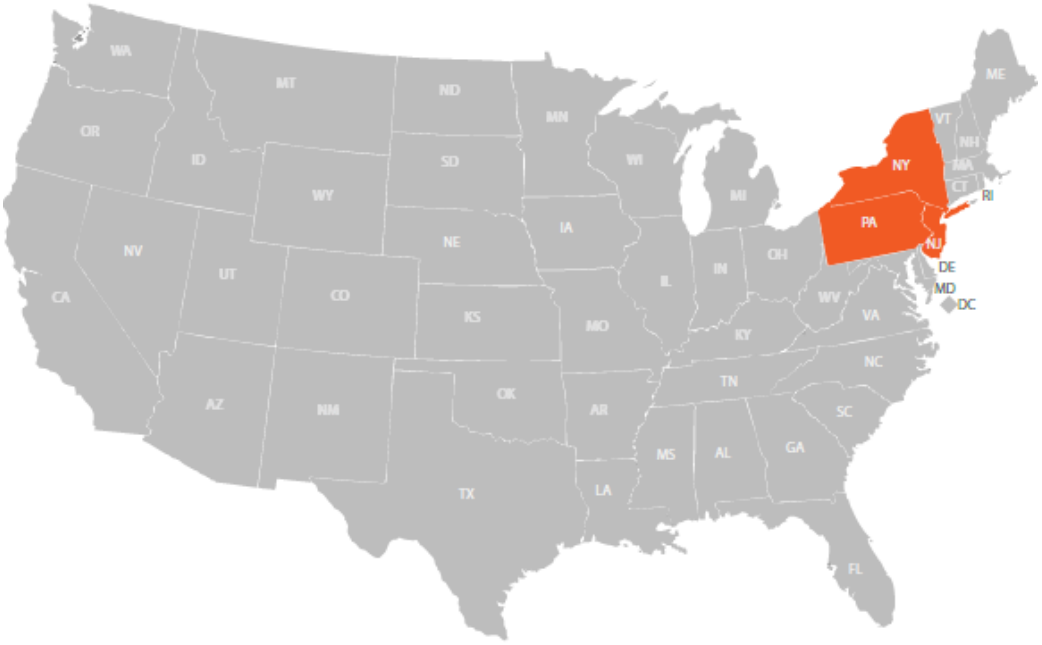


Figure 30. Middle Atlantic Division

Table 18. Middle Atlantic Survey Evaluation

OVERALL QUESTIONS N = 9	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (0) 2<x<5 years (0) 5<x<15 years (1) 15<x years (8)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (1) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (8)	PC has acceptable experience while SC has great construction experience
What position do you presently hold in your company?	Executive (8) PM (1) SI (0) Other (0)	Executive (0) PM (1) SI (0) Other (0)	Executive (8) PM (0) SI (0) Other (0)	SC has Executives in the sample, PC respondents came from on-site activities.
How long have you been in this position with your company?	x<2 years (1) 2<x<5 years (2) 5<x<15 years (2) 15<x years (4)	x<2 years (1) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (2) 5<x<15 years (2) 15<x years (4)	PC has short-term employees, in contrast, SC has long-term employees.
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (0) 1<x<10M (5) 10<x<50M (3) 50<x<250M (1) 250M<x (0)	x<1M (0) 1<x<10M (0) 10<x<50M (0) 50<x<250M (1) 250M<x (0)	x<1M (0) 1<x<10M (5) 10<x<50M (3) 50<x<250M (0) 250M<x (0)	PC has bigger contracts (50-250 M) than SC (1-50M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (1) SC (8) Other (0)	GC (1) SC (0) Other (0)	GC (0) SC (8) Other (0)	PC & SC keep their normal properties
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (1) SC (8)	N/A	N/A	GC has a smaller sample than SC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (4) Somewhat (3) Aware (2) Not Aware (0)	Fully (1) Somewhat (0) Aware (0) Not Aware (0)	Fully (3) Somewhat (3) Aware (2) Not Aware (0)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (0) 10<x<50M (6) 50<x<250M (2) 250<x<500M (0) 500<x<1B (0) 1B<x (1) Don't Know (0)	x<10M (0) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (0) 1B<x (1) Don't Know (0)	x<10M (0) 10<x<50M (6) 50<x<250M (2) 250<x<500M (0) 500<x<1B (0) 1B<x (0) Don't Know (0)	PC has the biggest revenues (1B) examples, but the average revenue amounts for SC are 10-250M

Table 18. Middle Atlantic Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 1	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (0) DB (1) CM/GC (0)	Respondent only is aware of using DB
Over the last 3 years, your company selected subcontractors based on:	Owner mand (0) Design Reqs (0) Best Qualif (1) Low Resp Bid (0) Business Relat (0)	Respondent only is aware of using Best Qualifications to select Subcontractors
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (1) No (0) Unsure (0)	Multiple contract practice is a common practice where 100% of participants recognize this method.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (0) PC (1) SC (0) Designer (0) Other (0)	The respondent states that PC is the only responsible for SC's performance and communication with more construction members

Table 18. Middle Atlantic Survey Evaluation (continued)

SPECIALTY CONTRACTORS (SC) QUESTIONS N = 8	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (1) Design Reqs (1) Best Qualif (5) Low Resp Bid (5) Business Relat (6) Other (0)	Business Relationships option is often used, but the two-steps method under hard bid selection is a common option.
How is your company usually selected as a Subcontractor?	Owner mand (3) Design Reqs (1) Best Qualif (7) Low Resp Bid (6) Business Relat (6)	Business Relationships option is often used, but the two-steps method under hard bid selection is still used by higher tiers to select subcontractors.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (7) PC (8) SC (4) Designer (4) Other (0)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC & Designer
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (4) No (4) Unsure (0)	Multiple contract practice is a common practice where 50% of participants recognize this method.

East North Central

The East North Central Division includes the states of Indiana (IN), Illinois (IL), Michigan (MI), Ohio (OH), and Wisconsin (WI) as shown in Figure 31. The total number of respondents in this region is 9, divided into 4 General Contractors and 5 Specialty Contractors. The next Evaluation Table 19 shows the contractual characteristics of the East North Central Division, the highlight responses represent the most common practices or data relevance in each question.

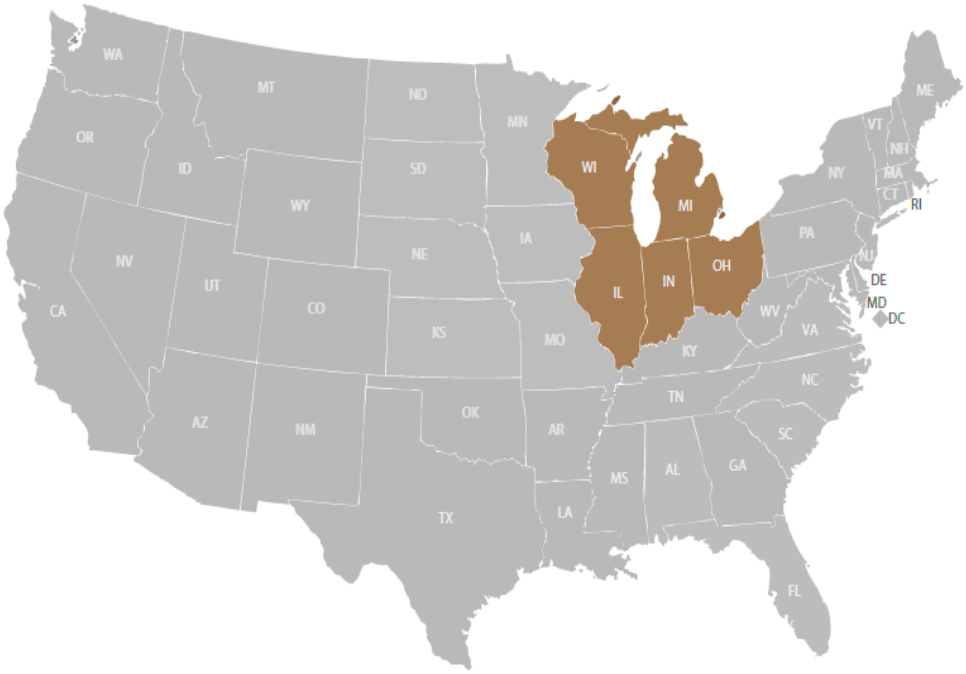


Figure 31. East North Central Division

Table 19. East North Central Survey Evaluation

OVERALL QUESTIONS N = 9	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (0) 2<x<5 years (3) 5<x<15 years (1) 15<x years (5)	x<2 years (0) 2<x<5 years (3) 5<x<15 years (1) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (5)	SC have great construction experience, PC has a more balanced sample but still has representative experience
What position do you presently hold in your company?	Executive (5) PM (2) SI (0) Other (2)	Executive (0) PM (2) SI (0) Other (2)	Executive (5) PM (0) SI (0) Other (0)	Executives are the most representative participants for SC. PC has construction field participants (Est, PM, Proj. Eng.)
How long have you been in this position with your company?	x<2 years (2) 2<x<5 years (2) 5<x<15 years (0) 15<x years (5)	x<2 years (2) 2<x<5 years (2) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (5)	PC has short/mid term employees, but SC has more lasting relationships than PC
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (0) 1<x<10M (4) 10<x<50M (1) 50<x<250M (1) 250M<x (3)	x<1M (0) 1<x<10M (0) 10<x<50M (1) 50<x<250M (1) 250M<x (2)	x<1M (0) 1<x<10M (4) 10<x<50M (0) 50<x<250M (0) 250M<x (1)	SC has average contracts from 1 to 50 M, PC has bigger contracts than SC (50-250M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (4) SC (5) Other (0)	GC (4) SC (0) Other (0)	GC (0) SC (5) Other (0)	PC & SC keep their normal prop. Others include: FM & manufacturer
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (4) SC (5)	N/A	N/A	SC has a bigger sample than GC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (5) Somewhat (4) Aware (0) Not Aware (0)	Fully (2) Somewhat (2) Aware (0) Not Aware (0)	Fully (3) Somewhat (2) Aware (0) Not Aware (0)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (5) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (1) 1B<x (3) Don't Know (0)	x<10M (0) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (1) 1B<x (3) Don't Know (0)	x<10M (5) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (0) 1B<x (0) Don't Know (0)	PC has the biggest revenues samples, SC has low revenues (less than 10M)

Table 19. East North Central Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 4	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (3) DB (1) CM/GC (3)	DBB & CM/GC are the principal alternatives, DB is not a recurrent PDM.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (2) Design Reqs (0) Best Qualif (3) Low Resp Bid (3) Business Relat (2)	Business Relationships & Owner Mandate option are often used, but the two-steps method under hard bid selection is the most used.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (3) No (0) Unsure (1)	Multiple contract practice is a common practice where almost the 100% of participants recognize this method.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (1) PC (3) SC (1) Designer (1)	PC holds its principal contractual place with subcontractors.

Table 19. East North Central Survey Evaluation (continued)

SPECIALTY CONTRACTORS (PC) QUESTIONS N = 5	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (0) Design Reqs (0) Best Qualif (2) Low Resp Bid (1) Business Relat (2) Other (No Subs) (2)	Business Relationships & Best Qualifications options are the most used. Sometimes, respondents identify low bid as an option to select lower tiers.
How is your company usually selected as a Subcontractor?	Owner mand (1) Design Reqs (0) Best Qualif (1) Low Resp Bid (5) Business Relat (1)	Low responsible Bid is the most used methodology.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (1) PC (5) SC (1) Designer (0)	PC holds its principal contractual place with subcontractors.
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (2) No (3) Unsure (0)	Multiple contract practice is not a common practice. Participants disagree to celebrate more than one contract.

West North Central

The West North Central Division includes the states of Iowa (IA), Kansas (KS), Minnesota (MN), Missouri (MO), Nebraska (NE), North Dakota (ND), and South Dakota (SD) as shown in Figure 32. The total number of respondents in this region is 76, divided into 41 General Contractors and 35 Specialty Contractors. The next Evaluation Table 20 shows the contractual characteristics of the West North Central Division, the highlight responses represent the most common practices or data relevance in each question.

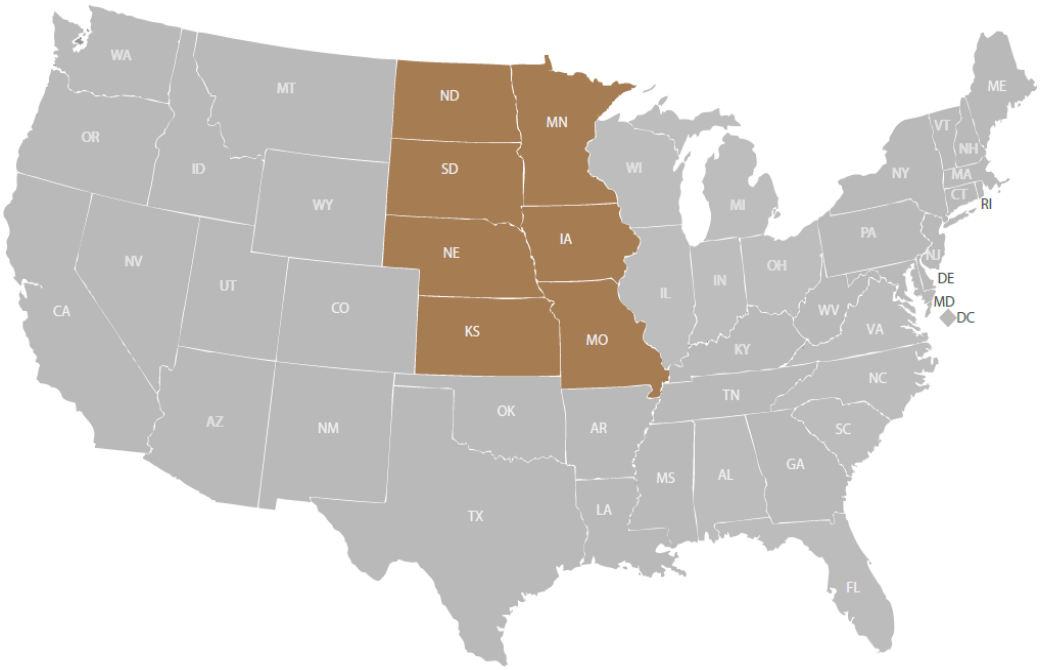


Figure 32. West North Central Division

Table 20. West North Central Survey Evaluation

OVERALL QUESTIONS N = 76	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (4) 2<x<5 years (14) 5<x<15 years (18) 15<x years (40)	x<2 years (4) 2<x<5 years (9) 5<x<15 years (13) 15<x years (15)	x<2 years (0) 2<x<5 years (5) 5<x<15 years (5) 15<x years (25)	SC have great construction experience, PC has a more balanced sample but still has representative experience
What position do you presently hold in your company?	Executive (29) PM (23) SI (5) Other (19)	Executive (6) PM (16) SI (5) Other (14)	Executive (23) PM (7) SI (0) Other (5)	Executives are the most representative participants for SC. PC has construction field participants (Est, PM, Proj. Eng.)
How long have you been in this position with your company?	x<2 years (20) 2<x<5 years (21) 5<x<15 years (18) 15<x years (17)	x<2 years (14) 2<x<5 years (15) 5<x<15 years (10) 15<x years (2)	x<2 years (6) 2<x<5 years (6) 5<x<15 years (8) 15<x years (15)	PC & SC have long/mid-term employees, but SC has more lasting relationships than PC.
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (6) 1<x<10M (30) 10<x<50M (24) 50<x<250M (8) 250M<x (8)	x<1M (1) 1<x<10M (10) 10<x<50M (16) 50<x<250M (7) 250M<x (7)	x<1M (5) 1<x<10M (20) 10<x<50M (8) 50<x<250M (1) 250M<x (1)	PC & SC share the same average in contracts (1-50 M), but PC has more opportunity to bigger ones than SC (50-250M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (37) SC (37) Other (2)	GC (37) SC (3) Other (1)	GC (0) SC (34) Other (1)	PC & SC keep their normal prop. Others include: FM & manufacturer
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (41) SC (35)	N/A	N/A	GC has a bigger sample than SC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (41) Somewhat (29) Aware (4) Not Aware (2)	Fully (24) Somewhat (14) Aware (2) Not Aware (1)	Fully (17) Somewhat (15) Aware (2) Not Aware (1)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (16) 10<x<50M (21) 50<x<250M (16) 250<x<500M (6) 500<x<1B (2) 1B<x (12) Don't Know (3)	x<10M (4) 10<x<50M (8) 50<x<250M (10) 250<x<500M (5) 500<x<1B (2) 1B<x (10) Don't Know (2)	x<10M (12) 10<x<50M (13) 50<x<250M (6) 250<x<500M (1) 500<x<1B (0) 1B<x (2) Don't Know (1)	PC has the biggest revenues examples, but the average revenue amounts for PC & SC are 10-250M

