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# Analysis of Construction-Related Research Compared to the Needs of Industry Professionals

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A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Science

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# ABSTRACT


Analysis of Construction-Related Research Compared to the

Needs of Industry Professionals

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Research plays a large role in the advancement of any industry. It is particularly important that relevant research is performed in an industry as large and critical as the construction industry. A review of literature shows that historically research has not played a major role in the advancement of the construction industry. The work of this thesis was to explore whether there has been a change in this relationship, or not.

This thesis explored whether the construction-related research being done is in alignment with the needs of industry. Comparisons of the rankings of construction research and industry views were done to evaluate their correlation to each other. This evaluation was done through a review of literature of four construction research journals. Articles were gathered and classified in common construction themes. Each research theme was given a ranking based on the quantity of articles classified into common construction themes. The research ranking demonstrated that the most popular research theme was training/ human resources, followed by management/ risks and technology/ innovation. A survey was sent to 259 industry professionals asking them to rank the 22 construction themes. A response rate of 14% was achieved through the survey respondents. Survey respondents determine that the most important research theme is constructability, followed by estimating/ bidding and economics/cost control. Findings demonstrate that there was no correlation between the themes that were popularly researched and what is most important to the construction professionals.



Keywords: construction research, ranking, research priorities, construction industry ranking

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# 1 INTRODUCTION

The Construction industry is one of the largest and oldest industries in the United States (Abudayyeh, 2002). In 2006 the Construction industry accounted for 9 percent of the U.S. Gross Domestic Product according to the U.S. Census Bureau's 2002 Economic Census. Traditionally the Construction industry is one of the least researched (Abudayyeh, 2002). Though the amount of research in the construction field has increased, it is still in need of adjustments. "For many years the construction industry was recognized as a leading driver of the world economy, yet it was an industry noticeably missing higher education and research that characterize most industries." (Tucker, 2007)

The beginning of construction education at U.S. universities can be traced back to events following World War II. To fill the demand for construction professionals many universities began to offer formal education in that field. Research in construction engineering helped establish construction as a legitimate academic subject (Halpin 2007). Research is widely acknowledged as a key factor in the advancement of technology and knowledge in an area of study. However, due to many of the unique challenges in the construction industry, research is not widely supported.

The nature of the industry requires greater focus on short-term economics than the long term planning that is required for research. Contracting is oriented toward achieving an immediate return on investment (Harris, 1991). The fee, which often represents the targeted profit margin, for many construction projects hovers between 3-5 percent. This low profit margin

discourages the use of funds for research purposes. With low profit margins construction firms have limited resources to support research and the less conventional results it might produce. Competition in the construction industry is so intense that companies are unable to give significant support to universities for research (Gerwick, 1989). It is difficult for a contractor to invest in anything that can only produce returns in the future, future being greater than three years (Harris, 1991). Financial support from the industry is far less than most industries. Less than 0.1 percent of the industry's annual income is devoted to research (Oglesby, 1990). This view of short-term payback is counter-productive to developing long-term solutions to underlying problems that are found in the construction industry. The competitive environment of the construction industry also prevents the sharing of research results. Construction companies treat any research results as proprietary and won't allow the results to be published. The work done by academia in these circumstances is considered consulting and not research. The benefits of stronger partnerships between researchers and the industry outweigh the effort required from both parties.

Since the development of degree programs for construction education at the university level, both parties have benefited from the relationship. Universities fill their primary goal when students are prepared for employment in the industry (Tener, 1996). Construction firms' benefit from qualified students trained in building principles, management techniques, and software and technology integration. Today, most construction programs are assisted by an industry advisory group (a group of industry professionals). This group provides: significant input into the needs of the construction industry; financial aid for school clubs and activities; other forms of support to improve the quality of education at the university (Tener, 1996). It is

in these types of committees that research topics should be obtained for graduate students and professors.

The majority of research being conducted is done at the university level or public institutions (Warsawski, 2007). Universities are in an advantageous position to integrate findings into curriculum and improve the quality of education provided to students. The role of education and research is to make the concepts and practices known and usable (Oglesby, 1990). To fulfill the role of research, research should produce results that are applicable to the industry. Greater cooperation is needed from industry professionals to consult on research topics and methodology to produce applicable results. Improving the cooperation between industry and academia will enhance: the quality and relevance of research; the stability and robustness of the research enterprise; the breadth and problem-solving capabilities of university graduates; the competitiveness of the U.S. industrial sector (Prager and Omen, 1980). Many of the benefits of research will more effectively be realized as it focuses on the needs of the construction industry.

Researchers are constantly looking for ways to add value to their areas of specialty. Establishing research priorities based on needs is an activity that many research organizations commonly practice. There are methods of obtaining research ideas such as; mail survey, industry advisory groups, review of literature, and other similar activities. Researchers that intend to provide the construction industry with new technologies and improvements of traditional processes should solicit the consultation of construction professionals.

## 1.1 *Problem Statement*

The problem is that we do not know if the construction-related research being done is in alignment with the needs of industry.

## 1.2 *Null Hypothesis*

There is no difference between investigator priorities of construction-related research and the needs of the construction industry.

## 1.3 *Research Questions*

1. What construction-related research themes are most common?
2. How do construction professionals rank the common construction-related research themes?
3. Are the most popular construction-related research themes in alignment with the industry ranking?

## 1.4 *Purpose of Research*

The purpose of this research was to find if the construction-related research was aligned with what construction professionals thought was important. The purpose was to define the most common construction-related topics so that they could then be ranked by construction industry professionals. The research results provide information that can focus the effort of future construction-related research to the topics which are most important to the industry. The results provide researchers the information to plan future research and establish research priorities for the future.

## 1.5 *Significance of Research*

Results from this study will help prioritize future research areas. This study compared the ranked topics of the construction practitioners with construction research trends. Findings from this study demonstrated whether the popular research themes are in fact most important to industry professionals. By collecting this information, individuals conducting research can explore avenues that are of significant importance to the industry. The comparison of ranking the construction research trends can be used to help individuals understand the needs of the industry, and increase the relevance of future research.

## 1.6 *Assumptions*

This study assumed the following:

- The rankings given by the construction professionals were based on issues affecting the entire industry and not specific to their organization.
- The construction professionals were knowledgeable of construction trends.
- Construction researchers published their findings in major construction journals.
- The researcher assumes that construction professionals in northern California are no different than construction professionals in other parts of the country.

## 1.7 *Delimitations*

For the purpose of the scope of the paper the following conditions were noted.

- This study included a sampling of journals and did not review all construction related journals.

- There was an understanding that not all research is published for proprietary reasons.
- The survey respondents were limited to construction professionals in Northern California selected from lists from the AGC of California, the American Society of Professional Estimators, and general contractor's list of peers.
- Topics were classified into general topics. A list of sub-topics was not given.

