RESEARCH TOPICS GROUNDED IN CONSTRUCTION

MANAGEMENT PROFESSIONALS PERCEPTIONS

A Thesis

by

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ABSTRACT

This study identifies areas of research where future investigation can make the highest impact and contribute to the expansion of knowledge in the field of construction management. A disconnect between academia and the construction management [CM] industry often results in research that lacks value for the industry. The purpose of this research is to better connect academia to the construction industry by producing a research topic bank to guide CM faculty and graduate students towards research that is of the greatest value to the industry. A comprehensive review and a funding analysis of published research were conducted and the resulting data used to develop an in-depth questionnaire to guide interviews with members of the Texas A&M University Construction Industry Advisory Committee or CIAC. Interviews were conducted as focus groups with CIAC business entity members in Houston, Austin, San Antonio, Dallas/Fort Worth and surrounding areas. To determine the appropriate direction of future research funding allotment and topic selection, the identified areas of industry priorities were analyzed in comparison to the results of existing published research funding.

Overarching topic rankings and specific themes emerged from interviews with construction industry participants. The results of the interview were summarized and specific topics that were repeatedly discussed were identified. A comparison was made between both: industry priorities and funding allotments, and industry priorities and existing published research. Results showed that industry priorities do not match with

current funding allotments or existing published literature.

ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

This research seeks to identify areas where future investigation can make the highest impact and contribute to the expansion of knowledge in the field of construction management. A disconnect between academia and the construction management [CM] industry often results in research that fails to add value to the industry. This ultimately creates a loss for the industry and for the members of the Construction Industry Advisory Council [CIAC]. Without the understanding of construction professional's needs at the academic level, researchers will struggle to create a constructive change in the industry (Rigby, McCoy and Garvin, 2012). Conducting research that has a positive impact will help improve student education and ultimately lead to superior performance on projects (Kwak and Anbari, 2009). The exchange of knowledge between practitioners and researchers promotes new advances that are translatable into practice and correspondingly meaningful in the academic domain. However, without communication between the two entities knowledge transfer is difficult to achieve. The purpose of this research is to better connect academia to the construction industry with the intention of producing a research topic bank to guide CM faculty and graduate students towards research that is of the greatest value to the industry. To evaluate the disconnect between industry and academia, this research asks the following research questions: (1) What are

the predominant areas of academic research in construction? (2) What are the current research priorities of the construction industry? (3) How do the research priorities of the construction industry align with the existing published literature? (4) How has CM research funding supported the current research priorities of the construction industry?

1.1.1 Problem Statement

The proposed research will identify, analyze, and document the current research priorities of industry professionals for the purpose of creating a research topic bank.

1.1.2 Delimitations of the Study

1. Participants of the study will be delimited to CIAC members.

2. CM research used to develop the questionnaire has been obtained from a journal-rating database produced by a review of over 100 top rated CM journals.

3. Publication dates of literature reviewed will be delimited to the past 10 years.

1.1.3 Assumptions

1. The questionnaire, pilot tested at the Spring 2014 CIAC Board Meeting, is valid and reliable.

2. Study participants have the requisite knowledge to respond to the questionnaire.

3. Study participants are truthful and unbiased in their responses.

1.1.4 Significance of the Study

The potential benefits of this research extend to Texas A&M graduate students and faculty, and the CIAC. The ultimate goal of research in the CM industry is to help advance and improve the body of knowledge. When researchers choose topics that are

relevant to industry professions, the consequential research is significant. A topic bank will benefit Texas A&M University faculty by providing research areas that are pertinent and thus publishable and fundable, helping them to meet their research obligations. Graduate students will also benefit by researching topics that are applicable to future projects. Finally, it will benefit the CIAC and the industry at large by facilitating research on topics they consider pertinent.

1.2   Literature Review

With a research topic bank, subjects proven to be significant to the industry will be identified. The following literature reviews will identify: (a) why focused and relevant research topics are needed to improve communication and expand the body of knowledge in the construction industry, (b) the various elements that form relevant model topic banks and (c) why communication between industry and academia is necessary.

1.2.1   *Focused and Relevant Research Topics*

Focused research topics will generate relevant published papers and assist inexperienced scholars in identifying theses and professional paper topics. There is great potential for CM research to provide innovation in the industry. However, innovative ideas often remain unrealized because of uninformed research topic choices. As is it often presented, theory on projects, including ambiguity and soft skills, is drastically different than the realities of construction. Researchers tend to respond to problems that

are pragmatic instead of those that are ambiguous and multidisciplinary (Geraldi, Turner, Maylor, Söderholm, Hobday, and Brady, 2008). Brochner and Björk (2008) reveal that research authors often place a great deal of value on being read by the core community of construction academics rather than by a wide audience. The university sector and the construction industry at large have traditionally been disunited as a result of cultural, motivational and operational differences. In recent years, various institutions have been implementing the model of a "connected university" and are beginning to understand their responsibilities as they relate to the industry and cross-sectoral disciplines (Aouad, Ozorhon, and Abbott, 2010). With a research focus identified by industry professionals, research papers will have greater significance and students will have gained industry specific knowledge through their topic study.

The disconnect between industry and university becomes largely apparent in emerging technology where CM research is failing to support the introduction of technologies and the synchronization of new development. The implementation of innovative technologies in the field is not harmonious with current research (Dorée and Miller, 2008). Construction managers have the ability to bring innovation and synchronization to the industry by responding to pressing social, economic and professional demands. According to Rigby et al. (2012), industry innovation also requires vertical proliferation, information shared across various disciplines in the CM process. The goal of research is to drive innovation, promote advancement, and attempt to find solutions to existing problems. Therefore, information sharing in the industry

should extend to researchers as well.

1.2.2   Topic Bank Model

For information proliferation, researchers must understand the needs of the industry. A topic bank developed by industry members will serve this purpose. In the study, *Identifying Management Research Priorities* (2005), by Brochner, Josephson, and Alte, practicing construction managers in Sweden were surveyed in order to identify their top priorities. The model created for the study consisted of both qualitative and quantitative techniques and resulted in a list of 20 CM themes. The list was sent as a ranking survey to a wide range of construction sectors including: architectural practices, construction contractors, clients/owners, technical consultants, specialty contractors, and material suppliers. From each sector there was a variety in the respondent hierarchy. Although the research focus of Gambatese and Hollowell's study, *Factors that Influence the Development and Diffusion of Technical Innovations in the Construction Industry* (2010), is not as noticeably connected, it argues the value in researching the model's core design. Because the study was investigating a specific set of research problems, a smaller more precise population was chosen. Participants of the study were asked to evaluate and answer a list of questions generated from the study's literature review. The questionnaire, relayed as a Likert scale survey to the selected population, received an 18% response rate. Data collection through interviews would not have resulted in a higher response rate for either of these studies because organizations would have needed to provide funding, and identify other sensitive information (Gambatese and Hollowell,

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2010).