Table 20. West North Central Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 41	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (26) DB (28) CM/GC (26) Other (LS, GMP, C+F) (3) Other (P3) (1) Other (CM Agency) (1)	DB, CM/GC, and DBB have the similar rates. However, the inclusion of P3 shows a new PDM tendency.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (23) Design Reqs (11) Best Qualif (33) Low Resp Bid (36) Business Relat (28) Other (MBE/WBE) (1)	Business Relationships option is often used, but the two-steps method under hard bid selection is the most used.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (21) No (13) Unsure (7)	Multiple contract practice is a common practice where more than 50% of participants recognize this method.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (20) PC (27) SC (7) Designer (18) Other (2)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. Designer 4. SC (Horizontal structures)

Table 20. West North Central Survey Evaluation (continued)

SPECIALTY CONTRACTORS (PC) QUESTIONS N = 35	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (4) Design Reqs (2) Best Qualif (15) Low Resp Bid (22) Business Relat (19) Other (No Subs) (3)	Business Relationships option is often used, but the two-steps method under hard bid selection is the most used. Sometimes, the only criteria used by SC is low bid.
How is your company usually selected as a Subcontractor?	Owner mand (5) Design Reqs (7) Best Qualif (16) Low Resp Bid (27) Business Relat (24) Other (MBE/WBE) (1)	Business Relationships option is often used, but the low bid selection process is the most used method among PC to select lower tiers.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (24) PC (32) SC (15) Designer (13) Other (Supplier) (2)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC (Horizontal Structures). Designers and SC's might have better relationships in designing stages.
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (17) No (15) Unsure (3)	Multiple contract practice is a common practice where almost 50% of participants recognize this method.

South Atlantic

The South Atlantic Division includes the states of Delaware (DE), District of Columbia (DC), Florida (FL), Georgia (GA), Maryland (MD), North Carolina (NC), South Carolina (SC), Virginia (VA), and West Virginia (WV) as shown in Figure 33. The total number of respondents in this region is 24, divided into 5 General Contractors and 19 Specialty Contractors. The next Evaluation Table 21 shows the contractual characteristics of the South Atlantic Division, the highlight responses represent the most common practices or data relevance in each question.

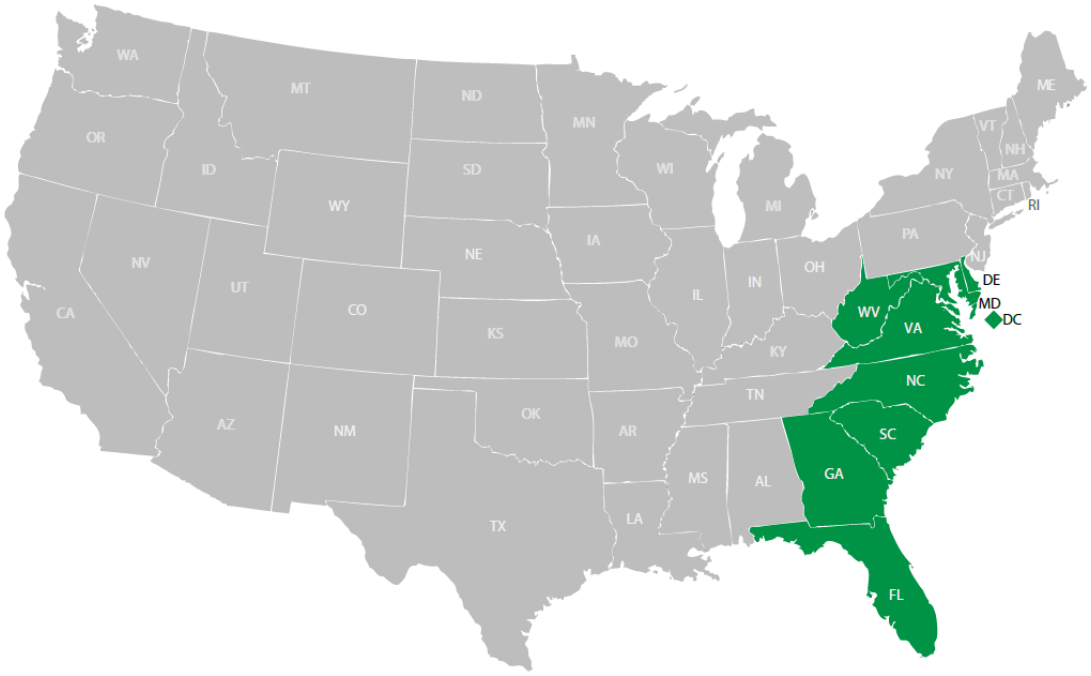


Figure 33. South Atlantic Division

Table 21. South Atlantic Survey Evaluation

OVERALL QUESTIONS N = 24	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (4) 2<x<5 years (1) 5<x<15 years (0) 15<x years (19)	x<2 years (3) 2<x<5 years (1) 5<x<15 years (0) 15<x years (1)	x<2 years (1) 2<x<5 years (0) 5<x<15 years (0) 15<x years (18)	SC has great construction experience, PC has a more balanced sample, but it doesn't have long experience
What position do you presently hold in your company?	Executive (19) PM (1) SI (0) Other (4)	Executive (1) PM (1) SI (0) Other (3)	Executive (18) PM (0) SI (0) Other (1)	Executives are the most representative participants for SC. PC has construction field participants (Est, PM, Proj. Eng.)
How long have you been in this position with your company?	x<2 years (6) 2<x<5 years (1) 5<x<15 years (3) 15<x years (14)	x<2 years (4) 2<x<5 years (0) 5<x<15 years (0) 15<x years (1)	x<2 years (2) 2<x<5 years (1) 5<x<15 years (3) 15<x years (13)	PC has short-term employees, but SC has more lasting relationships than PC
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (2) 1<x<10M (13) 10<x<50M (4) 50<x<250M (2) 250M<x (3)	x<1M (0) 1<x<10M (2) 10<x<50M (0) 50<x<250M (0) 250M<x (3)	x<1M (2) 1<x<10M (11) 10<x<50M (4) 50<x<250M (2) 250M<x (0)	SC has average contracts from 1 to 50 M, PC has bigger contracts than SC (+250M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (5) SC (17) Other (2)	GC (5) SC (0) Other (0)	GC (0) SC (17) Other (2)	PC & SC keep their normal prop. Others include: Supplier & manufacturer
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (5) SC (19)	N/A	N/A	SC has a bigger sample than GC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (13) Somewhat (10) Aware (1) Not Aware (0)	Fully (4) Somewhat (1) Aware (0) Not Aware (0)	Fully (9) Somewhat (9) Aware (1) Not Aware (0)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (3) 10<x<50M (12) 50<x<250M (1) 250<x<500M (2) 500<x<1B (2) 1B<x (4) Don't Know (0)	x<10M (0) 10<x<50M (0) 50<x<250M (1) 250<x<500M (0) 500<x<1B (0) 1B<x (4) Don't Know (0)	x<10M (3) 10<x<50M (12) 50<x<250M (0) 250<x<500M (2) 500<x<1B (2) 1B<x (0) Don't Know (0)	PC has the biggest revenues samples, SC has low revenues in most samples (10-250M)

Table 21. South Atlantic Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 5	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (4) DB (4) CM/GC (3)	DBB & DB are the principal alternatives.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (3) Design Reqs (3) Best Qualif (5) Low Resp Bid (4) Business Relat (4)	Business Relationship option is the most used, but two-steps method under hard bid selection is often used.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (2) No (2) Unsure (1)	Multiple contract practice is a common practice where almost 50% of participants recognize this method.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (2) PC (5) SC (3) Designer (4)	PC holds its principal contractual place with subcontractors, but designers and SC play an important role.

Table 21. South Atlantic Survey Evaluation (continued)

SPECIALTY CONTRACTORS (PC) QUESTIONS N = 19	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (0) Design Reqs (1) Best Qualif (10) Low Resp Bid (10) Business Relat (10) Other (No Subs) (3)	Business Relationships, Best Qualifications, and Low Bid options are the most used. The tendency of using specific method depends on the procurement requirements.
How is your company usually selected as a Subcontractor?	Owner mand (2) Design Reqs (3) Best Qualif (11) Low Resp Bid (14) Business Relat (13)	Low responsible Bid is the most used methodology, but Business Relationship option represents a good percentage rate.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (14) PC (19) SC (9) Designer (4) Other (Supplier) (2)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC (Horizontal Structures). Designers and SC's might have better relationships in designing stages.
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (9) No (10) Unsure (0)	Multiple contract practice is a common practice where almost 50% of participants recognize this method.

East South Central

The East South Central Division includes the states of Alabama (AL), Kentucky (KY), Mississippi (MS), and Tennessee (TN) as shown in Figure 34. The total number of respondents in this region is 4, divided into 0 General Contractors and 4 Specialty Contractors. The next Evaluation Table 22 shows the contractual characteristics of the East South Central Division, the highlight responses represent the most common practices or data relevance in each question. For this division, the study explains the results, but it will not be considered as a meaningful sample because of the lack of Prime Contractor's respondents.

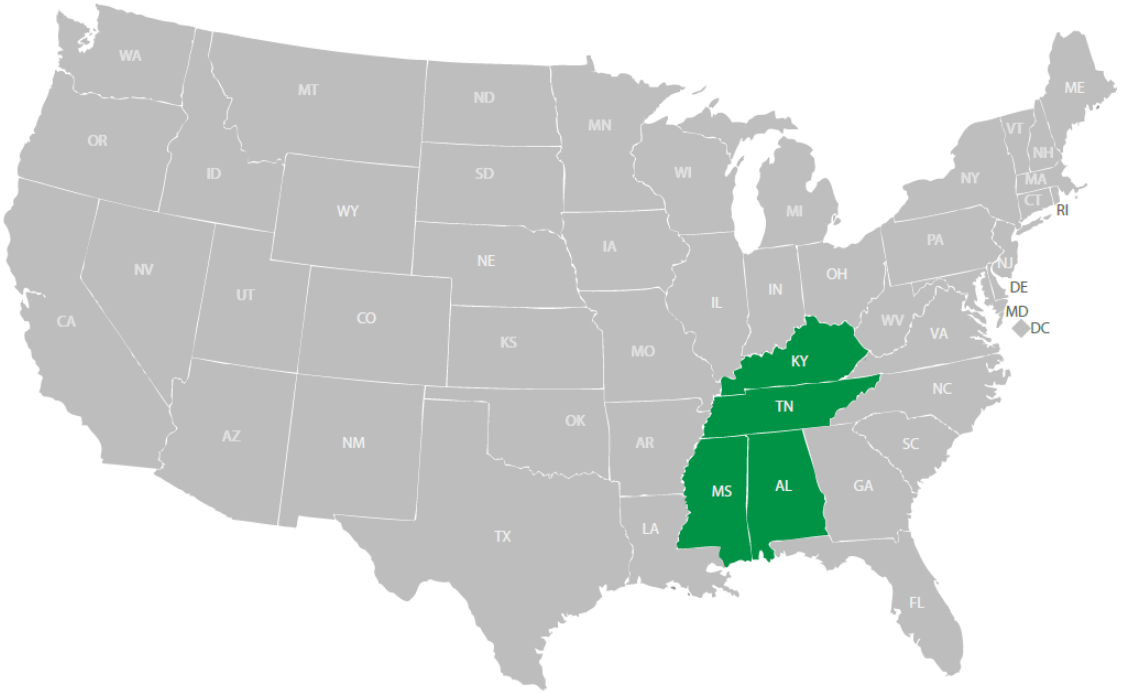


Figure 34. East South Central Division

Table 22. East South Central Survey Evaluation

OVERALL QUESTIONS N = 4	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (0) 2<x<5 years (1) 5<x<15 years (1) 15<x years (2)	x<2 years (0) 2<x<5 years 0) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (1) 5<x<15 years (1) 15<x years (2)	SC has a balanced sample with good time experience.
What position do you presently hold in your company?	Executive (4) PM (0) SI (0) Other (0)	Executive (0) PM (0) SI (0) Other (0)	Executive (4) PM (0) SI (0) Other (0)	Executives are the most representative participants for SC.
How long have you been in this position with your company?	x<2 years (0) 2<x<5 years (2) 5<x<15 years (0) 15<x years (2)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (2) 5<x<15 years (0) 15<x years (2)	SC has lasting relationships
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (1) 1<x<10M (1) 10<x<50M (2) 50<x<250M (0) 250M<x (0)	x<1M (0) 1<x<10M (0) 10<x<50M (0) 50<x<250M (0) 250M<x (0)	x<1M (1) 1<x<10M (1) 10<x<50M (2) 50<x<250M (0) 250M<x (0)	SC has average contracts from 1 to 50 M.
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (0) SC (4) Other (0)	GC (0) SC (0) Other (0)	GC (0) SC (4) Other (0)	SC keeps its normal properties
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (0) SC (4)	N/A	N/A	
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (2) Somewhat (1) Aware (1) Not Aware (0)	Fully (0) Somewhat (0) Aware (0) Not Aware (0)	Fully (2) Somewhat (1) Aware (1) Not Aware (0)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (1) 10<x<50M (1) 50<x<250M (2) 250<x<500M (0) 500<x<1B (0) 1B<x (0) Don't Know (0)	x<10M (0) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (0) 1B<x (0) Don't Know (0)	x<10M (1) 10<x<50M (1) 50<x<250M (2) 250<x<500M (0) 500<x<1B (0) 1B<x (0) Don't Know (0)	SC has low revenues in most samples (10-250M)

Table 22. East South Central Survey Evaluation (continued)

SPECIALTY CONTRACTORS (PC) QUESTIONS N = 4	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (0) Design Reqs (1) Best Qualif (3) Low Resp Bid (3) Business Relat (4)	Business Relationships is the most used option, but Best Qualifications and Low Bid are still accepted options.
How is your company usually selected as a Subcontractor?	Owner mand (0) Design Reqs (1) Best Qualif (3) Low Resp Bid (4) Business Relat (3)	Low responsible Bid is the most used methodology, but Business Relationship and Best Qualification options represent a good percentage in preferences.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (3) PC (4) SC (2) Designer (2)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC (Horizontal Structures). Designers and SC's might have better relationships in designing stages.
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (1) No (3) Unsure (0)	Multiple contract practice is not a common practice. Participants disagree to celebrate more than one contract.