# 2 LITERATURE REVIEW

This chapter discusses the literature related to construction research, industry-research partnerships, and research trends. The history of construction education and research must be understood to see how it has helped the construction profession. The literature review provides information about the economics of construction research and its relationship to the industry's support of research. This review also explored the need for stronger collaboration between researchers and the construction industry. Needs-based research is fundamental to provide real and applicable results that drive the progress of the industry. The importance of establishing research priorities is understood by a summary of other's efforts on determining research trends in the industry. As the formal education in Construction expands, so has the number of technical papers and publications. These papers and publications can be used to determine what research has recently been done and then categorized to understand the areas or topics that are receiving the most attention from researchers. A review of literature helps to determine what research is being done in the construction industry and if the importance of research topics is aligned with needs of the industry.

## 2.1 *The History of Research in the Construction Industry*

Research has not historically been a primary focus in the industry. The development and prominence of the construction profession has progressed as formal education and research has become mainstay in the industry (Halpin, 2007).

In the early days family members generally passed down the skills and knowledge of construction on the job through generations in a very isolated manner. The establishment of formal construction and engineering education was minimal prior to World War I (Harris, 1991). In those days builders had little or no formal education. Experience was the only proven method for training. After World War I some efforts were made to teach the building processes in an educational setting at MIT, Union College and Yale University, but still contractors felt that the only real education was on the job. Educational institutions viewed construction as a trade and made few attempts to integrate it with a formal curriculum.

With the great depression looming, university enrollment in areas of building science diminished and remained stagnant until after WW II. After the war the construction industry was unable to produce enough manpower to fulfill all the projects ready to begin construction. Education was desired as an option to produce trained individuals; however, it was not available in the area of construction. With the efforts of educators and contractors, construction education was formalized (Harris, 1991). The profession of construction management and engineering can be traced to this time at the end of World War II. The Associated General Contractors of America (AGC) made several attempts to encourage universities to formalize construction education. These were the beginnings of several steps in validating construction as a legitimate profession.

With the formation of the Associated Schools of Construction (ASC), construction educators could collaborate to improve the quality of the education offered. In 1965, fourteen representatives from nine universities gathered at the University of Florida to establish an organization to meet the needs of education in construction (Ascweb, 2008). Due to the increasing need for construction professionals, construction education at universities also grew, with the number of institutional memberships to the ASC at near one hundred and forty today.

"For many years the construction industry was recognized as a leading driver of the world economy, yet it was an industry noticeably missing higher education and research that characterize most industries." (Tucker, Construction Industry Institute). In the early efforts to formalize construction education, research was recognized as a necessary part of construction education. Research has always been viewed as an avenue in the development of new technologies and improved processes. Traditionally research done at universities improves the stature of an area of study. Much of the opposition of the construction profession's transition to a legitimate academic subject was overcome by research in construction engineering (Halpin 2007). One of the first critical events to establish construction research was the establishment of Construction Engineering Research Laboratory (CERL) by the Army Corp of Engineers. This, with other events, improved the foundation of construction engineering and management as a focus for research. With the establishment of this lab partnerships between educators and construction professionals were improved and more direct interaction took place.

In the 1970s more organizations were developed to fulfill the need for research in the field of construction. Another such organization was the Construction Research Council (CRC), which was organized by the Nuclear Regulatory Commission to study aspects of the construction of nuclear power stations. The Business Roundtable, a group of CEOs from leading U.S.

Companies, recommended beginning an initiative called the Construction Industry Cost Effectiveness (CICE). The CICE's purpose was to provide recommendations for improving construction projects after World War II. In 1982 the CICE made various recommendations for the improvement of projects. Among the recommendations was the establishment of continuing research to improve the industry.

From the framework of the CICE, another organization was developed to coordinate research between the Industry and Academia. This organization, the Construction Industry Institute (CII), was formed in the 1980's with leaders from both the clients of the industry and contracting firms. Since that time the CII has played a large part in research in the construction field. CII has become a model for collaboration between industry and academia, linking practice and related problems with solutions based on proven academic research (Halpin, 2007).

As research in the industry has progressed, so has the recognition of leading researchers. The Robert L. Peurifoy Award was established in the mid-80s to recognize individuals who have significantly contributed to the progress of construction through research and development. Peurifoy was one of the early pioneers of research and education in Construction. Therefore, his award is known as one of the most prestigious in the construction research community.

Research in the construction community continues to grow at an increasing rate. This is evident as more students graduate with advanced degrees in Construction, which require research. Valuable research can be conducted through partnerships and support from the industry.

## 2.2 *The Economics of Construction Research*

The construction industry is a very competitive market and is highly fragmented. These are a few reasons that funding in construction research is lower than most other industries. The discretionary funds to be used towards research are minimal or non-existent. Support for research in the construction industry is primarily a result of the economics of construction as it relates to profit margins, procurement of projects, and time sensitive results (Harris, 1991).

In the late 1980's Ben Gerwick wrote a paper regarding the implementation of construction research. He found that the development of research is frequently hindered by the application of short-term business economics. Many authors view the focus of short-term economics as a major factor contributing to the lack of involvement of contractors in research. The very nature of projects and their problems hinder a forward thinking attitude. The solutions needed are often determined as project specific and immediate. This view of short-term payback is counter-productive to developing long-term solutions to overlying problems that are found in the construction industry. No segment of the U.S. industry offers a more striking example of the consequences of this short-run viewpoint and its effects on education and research than Construction (Oglesby, 1990). At the time of the publication of his paper in 1990, Clarkson Oglesby reported that less than 0.1 percent of the industry's annual income was devoted to research. This is contrasted with other industries that generally provide 3 percent or more.

The industry's expectations for construction education are that it will provide skilled people and new technologies (Harris, 1991). However, the economics of contracting is focused on the immediate return on its investment. The construction professionals are experts at finding solutions quickly so they can move forward on projects, thus increasing profits. If research and development is the key to generating new improvements in methods and materials, then the lack

of research and development is a cause of low productivity in the industry (Adrian, 1995), which ultimately affects the profit potential of a company.

Contractors do not see themselves as having any part to play in the research process, even though they are eager to reap the benefits from it (Harris, 1991.) The time between the recognition of a problem and the project completion is too short to involve extended research. This is one reason why many contractors do not involve researchers. The competitive nature of the construction industry encourages contractors to stick to time-tested methods and with lower margins than comparable industries the funds are not readily available to explore less conventional techniques. For these reasons few contractors are willing to take the risk of providing financial support towards research that will not produce results immediately.

## 2.3 *The Need for Collaboration*

Since the development of construction management and engineering programs, both educators and construction firms have benefited from working together. Contractors are the primary customers of construction management and engineering educational programs. The graduates fill many of their employment needs on a regular basis. The university fulfills one of its primary goals when it adequately prepares students for the demands of full-time employment in the construction industry. Through the years both parties have apparently added value to their organizations through effective communication.

In many instances, construction related programs have developed advisory committees made up of professionals and executives in the construction industry. The advisory committee informs on current changes in the construction industry and on the needs in organizations, which leads to improvement in the curriculum offered the students. The role of an effective industry

advisory committee approaches that of a governance or trusteeship board, where members accept some accountability for the outcomes of the program (Tener, 1996.) In addition to improving the quality of the construction program these committees or similar types of organizations should be used to develop solid research topics for professors and graduate students. These topics would be based on the important needs of the industry.