1.2.3   Communication is Necessary

In order to effectively implement communication, an interaction process must be designed with responsiveness to each community's characteristics (Sexton and Lu, 2009). Pemel and Widen (2011) discuss connection problems and communication solutions in the context of industry and end-users. Past interaction problems were identified and grouped into two main problem areas, the inability for each group to properly express their needs and the tendency to misunderstand the other sector's perspective. The resulting model employed seven strategies for cross-disciplinary interaction: translate, educate, interpret, evaluate and learn, encourage change and support, stereotype, and protect.

1.2.4   Conclusion

If CM research fails to connect with industry it will struggle to maintain its meaningful contribution in the improvement of the construction field. CM is no longer considered a practice where projects are simply designed, built and completed. It has developed another element on the side of the academic field where both practical and theoretical research exists (Kwak and Anbari, 2009). Brochner et al (2005) state at the conclusion of their study, "The process that we have outlined here is not intended to replace the more traditional approaches for setting a research agenda; rather, it should be viewed as an opportunity for revising priorities that have been identified mainly by university researchers". It is important to understand that this research does not dismiss

research topics unconnected to industry for they have value in a different setting.

However, there is a large and unfulfilled need for pertinent industry related research that

a topic bank could help to meet.

CHAPTER II

METHODOLOGY

To meet the objective of creating a research topic bank, a two-part study was conducted. During the initial portion of the study a journal-rating database produced by a review of over 100 top rated CM journals (see appendix B) was accessed in order to conduct a comprehensive review and a funding analysis of published research. The resulting data was used to develop an in-depth questionnaire to guide interviews with members of the Texas A&M University CIAC. The following section discusses the study's sample population, data collection instrument, and the methodology for data collection and analysis.

The designated end users for this research are the graduate students in the Texas A&M department of Construction Science and the faculty members overseeing graduate student research. Given the CIAC's investment in the research, there was a high level of response and feedback from industry recipients asked to participate. In addition, the CIAC member companies that were interviewed were diverse in both size and construction disciplines giving the study a more comprehensive scope. Focus groups consisted of 1-4 employees from at least 30 different CIAC companies. The minimum expected amount of CIAC member participation was 50 individuals and 56 individuals participated.

Limiting the articles selected from the journal-rating database to the past 10

years, a comprehensive review was conducted to learn what areas have seen the most research and to serve as a basis for an interview questionnaire. The results from the comprehensive review were then subcategorized by date published and funding status. Journal articles pulled from the database were separated into 15 main categories of existing construction industry research using a coding system. An analysis was conducted using categorical data to establish the significance of these categories independently and in correlation with one another. The resulting 9 categories found to have the most significance and relevance to management were identified as the focus for the interview questionnaire. The questionnaire (see Appendix A) was evaluated for internal validity and reliability at the spring 2014 CIAC Board Meeting. Included in the questionnaire were 10 questions related to the findings of the comprehensive review and 5 general questions about each company's specific research needs. The questionnaire was used to guide the interview questions and to ensure consistency between interviews.

Interviews were conducted as focus groups with CIAC business entity members in Houston, Austin, San Antonio, Dallas/Fort Worth and surrounding areas. To ensure the confidentiality of the participants, no personally identifiable information (PII) was documented. With interview participant permission an audio recording device was used to record the interviews. Please see appendix B for a copy of the consent form. The questionnaire was sent by email along with a consent form a week before the scheduled interview to allow participants adequate time to review each document. The questionnaire allowed participants to rank the importance and need for research of the 9

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categories selected from the comprehensive review. Using the research areas identified in the first section of this study, participants were then asked a series of questions centering on the research needs of CM.

The 9 categories previously ranked by interview participants and subsequent interview transcriptions were analyzed using sorting matrices to establish a mean rank and standard deviation of that ranking. The highest ranked topics identified by interviewees were used to establish a research topic bank with specific topics available to graduate students at Texas A&M University's Construction Management Department.

To determine the appropriate direction of future research funding apportionment, the identified areas of industry priorities were analyzed in comparison to the historical allocation of funding identified in the comprehensive review. Initial funding information of existing literature was identified through the comprehensive literature review. Articles with funding were identified and compared to the overall number of articles within the overarching topic group.

Reliability of the methods used in the study was ensured using an inter-rater process, as the evaluation procedures were conducted by both the principle researcher, Dr. Ben Bigelow, and by research assistant, Michele Baker. For more information, please refer to Texas A&M University Institutional Review Board, Protocol # IRB2014-0261D (Expires 12/05/2015).

CHAPTER III

RESULTS

3.1 Introduction

This study has endeavored to better connect academia to the construction industry by (1) identifying research trends, (2) producing a research topic bank to guide CM faculty and graduate students towards research that is of the greatest value to the industry, and by (3) evaluating the accuracy of funding apportionment and research priorities. The results of this study represent the predominate areas of CM academic research, current industry priorities, and accuracy of current funding. Disclosed in this chapter are the findings of interview and data analysis.

3.2 Comprehensive Literature Review of Existing Topics

The initial undertaking of this study consisted of a comprehensive literature review of existing topics taken from over 100 top rated CM journals and spanning thousands of related articles. Please see Appendix C for A and B rated journals used in this study. This review was limited to the past 10 years with emphasis on the past 5 years of research in regards to funding.

3.2.1 Comprehensive Review Findings

The comprehensive review identified 15 main overarching categories where the majority of research was conducted. These categories included the following: building

shell, energy and HVAC, infrastructure and heavy highway, materials and structure, equipment, residential construction, sustainability and the environment, business and finance, education and innovation, existing and emerging technology, personnel and workforce, planning and decision making, productivity and scheduling, project delivery methods, and safety. The following graph displays the percentages of overall existing research in these 15 areas.
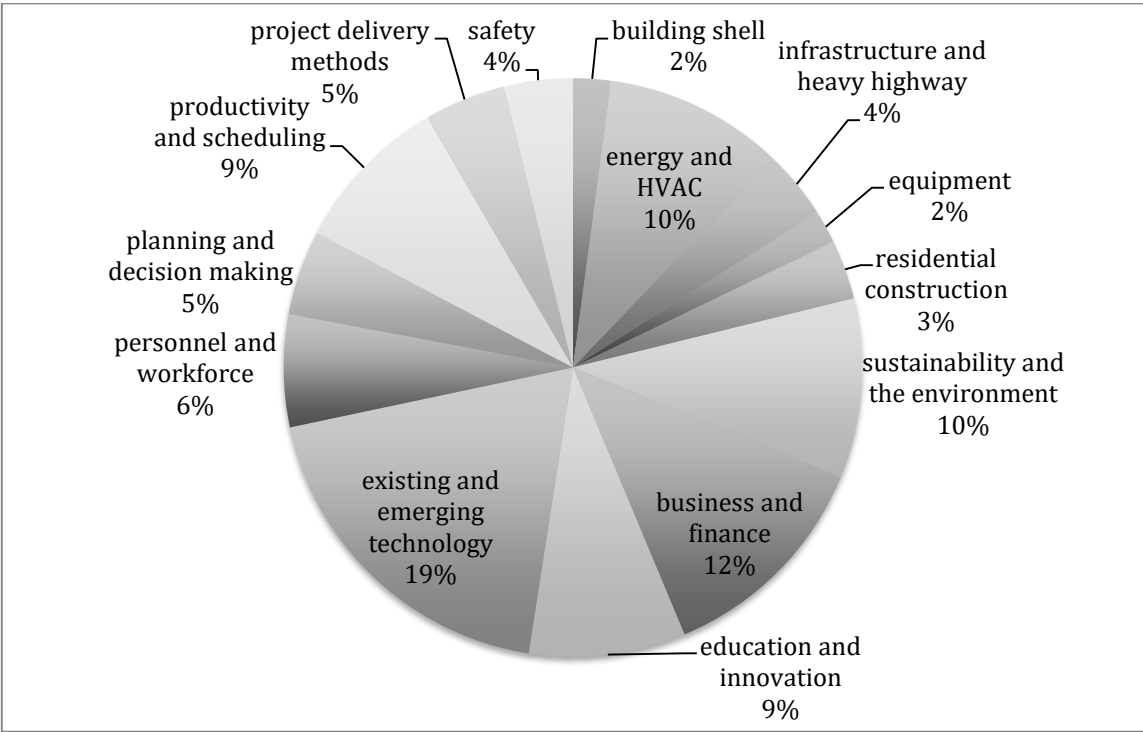