West South Central

The West South Central Division includes the states of Arkansas (AR), Louisiana (LA), Oklahoma (OK), and Texas (TX) as shown in Figure 35. The total number of respondents in this region is 30, divided into 8 General Contractors and 22 Specialty Contractors. The next Evaluation Table 23 shows the contractual characteristics of the West South Central Division, the highlight responses represent the most common practices or data relevance in each question.

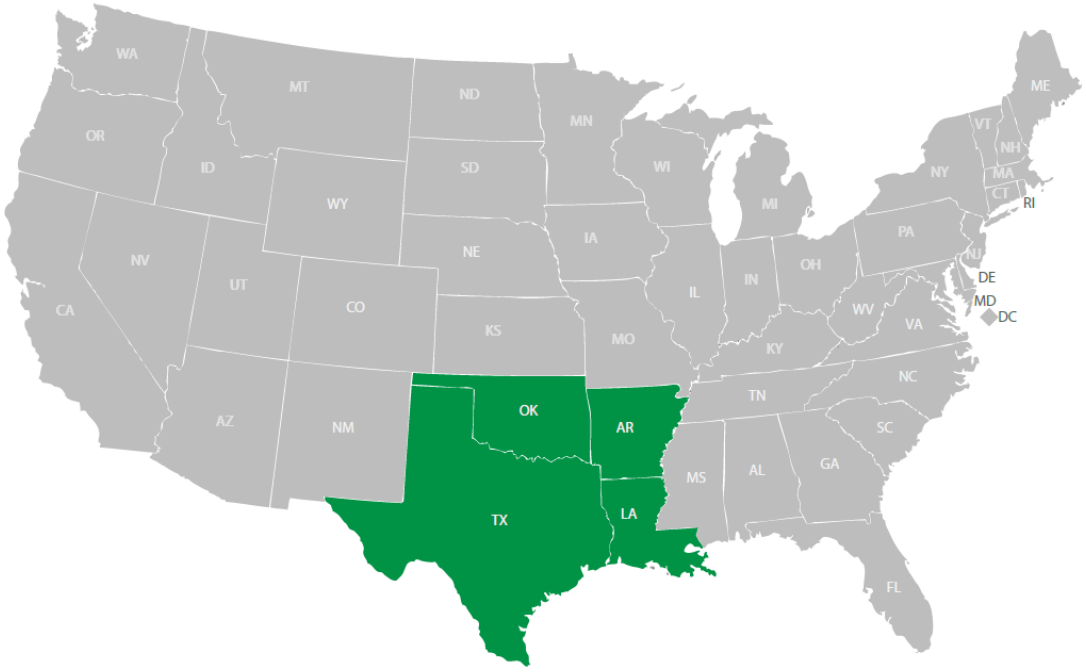


Figure 35. West South Central Division

Table 23. West South Central Survey Evaluation

OVERALL QUESTIONS N = 30	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (2) 2<x<5 years (2) 5<x<15 years (7) 15<x years (19)	x<2 years (2) 2<x<5 years (2) 5<x<15 years (2) 15<x years (2)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (5) 15<x years (17)	SC have great construction experience, PC has a more balanced sample but still has novice respondents.
What position do you presently hold in your company?	Executive (14) PM (2) SI (2) Other (12)	Executive (1) PM (1) SI (2) Other (4)	Executive (13) PM (1) SI (0) Other (8)	Executives are the most representative participants for SC. PC has construction field participants (Est, PM, Proj. Eng.)
How long have you been in this position with your company?	x<2 years (3) 2<x<5 years (5) 5<x<15 years (13) 15<x years (9)	x<2 years (3) 2<x<5 years (1) 5<x<15 years (3) 15<x years (1)	x<2 years (0) 2<x<5 years (4) 5<x<15 years (10) 15<x years (8)	PC has short-term employees, in contrast, SC has long-term employees.
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (4) 1<x<10M (14) 10<x<50M (7) 50<x<250M (4) 250M<x (1)	x<1M (1) 1<x<10M (1) 10<x<50M (3) 50<x<250M (2) 250M<x (1)	x<1M (3) 1<x<10M (13) 10<x<50M (4) 50<x<250M (2) 250M<x (0)	PC & SC share the same average in contracts (1-50 M), but PC has more opportunity to bigger ones than SC (50-250M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (6) SC (24) Other (0)	GC (6) SC (2) Other (0)	GC (0) SC (22) Other (0)	PC & SC keep their normal prop. Others include: suppliers & Manufacturers
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (8) SC (22)	N/A	N/A	SC has a bigger sample than GC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (17) Somewhat (10) Aware (3) Not Aware (0)	Fully (5) Somewhat (3) Aware (0) Not Aware (0)	Fully (12) Somewhat (7) Aware (3) Not Aware (0)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (8) 10<x<50M (12) 50<x<250M (3) 250<x<500M (2) 500<x<1B (3) 1B<x (1) Don't Know (1)	x<10M (1) 10<x<50M (1) 50<x<250M (1) 250<x<500M (0) 500<x<1B (3) 1B<x (1) Don't Know (1)	x<10M (7) 10<x<50M (11) 50<x<250M (2) 250<x<500M (2) 500<x<1B (0) 1B<x (0) Don't Know (0)	PC has the biggest revenues (500M - 1B) examples. SC has a revenue average from 10 to 250M.

Table 23. West South Central Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 8	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (5) DB (4) CM/GC (5) Other (Low Bid) (1)	DBB & CM/GC are the most used option, DB is gaining popularity.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (4) Design Reqs (3) Best Qualif (6) Low Resp Bid (8) Business Relat (6)	Business Relationships & Best Qualification options are often used, but hard bid selection is the most used.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (7) No (0 Unsure (1)	Multiple contract practice is a common practice where almost 100% of participants recognize this method.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (5) PC (5) SC (6) Designer (4)	The results show an important factor where PC and SC have strong relationships, also, they work closely with owners.

Table 23. West South Central Survey Evaluation (continued)

SPECIALTY CONTRACTORS (PC) QUESTIONS N = 22	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (2) Design Reqs (2) Best Qualif (12) Low Resp Bid (7) Business Relat (16) Other (No Subs) (3)	Business Relationships option is the most used method, and Best Qualifications represents the second most popular option. Hard bid selection is a common option, but it is losing popularity when SC's select their lower tiers.
How is your company usually selected as a Subcontractor?	Owner mand (6) Design Reqs (7) Best Qualif (19) Low Resp Bid (11) Business Relat (19)	Business Relationships & Best Qualifications options are the most used method, where hard bid selection is a common option. As SC example, PC's are changing their Low Bid practices.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (13) PC (21) SC (6) Designer (5)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC (Horizontal Structures). Designers and SC's might have better relationships in designing stages.
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (14) No (8) Unsure (0)	Multiple contract practice is a common practice where more of 50% recognize this method.

Mountain

The Mountain Division includes the states of Arizona (AZ), Colorado (CO), Idaho (ID), New Mexico (NM), Montana (MT), Utah (UT), Nevada (NV), and Wyoming (WY) as shown in Figure 36. The total number of respondents in this region is 6, divided into 1 General Contractors and 5 Specialty Contractors. The next Evaluation Table 24 shows the contractual characteristics of the Mountain Division, the highlight responses represent the most common practices or data relevance in each question.

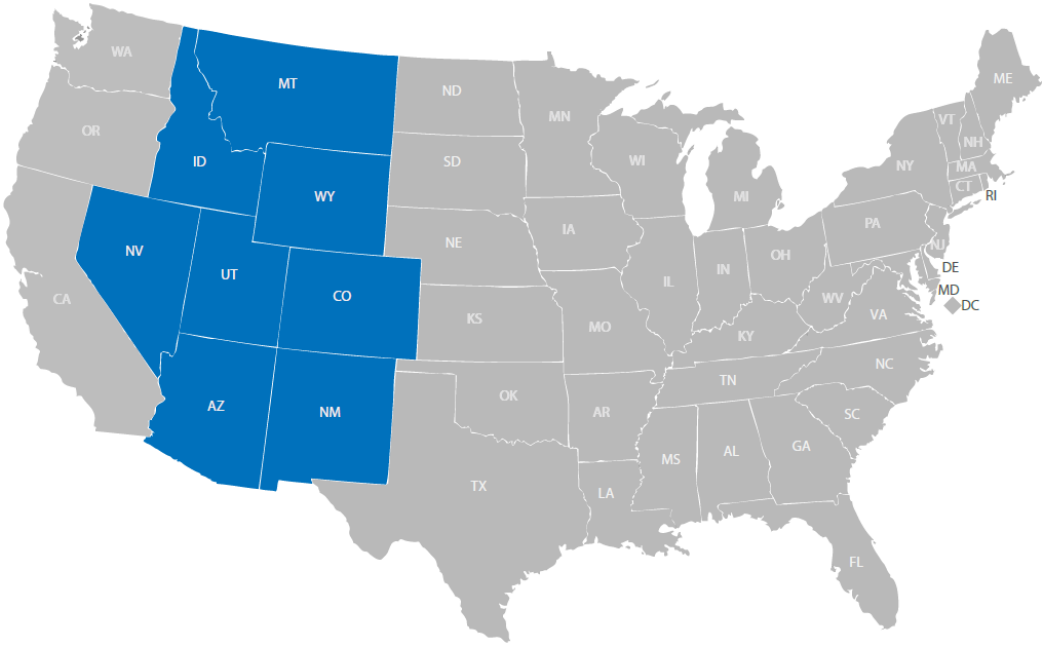


Figure 36. Mountain Division

Table 24. Mountain Survey Evaluation

OVERALL QUESTIONS N = 6	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (1) 2<x<5 years (0) 5<x<15 years (0) 15<x years (5)	x<2 years (1) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (5)	SC has great construction experience, PC doesn't have long-experienced employees
What position do you presently hold in your company?	Executive (3) PM (0) SI (0) Other (3)	Executive (0) PM (0) SI (0) Other (1)	Executive (3) PM (0) SI (0) Other (2)	Executives are the most representative participants for SC. PC has construction field participants (Est, PM, Proj. Eng.)
How long have you been in this position with your company?	x<2 years (1) 2<x<5 years (0) 5<x<15 years (1) 15<x years (4)	x<2 years (1) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (1) 15<x years (4)	PC has short-term employees, but SC has more lasting relationships than PC
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (1) 1<x<10M (2) 10<x<50M (1) 50<x<250M (2) 250M<x (0)	x<1M (0) 1<x<10M (0) 10<x<50M (0) 50<x<250M (1) 250M<x (0)	x<1M (1) 1<x<10M (2) 10<x<50M (1) 50<x<250M (1) 250M<x (0)	SC has average contracts from 1 to 50 M, PC has bigger contracts than SC (50-250M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (1) SC (2) Other (3)	GC (1) SC (0) Other (0)	GC (0) SC (2) Other (3)	PC & SC keep their normal prop. Others include: Supplier
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (1) SC (5)	N/A	N/A	SC has a bigger sample than GC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (4) Somewhat (2) Aware (0) Not Aware (0)	Fully (0) Somewhat (1) Aware (0) Not Aware (0)	Fully (4) Somewhat (1) Aware (0) Not Aware (0)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (2) 10<x<50M (2) 50<x<250M (1) 250<x<500M (0) 500<x<1B (0) 1B<x (1) Don't Know (0)	x<10M (0) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (0) 1B<x (1) Don't Know (0)	x<10M (2) 10<x<50M (2) 50<x<250M (1) 250<x<500M (0) 500<x<1B (0) 1B<x (0) Don't Know (0)	PC has the biggest revenues samples, SC has low revenues in most samples (10-250M)

Table 24. Mountain Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 1	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (0) DB (1) CM/GC (0)	DB is the only PDM selected by the respondent.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (0) Design Reqs (0) Best Qualif (1) Low Resp Bid (0) Business Relat (0)	Best Qualifications option is the only procurement method selected by the respondent.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (0) No (0) Unsure (1)	Unable to specify multiple contract practices.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (1) PC (1) SC (1) Designer (0) Other (0)	The results show an important factor where PC and SC have strong relationships, also, they work closely with owners.

Table 24. Mountain Survey Evaluation (continued)

SPECIALTY CONTRACTORS (PC) QUESTIONS N = 5	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (0) Design Reqs (1) Best Qualif (4) Low Resp Bid (2) Business Relat (3)	Business Relationships option is the most used method, and Best Qualifications represents the second most popular option. Hard bid selection is a common option, but it is losing popularity when SC's select their lower tiers.
How is your company usually selected as a Subcontractor?	Owner mand (2) Design Reqs (2) Best Qualif (1) Low Resp Bid (3) Business Relat (3)	Business Relationships & Low Bid options are the most used method, where Owner mandate and Design Requirements are common options.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (3) PC (4) SC (2) Designer (1) Other (Sup/Manuf)(2)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC (Horizontal Structures with Suppliers).
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (1) No (4) Unsure (0)	Multiple contract practice is not a common practice. Participants disagree to celebrate more than one contract.

Pacific

The Pacific Division includes the states of California (CA), Oregon (OR), Washington (WA), Alaska (AK), and Hawaii (HI) as shown in Figure 37. This study excluded Alaska, and Hawaii participants because of the lack of contact information available in public databases. For this Census Division, databases from Osmanbhoy's research and the current survey were separated to obtain a detailed report of the respondents' preferences. The total number of respondents between both studies is 95, divided into 65 General Contractors (0 from the current thesis) and 30 Specialty Contractors (4 from the current thesis). The next Evaluation Tables 25 and 26 show the contractual characteristics of the Pacific Division, the highlight responses represent the most common practices or data relevance in each question.