Without direct communication between contractors and researchers, the topics selected for research are derived from inferred ideas from literature and other second hand sources. This method leads to topics that can be meaningless and trivial. Researchers need communication with the industry. In turn, the industry needs the input from research findings to develop and maintain a competitive advantage. Universities, where much of the research is done, have the advantage of promptly integrating research results into curriculum. The students invariably go to work for contractors; making this a benefit for both parties. The beneficial cycle is: needs, research, results, and application. Thus the role of education and research is to make the concepts and practices known and useable (Oglesby, 1990).

Robert Harris, in "A Challenge for Research," argues that the industry needs research for some important reasons. First, the industry needs research to increase its competitive potential. Through a stronger relationship with the research community contractors have a source of new ideas in methods and materials. Research is needed when doing innovative projects. Construction research institutions are in a position to supply information to contractors regarding new technology and innovations that can be used on one-of-a-kind projects. Harris also argues that research is needed to participate in global construction. Many foreign firms have a competitive advantage from their research. Contractors in the USA need research to meet the

demands of competition. Harris also discussed that graduates of programs that require research would provide the creative skill and vision that are required in top management positions.

Traditionally, industry and academia help each other accomplish their missions. In the 1970's the links between universities and industry weakened to their lowest point which Smith and Karlesky linked to three main factors: 1) the separation of academic research from perceived industry needs, 2) the decreased interest among university graduates in industrial research careers and 3) the industry's diminishing role in basic research.

Only recently have those active in the field of Building and Construction Research & Development have taken a more active role and a more innovative attitude concerning partnerships between industry and the research community (Bakens, 1997.) These were the findings of Wim Bakens as presented by the author at a meeting of the International Council for Building Research. Bakens' paper discusses the differences in trends from various countries of the world and the trends being reflective of each country's needs. His paper established that there is a need for a system to share the results of research between research communities across the globe. The author identifies six international trends that are likely to have the greatest impact on construction research. These are: growing partnerships between researchers and the industry, internationalization of competitions and collaboration in the research community, growing emphasis on integrated topics and approaches in research, electronic collaboration, information technology in construction, and sustainable development and construction. These trends were established as a result of conversations with senior researchers from many types of organizations in different parts of the world. In the view of the author these trends are changing the way research is done in the industry.

Bakens notes the research community is beginning to focus more of its attention on the industry and its needs. The needs of the industry ideally should determine the priorities of researchers. Bakens specifically states, "Research methodologies have to be oriented more towards developing applicable products and in doing so there has to be cooperation and consultation with those who are expected to actually apply them." This cooperation will not only change the methods of research but also the priorities of the topics being researched. Identifying priorities is an activity that must require the involvement of two parties, the industry and research community.

The avoidance of cooperation must not be entirely blamed on the contractors or their lack of support. The industry may be hesitant to involve itself with academia because of the process of tenure. The popular belief of others outside of academia understand that "publish or perish" may result in pressure to research in areas that can produce quick results and require little involvement from others.

In a lecture at the ASCE convention in 1992, Daniel Halpin shared his view that a major dilemma of research in construction is with academia. His lecture on process-based research to meet the international challenge was one of many studies and reports that he has done on research in the construction industry. He believes that faculty is faced with the dilemma of serving the industry and the university. The industry is looking to academia for a product, a student entering the workforce; the university requires research interest and accomplishment. In his argument he sets out to establish the need of a framework in processed-based research that would better serve the industry. The paper demonstrates that the majority of innovations in methods and techniques being developed are done outside of the U.S. This is due to the lack of interest in studying processes and operations by researchers in the U.S. This is a threat to the

competitive advantages of many U.S. firms. The industry must recognize that research and development is critical to keeping pace with international competition.

Both the industry and the research community would mutually benefit by strengthening the ties between these institutions. In decades past the decline in the relationship between industry and university was attributed to the separation of academic research from perceived industrial needs (Prager and Omenn, 1980.) Without support from the industry, research at the university level is often left up to individual interests. Forging a link between the construction industry and researchers can serve the interests of both parties. For the industry, academia can represent a source of new ideas, knowledge, and technology. Academia reaps the benefits in the form of suggestions to improve curriculum or advice on applicable topics taught to students. In some cases companies can provide financial support to sustain part-time faculty or research assistants. Prager and Omenn further state "the strengthening of both the academic and industrial sectors would enhance the quality and relevance of research, the stability and robustness of the research enterprise, the breadth and problem-solving capabilities of university graduates, and the competitiveness of the U.S. industrial sector." These benefits can be recognized through an increase in collaboration between industry and academia.

Research will always be an effective method of improving construction processes and techniques. However, it is a necessity to achieve greater support and coordination with the industry. Industry plays a key role in identifying the needs to bring realism to research, to capture the creativity of the individuals working on construction projects, and to increase applicability of research to construction processes (Harris 1992).

## 2.4 *Needs Based Research*

The construction industry is a dynamic and tangible industry that requires the most current information to remain competitive. Creating real-time solutions is a very natural occurrence for contractors because they are commonly faced with complicated problems that need instant results. Research is a delicate process that often takes long periods of time to produce results that can be trusted and proven. A systematic process such as research can take to long for an industry that relies on immediate application and results like the construction industry.

Researchers are constantly looking for ways to add value to their areas of specialty. Establishing research priorities based on needs is an activity that many research organizations commonly engage in. There are methods of obtaining research ideas such as mail survey, industry advisory groups, reviews of literature, and others similar activities. The development of research topics based on the needs of its intended users is often complicated by the lack of definition of the end user. Is the research being done meant to provide evidence to support an improved process or critique an old one? Is it meant to inform colleagues in the research community or academia of new ideas or theories? If the intended use is to advance the construction industry towards new technologies or improve traditional processes then contractors should be consulted for feedback or direction.

There are also different avenues to end up at an intended solution. The struggle for control or directing research has affected all areas of research. Much of research is based upon the needs of those who support research. In the terms of construction research the direction of the practitioners may not be sought after because they provide minimal funds for direct use in research. This is similar to a dilemma face in biomedical research, in the UK during the 20$^{th}$

century. Research priorities were placed under the same pressing influence by public funds for needs-driven research versus curiosity driven research (Shergold and Grant, 2008). They were forced to find equilibrium in opportunity-led research that would relate to certain government departments or research to advise the administration on decisions. There was worry the research directed by immediate needs would be limited and not produce the highest quality of research that is given under scientific freedom in research. Research ideas solely selected by construction professionals could be limited or controlled to the point that it restricts curiosity that leads to new innovations

Similarly it may be true of research in the construction community; by basing research solely on the needs of the contractors, we may miss the potential of producing some evidence for future solutions. However, the construction industry is a process-based industry. Innovations in technologies and processes are primarily improvements to methods that are currently in practice. The ultimate purpose of industrial research is the application. The knowledge of contractors is based on the history of results, but competition requires this knowledge to be improved upon. There must be a balance of both need-based and curiosity-driven solutions in research.