Figure 1 Existing Published Research

Research areas chosen for the questionnaire were selected based on relevance to management and by percentage of existing research. The categories selected from the literature review were chosen with the feedback from the CIAC research advisory board and principle researcher Dr. Ben Bigelow. The following categories emerged as the top 9: existing and emerging technology (19%), business, expenses and finance (12%), sustainability and energy efficiency (10%), productivity and scheduling (9%), education and innovation (9%), personnel and workforce (6%), planning and decision making (5%), project delivery methods (5%), and safety (4%).

3.3   CIAC Member Interview Analysis

The findings of this study represent a wide range of construction professionals. Research participants included assistant PMs and PMs, assistant superintendents and superintendents, vice presidents & presidents, and preconstruction professionals. The majority of interviews (78%) were conducted with general contractors. Also interviewed were residential contractors and subcontractors. Interviews were recorded and transcribed, and then coded to search for topics and themes addressed by participants.

3.3.1   *Construction Management Research Questionnaire*

A questionnaire was developed from the 9 overarching topic areas to facilitate a guided interview with CIAC focus groups. The questionnaire (Appendix A) identified participants' job title and industry segment, their rankings of the chosen 9 overarching topic areas, and specific focused research questions and hypothesis.

3.3.2   Rankings of Overarching Topic Categories

Participants were asked to rank the 9 topics in order of their importance and perceived need for research. Shown below are the rankings of the 9 main topic areas discussed.

Rank	Topic	Mean	Standard Deviation
1	Productivity and Scheduling	3.3	5.52
2	Planning and Decision Making	3.4	5.41
3	Personnel and Workforce	3.6	4.47
4	Safety	4	3.87
5	Business, Expenses, and Finance	4.2	2.86
6	Education and Innovation	5.6	4.15
7	Existing and Emerging Technology	5.7	2.42
8	Project Delivery Methods	6.1	4.26
9	Sustainability and Energy Efficiency	7.9	7.76

Table 1 Industry Topic Rankings

While 30% of the interviewees chose Safety as their number one, they qualified that while safety was number one for them, it didn't require more research. Both project delivery methods and sustainability and energy efficiency were identified as important aspects of construction. However, the majority of interviewees explained that they have

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little input into those areas of a project as owners and designers typically dictate these areas to the contractor, and therefore would not rank them highly on the list.

3.3.3   *Resulting Specific Topics*

The interview discussions of the 9 topic areas as chosen by industry professionals are provided below in summary. Specific research questions and hypotheses that emerged during the interview process are listed underneath each topic summary. The specific topics are listed with the most discussed theme at the top of each category (listed in descending order of research priorities).

3.3.3.1   *Productivity and Scheduling*

Owners, unaware of factors such as long lead times, weather delays, and discontinued products, are getting more demanding on schedules. In addition to this, manufacturers are no longer keeping materials on their shelves; instead they are producing as the order comes in or putting it on a wait list to reduce their risk. These concerns factor into the process of scheduling and affect the productivity of a project. In interview number 5, Interviewee 4 stated: "No contractor makes money on a project that is drug out. Productivity is based on good scheduling. Any decision made needs to be made in a timely manner. People also think that every contractor is like Pizza Hut and they have people ready to deliver. It is not like that."

The specific topics (research questions and hypothesis) that emerged from this section include the following:

Research Questions

a. What technologies can assist with leveling out manpower and a lack of skilled labor?

b. Do daily/weekly scheduling meetings help productivity? How?

c. Shortages occur when multiple contractors require materials on concurrent jobs. How do you schedule to counter the lack of resources?

d. Many times subs will be scheduled to work concurrently with each other to save time or to encourage speed. What is the effect on productivity when subs are stacked on each other?

e. How are milestones changing with the incorporation of BIM?

Research Hypothesis

a. Lean will be the solution for the dwindling workforce problem.

b. Milestones with concurrent cost monitoring are needed to schedule effectively.

3.3.3.2 *Planning and Decision-Making*

One of the biggest difficulties in planning and decision-making is the requirement of speed. Slow decisions and poor planning effect risk profiles and the efficiency of construction (compounded risk, safety concerns, change orders, people working on top of each other). Employees that ask questions, are driven, and are able to handle outside influences quickly make the best decision makers.

Overall, participants felt they had a good handle on planning and decision-making; there was more of a concern for training incoming employees in planning and decision-making. Participant 2, from interview 5 stated in summary: "I think when

management takes time to think about what they are doing. In most projects we are in reactive mode 90% of the time. But if you are to pause for a minute and get on the offense and think then you can start planning for that week, month etc. and now you can say this is what I can get done. If it starts from the top the people below can get organized and then when a big problem comes there is more time for it."

The specific topics (research questions and hypothesis) that emerged from this section include the following:

Research Questions

a. When a decision is out of the construction company's control (i.e. owner/AE decision) what factors contribute to the workflow continuing smoothly?

b. Decision speed gets bogged down because "everyone wants to touch the ball". Is there a way to make this process more efficient?

c. How do people in planning or decision-making roles combat the shrinking margins and deal with the volatility happening in today's market?

d. How can critical thinkers be effectively identified?

Research Hypothesis

a. There is a large portion of recoverable time that can be taken back by good planning at the beginning of a project.

b. A wrong decision is better than paralysis of decision.

c. Critical thinkers that can plan and deliberate logically are better decision makers.

d. To make a decision an individual must have the support of their team.

3.3.3.3   Personnel and Workforce

There is a great need for people in construction, both laborers and management. Specifically, skilled laborers are in great demand. In interview number 24, participant 3 discussed this topic in detail stating: "We may make it to the point where the workforce availability actually chokes down development, if you cannot find the contractors and the people to build the job you can't work a job." There are many factors that have led to this problem including the 2009 crash when 30% of the workers left the industry, the current oil boom attracting workers with higher salaries, and the lack of interest in construction by the younger generation. This leads to fewer workers, which in turn can translate into longer project durations, and higher costs for labor.