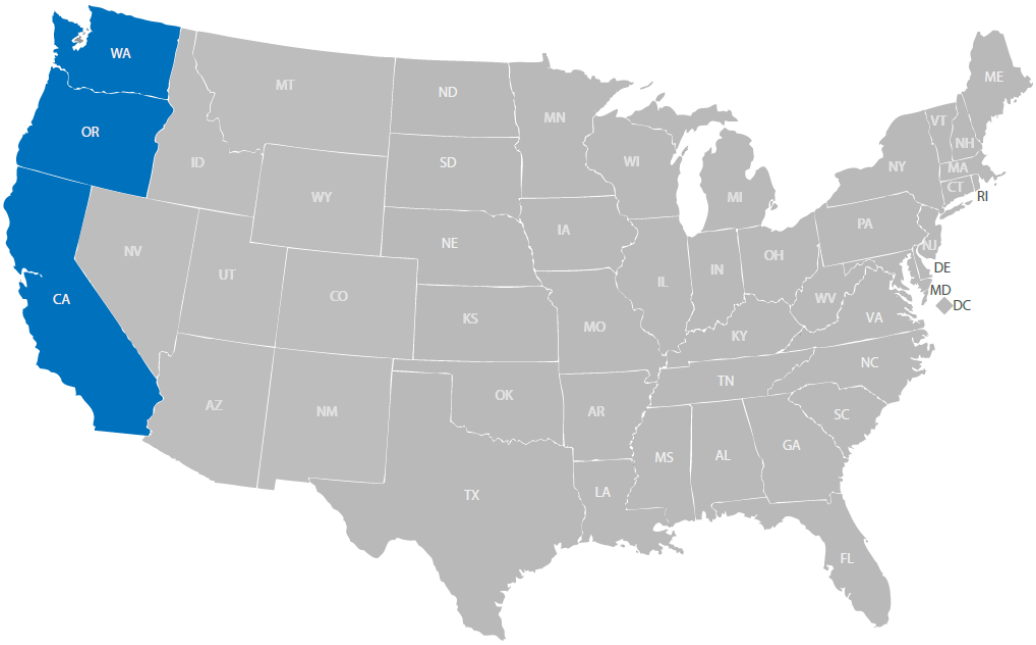


Figure 37. Pacific Division

Table 25. Pacific Current Survey Evaluation

OVERALL QUESTIONS N = 4	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (0) 2<x<5 years (0) 5<x<15 years (1) 15<x years (3)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (1) 15<x years (3)	Not enough participants
What position do you presently hold in your company?	Executive (2) PM (0) SI (0) Other (2)	Executive (0) PM (0) SI (0) Other (0)	Executive (2) PM (0) SI (0) Other (2)	Not enough participants
How long have you been in this position with your company?	x<2 years (0) 2<x<5 years (0) 5<x<15 years (1) 15<x years (3)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (0)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (1) 15<x years (3)	Not enough participants
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (0) 1<x<10M (1) 10<x<50M (3) 50<x<250M (0) 250M<x (0)	x<1M (0) 1<x<10M (0) 10<x<50M (0) 50<x<250M (0) 250M<x (0)	x<1M (0) 1<x<10M (1) 10<x<50M (3) 50<x<250M (0) 250M<x (0)	Not enough participants
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (0) SC (4) Other (0)	GC (0) SC (0) Other (0)	GC (0) SC (4) Other (0)	Not enough participants
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (0) SC (4)	N/A	N/A	Not enough participants
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (1) Somewhat (3) Aware (0) Not Aware (0)	Fully (0) Somewhat (0) Aware (0) Not Aware (0)	Fully (1) Somewhat (3) Aware (0) Not Aware (0)	Not enough participants
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (0) 10<x<50M (0) 50<x<250M (3) 250<x<500M (0) 500<x<1B (0) 1B<x (1) Don't Know (0)	x<10M (0) 10<x<50M (0) 50<x<250M (0) 250<x<500M (0) 500<x<1B (0) 1B<x (0) Don't Know (0)	x<10M (0) 10<x<50M (0) 50<x<250M (3) 250<x<500M (0) 500<x<1B (0) 1B<x (1) Don't Know (0)	Not enough participants

Table 25. Pacific Current Survey Evaluation (continued)

SPECIALTY CONTRACTORS (SC) QUESTIONS N = 4	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (0) Design Reqs (2) Best Qualif (3) Low Resp Bid (3) Business Relat (4) Other (No Subs) (0) Other (Ins/Bonds) (0)	Not enough participants
How is your company usually selected as a Subcontractor?	Owner mand (0) Design Reqs (2) Best Qualif (4) Low Resp Bid (3) Business Relat (4)	Not enough participants
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (2) PC (4) SC (1) Designer (0) Other (0)	Not enough participants
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (3) No (1) Unsure (0)	Not enough participants

Table 26. Pacific Osmanbhoy Survey Evaluation

OVERALL QUESTIONS N = 91	OVERALL RESULTS	PRIME CONTRACTORS (PC)	SPECIALTY CONTRACTORS (SC)	CONCLUSIONS
How long have you worked in the construction industry?	x<2 years (0) 2<x<5 years (3) 5<x<15 years (8) 15<x years (80)	x<2 years (0) 2<x<5 years (3) 5<x<15 years (8) 15<x years (54)	x<2 years (0) 2<x<5 years (0) 5<x<15 years (0) 15<x years (26)	PC & SC have great construction experience
What position do you presently hold in your company?	Executive (65) PM (15) SI (2) Other (9)	Executive (44) PM (12) SI (1) Other (8)	Executive (21) PM (3) SI (1) Other (1)	Executives are the most representative participants
How long have you been in this position with your company?	x<2 years (3) 2<x<5 years (16) 5<x<15 years (36) 15<x years (36)	x<2 years (3) 2<x<5 years (14) 5<x<15 years (24) 15<x years (24)	x<2 years (0) 2<x<5 years (2) 5<x<15 years (12) 15<x years (12)	PC & SC have long-term employees
What is the approximate value of the largest construction contract you have worked personally on in the last 3 years?	x<1M (2) 1<x<10M (30) 10<x<50M (32) 50<x<250M (20) 250M<x (7)	x<1M (1) 1<x<10M (16) 10<x<50M (23) 50<x<250M (18) 250M<x (7)	x<1M (1) 1<x<10M (14) 10<x<50M (9) 50<x<250M (2) 250M<x (0)	PC has bigger contracts (10-250 M) than SC (1-50M)
Does your company mostly work as a General Contractor or as a Specialty Contractor?	GC (63) SC (23) Other (5)	GC (62) SC (1) Other (2)	GC (1) SC (22) Other (3)	PC & SC keep their normal prop. Others include: suppliers & agencies
Does your company mostly act as a Prime Contractor or as a Subcontractor?	GC (65) SC (26)	N/A	N/A	GC has a bigger sample than SC
To what extent are you involved in the administration of work subcontracted out by your company?	Fully (43) Somewhat (43) Aware (5) Not Aware (0)	Fully (26) Somewhat (35) Aware (4) Not Aware (0)	Fully (17) Somewhat (8) Aware (1) Not Aware (0)	Fully and Somewhat levels provide data certainty
To understand the general size of your company, what is the estimated average annual revenue (in US dollars) of your company for the past 3 years?	x<10M (14) 10<x<50M (32) 50<x<250M (21) 250<x<500M (8) 500<x<1B (3) 1B<x (12) Don't Know (1)	x<10M (4) 10<x<50M (20) 50<x<250M (18) 250<x<500M (8) 500<x<1B (3) 1B<x (11) Don't Know (0)	x<10M (10) 10<x<50M (12) 50<x<250M (3) 250<x<500M (0) 500<x<1B (0) 1B<x (1) Don't Know (1)	PC has the biggest revenues (1B) examples, but the average revenue amounts for PC & SC are 10-250M

Table 26. Pacific Osmanbhoy Survey Evaluation (continued)

GENERAL CONTRACTORS (PC) QUESTIONS N = 65	ANSWERS	CONCLUSIONS
Over the last 3 years, what delivery methods are commonly used in the projects for which your company acted as a Prime Contractor?	DBB (38) DB (43) CM/GC (39) Other (LS, GMP, C+F) (37) Other (IPD) (1)	Lack of knowledge to differentiate PDM & Contracts. DB and CM/GC represents the most used PDM, but DBB is an available option for many projects.
Over the last 3 years, your company selected subcontractors based on:	Owner mand (24) Design Reqs (26) Best Qualif (53) Low Resp Bid (56) Business Relat (48)	Business Relationships option is often used, but the two-steps method under hard bid selection is the most used.
Over the last 3 years, have any of your subcontractors signed contracts with any other project team members?	Yes (29) No (29) Unsure (7)	Multiple contract practice is a common practice where almost 50% of participants recognize this method.
Which of the following parties has a direct functional relationship with any of your subcontractors?	Owner (34) PC (41) SC (23) Designer (31) Other (17)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. Designer 4. SC (Horizontal structures)

Table 26. Pacific Osmanbhoy Survey Evaluation (continued)

SPECIALTY CONTRACTORS (SC) QUESTIONS N = 26	ANSWERS	CONCLUSIONS
How do you select your lower-tier subcontractors?	Owner mand (1) Design Reqs (8) Best Qualif (15) Low Resp Bid (15) Business Relat (19) Other (No Subs) (1) Other (Ins/Bonds) (1)	Business Relationships option has the biggest preferences, but SC usually uses two-steps method under hard bid selection.
How is your company usually selected as a Subcontractor?	Owner mand (5) Design Reqs (7) Best Qualif (16) Low Resp Bid (22) Business Relat (17)	Business Relationships & Best Qualifications options are often used, but hard bid selection is the most used.
Over the last three years, which of the following parties has had a direct contractual relationship with your company on a single project?	Owner (17) PC (26) SC (6) Designer (4) Other (1)	The contractual links between higher and lower tiers are the traditional ones: 1. PC 2. Owner 3. SC (Horizontal Structures).
Over the last 3 years, did your company sign more than one contract on a single project?	Yes (13) No (12) Unsure (1)	Multiple contract practice is a common practice where almost 50% of participants recognize this method.

APPENDIX D

The data evaluation from the online surveys and follow-up interviews provided significant information to understand the subcontracting knowledge and practices among the participants. In addition, if future research includes the detailed evaluation of construction statutes and the economic impact of the construction industry for each American region throughout the time, these topics would improve the comprehension of the external factors that might impact the selection and development of the subcontracting models. It's important to emphasize that the economic and public statutory analysis of one year might not support future conclusions, the evaluation of one year cannot track all the variations and factors throughout the time, generating isolated results.

The next subchapters will describe examples of how the information could be reached and analyzed. Future researches could track data for the last five or ten years in order to provide well-defined scenarios which can explain why some regions have been developed more collaborative subcontracting practices than others and which factor is predominant; the economic or public statutes.

Project Delivery Method Statutory Situation by States

This section shows the current statutory situation for all states in the following Project Delivery Methods:

- Design – Build,
- CM@Risk (CM/GC), and
- Public-Private Partnership (P3)

Tracking the current statutory requirements for Integrated Project Delivery is not easy. Similarly, information on the private sector are incomplete. Still, this section reports information on what states have been testing IPD on their public projects.

Design – Build statutory state situation

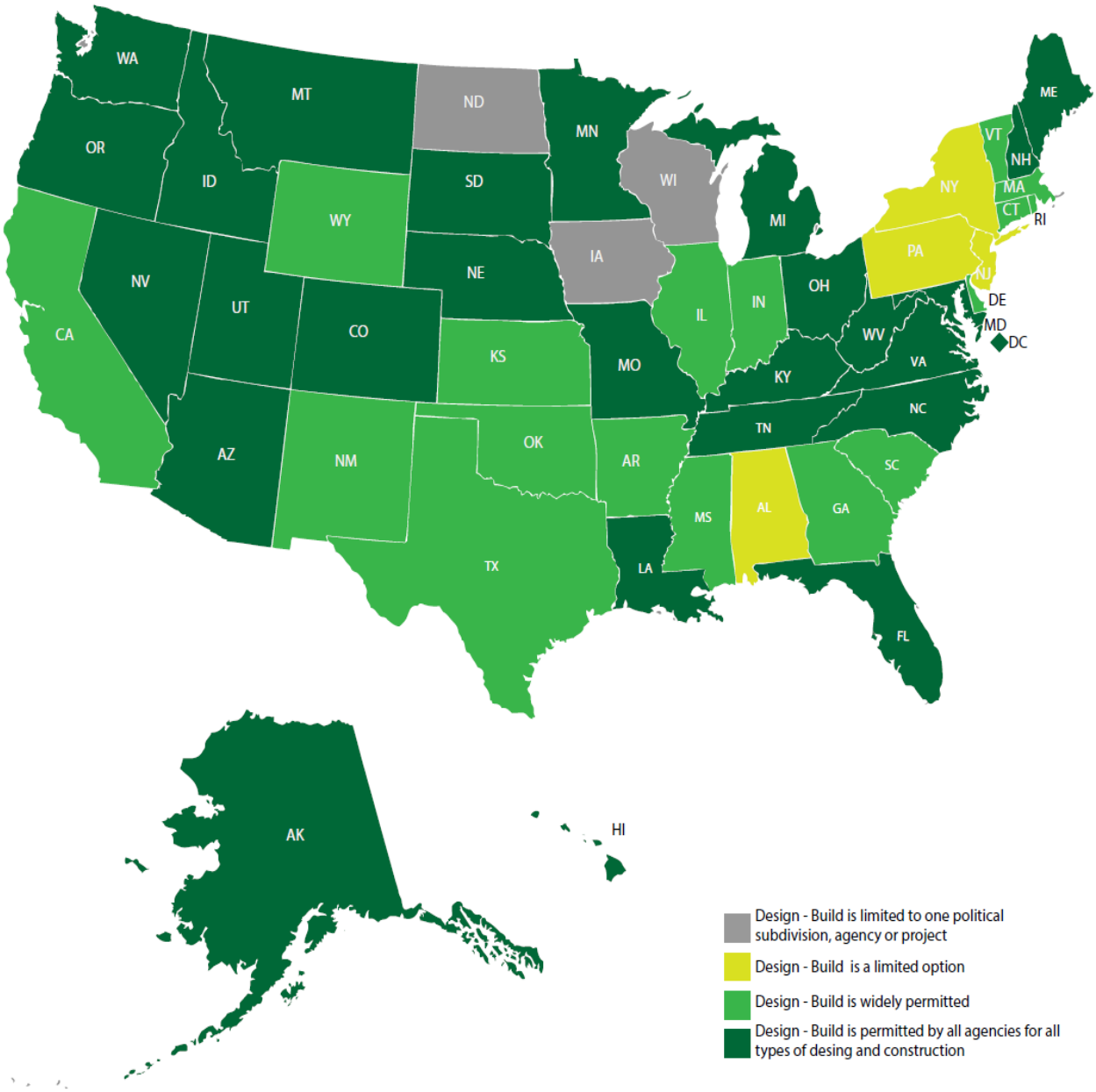


Figure 38. Design-Build Statutory Situation (Adapted from Design-Build Institute of America 2018)