## 2.5 *Establishing Research Priorities*

The natural economics of research require a decision process to allocate funds based on immediate needs and also the time involved to reach substantial results. This planning process requires a strategic method for determining what is most important first. Industrial research is driven primarily on immediate application of results and less on purpose driven results that are found in other areas of research. Determining research priorities through strategic plans or agendas is an effective way to direct knowledge and research results to immediate application.

Changes in the construction industry occur at a very rapid rate, which causes many challenges in the establishment of research priorities. The purpose of developing a strategic research plan is to tackle the need to increase professional knowledge in the areas associated with building and the general knowledge necessary for the solution of the current problems (Warszawski, 2007).

In the development of a strategic plan, Warszawski uses the framework of establishing a disciplinary base to determine research topics. In his study he developed five disciplines that research in the building industry falls under. They are structural engineering, building materials and technology, geo-technology, construction management and economics, and physical performance of buildings. Then to find research topics for potential research he promotes conducting a review of literature of publications, conference proceedings, and academic journals. The review should focus on recent years to avoid topics that have become irrelevant with time. Once discovered, the research topics should be classified under the previously determined topics, and then ranked to determine importance to the topic. The ranking should be from those who are the end users, the industry professionals. In Warszawski's study he asked the responders to rank the topics very important or urgent, important but without urgency, subject not justifiable for their research costs. However it is important to note that opinions of industry professionals may be distorted by problems they are facing immediately, or there may be little familiarity with a large amount of research already available on a topic. Nevertheless, the experience and insight of industry professionals "bring an invaluable dimension to the knowledge acquisition process (Warszawski, 2007)."

In addition to supporting the case for more collaboration between the research community and the construction industry, Garold Oberlender produced an analysis of studies that

had been done assessing this need of industry-provided research topics. In his study entitled, "Development of Construction Research" he outlined techniques used to define research needs. One such study conducted by Borcherding was done through a review of literature, mail questionnaires and personal interviews to develop current research efforts. The basis of establishing research priorities has two reoccurring components; a review of literature and a survey or questionnaire to professionals. This method appears to be a strong force in determining valuable and current research needs.

Murray Muspratt author of "Construction Research and Education," also supports the need to tackle the dilemma of finding valuable research topics by offering other recommendations for establishing a research and development policy. A few such recommendations are: identify issues of importance to the industry by a direct questionnaire to ENR's top 400 contractors, survey key words in current publications, note topics and debates at conferences, and issues in the news.

Establishing a research agenda through academia can be done as long as feedback and consultation is encouraged from industry leaders. The use of only academia or only industry to determine research priorities negates the individual expertise of both parties. With a wide range of techniques available for acquiring research topics and establishing priorities, some researchers are using both qualitative and quantitative methods. In a study to identify research priorities in management, Jan Brochner combines both methods to elicit priorities. His first process used was a search of keyword and suggestions from a focus group to develop 114 suggestions for research topics. These topics were reduced to twenty themes through clustering ideas that were similar in nature. A survey was then developed to rank the ten most important themes based on a Likert-type scale. This survey was distributed to 260 Swedish firms. This method produced

results that ranked the themes based on research rank versus trend rank from 1 to 20. This produced a simple method to analyze the views of the industry and trends in research.

There are common processes in establishing research priorities as demonstrated by the studies discussed above. It is important to do a review of literature to determine the trends from topics recently published. It is also critical to consult with industry professionals for feedback on research priorities. These are the underlying elements in determining a real basis for applicable research and establishing research priorities.

## 2.6 *The Study of Current Trends in the Construction Industry*

A common theme in developing research priorities is a review of literature. A study of publications allows one to understand the current trends of researchers across the globe. Analyzing publications enables us to see multiple trends, such as; research topics, contributions by industry, contributions by individual authors, location by country and more. Classification of articles into reoccurring themes permits us to identify those receiving the most attention. Through the study of journals and conference proceedings, we understand what general topics are receiving the most interest by researchers by the volume of articles being published on that topic.

Professional journals are available to disseminate information to a relevant audience. A primary goal of researchers is to share their results to further the advancement of methods or technologies in specific areas of study. In "Analysis of Trends in Construction Research: 1985-2002," the authors provide a historical perspective on construction research trends for those years. The study covered eighteen years of the American Society of Civil Engineer's Journal of Construction Engineering and Management (JCEM), which is one of the primary research

publications on construction and engineering. The paper discussed the construction research trends as discovered through the study of the JCEM.

The methodology was analyzing each technical paper published, extracting data pertaining to the: publication, author, affiliations (academic, industry, government), relationship to ASCE, collaborations between industry, government and academia, paper's origin (state, country), and the topics addressed in the journal. The authors were able to study and present trends that related to contributing authors and appearances, organizations, contributions by country and state, top contributing academic institutions, and top research topical areas.

In this study the volume of papers being published on a research topic determined the trends. Topics that were discussed fewer than nine times did not make the cut that included twenty-nine separate topics. No topic covered represented more than 4.65% of the total number of papers published, demonstrating the diversity of much of the research being done.

In the study of construction research trends it was determined the nearly seventy five percent of the authors were from academia. This is crucial. The majority of the research being published in journals is authored by academia. Much of the research for construction in the United States will be done in educational institutions (Oglesby, 1990). It is for this very reason that universities and the construction industry must strengthen their cooperating link to improve the practicality of the topics being researched. In his study of construction trends Abudayyeh determined, "There is a need to increase research collaboration between industry and academia, between government and academia, and between industry and government to advance the construction industry." It is appropriate to note that through a study of construction research trends the need for greater collaboration between the industry and the research community was recognized.

To validate my study of construction research trends I chose a sampling of multiple journals that publish research on construction topics. Limiting the study to trends published in one journal would not produce an accurate sample of construction management topics. Authors may tailor their writing to a certain area of topics that one journal may more strongly represent. A sampling of four journals will more accurately encompass vast number of issues that make up the construction industry

## 2.7 *Summary*

A review of literature has shown the role of research in the construction industry. The history of construction research demonstrates that research has played a major role in validating the research profession. Through its history we see that the interest in construction research and education has increased since the end of World War II. However the support of research from the construction industry has been relatively low, due to the short-term economics of processing the work and knowledge in the industry.

Traditionally research partnerships between the construction industry and academia have been weak. There has been a call for greater collaboration between industry and academia to increase applicability of research and competitiveness of the industry. Both organizations will benefit as stronger partnerships are made.

As research is performed based on the needs of the industry, more relevant results will be produced. Focus on the needs of the industry will help the research community establish priorities for topics that are most urgent and important. Two of the underlying methods discovered in the literature review of previous studies are reviews of literature from recent publications and consultation of industry professionals through surveys or direct consultation. A

study of trends through recently published research establishes a base to understand if the research that is currently being done is relevant to the needs of the end users.