The specific topics (research questions and hypothesis) that emerged from this section include the following:

Research Questions

a. How can we encourage the younger generation's interest in construction (skilled trade as well as management)?

b. What effect has the decline in workforce had on the accuracy of historical data and job cost forecasting?

c. How successful is high school recruiting? How can it be improved?

d. The role of estimator has changed for the better; how do we convince more people to be estimators?

Research Hypothesis

a. Less productivity and longer job durations are becoming reality because of the lack of skilled labor.

b. Managers with more soft skills are needed.

c. Short and long term incentives for employees and workers counteract the effects of workforce poaching.

d. The labor shortage will take care of itself either through higher wages or changes in the way a building is constructed (prefabrication, lean etc.).

3.3.3.4   Safety

Construction by its nature presents an environment where people can be injured. However, accidents can be prevented by the implementation of safety protocols within a company. In interview 9, participant 1 discusses the importance of safety stating: "Safety for us is always a first. Every meeting starts with safety. We try to develop a culture of safety not just talk about it. If at all possible everyone goes home in the same condition they left in." On a job site the success of the safety protocols are dependent on communication, safety of other companies working on the site, and unforeseen events. Suggestions for data sources include vendors, insurance companies, and select companies interviewed.

Although it ranked as the most important topic, 30% of the interviewees that chose safety as their number one specifically indicated that they didn't feel it needed more research, that they chose it as the most important based primarily on company culture.

The specific topics (research questions and hypothesis) that emerged from this section include the following:

Research Questions

    a. How can team members be trained to be observant?

    b. How do you make safety personal to the workforce in the field?

    c. The increase in speed of construction results in a decrease in safety; what are best practices to manage this?

    d. How does the language barrier impact safety and what can be done to overcome it?

    e. Is safety software and training worth the investment?

    f. Why are there more injuries in the summer than in winter?

Research Hypothesis

    a. Strong consequences make for safer work environments.

    b. Rewards and incentives make for safer work environments

    c. Area specific data would improve safety.

    d. Jobs are safer when management is not remote.

3.3.3.5 *Business, Expenses, and Finance*

Many people lose sight of the business aspect of construction, but by doing that they are forgetting that they need to make money to stay in business. A construction company is successful if its employees understand risk management and the cost of doing business. Participant 3 discusses this explaining: "I chose business expenses and

finance (as the most important) and that is simply because if you don't have that right, nothing else matters. If you can't make money or pay the bills on time everything else is irrelevant."

Many participants identified a large concern in the industry right now being payroll and retainage. Problems with pay schedules create an adversarial environment and drive up the cost of construction.

The specific topics (research questions and hypothesis) that emerged from this section include the following:

Research Questions

a. What effect does the subcontractors' financial burden to finance construction have on the cost of construction?

    a. How much money is lost for a subcontractor through unpaid retainage or a pay schedule that pays late (i.e. 90+ days)?

    b. How much extra does an owner pay by paying late (i.e. 90+days)?

b. Margins are still shrinking and fees are still depressed. Why are construction companies still pricing work as if they have none?

Research Hypothesis

a. Cost of construction would be lower if contractors were paid in a timely fashion.

b. If firms used "e-signature" the pay schedule would move faster and subcontractors would be paid on time more consistently.

c. If the GC had the option to process change orders before the work is required to

be done, subcontractors would be able to be paid in a timelier manner for their work.

3.3.3.6 Education and Innovation

There are many impediments to training and education in the construction industry. Much of the training comes with experience, however with many new workers coming into the field there is a need for improved programs. Many larger companies have training programs implemented for new workers and existing employees. Training in smaller companies is harder to come by because of limited resources and personnel. One participant stated: "We are not learning, we are not passing along information. The construction industry has been around for thousands of years the challenges are still schedule, materials, and manpower. The same litany of problems and everyone just sits there and scratches their heads. It's really kind of just Legos isn't it? We can't learn to do the Legos better, faster?"

The specific topics (research questions and hypothesis) that emerged from this section include the following:

Research Questions

    a. How do you encourage the skilled, semi-skilled and unskilled labor force to spend extra time and/or money training?

    b. How successful/effective are training programs like the Construction Education Foundation (CEF) or ACI?

    c. What is the most effective internal training method for management?

Research Hypothesis

a. Formal training programs in combination with mentorship are the most efficient way to train an employee.

3.3.3.7 Existing and Emerging Technology

In recent years there have been many improvements in technology. Innovations such a Project Management Information Systems (PIMS), Building Information Modeling (BIM), and many others have improved the construction process. Unfortunately, there is also a downside to technology. For example, the younger generation many times lacks the ability to communicate effectively because of their reliance on email and other technological communication tools. Interoperability between programs is also a great concern for the industry. One participant discussed interoperability concerns explaining: "What is going to be neat is when everybody's drawing program and scheduling program and estimating program are all tied in, because currently they are not. People say they are, but I can tell you they are not. Whoever gets to the finish line with that will be very successful."

The specific topics (research questions and hypothesis) that emerged from this section include the following:

Research Questions

a. How does the industry deal with the age gap of the younger technologically inclined generation and train them to also use traditional skills (i.e. face-to-face communication)?

b. How do you motivate the older generation to learn and subsequently utilize new technology?

c. How can technology help reduce the amount of man-hours spent on a job site right now?

d. What are the actual cost and time savings when portions of the building are prefabricated?

e. In what ways can you incentivize subcontractors to use technology in the field?

f. How can subcontractors see the benefits of technology adoption?

g. How can the younger generation of managers be taught communication skills outside of technology?

h. What technology is the most successful in keeping subcontractor's day-to-day drawings up to date?

Research Hypothesis

a. A program that would allow interoperability between programs would cut the cost of construction and ease the burden of duplicate entry and updates.

3.3.3.8   Project Delivery Methods

Most participants identified project delivery methods as something they didn't have control over so research on the topic was not as valued. The overall consensus of a preferred delivery method was CMR followed by CSP. Design Build's value was noted however the obstacles that come with a more unified delivery method caused most of the companies to rate it lower. One participant summarized this as: "Design Build is not a

preferred delivery method for us as it stands right now. When you don't have the right partnership on the design side it just doesn't work. Architects are looking for something that's pretty and wins blue ribbons and we are looking at the practicality of it."

The specific topics (research questions and hypothesis) that emerged from this section include the following:

Research Questions

a. How effective is the Concept to Completion (C2C) method? How does it compare to traditional methods?

b. What factors positively or negatively affect design-build delivery as it relates to cost?

Research Hypothesis

a. Design Build is many times the preferred method when working with the right partners. Unfortunately, it often ends up being riskier and more costly when the partners do not have the same goals.

3.3.3.9   Sustainability/Energy Efficiency

There was not much discussion over Sustainability and Energy Efficiency. Interview participants indicated that most of the features and designs that make a building sustainable are chosen by the architect or the owner and as a result are not decisions they are concerned with. In addition, products are designed to be as efficient as possible and the requirements for sustainability are becoming standard. So no specific topics or hypotheses emerged from the research.