Construction Management at Risk statutory state situation

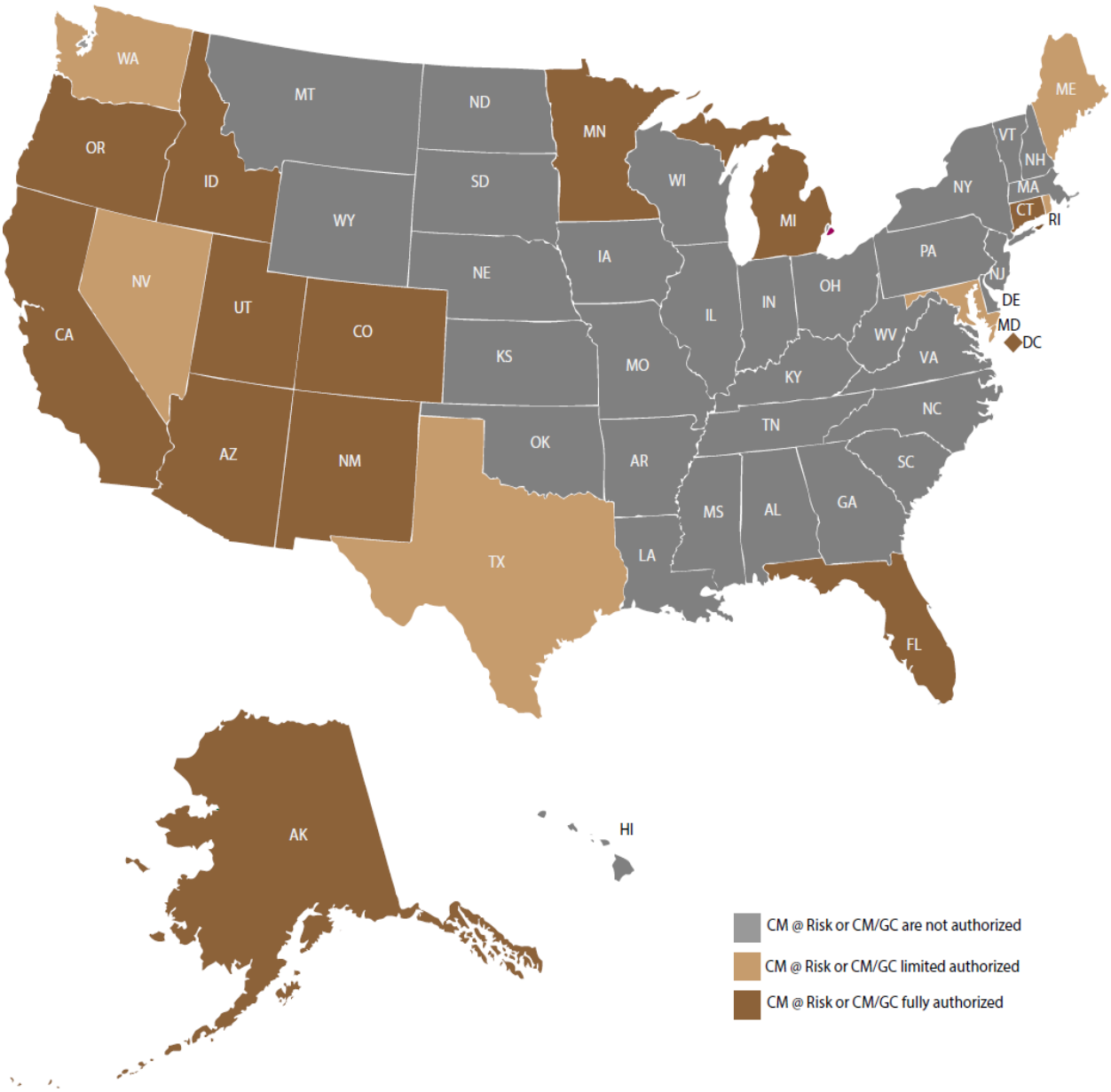


Figure 39. CM@Risk CM/GC Statutory Situation (Adapted from Federal Highway Administration 2012)

Public-Private Partnership (P3) statutory state situation

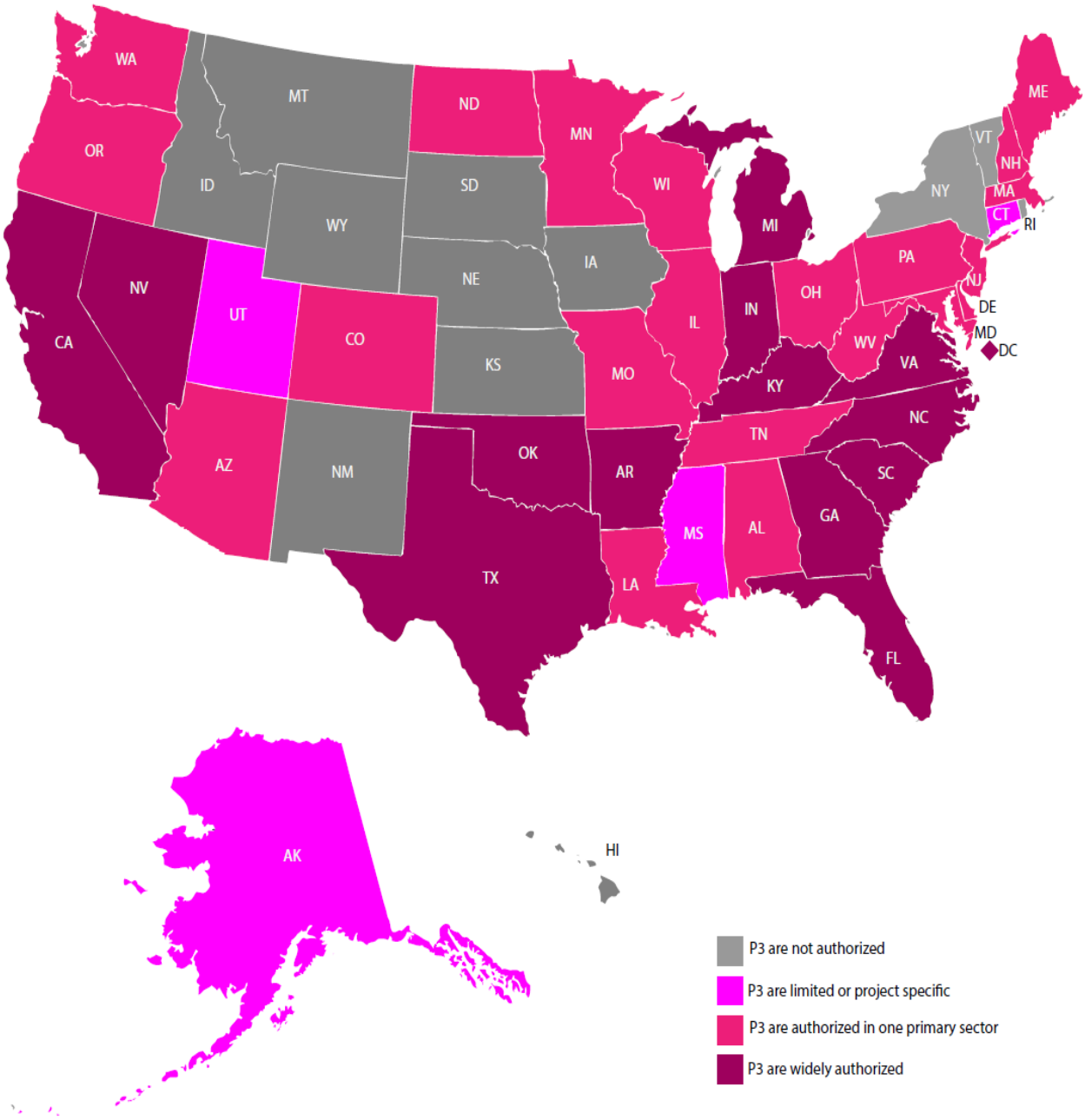


Image 40. P3 Statutory Situation (Adapted from Design-Build Institute of America 2018)

Integrated Project Delivery testing projects

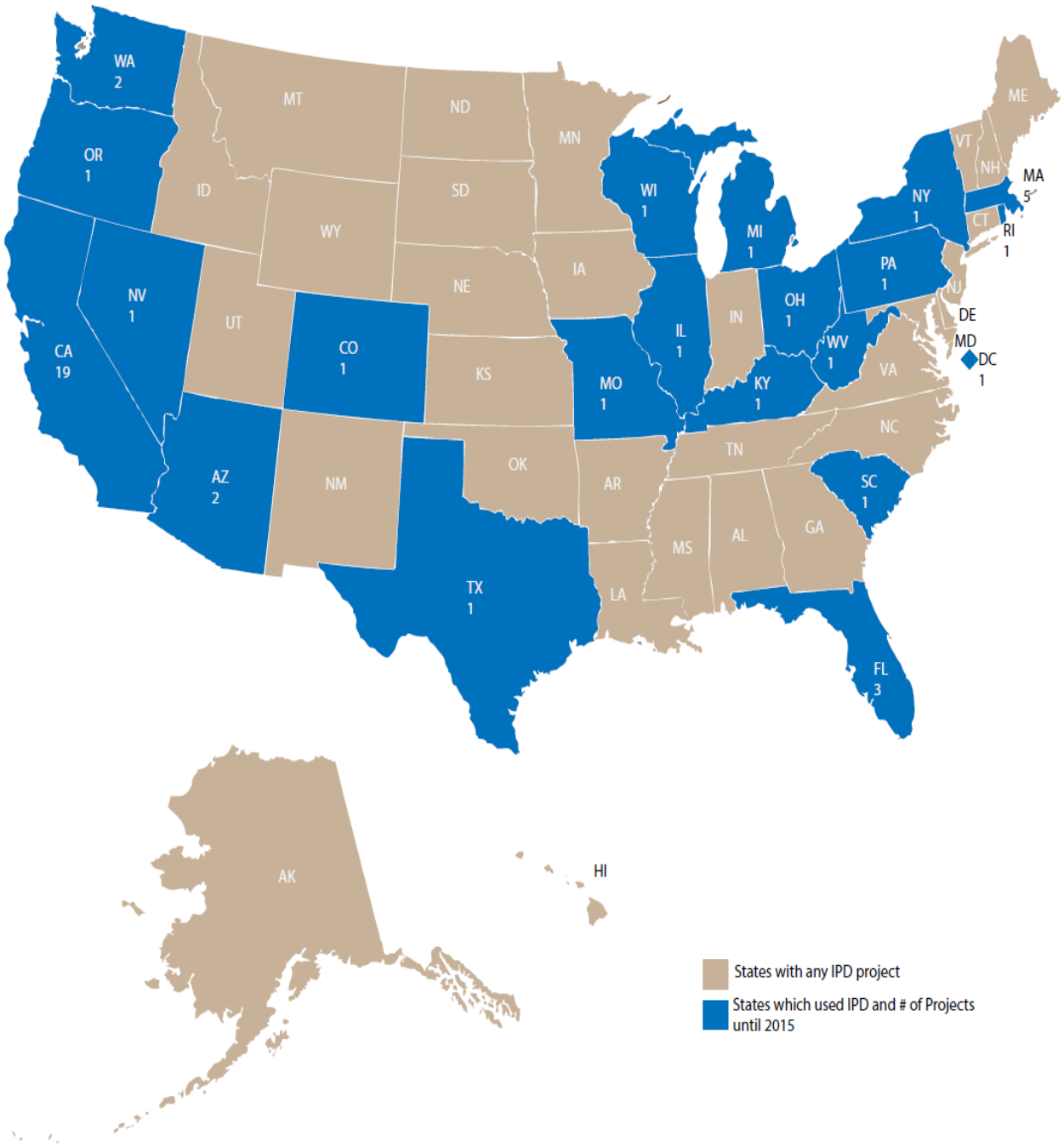


Image 41. IPD Projects by State (Adapted from University of Minnesota 2015)

Principal Construction Investment Indicators

All subcontracting practices are related to economic activities which generate an expense or investment. The cashflow transactions between general and specialty contractors are the results of contractual arrangements among all construction parties (owners, prime contractors, designers, specialty contractors, suppliers, and others) where their objective is based on obtaining economic benefits. Economic data on the construction industry are compiled and categorized by the U.S. Census Bureau (2018).

Data from the U.S. Census Bureau is categorized into:

- Total expenses
- Public Expenses
- Private Expenses

The following subchapters show the tables and charts of the total construction expenditures in 2017 based on the US Census Bureau (2018) reviewed information. Charts 20, 21, 22, 23, 24, and 25 show the principal construction expenses in the US in 2017.