# 3 METHODOLOGY

The purpose of this research was to find if what is being researched by academicians is what construction professionals think is important. A comparison study of construction research trends and rankings from construction professionals was used to explore this issue. A combination of qualitative and quantitative research methods were used to collect and analyze the data. These methods were used to observe the correlation of construction research trends and contractor needs. The study of construction research trends was done through a review of literature from a selection of four journals and conference proceedings and classification of those articles. Articles from the literature review were classified into prominent research themes. The research themes were then given a research ranking based upon the number of articles that were classified into the theme. The second part of the study was a survey to construction professionals asking them to rank research topics by their importance to the contractor. The results of both studies were then compared.

## 3.1 *The Study of Current Trends in Construction Research*

This study investigated the construction research trends as demonstrated by the data collected from four construction-related journals. The study of construction research trends was modeled after the Analysis of Trends in Construction Research: 1985-2002 (Abudayyeh, Dibert-DeYoung, Jaselskis, 2003). Their study aimed to find the trends through seventeen years of data

from a single construction journal. It was comprehensive of who, what, where and when of construction research over seventeen years of technical papers. That study determined the trends in construction research for the purpose of analyzing how things had changed. Data collection for this study was done in a similar manner to determine current research trends. The journals selected for this study were the *Journal of Construction Engineering and Management*, *Construction Management and Economics, International Journal of Construction Education and Research*, and the *Associated Schools of Construction Annual Conference Proceedings,* based on results from key word searches and recommendations from faculty members of Brigham Young University. The data was collected from the technical papers published in the journals between the years 2006 – 2007. The information was gathered and stored in a spreadsheet and by the following information:

- Journal title

-Article Title

-Volume Number, Issue, Publication Year

A review of the articles determined the primary topic of each article. Each article was then classified into a popular research theme. Information gathered from the study determined the frequency of the topics researched. The number of articles under each theme demonstrates the rank of importance. The null hypothesis suggests that the more frequently the topics have been researched, the greater importance they have to the industry. This information was compared to the ranking by construction industry professionals.

### 3.2 *Journal Selection*

A selection of journals for review of construction research topics was made to include four journals and conference proceedings. The selection of journals was made from the results of key word searches and direct relevance to construction research. The selection was also based on recommendation of faculty from Brigham Young University. A description of the journals used in this study follows.

*Journal of Construction Engineering and Management*- the JCEM has been one of the premier archival research publications in construction and has made significant contributions to the world of construction research. In 1983 the journal was published quarterly until 1998 when it became a bi-monthly publication. Since 1983 the goal of the journal has been to publish quality papers whose aim is to advance the science of construction engineering, to harmonize construction practices with design theories, and to further education and research in construction engineering and management (ASCE 2002).

*Construction Management and Economics*-is the leading international refereed journal that publishes original research concerning the management and economics of building and civil engineering, while also including the management of built facilities. Its publication began in spring of 1983. It has recently been recognized by the Australian Business Deans Council as an A* rated journal, signifying that it is amongst the best in its field (Taylor & Francis, 2008).

*International Journal of Construction Education and Research*- The journal replaces the Journal of Construction Education, which was established in 1996 (Ascweb, 2008). The journal is a respected international refereed journal that publishes original works that

address cutting edge issues related to construction around the globe. The Journal supports the mission of the Associated Schools of Construction (ASC), a professional association comprised of about 100 universities and colleges. The ASC encourages the sharing of ideas and knowledge and promotes excellence in curricula, teaching, research and service relating to the construction industry.

*Associated Schools of Construction Annual Conference Proceedings* – The Inaugural meeting was originally held in 1965 at the University of Florida. In 2008, the 44th Annual conference was held at Auburn University. The ASC is dedicated to the professional growth and success of its membership, and is committed to fostering excellence in construction communication, scholarship, research, education, and practice (www.ascweb.com, 2008). The conference proceeding are archived from 1987 to the present time.

## 3.3 *Development of Themes*

Themes were collected during the review of literature from multiple studies that explored construction research trends, current industry issues and common construction topics. Primary authors in the publication of popular themes included: Brochner, Abudayyeh, Bakens, and Warszawski. The original list included 41 themes which upon review were reduced by common topics. By further review the list was narrowed to 22 themes. The goals were to cover similar topics in one theme and also formulate the theme so it could be used for potential research topics. These themes were then reviewed and approved by a committee of construction management faculty from Brigham Young University and with feedback from additional construction professionals. Each theme was then defined so that it was relevant to

the industry so that an accurate opinion could be formed while participating in the survey instrument. A list of themes and definitions follows.

1. Computer systems/ Expert Systems – Use of artificial intelligence techniques to offer advice or make decisions.
2. Constructability – the ability of a project to be built, or the project management technique to review the construction process.
3. Design/ BIM - Design methods, activities, or techniques that are used in construction projects.
4. Economics/ Cost Control – Factors that influence the financial aspect of projects, and the industry as a whole. Issues such as controlling costs on projects, accounting strategies and other building economics.
5. Estimating/ Bidding – Judging the cost of a project and securing the work through the competitive process of bidding. Research of topics such as bidding models, estimating techniques, pricing construction projects.
6. Facilities Management – Integration of multiple disciplines to maintain the functionality of a structure. Research includes building life issues and construction cycles that effect the operation of facilities.
7. Globalization – International operations or influences on the construction industry.
8. Heavy Civil Construction – The construction of bridges, tunnels, and roads. Research includes topics such as infrastructure needs and techniques in civil construction.
9. Industry Overview – A look at the industry in general, such as the history, progress or trends.

10. Legal/Contracts - Studies that involve contracts, change orders, or other legal issues impacting the construction industry.
11. Management/ Risks - The development of programs, practices or strategies for minimizing risk on construction projects or in companies.
12. Materials/ Equipment- The selection of proper equipment and materials to complete construction projects.
13. Performance - Research of measurement techniques of performance of the various construction entities or individuals.
14. Procurement - The process of obtaining projects, labor, or material.
15. Productivity/ Optimization - The study of individual techniques and methods, or general productivity in the industry.
16. Project Delivery – The method of management, execution, and delivery of a project as it relates to information and risk sharing.
17. Project/ Quality Management – The method of controlling the quality, safety and cost of a project.
18. Safety - The study of techniques and advances in construction safety.
19. Scheduling - Establishing the sequence of activities on a construction project. Researching scheduling practices or techniques.
20. Sustainability - Research on sustainability techniques, waste and reduction methods, and environmental impacts.
21. Technology/ Innovation - The development and implementation of new technology for the construction industry.

22. Training/ Human Resources – The organization that deals with human factors, such as motivation techniques, job skill sets, training, education, and leadership techniques.

### 3.4 *Classification of Major Research Topics*

A study of the publications produced a list of all the topics that have been published in years 2006-2007. Research published in each article varied and required classification into a general theme. Classifications of articles allowed for an observation of general trends in construction research. Although the topic of some papers could fall into multiple categories, only the main topic was classified. The topics were used as the basis for contractor ranking of construction research trends. Each article was classified into one of the primary research theme mentioned above.