3.3.3.10 Additional Topics Discussed

At the end of each interview participants were asked if they had reoccurring problems from job to job. From this question, in addition to the nine topics identified from the literature, there were three additional topic areas that came up consistently in the interviews. The three topics that came up multiple times include: The decline in design documents, specifically from the architect, communication, and the Hispanic workforce all are summarized below.

Decline in Architectural Design Documents

The decline of architectural documents was discussed most often by participants (14 discussions over this topic in total). The problematic documents often include delegated design, incompatible materials, incomplete or conflicting details, and problems with the building envelope. One interview participant stated: "The plans that we get seem to be deteriorating in quality and we struggle with this because we have an owner that says he needs a building by a specified date; this date doesn't change. The designer is squeezed on his time to design the project-therefore we don't get the documents that we need-therefore there are more questions and problems as we move forward. It just doesn't get any better."

The specific topics (research questions and hypothesis) that emerged from this section include the following:

Research Questions

    a. In what ways can BIM models prepared by architects be improved?

b. To what extent are architects using delegated design?

c. What do architects see as the future of design documents?

d. How is the incorporation of BIM in the design phase affecting architectural drawings?

Research Hypothesis

a. Building envelope is where the documents are worsening most prevalently.

Communication

Good communication takes many things: collaboration, ability to talk to one another, trust, and respect. However, as one participant stated: "What you probably see on many jobsites is a lack of teamwork, everybody is out for their best interest. I would tell you that if there was one item on this list of nine things that is missing is just research on what it takes to be an effective team."

These individual components need to be established by all parts of the team, the owner, the architect, the GC and the subcontractors. Project delivery methods such as design-build or IPD lend themselves to more communication than others but problems still arise, as was found in the responses regarding delivery methods.

The specific topics (research questions and hypothesis) that emerged from this section include the following:

Research Questions

a. Which project delivery method is best for owner collaboration of project members, but still cost effective?

Research Hypotheses

a. Because of the industry fragmentation, BIM is not as successful as it could be.

b. If owners had the ability to correctly line up their priorities for both architects
    and contractors at the beginning of a job, projects would be completed faster for
    a lower cost.

Hispanic Workforce

The Hispanic workforce is something that is here to stay. Often times there are
safety concerns that come with language and cultural barriers. One participant stated:
"Even when we speak the same language and come from the same culture we are
horrible at communication as humans. When you throw a language barrier in there and it
just becomes that much harder."

 On the other hand, many interview participants stated that some of their best
workers were Hispanic. It is the difficulty Hispanic workers experience progressing to a
leadership role because of their inability to speak/write English and direct native workers
that unfortunately holds many of them back.

The specific topics (research questions and hypothesis) that emerged from this
section include the following:

Research Questions

a. Opportunities for Hispanic workers to take English education classes are often
    passed up. Why are employers having this problem and how can it be addresses?

b. How should training methods change for Hispanic labors so that they are being

taught in a culturally correct way?

Research Hypotheses

    a. If Hispanic workers were taught safety in Spanish, fewer accidents would occur.

3.4   Funding Analysis

        A funding analysis of existing literature was completed to compare the past 5 years of published research allotments to the current needs of the industry. The analysis identified the funding proportions of journal articles in each of the 9 overarching topic categories. The graph below shows the findings of the funding analysis.
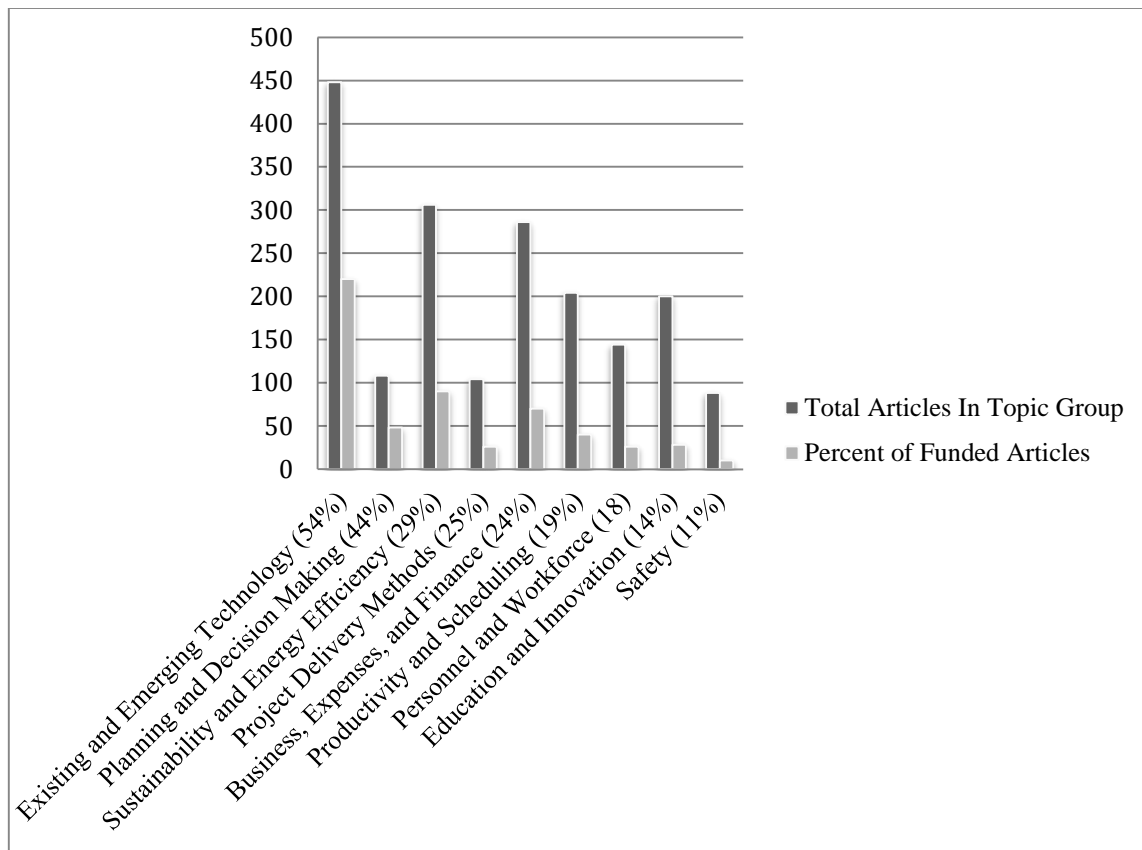
Figure 2 Percentages of Funded Articles in Each Topic Group

The percentage of funding in proportion to the number of existing published articles shows that current funding allotments are ranked in the following descending order: existing and emerging technology; planning and decision making; sustainability and energy efficiency; project delivery methods; business, expenses, and finance; productivity and scheduling; personnel and workforce; education and innovation; and safety.