Construction Expense in the United States of America

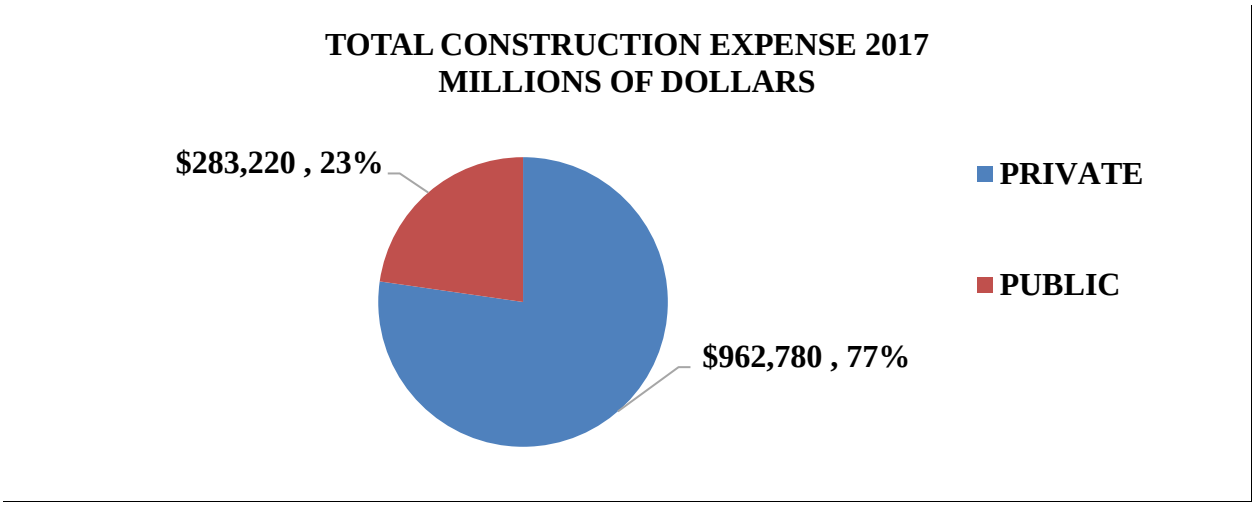


Chart 20. Total Construction Expense 2017

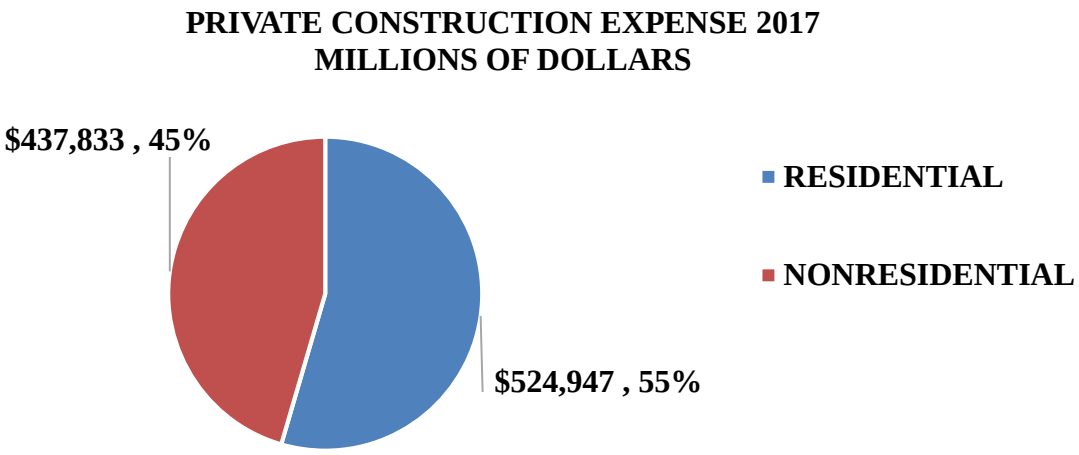


Chart 21. Private Construction Expense 2017

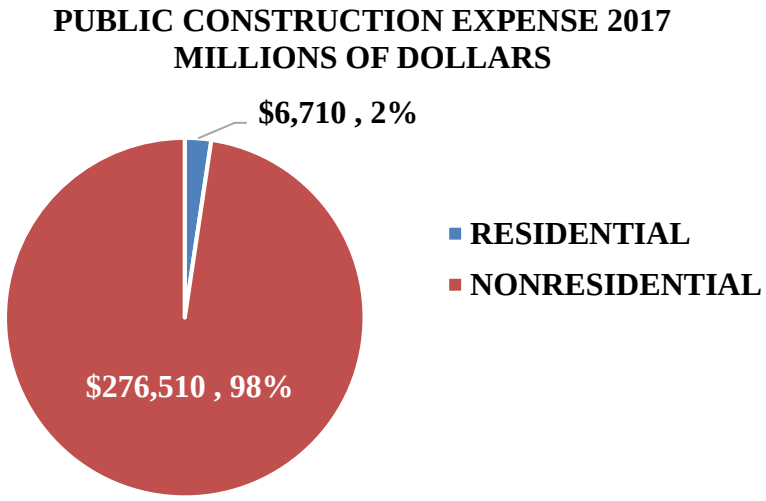


Chart 22. Public Construction Expense 2017

Construction Expenses by US Census Region

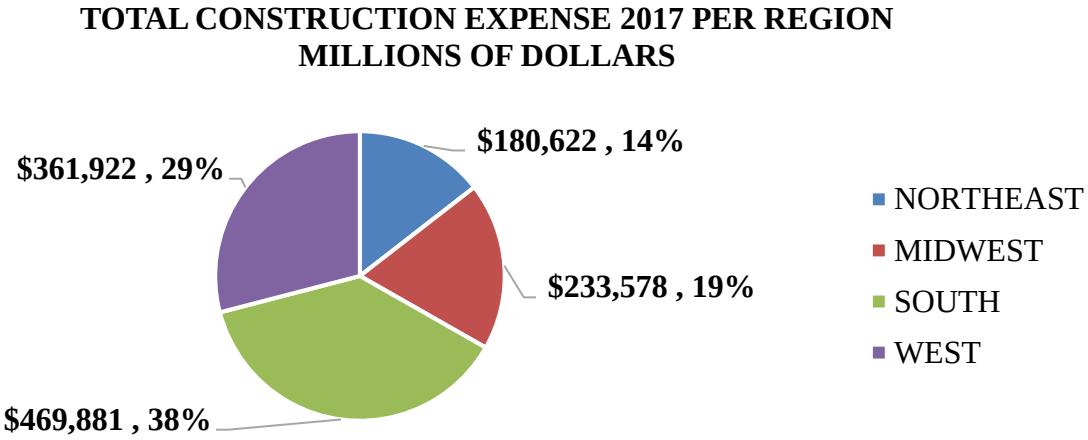


Chart 23. Total Construction Expense 2017 per Region

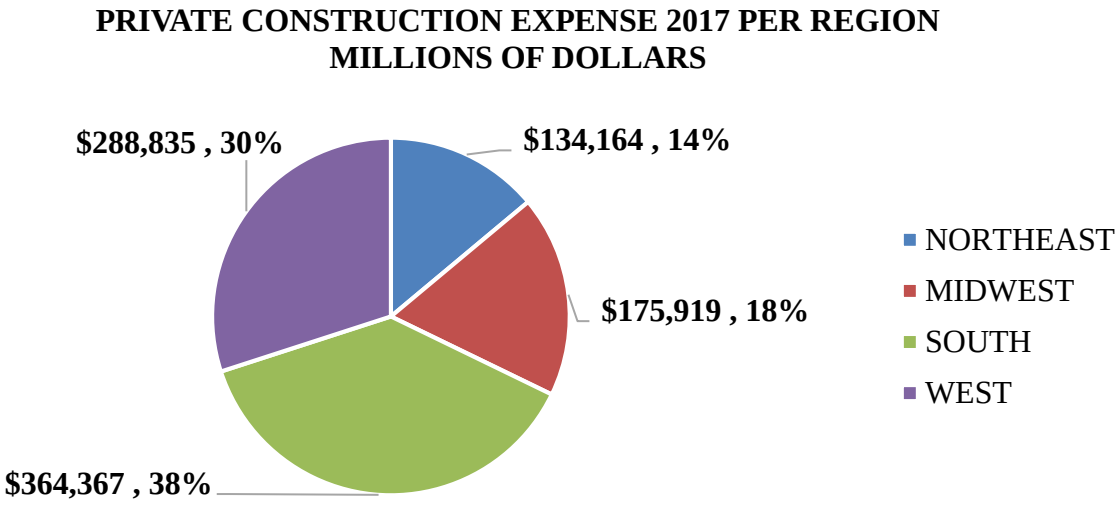


Chart 24. Private Construction Expense 2017 per Region

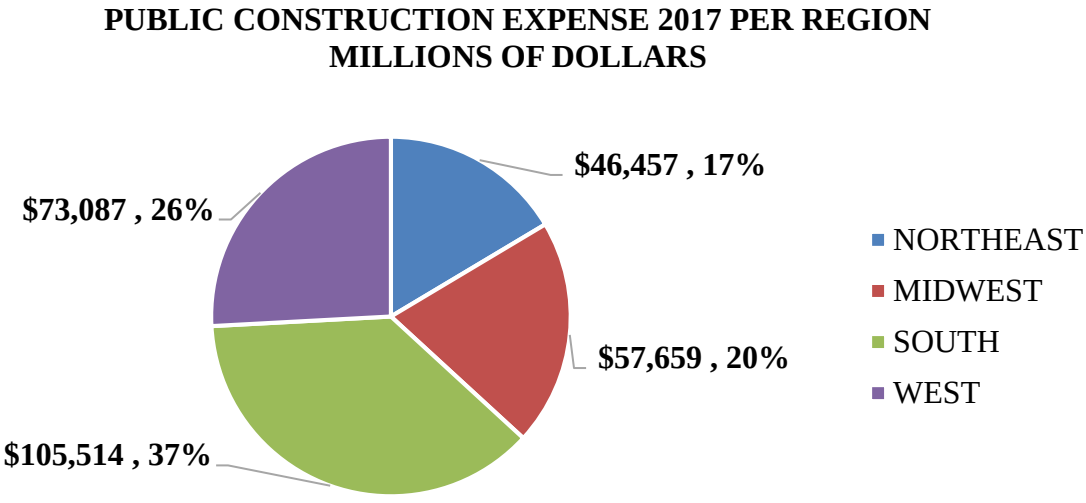


Chart 25. Public Construction Expense 2017 per Region

Construction Expenses by US Division

This section used a different methodology from nationwide and region dataset. The main reason to use a different data gathering strategy is based on the lack of detailed information for each division provided by the census office. For example, private construction category doesn't show the money amounts for residential projects. In addition, nonresidential divisions show 20% of the difference from nationwide datasets due to the division categorization doesn't include all the nonresidential concepts.

The study used the U.S. Markets Construction Overview from Fails Management Institute (FMI) (2017) to calculate the missed data. The FMI report provides a construction investment forecast for 2017 with Census Office's categories and criteria. Comparing the Census Office results with FMI forecast, the nationwide amount differs -0.86%, residential amount by regions -6.58%, and the nonresidential amount by regions 3.41%. Given these percentages, the research can use the proportional percentages from FMI to calculate the Census Office missed data. Table 27 shows all the FMI construction investment amount that were used to calculate the complete dataset with examples.

Table 27. U.S. Markets Construction Overview by Divisions - Residential (R) and Non-Residential (NR) (millions of dollars)

TYPE	NE	MA	ENC	WNC	SA	ESC	WSC	MN	PA
R	16,172	37,471	27,160	58,073	107,533	15,357	50,737	51,202	132,983
NR	36,307	96,647	102,593	67,156	144,994	39,975	92,592	52,280	106,128

The next paragraphs show the procedures to determine residential amounts for private construction sectors (Case A) and the steps to prorate nonresidential difference between nationwide and divisional amounts (Case B). Both cases are exemplified using the New England division.

Case A.

- Given information by Census Office
    - Public Residential Expense per Division (New England) = 569
    - Total Residential Expense National = 531,657
- Given information by FMI
    - New England Residential Total / FMI Residential Total
        - Prop. Percentage = 16,172 / 496,686 = 3.26% (Check Table #002A)
- **Private Residential Expense Results**
    - (Public Residential Expense National x Prop. Percentage) - Public Residential Expense per Division
        - (531,657 x 3.26%) – 569 = **16,742**

Case B.

- Given information by Census Office
    - Total Nonresidential Expense National = 714,343
        - Private Nonresidential Expense National = 437,833
        - Public Nonresidential Expense National = 276,510
    - Private Nonresidential Expense (New England) = 15,640
    - Public Nonresidential Expense (New England) = 9,844
    - Summarized Expense Using Division Info = 567,924
    - Total Difference between National and Division Info = 146,419
        - Difference Private = 125,403
        - Difference Public = 21,016

- Given information by FMI
    - New England Nonresidential Total / FMI Residential Total
        - Prop. Percentage = 36,307 / 738,670 = 4.92% (Check Table #002A)
- **Private Nonresidential Expense Results**
    - Priv. Nonresidential Exp. (NE) + (Difference Private x Prop. Percentage)
        - 15,640 + (125,403 x 4.92%) = **21,804**
- **Public Nonresidential Expense Results**
    - Public. Nonresidential Exp. (NE) + (Difference Public x Prop. Percentage)
        - 9,844 + (21,016 x 4.92%) = **10,877**

Following these parameters and procedures, the next charts 31, 32, and 33can be released to future economic comparison with the survey and follow-up interview outputs.

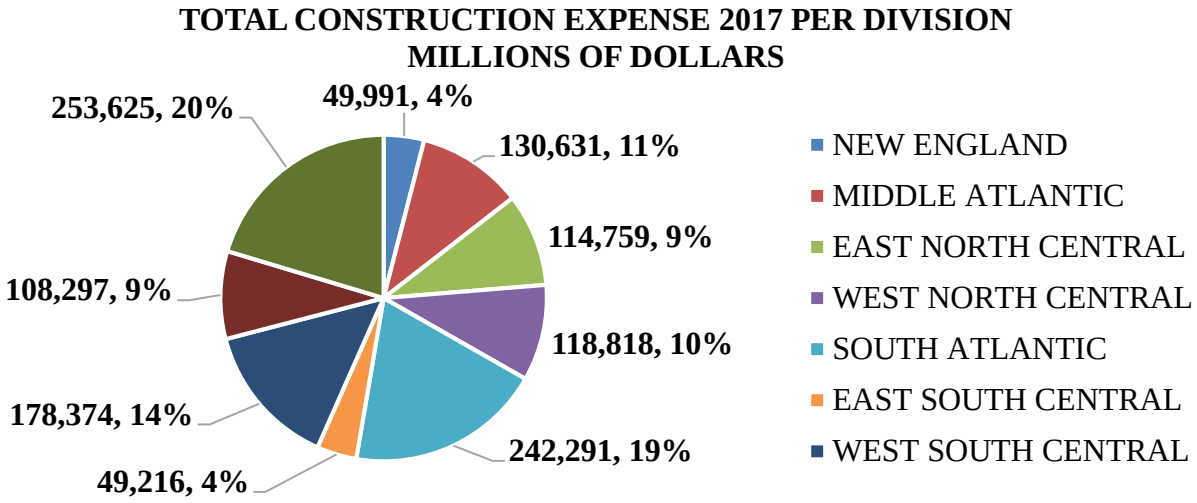


Chart 26. Total Construction Expense 2017 per Division

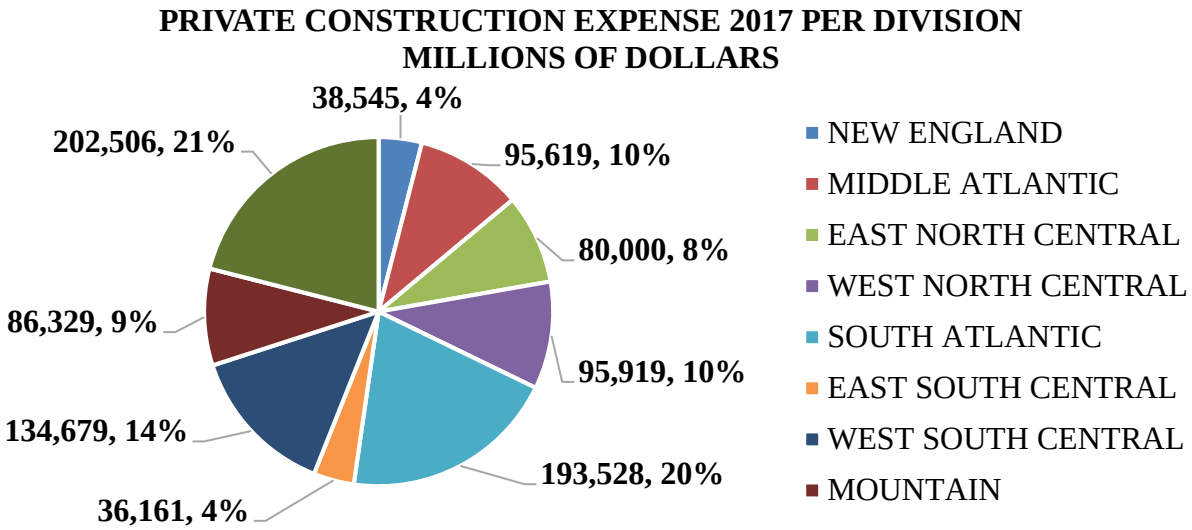


Chart 27. Private Construction Expense 2017 per Division

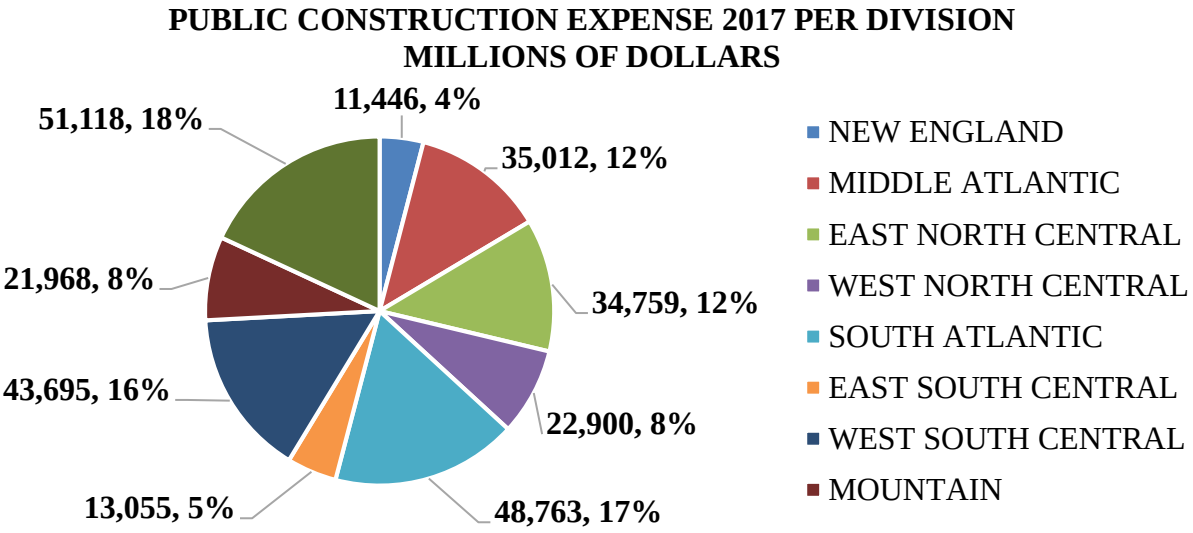


Chart 28. Public Construction Expense 2017 per Division

APPENDIX E

Interview Packet

This document intends to inform you about this study and to provide an overview of what we will discuss during the interview. You are receiving this packet because you accepted to be contacted for a follow-up on your survey responses. Again, we appreciate the time and effort that you are dedicating in helping us with this research.