### 3.5 *The Ranking of Construction Topics*

This study compared the current trends in construction research and the needs as seen through the end practitioners, construction professionals. The ranking portion of the study determined the views industry leaders. This allowed for a comparison to be made to the current research trends. The number of articles that were categorized under one theme established rankings in research trends. The ranking of each theme was based on the number of articles within each specific theme. These rankings were used to compare with the ranking from construction professionals. The ranking of construction professionals was obtained through the survey instrument. This portion of the study will include a description of the population of interests, the research design, and the creation of the survey instrument.

### 3.6 *The Research Design*

The survey was administered through an online survey management system. The management system allowed the survey to be created, collected, and analyzed within the system. Distributing the survey through email was chosen for the ability to distribute the survey quickly and low cost. Data that was collected from the survey system was exported to a spreadsheet and analyzed and prepared for further presentation. The twenty-two themes and definitions were the basis of the ranking survey. The online survey was used to allow respondents to access the survey quickly and conveniently. Surveys distributed by email must be simple and easy to complete, the more burdensome the task the lower the response rate (Babbie). The cost of the distribution of the survey was substantially lower. Access through Brigham Young University for the online survey tool, Qualtrics, involved no direct cost to the researcher. Surveys through the postal service were estimated to be substantially higher in cost. The time to receive responses from email surveys has proven to be significantly faster than traditional mail out questionnaires (Truell, 2002). Another benefit considered in the survey design was verifiable delivery (Kaye, 1999).

Through a review of literature, a few basic recommendations were followed for the design of the email survey (Kaye, 1999). The primary goal in designing an online survey was simplicity and ease. Other recommendations include:

- The survey should be as short as possible for quick completion and to minimize excessive scrolling.
- Simple design with sparse use of graphics saves downloading time.
- Drop-down boxes save space and clutter by avoiding repeating responses.

- Instructions should be clearly stated.
- Responding to questions should be easy and intuitive.

### 3.7 *Population of Interest*

An effort was made to obtain a national distribution list of general contractors, members of the Associated General Contractors (AGC). The organization was unwilling to provide the distribution list for protection to its members and therefore the selection of respondents was made from smaller geographical region were contact could more easily be acquired. The assumption was that construction professionals in northern California have similar views to construction professionals nationally.

This study was conducted using a sampling of construction professionals throughout Northern California. A random sampling for this survey was collected from a member search of general contractors on the website of the Association of General Contractors of California. A search on the member search on the website returned 407 companies. The sampling of these contractors was gathered by selecting every fourth contractor. Many of companies on this list did not have a contact email address and were, therefore not included in this list. A total of 86 contacts were compiled from the membership of the AGC of California. Portions of the contractors listed in the member search for general contractors primarily performed subcontractor responsibilities and were included in this study. Contacts were also gathered from distribution list of the Northern California Chapter of the American Society of Professional Estimators. The email survey was sent to all 302 contacts on this distribution list. An additional list of 26 general contractors was obtained and included in this list. The survey population consisted of general contractors, construction managers, and subcontractors. An electronic

mailing was sent to 414 construction professionals. The survey was undeliverable to 155 of the contacts on the distribution list. Survey respondents were listed on the distribution lists as the company contact; direct responsibilities were unknown but can reasonably assumed to be in positions within their organization to provide appropriate representation of the companies views.

### 3.8 *Development of Survey Instrument*

An online survey instrument was selected by recommendation. This tool was chosen to provide a simple and quick method for respondents. Distribution through email allowed respondents to complete the survey by clicking a link. The online survey provider, Qualtrics, was selected because of accessibility for Brigham Young University students. Bruce Burgon of the Marriot School of Business gave access to the survey management tool and an account was created. Qualtrics provided the online survey technology to create, distribute and analyze data for this study.

### 3.9 *Survey Composition*

The survey instrument had two questions. The first question required the participants to rank the twenty-six research topics. Participants ranked the research categories by clicking and dragging the topics to their rank. The survey respondents simply clicked and dragged each category into the correct position based on importance to the industry. Rankings were automatically redistributed by the arrangement of each theme. The themes were placed in alphabetical order to begin the survey. The second questions requested the respondents to provide additional research topics. These topics were specific in nature and likely would fall under the 22 themes.

### 3.10 *Pilot Study*

After the survey design was completed, it was sent to 11 construction colleagues for review. These colleagues held positions in their companies of project engineers, senior estimators, project managers, superintendents, construction managers, and professors of construction management. They were located in number of states such as Washington, Oregon, Wyoming, Utah, and California. The job titles and experiences of each reviewer were varied to receive useful responses and feedback. The group was asked to complete the survey online and provide feedback regarding its clarity and functionality. Responses from the pilot study were positive in nature. Feedback from the study confirmed that directions were clear and the respondents could drag and rank themes with relative ease. Themes and definitions were also confirmed to be easy to understand. Feedback was given to adjust the format of the type to be clearer to read.

### 3.11 *Survey Review*

Upon final draft the survey was reviewed and approved by Brigham Young University's Institutional Review Board for Human Subjects to assure that no harm or threat would be caused to survey recipients. Upon submission for review, the survey was not required to provided waivers since distribution was electronic and participation was voluntary and no personal information was requested.

### 3.12 *Correlation Test*

A Pearson correlation test was run on the results to verify the correlation between the research ranking and industry ranking. The correlation function from Microsoft Excel was used to determine the correlation coefficient. Results were then graphed to show the linear dependence of the industry and research ranking.

# 4 DATA

The following is data collected from the study of research journals and the ranking survey. Articles were gathered from four construction research publications and classified into 22 common construction themes. The quantity of articles under each theme determined the research ranking. The themes were developed by review of literature and consultation with a committee of construction management faculty members of Brigham Young University. The 22 themes were sent to construction professionals for ranking. The highest average ranking determined the themes' importance to the industry. The findings of the research are found below.

## 4.1 *Development of Themes*

Themes were collected during the review of literature from multiple studies that explored construction research trends, current industry issues and common construction topics. The original list included 41 themes which upon review were reduced by common topic. By further review the list was narrowed to 22 themes. The goals were to cover similar topics in one theme and also formulate the theme so it could be used for potential research topics. These themes were then reviewed and approved by a committee of construction management faculty from Brigham Young University. Each theme was then defined so that it was relevant to the industry so that an accurate opinion could be formed while participating in the survey instrument. The list of themes and definitions are found below.

1. Computer systems/ Expert Systems – Use of artificial intelligence techniques to offer advice or make decisions.
2. Constructability – the ability of a project to be built, or the project management technique to review the construction process.
3. Design/ BIM - Design methods, activities, or techniques that are used in construction projects.
4. Economics/ Cost Control – Factors that influence the financial aspect of projects, and the industry as a whole. Issues such as controlling costs on projects, accounting strategies and other building economics.
5. Estimating/ Bidding – Judging the cost of a project and securing the work through the competitive process of bidding. Research of topics such as bidding models, estimating techniques, pricing construction projects.
6. Facilities Management – Integration of multiple disciplines to maintain the functionality of a structure. Research includes building life issues and construction cycles that effect the operation of facilities.
7. Globalization – International operations or influences on the construction industry.
8. Heavy Civil Construction – The construction of bridges, tunnels, and roads. Research includes topics such as infrastructure needs and techniques in civil construction.
9. Industry Overview – A look at the industry in general, such as the history, progress or trends.
10. Legal/Contracts - Studies that involve contracts, change orders, or other legal issues impacting the construction industry.