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3.5   Comparison of Existing Research to Industry Priorities

The table below shows the comparison of existing published research rankings to previously identified industry priority rankings. As it is shown below, industry priorities do not match with that of existing research.

Rank	Topics Ranked by Industry	Rank	Topics Ranked by Existing Research
1	Productivity and Scheduling	1	Existing and Emerging Technology
2	Planning and Decision Making	2	Business, Expenses, and Finance
3	Personnel and Workforce	3	Sustainability and Energy Efficiency
4	Safety	4	Productivity and Scheduling
5	Business, Expenses, and Finance	5	Education and Innovation
6	Education and Innovation	6	Personnel and Workforce
7	Existing and Emerging Technology	7	Planning and Decision Making
8	Project Delivery Methods	8	Project Delivery Methods
9	Sustainability and Energy Efficiency	9	Safety

Table 2 Existing Published Research vs. Industry Priorities

The table below shows the comparison of published funded research to previously identified industry needs. The results conclude that industry priorities do not align with current funding apportionments.

Rank	Topics Ranked by Industry	Rank	Topics Ranked by Funding Apportionment
1	Productivity and Scheduling	1	Existing and Emerging Technology
2	Planning and Decision Making	2	Planning and Decision Making
3	Personnel and Workforce	3	Sustainability and Energy Efficiency
4	Safety	4	Project Delivery Methods
5	Business, Expenses, and Finance	5	Business, Expenses, and Finance
6	Education and Innovation	6	Productivity and Scheduling
7	Existing and Emerging Technology	7	Personnel and Workforce
8	Project Delivery Methods	8	Education and Innovation
9	Sustainability and Energy Efficiency	9	Safety

Table 3 Funding vs. Industry Priorities

CHAPTER IV

DISCUSSION

This study identified research topic areas where the industry sees the greatest

perceived need. By focusing future research on these topics there will be a greater

expansion of knowledge in the field of CM. Industry professionals would find more

value in these topics as they have a more direct correlation to present-day demands. If

researchers had a better link to industry, they could more easily gain industry

investment. As a result of this study, several participants interviewed suggested that they

would consider funding specific topics identified above. With proper funding given to

research projects, academics have greater chances of completing a successful research

project that adds value to the industry. This exchange of knowledge between

practitioners and researchers promotes new advances that are translatable from the

academic domain to practice.

4.1   Analysis of Findings

4.1.1   Predominate Topics in Existing CM Research

As it is exhibited in Table 1, the predominate areas of academic research

specifically pertaining to CM from the past 10 years were found to be: existing and

emerging technology; business, expenses, and finance; sustainability and energy

efficiency; productivity and scheduling; education and innovation; personnel and

workforce; planning and decision making; project delivery methods; and safety (listed in descending order). These areas are where the majority of research has been conducted over the past ten years. The findings conclude that construction research in these areas is most prevalent in the academic community and therefore most published.

4.1.2 Industry Priorities

The research priorities of industry professionals consist of a wide range of topics listed in the results section 3.3.2 and summarized for student use in appendix C. Participants of the study professed a great deal of interest in the idea of research that would solve problems and answer questions they found problematic.

The highest ranked overarching topic group, productivity and scheduling, was consistently the uppermost difficulty discussed throughout the interviews. Within this topic group, one of the most repeated concerns discussed by interview participants was that owners are getting more demanding on schedules and manufacturers are no longer keeping product on shelves to accommodate this. Additionally, students may find interest from companies in the second topic, planning and decision-making. Participants of the study stated (as a majority) that they were successful when it came to planning and decision-making; however, their concerns lay with training incoming employees on this topic. Training is a large portion of the ever-evolving construction domain. New scholars at the start of their construction career may find common ground with this topic as they will soon experience it firsthand. Topic group number three, Personnel and Workforce, is a pertinent concern for the construction industry. There is a great need for

workers in both the field and office. The next topic, Safety, was ranked highly however, 30% of participants ranked it so because of company culture. It was identified early in the study that safety was difficult to research because of the protection of highly sensitive material. Participants suggested data sources such as vendors and insurance companies as resources for student researchers. Topic number 5, business, expenses, and finance, poses many different research avenues, as business is a large portion of construction. Being in the academic world that is constantly looking toward the future, researchers have great opportunity to expand on topics in education and innovation with firsthand knowledge. Emerging and existing technology research is also more easily accessible for academics. The last two topics, project delivery methods and sustainability were identified in this study as something that participants didn't have control over so research on the topics would be less valued. In addition to the 9 topic groups that were identified in the comprehensive review, 3 additional topics emerged consistently throughout the interviews (declining architectural documents, communication, and the Hispanic workforce).

For researchers, these identified topics present a great opportunity to identify solutions and work with these companies to develop a superior process. Companies suggested that they were open to funding on specified topics.

4.2   Assessment

When comparing the alignment of interview results to existing published

literature and funding status a disconnect can be seen. As Table 2 shows, industry priorities and published literature do not align. In addition, CM research funding has not been accurately supporting the research priorities of the construction industry as Table 3 illustrates.

The disconnect is occurring because of a lack of information sharing across disciplines (academic and industry) and from the value placed on being read by the core community of construction academics rather than industry. As a result of cultural, motivational and operational differences the university sector and the construction industry at large have traditionally been disunited. However, as Aouad, Ozorhon, and Abbott explain in *Facilitating innovation in construction: directions and implications for research and policy* (2010), several institutions have been employing the model of a connected university. Preceding this study, students and faculty members overseeing research were disunited from topics relating to industry. With the implementation of this topic bank, students will be part of a newly "connected" university.

4.3   Existing Studies

The results of this study are in correlation with existing literature findings. However, the study differs from existing literature in the following ways: (1) The study is local to Texas, however, the issues discussed can be applied in a greater capacity. (2) The study contains up to date industry opinions. (3) The study was conducted through an interview process.

This study supports existing literature on the topic such as Brochner et al's, *Identifying Management Research Priorities* (2005), where practicing construction managers in Sweden were surveyed in order to identify their top priorities. Brochner et al's study resulted in 20 CM themes, which were all identified for a second time in the specific topics of this study. Unlike Brochner et al's study, this research focused on construction management industry professionals (such as project managers, superintendents, presidents, and CEOs) instead of a wide range of construction sectors (such as architectural practices, construction contractors, clients/owners, technical consultants, specialty contractors, and material suppliers). Gambatese and Hollowell's, *Factors that Influence the Development and Diffusion of Technical Innovations in the Construction Industry*, was similar in design, both first generating a questionnaire from a comprehensive literature review and then ranking the results.