Interview Objective: To verify current subcontracting models and identify any additional emergent model of subcontracting.

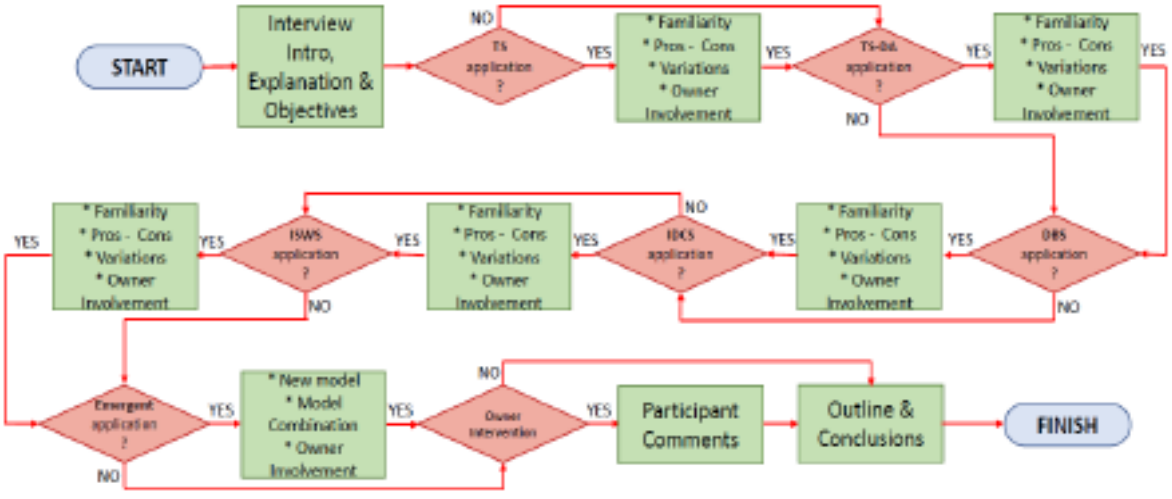
Process: The interviewer will make a series of open-ended questions, that are designed to allow you to provide information about your experience with current subcontracting practices. All the questions are focused on determining the participant's approach, experience, and knowledge of the following subcontracting models:

- Traditional Subcontracting (TS)
- Design Assistance (TS-DA)
- Integrated Specialty Work Subcontracting (ISWS)
- Integrated Design-Construction Subcontracting (IDCS)
- Design Build Subcontracting (BDS)
- Any different methodology (Other)

The questionnaire format is flexible, but the following question's examples can give to the participants a better idea of what information is expected by the researchers.

- Have you ever used or been contracted under the following subcontracting model (one of the above)?
- If your answer is negative, we will start discussing the next model
- If your answer is affirmative,
  - How familiar are you with this model?
  - How often have you encountered this model?
  - What are the pros and cons of this model?
  - Have you encountered variations or differences to this subcontracting model with your common practices?
- What is the role of the project owner in deciding the subcontracting model? Is there any specific example you would like to provide?

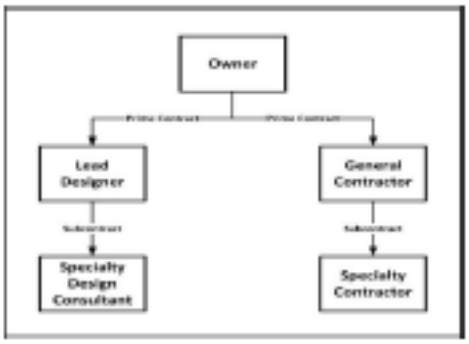
Time: We expect that we would not need more than 45 minutes to complete the interview. We would like to ask your permission to record this conversation to reduce the interview time by eliminating the need to take notes. Audio recording will be deleted once we have compiled our notes.



Subcontracting Models.

Traditional Subcontracting Model (TS)

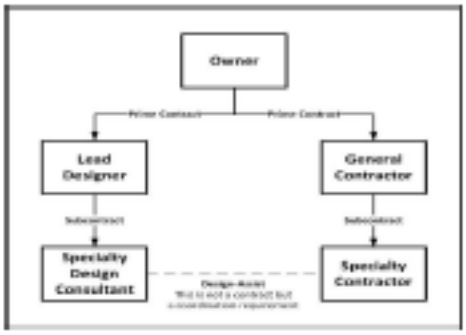
The project owner has separate contracts with designers and general contractors. These contracts lack specifics on how these parties should collaborate. Consequently, their lower tiers subcontracts will not regulate any communication with another contractual party outside the local contractual hierarchy.



- Have you ever used or been contracted under the following subcontracting model (one of the above)?
- If your answer is negative, we will start discussing the next model
- If your answer is affirmative,
    - How familiar are you with this model?
    - How often have you encountered this model?
    - What are the pros and cons of this model?
    - Have you encountered variations or differences to this subcontracting model with your common practices?
- How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?

Traditional Subcontracting with Design Assist (TS-DA)

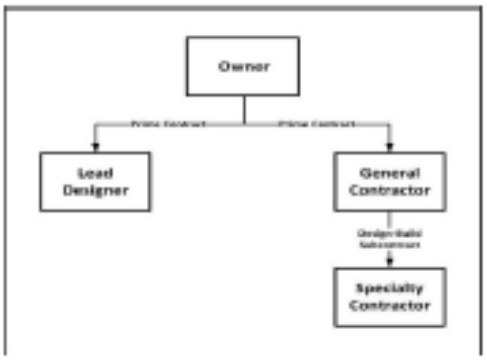
This method has the same hierarchy as TS; the main difference relies on the design assistance between sub-designers and subcontractors.



- Have you ever used or been contracted under the following subcontracting model (one of the above)?
- If your answer is negative, we will start discussing the next model
- If your answer is affirmative,
    - How familiar are you with this model?
    - How often have you encountered this model?
    - What are the pros and cons of this model?
    - Have you encountered variations or differences to this subcontracting model with your common practices?
- How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?

Design-Build Subcontracting (DBS)

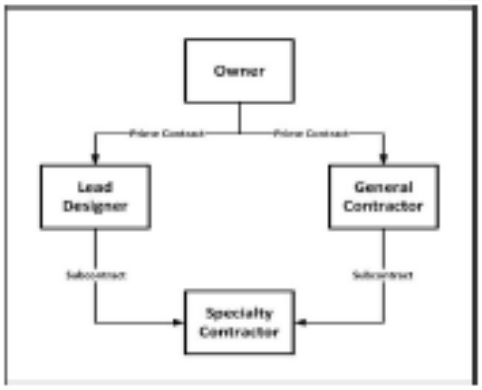
This subcontracting approach uses specialty contractors for design and construction tasks where the general contractor can only administrate on-site resources and designers provide the project guidelines (general requirements).



- Have you ever used or been contracted under the following subcontracting model (one of the above)?
- If your answer is negative, we will start discussing the next model
- If your answer is affirmative,
    - How familiar are you with this model?
    - How often have you encountered this model?
    - What are the pros and cons of this model?
    - Have you encountered variations or differences to this subcontracting model with your common practices?
- How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?

Integrated Design-Construction Subcontracting (IDCS)

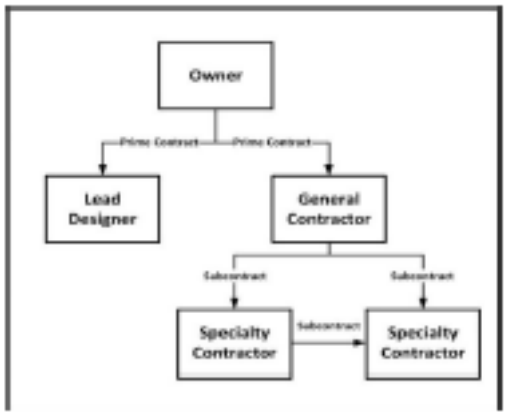
Subcontractors have contractual responsibilities with designers and general contractors. Under this early design involvement, subcontractors play an important role in the collaborative process, giving the opportunity to integrated processes.



- Have you ever used or been contracted under the following subcontracting model (one of the above)?
- If your answer is negative, we will start discussing the next model
- If your answer is affirmative,
    - How familiar are you with this model?
    - How often have you encountered this model?
    - What are the pros and cons of this model?
    - Have you encountered variations or differences to this subcontracting model with your common practices?
- How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?

Integrated Specialty Work Subcontracting (ISWS)

This subcontracting procedure has the TS characteristics, where the lower tiers (subcontractors) have a collaborative process among them without a contractual arrangement. ISWS methodology is known as "Horizontal Hierarchy" where the project execution is controlled by subcontractors because of their continuous interaction on-site.



- Have you ever used or been contracted under the following subcontracting model (one of the above)?
- If your answer is negative, we will start discussing the next model
- If your answer is affirmative,
  - How familiar are you with this model?
  - How often have you encountered this model?
  - What are the pros and cons of this model?
  - Have you encountered variations or differences to this subcontracting model with your common practices?
- How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?

Other Emergent Subcontracting Model

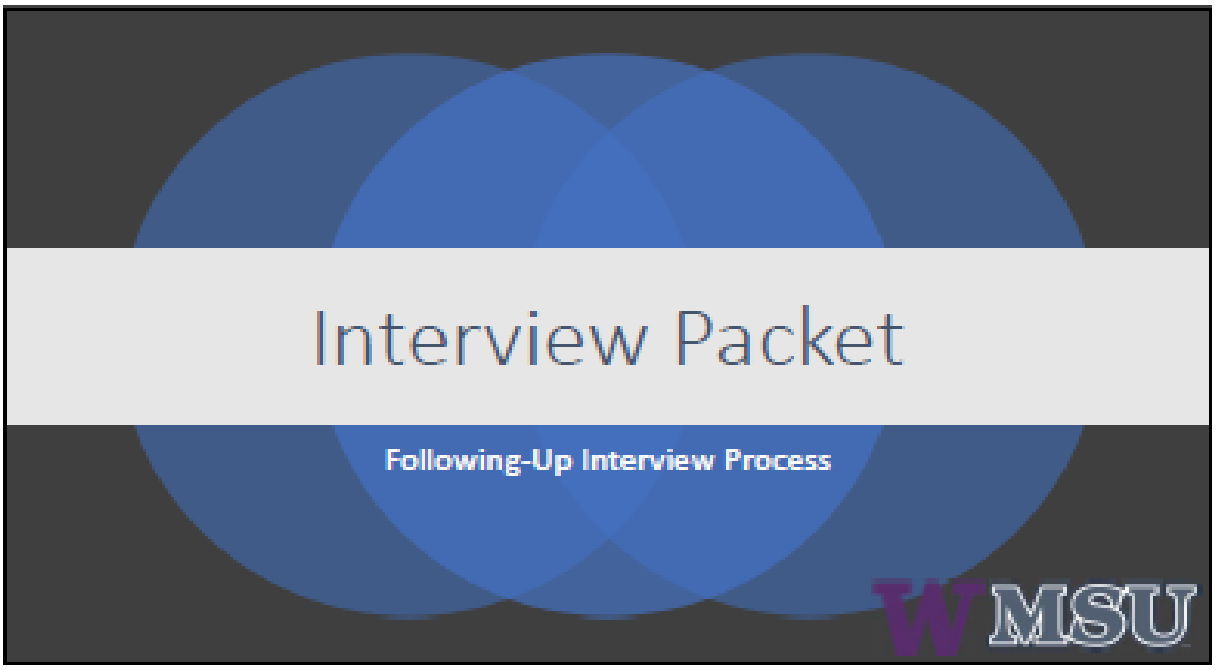
Please reflect about the five subcontracting models that we have discussed.

- Have you ever used any different subcontracting model from the ones presented so far?
  - If so, please explain.
- Have you found any situation where a combination of the previous models were used?
  - If so, please explain.
- How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?
- Is there anything else that you would like to share with us?

Now that we have reviewed all subcontracting model, I have a last question

- What is the role of the project owner in deciding which subcontracting model to use? Is there any specific example you would like to provide?

APPENDIX F



1

OUTLINE

WMSU

- Introduction
- Traditional Subcontracting Model
- Traditional Subcontracting with Design-Assist Model
- Design-Build Subcontracting Model
- Integrated Design-Construction Subcontracting Model
- Integrated Specialty Work Subcontracting Model
- Other Emergent Subcontracting Model
- Project Owner Intervention.