11. Management/ Risks - The development of programs, practices or strategies for minimizing risk on construction projects or in companies.
12. Materials/ Equipment- The selection of proper equipment and materials to complete construction projects.
13. Performance - Research of measurement techniques of performance of the various construction entities or individuals.
14. Procurement - The process of obtaining projects, labor, or material.
15. Productivity/ Optimization - The study of individual techniques and methods, or general productivity in the industry.
16. Project Delivery – The method of management, execution, and delivery of a project as it relates to information and risk sharing.
17. Project/ Quality Management – The method of controlling the quality, safety and cost of a project.
18. Safety - The study of techniques and advances in construction safety.
19. Scheduling - Establishing the sequence of activities on a construction project. Researching scheduling practices or techniques.
20. Sustainability - Research on sustainability techniques, waste and reduction methods, and environmental impacts.
21. Technology/ Innovation - The development and implementation of new technology for the construction industry.
22. Training/ Human Resources – The organization that deals with human factors, such as motivation techniques, job skill sets, training, education, and leadership techniques.

## 4.2 *Analyzing Research Journals*

Four research journals were selected for their focus on construction research. Articles from each of these journals were gathered from the volumes between the years 2006 and 2007. The data gathered from these journals included journal, title, and year of publication. These articles were classified into themes based on the primary topic of the research in the article. The total number of articles that were gathered and stored was 607. The Journal of Construction and Engineering Management contained 41% of the articles collected, Construction Management and Economics 34%, International Journal of Construction Education and Research 5%, and the ASC Conference Proceedings 20%. A breakdown of number of articles from each journal can be found in Table 4-1. The information that was gathered from each journal included: Article title, year published, and author.

**Table 4-1: Research Publications**

| Research Journal | Publications |
|---|---|
| Journal of Construction and Engineering Management | 249 |
| Construction Management and Economics | 207 |
| International Journal of Construction Education and Research | 30 |
| Associated Schools of Construction Annual Conference Proceedings | 121 |
| Total | 607 |

All the articles were collected into a database for storage and sorting. Each article was then classified into one of 22 themes based upon the primary research topic. The number of occurrences of each theme was then counted and recorded into the database. Each theme was then ranked based upon the total number of occurrences from the journals.

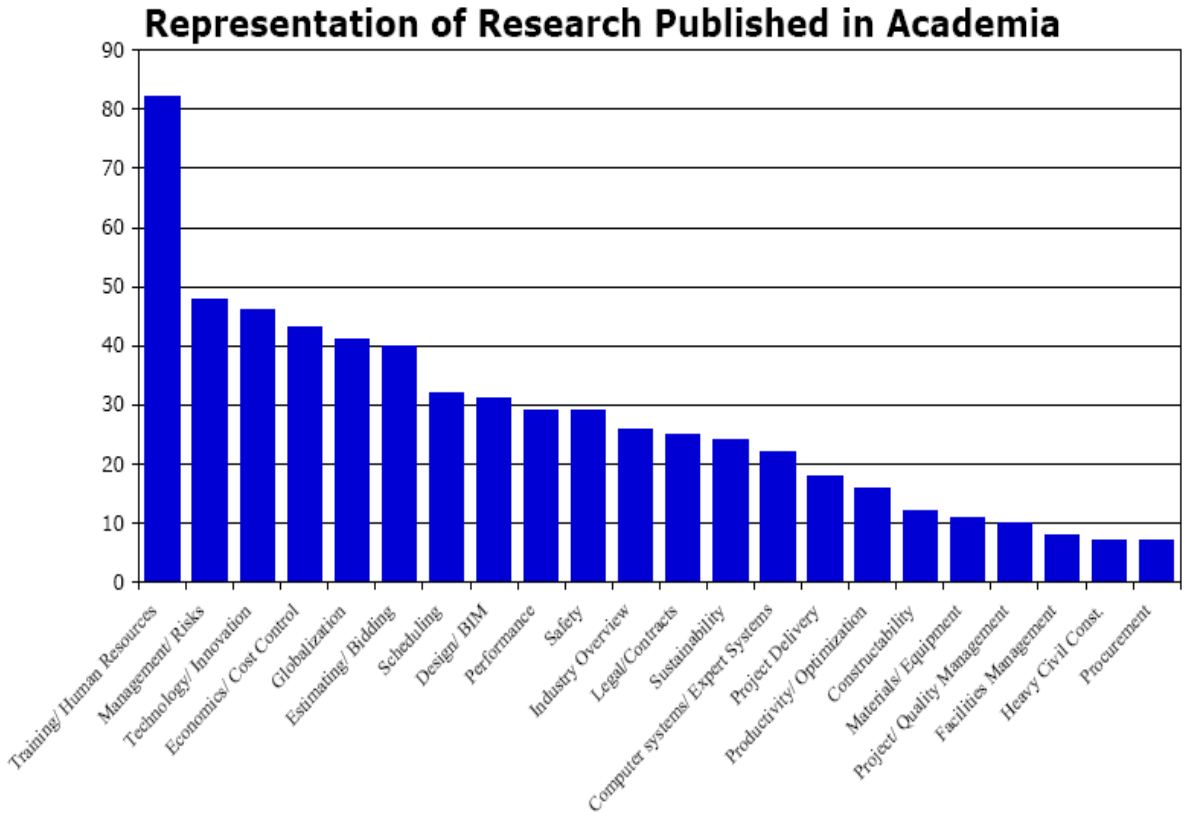


**Figure 4-1: Research Distribution by Theme**

The most commonly researched theme was Training/ Human Resources with nearly 14% of the research done on that topic. The lowest published theme(s) were Procurement and Heavy Civil Construction each containing only one percent of the articles collected. A full breakdown of the findings can be found in Figure 4-1. Each theme was ranked by the quantity of articles classified into that theme and not magnitude of the research done.

## 4.3 *Survey Instrument*

The survey was administered through an online survey management system. The management system allowed the survey to be created, collected, and analyzed within the system.