4.4   Limitations

Although this study was designed and carefully conducted to ensure accuracy there were limitations to the research. The research was conducted in a two month time period. As CM is an ever-evolving discipline, results may be affected by current trends and motivations of the participating companies and their employees. To establish a better understanding of current research topics a longer period of study could have been conducted if time allowed. A probability sampling technique could not be used, as participants were limited to CIAC members available for interviews. The lack of a

probability sampling technique will limit the generalizability of the results. However, as the CIAC represents a wide range of construction companies, this factor is not harmful to the study. The duration of the focus group session varied from interview to interview lasting anywhere from 30 minutes to an hour and a half depending on how much time each company had available. Shorter interviews where questions were rushed might have not received the same quality of results. The aggregation of individual contributions from participants with diverse backgrounds and job descriptions hold bias. In addition, those who participated in the interviews may have misunderstood the objective of the study. Funding status was identified in as many articles as possible, however, some studies may have been funded without disclosing the information. Lastly, since an interview process was used to conduct this study, it is probable that a certain degree of researcher subjectivity can be found. To combat this subjectivity, two researchers were present at each interview, principle researcher Dr. Bigelow and research assistant Michele Baker. In future research these limitations could be overcome with a greater allotment of time to plan and coordinate the study to gain a greater sample size. Future research on CM topic study would also benefit from longer interview sessions.

4.5   Alternative Explanations

Although most of the data obtained from this study is straightforward, some aspects could have an alternative explanation. It could be concluded that the industry

does not put as much value on topics such as existing and emerging technology, ranked 7 out of 9 in Table 1, because they already have access to considerable quantities of current research. For example, if researchers focused on existing and emerging technology were to abandon their research to pursue a study on a topic related to number 1 ranked productivity and scheduling, technology and innovation research would begin to see a deficit of information. Additionally, there is a chance that overlap of topic areas occurs on research projects. Conceivably technological advances could result in greater productivity and so consequently the research performed has intersected two topic groups. It is this balancing act that must be dealt with to provide the greatest expansion of knowledge.

It could also be stated while industry professionals have the most accurate knowledge of the realities of the physical construction world they are focused mainly on present day problems. Academics have the advantage of being able to look to the future for innovative ideas. Additional research on the previously listed topic areas would help to bridge this gap.

4.6   Importance of the Work

This topic bank will help align future research with industry priorities. Texas A&M University graduate students and faculty, and the CIAC will benefit from enhanced alignment of research in CM. A topic bank will benefit Texas A&M University faculty by providing research areas that are pertinent and thus publishable

and fundable, helping them to meet their research obligations. Graduate students will also benefit by researching topics that are applicable to future projects. Finally, it will benefit the CIAC and the industry at large by facilitating research on topics they consider pertinent.

CHAPTER V

CONCLUSIONS

5.1 Conclusions

Our results show that current research funding and priorities do not align with industry priorities. With a research focus identified by industry professionals, research papers will have greater significance and students will have gained industry specific knowledge through their topic study. By researching topics identified in this study, academics will help advance and improve the body of knowledge in CM. It is important to note that the topics identified in this study are not intended to dismiss research topics independent from industry as they have value in a different setting. Nevertheless, research on these topics will fill an essential gap for research related directly to industry.

5.2 Summary of Contributions

Although not all of the questions or hypothesis that emerged from this research will be considered valuable by all companies, a significant level of consistency emerged from the interviews. As a result, the research questions and hypotheses presented in this report are almost all reflective of the input from multiple individuals at different companies. The study concludes that industry priorities and published literature do not align. In addition, CM research funding has not been accurately supporting the research priorities of the construction industry. Students and faculty members overseeing research

have traditionally been disunited from topics relating to industry. However, with the use of this topic bank, students and faculty will be connected to industry through meaningful research.

The intent of this study and report was to provide researchers (faculty and graduate students alike) in the Texas A&M University Department of Construction Science with a starting point for future study that is relevant to the construction industry in Texas. While some topics have been considered in existing research, all of the topics presented yet contain avenues for additional research.

5.3   Future Research

The information produced in this study provides a natural guide to future research on the topics listed above in section 3.3.2. Much research remains to be explored on the dynamics of connecting academia to industry. Specifically, a future research study could be conducted on a method of an ongoing communication model for continued knowledge and topic idea transfer. In addition, a study on making completed research more accessible to the industry to further assist in connecting and aligning industry with academia.

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APPENDIX A

QUESTIONNAIRE

CONSTRUCTION MANAGEMENT RESEARCH QUESTIONAIRE
This study is intended to evaluate the areas of construction research where industry practitioners perceive the greatest value. Through an evaluation of the research that has been performed over the last 15 years nine topic areas have been identified, this questionnaire will ask you to rank those topic areas and will ask you some specific questions about each area. The goal of this study is to provide direction to construction management graduate students and faculty in the research they perform.

What is your job title?
        a. Can you tell us a little bit about what your responsibilities are?

In what construction industry segment do you primarily work?
        Are the specific types or sizes of projects you typically work on?

The following topic areas were identified as the most commonly studied over the last 15 years. Please rank them in order of importance to your job. (1 being most important, 9 being least)

Existing and emerging technology	_____
Business, Expenses and Finance	_____
Productivity and Scheduling	_____
Sustainability/Energy Efficiency	_____
Education and Innovation	_____
Personnel and Workforce	_____
Planning and Decision Making	_____
Project Delivery Methods	_____
Safety	_____

Regarding existing and emerging technology:
1. How do you use BIM, or other advanced technology in your position?
        a. Are there places where the technology falls short of your needs?

Regarding business, Expenses and Finance:
2. What are some of your company's main concerns related to business, expenses and finance?

3. In what ways does your company handle risk management?
        a. Do you think they are effective?

Regarding productivity and scheduling:
4. Do you think there are processes, technology or other things that could make you more efficient in your job?
        a. What do you think would help your company build projects more efficiently?

     b.   What areas of the construction process do you think has the most room for improvement?
     c.   What kinds of challenges do you face that effect project success?

5.   What is your definition of lean construction?
     a.   To what extent are lean construction practices used in your company?
     b.   What do you believe are the positives/negatives of lean construction?

Regarding energy efficiency/sustainability:
6.   When a project includes LEED or other sustainability requirements, how does that effect your job?
     a.   What effect does it have on the project as a whole?

Regarding Education and Innovation:
7.   What do you see as the future for the construction management discipline?

Regarding Personnel and workforce:
8.   What problems do you have during your training process for new employees?

Regarding Planning and Decision Making:
9.   In your opinion how do in-office politics, employee-to-employee interactions, and management styles impact productivity?
     a.   Are there characteristics you see recurring in employees who have the greatest success
     b.   Are there characteristics you see recurring in employees who have the least success?
     c.   A majority of the construction workforce is Hispanic. In your position, does the language or cultural difference present a problem?

Regarding project delivery systems:
10. In your current project what delivery method are you utilizing?
     a.   What are the positive/negative aspects of this method?
     b.   How could the project delivery system discussed be improved?

Regarding safety:
11. Construction is an inherently dangerous profession however the amount of research done on safety is limited (likely due to the additional liability concerns from sharing accident information). Do you have any suggestions to help researchers obtain information to perform research on construction safety?

We have talked about some specific areas, the last few questions please consider in a general sense.
1.   How could you be more effective or efficient in your job?

2.   What specific problems do you see recurring on the jobs/projects you work on?

3.   What types of unanswerable questions or problems have you experienced?

4.   If there was a way of communicating topics that you would like to have examined, would you use it?
     a.   What do you believe would be the easiest method of communication (email, phone etc.)?