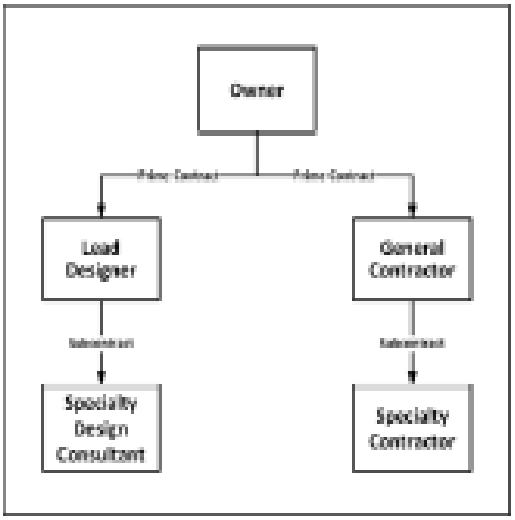
2

Introduction

- **Interview Objective:** To verify current subcontracting models and identify any additional emergent model of subcontracting.
- **Process:** The interviewer will make a series of open-ended questions, that are designed to allow you to provide information about your experience with current subcontracting practices. All the questions are focused on determining the participant's approach, experience, and knowledge of the following subcontracting models:
  - Traditional Subcontracting (TS)
  - Design Assistance (TS-DA)
  - Integrated Specialty Work Subcontracting (ISWS)
  - Integrated Design-Construction Subcontracting (IDCS)
  - Design Build Subcontracting (BDS)
  - Any different methodology (Other)
- **Time:** We expect that we would not need more than 45 minutes to complete the interview. We would like to ask your permission to record this conversation to reduce the interview time by eliminating the need to take notes. Audio recording will be deleted once we have compiled our notes.

3

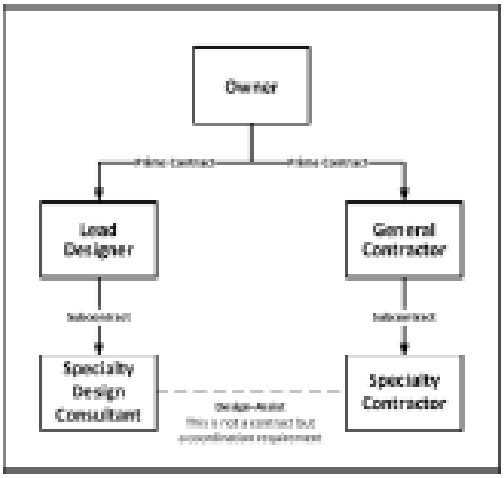
1. Traditional Subcontracting Model



- **Have you ever used or been contracted under the following subcontracting model (one of the above)?**
- **If your answer is negative, we will start discussing the next model**
- **If your answer is affirmative,**
  - i. **How familiar are you with this model?**
  - ii. **How often have you encountered this model?**
  - iii. **What are the pros and cons of this model?**
  - iv. **Have you encountered variations or differences to this subcontracting model with your common practices?**
- **How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?**

4

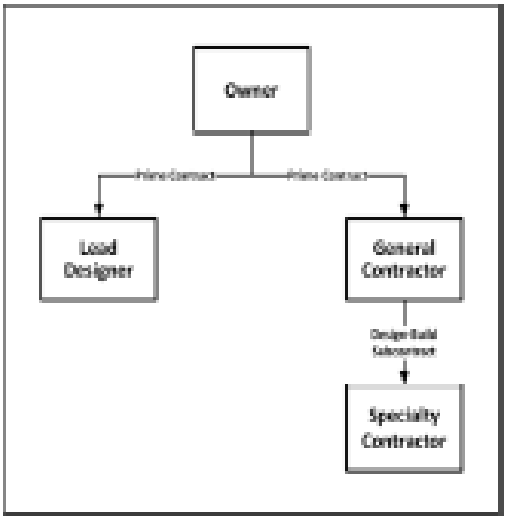
2. Traditional Subcontracting with Design-Assist Model



- Have you ever used or been contracted under the following subcontracting model (one of the above)?
- If your answer is negative, we will start discussing the next model
- If your answer is affirmative,
  - i. How familiar are you with this model?
  - ii. How often have you encountered this model?
  - iii. What are the pros and cons of this model?
  - iv. Have you encountered variations or differences to this subcontracting model with your common practices?
- How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?

5

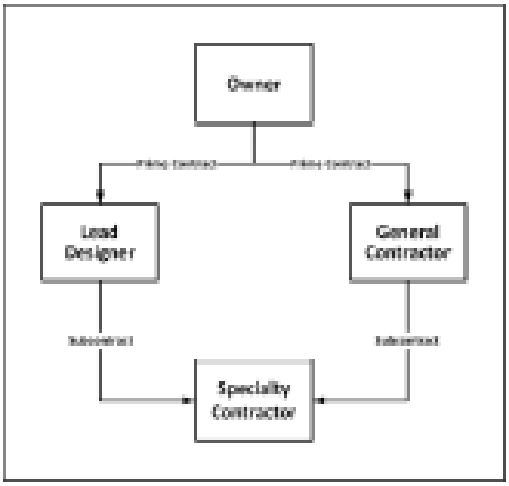
3. Design-Build Subcontracting Model



- Have you ever used or been contracted under the following subcontracting model (one of the above)?
- If your answer is negative, we will start discussing the next model
- If your answer is affirmative,
  - i. How familiar are you with this model?
  - ii. How often have you encountered this model?
  - iii. What are the pros and cons of this model?
  - iv. Have you encountered variations or differences to this subcontracting model with your common practices?
- How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?

6

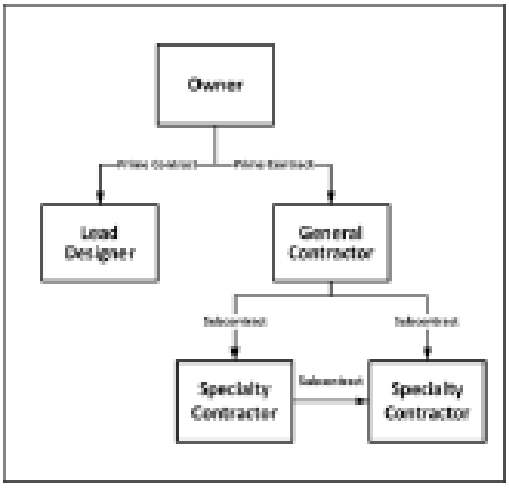
4. Integrated Design-Construction Subcontracting Model



- Have you ever used or been contracted under the following subcontracting model (one of the above)?
- If your answer is negative, we will start discussing the next model
- If your answer is affirmative,
  i. How familiar are you with this model?
  ii. How often have you encountered this model?
  iii. What are the pros and cons of this model?
  iv. Have you encountered variations or differences to this subcontracting model with your common practices?
- How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?

7

5. Integrated Specialty Work Subcontracting Model



- Have you ever used or been contracted under the following subcontracting model (one of the above)?
- If your answer is negative, we will start discussing the next model
- If your answer is affirmative,
  i. How familiar are you with this model?
  ii. How often have you encountered this model?
  iii. What are the pros and cons of this model?
  iv. Have you encountered variations or differences to this subcontracting model with your common practices?
- How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?

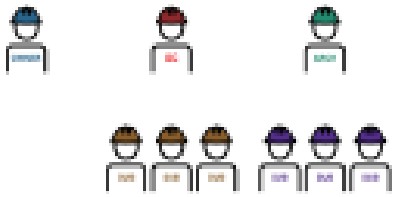
8

6. Other Emergent Subcontracting Model

- Have you ever used any different subcontracting model from the ones presented so far?
  - If so, please explain.
- Have you found any situation where a combination of the previous models were used?
  - If so, please explain.
- How does the owner get involved with other parties in this model? Is there any specific example you would like to provide?
- Is there anything else that you would like to share with us?

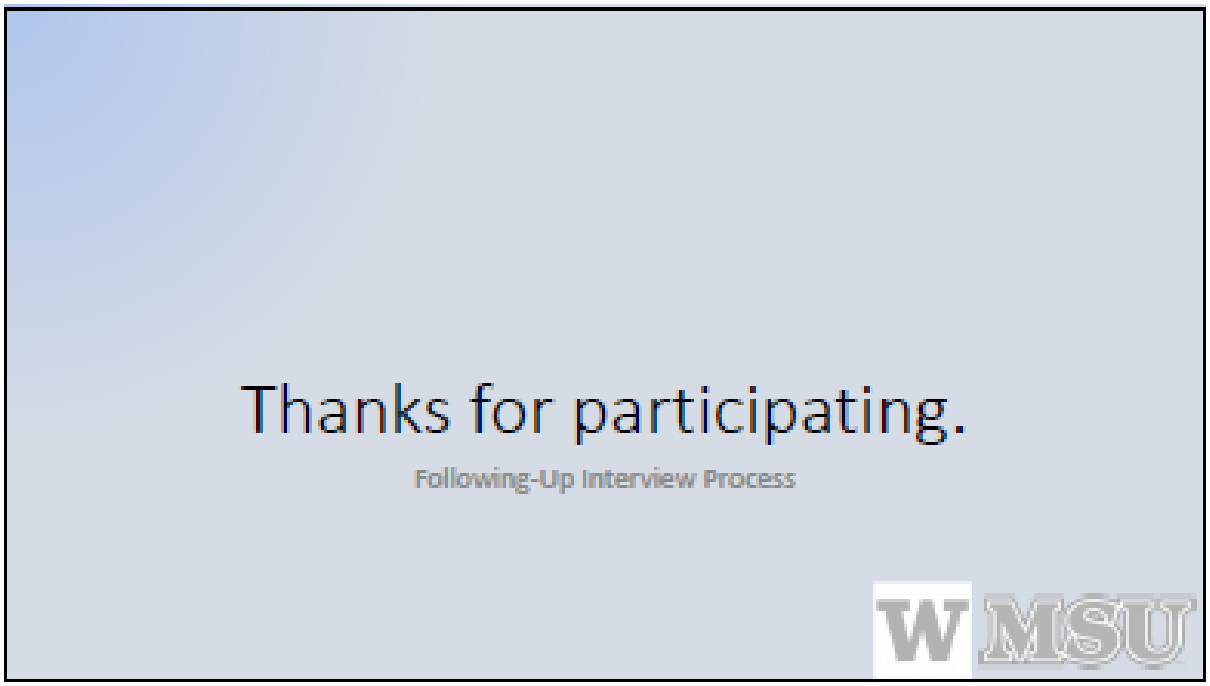
9

7. Project Owner Intervention.



- Now that we have reviewed all subcontracting model, I have a last question
  - What is the role of the project owner in deciding which subcontracting model to use? Is there any specific example you would like to provide?

10


Thanks for participating.
Following-Up Interview Process
WMSU

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APPENDIX G

Survey Invitation Type 1

Dear Mr/Ms.

My name is Luis R. Fernandez and I am a graduate student in Construction Management at the University of Washington.
Recently, Prof. Giovanni C. Migliaccio, Executive Director of the Center for Education and Research in Construction at the University of Washington, Seattle., sent you a request to participate in our current research project to learn more about the changes in contracting practices for the U.S. construction industry. This research is done in association with Dr. Richard J. Gebken, Associate Professor and coordinator of the Construction Management program at Missouri State University.
This email is a friendly reminder to participate in our brief survey (it should take less than 10 minutes) that will help us better understand the variety and developing trends in the specialty construction contracting market. Your participation is important to our study. The survey can be completed online at:
https://www.surveymonkey.com/r/UW-MSU_subcontracting_survey
If you have any questions about the survey or would like a copy of the findings when they are complete, please feel free to contact any of the research partners (email contacts: richardgebken@missouristate.edu; gianciro@uw.edu; lrfa@uw.edu).
Again, thank you for your time and participation! We truly appreciate your insights.

Survey Invitation Type 2

Dear Mr/Ms.
My name is Luis R. Fernandez and I am a graduate student in Construction Management at the University of Washington.
Recently, Dr. Richard J. Gebken, Associate Professor and coordinator of the Construction Management program at Missouri State University, sent you a request to participate in our current research project to learn more about the changes in contracting practices for the U.S. construction industry. This research is done in association with Prof. Giovanni C. Migliaccio, Executive Director of the Center for Education and Research in Construction at the University of Washington, Seattle.
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First Survey Reminder Type 1

Dear Mr/Ms.

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This email is another friendly reminder to participate in our survey that will close soon (Wednesday, August 17, 2018 at 11:59 pm). If your firm has already participated, please, ignore this email.
The survey can be completed online at:
https://www.surveymonkey.com/r/UW-MSU_subcontracting_survey
If you have any questions about the survey or would like a copy of the findings when they are complete, please feel free to contact any of the research partners (email contacts: richardgebken@missouristate.edu; gianciro@uw.edu; lrfa@uw.edu).
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First Survey Reminder Type 2

Dear Mr/Ms.

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This email is another friendly reminder to participate in our survey that will close soon (Wednesday, August 17, 2018 at 11:59 pm). If your firm has already participated, please, ignore this email.
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Again, thank you for your time and participation! We truly appreciate your insights.

Second Survey Reminder

Dear Mr/Ms.
My name is Luis R. Fernandez and I am a graduate student in Construction Management at the University of Washington.
Recently, Dr. Richard J. Gebken, Associate Professor and coordinator of the Construction Management program at Missouri State University, sent you a request to participate in our current **research project to learn more about the changes in contracting practices for the U.S. construction industry.** This research is done in association with Prof. Giovanni C. Migliaccio, Executive Director of the Center for Education and Research in Construction at the University of Washington, Seattle.
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Again, thank you for your time and participation! We truly appreciate your insights.

Follow-up Interview Invitation

Hello Mr/Ms.
Thank you for completing the online survey about subcontracting practices, we appreciate your support in contributing to our research.
As you had agreed to follow up with us, we would like to arrange an interview with you to explain the purpose of our research. We also want to have a brief talk to understand your contractual practices regarding subcontracting procurement.
Kindly let us know convenient dates and times to conduct this interview using a conference call system.
Thank you, again, for your valuable time

Follow-up Interview Confirmation

Hello Mr/Ms.
We appreciate your support in contributing to our research. As discussed over past emails, based on your availability, we suggest conducting our interview at the following date and time: -
Date:
Time:
Do let us know if the above schedule information is convenient for you.
The interview can be attended by using your phone (standard call) or personal computer (video conference). We expect that we would not need more than 45 minutes to complete the interview.
After your date confirmation, you will receive the invitation from freeconference.com. This web-based system will facilitate our communication channels.
Also, we attached in this email an Interview Packet with the interview outline and process.

Thank you for your valuable time!

Follow-up Interview Reminder

Hello Mr/Ms.
My name is Luis R. Fernandez; I'm a graduate student in Construction Management from the University of Washington (UW). Currently, I'm working in one research that tries to detect the Subcontracting Methods between General Contractors and Specialty Contractors in the construction industry. This research is being supervised by Dr. Giovanni Migliaccio (UW) and Dr. Richard Gebken from Missouri State University (MSU).
In past days, I tried to contact you via email to invite you to participate in this research without success. We got your contact information from our online survey where you helped us three months ago, and you agreed to be contacted for a follow-up interview. For this reason, we would like to arrange for an interview with you to explain the purpose of our research.
Probably, you may have concerns about the privacy and protection of your information. In that regard, the present research has the approval from the UW Institutional Review Board which guarantees the protection, privacy, and anonymity of your information.
Kindly let us know a convenient date and time to conduct this interview or any question that you may have after reading this email.
Thank you for your valuable time.