APPENDIX B

CONSENT FORM

You are invited to take part in a research study being conducted by Dr. Ben Bigelow and Graduate Assistant Michele Thomas, researchers from Texas A&M University. The information in this form is provided to help you decide whether or not to take part.

What Is The Purpose Of This Study?
To explore what CIAC members deem relevant to research in construction management.

Why Am I Being Asked To Be In This Study?
Because your contribution as an industry professional will help to guide research in the construction science department.

What Will I Be Asked To Do In This Study?
You will be asked to participate in an interview that should take no longer than 20 minutes. The interview questions are provide for you to review prior to the interview.

Are There Any Risks?
There are no risks anticipated from participation, however all responses will be kept confidential in any reporting.

Audio Recordings of Interviews.
An audio recording will assist in the documentation process of the study. Please indicate below if you give permission to be recorded by initialing in the space provided.
_____ I give my permission for audio recordings to be made of me during my
participation in this research study.
_____ I do not give my permission for audio recordings to be made of me during
my participation in this research study.

Who Will Know About My Participation In This Study?
People who have access to your interview include the Principal Investigator and research study personnel. Representatives of regulatory agencies such as the Office of Human Research Protections (OHRP) and entities such as the Texas A&M

University Human Subjects Protection Program may access your records to make sure the study is being run correctly and that information is collected properly. Information about you and related to this study will be kept confidential to the extent permitted or required by law.

Who May I Contact For More Information?
You may contact the Principal Investigator Dr. Ben Bigelow about this research bbigelow@arch.tamu.edu. You may also contact the Graduate Assistant, Michele Thomas, at 713-598-7070 or mlt995@tamu.edu. For questions about your rights as a research participant; or if you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office at (979) 458-4067 or irb@tamu.edu.
Participation:
Please be sure you have read the above information, asked questions and received answers to your satisfaction.

RESEARCH TOPICS IDENTIFIED BY INDUSTRY

Topics Selected By Industry Professionals
Productivity and Scheduling
Research Questions
a. What technologies can assist with leveling out manpower and a lack of skilled labor?
b. Do daily/weekly scheduling meetings help productivity? How?
c. Shortages occur when multiple contractors require materials on concurrent jobs. How do you schedule to counter the lack of resources?
d. Many times subs will be scheduled to work concurrently with each other to save time or to encourage speed. What is the effect on productivity when subs are stacked on each other?
e. How are milestones changing with the incorporation of BIM?
Research Hypothesis
a. Lean will be the solution for the dwindling workforce problem.
b. Milestones with concurrent cost monitoring are needed to schedule effectively.
Planning and Decision Making
Research Questions
a. When a decision is out of the construction company's control (i.e. owner/AE decision) what factors contribute to the workflow continuing smoothly?
b. Decision speed gets bogged down because "everyone wants to touch the ball". Is there a way to make this process more efficient?
c. How do people in planning or decision-making roles combat the shrinking margins and deal with the volatility happening in today's market?
d. How can critical thinkers be effectively identified?
Research Hypothesis
a. There is a large portion of recoverable time that can be taken back by good planning at the beginning of a project.
b. A wrong decision is better than paralysis of decision.
c. Critical thinkers that can plan and deliberate logically are better decision makers.
d. To make a decision an individual must have the support of their team.
Personnel and Workforce

Research Questions

    a. How can team members be trained to be observant?

    b. How do you make safety personal to the workforce in the field?

    c. The increase in speed of construction results in a decrease in safety; What are best practices to manage this?

    d. How does the language barrier impact safety and what can be done to overcome it?

    e. Is safety software and training worth the investment?

    f. Why are there more injuries in the summer than in winter?

Research Hypothesis

    a. Strong consequences make for safer work environments.

    b. Rewards and incentives make for safer work environments

    c. Area specific data would improve safety.

    d. Jobs are safer when management is not remote.

Safety

Research Questions

    a. What effect does the subcontractors' financial burden to finance construction have on the cost of construction?

        a. How much money is lost for a subcontractor through unpaid retainage or a pay schedule that pays late (i.e. 90+ days)?

        b. How much extra does an owner pay by paying late (i.e. 90+days)?

    b. Margins are still shrinking and fees are still depressed. Why are construction companies still pricing work as if they have none?

Research Hypothesis

    a. Cost of construction would be lower if contractors were paid in a timely fashion.

    b. If firms used "e-signature" the pay schedule would move faster and subcontractors would be paid on time more consistently.

    c. If the GC had the option to process change orders before the work is required to be done, subcontractors would be able to be paid in a timelier manner for their work.

Education and Innovation

Research Questions

    a. How do you encourage the skilled, semi-skilled and unskilled labor force to spend extra time and/or money training?

    b. How successful/effective are training programs like the Construction Education Foundation (CEF) or ACI?

    c. What is the most effective internal training method for management?

Research Hypothesis

a. Formal training programs in combination with mentorship are the most efficient way to train an employee.

Existing and Emerging Technology
Research Questions
a. How does the industry deal with the age gap of the younger technologically inclined generation and train them to also use traditional skills (i.e. face-to-face communication)?
b. How do you motivate the older generation to learn and subsequently utilize new technology
c. How can technology help reduce the amount of man-hours spent on a job site right now?
d. What are the actual cost and time savings when portions of the building are prefabricated?
e. In what ways can you incentivize subcontractors to use technology in the field?
f. How can subcontractors see the benefits of technology adoption?
g. How can the younger generation of managers be taught communication skills outside of technology?
h. What technology is the most successful in keeping subcontractor's day-to-day drawings up to date?
Research Hypothesis
a. A program that would allow interoperability between programs would cut the cost of construction and ease the burden of duplicate entry and updates.

Project Delivery Methods
Research Questions
a. How effective is the Concept to Completion (C2C) method? How does it compare to traditional methods?
b. What factors positively or negatively affect design-build delivery as it relates to cost?
Research Hypothesis
a. Design Build is many times the preferred method when working with the right partners. Unfortunately, it often ends up being riskier and more costly when the partners do not have the same goals.

APPENDIX D

A AND B RATED JOURNAL LIST

1	ACI Materials Journal
2	ACI Structural Journal
3	Automation in Construction
4	Building Acoustics
5	Building Physics
6	Building Research and Information
7	Chartered Institute of Building: Construction Information Quarterly
8	Construction and Building Materials
9	Construction Innovation: Information, Process, Management
10	Construction Management and Economics
11	Energy and Buildings
12	Engineering, Construction and Architectural Management
13	Indoor and Built Environment
14	International Journal of Construction Education and Research
15	International Journal of Construction Management
16	International Journal of Construction Marketing
17	International Journal of Project Management
18	Journal of Architectural Engineering
19	Journal of Computing in Civil Engineering
20	Journal of Construction Engineering and Management
21	Journal of Construction Procurement
22	Journal of Construction Research
23	Journal of Green Building
24	Journal of Information Technology in Construction
25	Journal of Management in Engineering
26	Journal of Materials in Civil Engineering
27	Practice Periodical on Structural Design and Construction