Distributing the survey through email was chosen for the ability to distribute the survey quickly and low cost. Data that was collected from the survey system could be exported to a spreadsheet and be analyzed and prepared for further presentation. The twenty two themes and definitions were the basis of the ranking survey. The survey instrument was sent by electronic mail to 414 construction professionals throughout Northern California. The survey was undeliverable to 155 of the contacts on the distribution list. The response rate was 14% among those construction professionals representing 36 respondents. The survey management system rejected four surveys because they were not entirely complete. The first distribution of surveys yielded a 9% response rate. After one week a reminder was sent to the distribution list and an additional 5% response was received. Dennis Egget, Director of the Statistical Consulting Center at Brigham Young University confirmed that 10-15% response rate demonstrates a good representation from survey respondents. The respondents were asked to complete the survey by opening a link that commenced the survey. The survey was a two-part questionnaire. The primary question required the respondents to rank the 22 themes by importance to the industry. The themes were placed in alphabetical order to begin the survey. The respondents ranked the themes by dragging each topic into its given place holder. This method gave the respondents the capability of adjusting each theme without rework of the entire ranks. The second questions requested the respondents to provide additional research topics. The latter question was created to offer the respondents an option to suggest additional research topics. These topics were specific in nature and likely would fall under the 22 themes.

## 4.4 *Ranking Themes*

Construction professionals were asked to rank the 22 themes by importance to the industry. The respondents were required to place each theme in order from most important being the highest (1) to least important being the lowest (22). The results were determined by ranking the themes by their mean. The mean represented the average ranking given to each theme. The closer the mean was to one (the rank with the most importance) the higher its average ranking. This method demonstrates the collective opinion of the respondents.

**Table 4-2: Survey Results**

| Research Topics | Rank | Mean | Variance | Standard Deviation |
|---|---|---|---|---|
| Constructability | 1 | 4.29 | 14.81 | 3.85 |
| Estimating/ Bidding | 2 | 5.58 | 17.58 | 4.19 |
| Economics/ Cost Control | 3 | 5.71 | 22.68 | 4.76 |
| Design/ BIM | 4 | 7.29 | 26.95 | 5.19 |
| Materials/ Equipment | 5 | 10.87 | 25.38 | 5.04 |
| Project Delivery | 6 | 11.26 | 33 | 5.74 |
| Management/ Risks | 7 | 11.42 | 13.78 | 3.71 |
| Performance | 8 | 11.48 | 30.06 | 5.48 |
| Safety | 9 | 11.58 | 37.92 | 6.16 |
| Productivity/ Optimization | 10 | 11.81 | 36.76 | 6.06 |
| Technology/ Innovation | 11 | 11.84 | 45.61 | 6.75 |
| Project/ Quality Management | 12 | 11.87 | 30.78 | 5.55 |
| Procurement | 13 | 11.9 | 26.22 | 5.12 |
| Computer systems/ Expert Systems | 14 | 12 | 46.87 | 6.85 |
| Legal/Contracts | 15 | 12 | 29.33 | 5.42 |
| Facilities Management | 16 | 12.55 | 30.79 | 5.55 |
| Scheduling | 17 | 12.87 | 32.98 | 5.74 |
| Sustainability | 18 | 14.06 | 40.4 | 6.36 |
| Heavy Civil Const. | 19 | 14.68 | 38.49 | 6.2 |
| Training/ Human Resources | 20 | 15 | 46.87 | 6.85 |
| Industry Overview | 21 | 16.39 | 27.31 | 5.23 |
| Globalization | 22 | 16.55 | 32.06 | 5.66 |

The theme with the highest ranking was Constructability, with a mean of 4.29 and a standard deviation of 3.85. Based on the ranking from survey respondents, constructability was determined as the most important theme followed by estimating/ bidding (mean=5.58),

economics/ cost control (mean=5.71), design/ BIM (mean= 7.29), and materials/ equipment (mean= 10.87). The lowest ranking was given to globalization with a mean of 16.55. A complete list of the rankings and analysis can be found in Table 4-2.

Question two of the survey was designed to solicit feedback for additional research topics. The responses were subjective, many of which could be included in the 22 themes that were previously ranked. A complete list of those responses is included below. They are given in no particular order.

1. Innovation in materials - material development
2. Skilled labor training and development
3. Soil Structure Interaction
4. The future of available skilled labor
5. Integration/communication/accountability of: end user (operator), owner (if different than end user), financial, trade disciplines, subcontractors, vendors, suppliers.
6. Relationship of cost of oil and how it affects construction materials.
7. Roll of professional Societies AACE, ASPE, DBIA, AIA in the Construction market.
8. Communication
9. Contractual and how relationships are established and early in the planning stage.
10. Data on "Team Building" activities and if good results are measurable.
11. Overview of past research that was trendy, but faded away .i.e. TQM.
12. Making it easier to include and address all issues of scope in every project specification.
13. How subcontractors and/or general contractors can morph from new construction into tenant improvement or other sub-markets.
14. Research in excavation and soil preservation.

15. Research in sanitary sewer systems.
16. Estimating-systems analysis
17. Construction Materials and Methods – (Bottom line: If you don't know how to build it, you cannot successfully design or manage it.)
18. Construction Quality Assurance.

## 4.5 *Comparison of Research Trends and Industry Ranking*

The goal of this research was to compare popular research themes to industry ranking. The research rankings were developed by the quantity of research articles published in the research journals selected. Industry ranking was established by responses from industry professionals.

**Table 4-3: Research Ranking Comparison**

| Research Topics | Research Rank | Industry Rank |
|---|---|---|
| Training/ Human Resources | 1 | 20 |
| Management/ Risks | 2 | 7 |
| Technology/ Innovation | 3 | 11 |
| Economics/ Cost Control | 4 | 3 |
| Globalization | 5 | 22 |
| Estimating/ Bidding | 6 | 2 |
| Scheduling | 7 | 17 |
| Design/ BIM | 8 | 4 |
| Performance | 9 | 8 |
| Safety | 9 | 9 |
| Industry Overview | 11 | 21 |
| Legal/Contracts | 12 | 15 |
| Sustainability | 13 | 18 |
| Computer systems/ Expert Systems | 14 | 14 |
| Project Delivery | 15 | 6 |
| Productivity/ Optimization | 16 | 10 |
| Constructability | 17 | 1 |
| Materials/ Equipment | 18 | 5 |
| Project/ Quality Management | 19 | 12 |
| Facilities Management | 20 | 16 |
| Procurement | 21 | 13 |
| Heavy Civil Const. | 21 | 19 |

The importance was determined by highest average ranking. Table 4-3 represents the ranking sorted by research rank and the corresponding link by industry. Table 4-4 represents the ranking sorted by industry rank and the corresponding link by research. A graphical representation of the ranking comparison is given in Figure 4.3.

## 4.6 *Results of the Comparison*

The results of the two studies provide comparisons of the research and industry ranking. The purpose of the research was to determine if the popular research being conducted was a direct reflection of the industries views. The results were mixed and demonstrate that the research that is being done is not aligned with the needs of the industry.

**Table 4-4: Industry Ranking Comparison**

| Research Topics | Industry Rank | Research Rank |
|---|---|---|
| Constructability | 1 | 17 |
| Estimating/ Bidding | 2 | 6 |
| Economics/ Cost Control | 3 | 4 |
| Design/ BIM | 4 | 8 |
| Materials/ Equipment | 5 | 18 |
| Project Delivery | 6 | 15 |
| Management/ Risks | 7 | 2 |
| Performance | 8 | 9 |
| Safety | 9 | 9 |
| Productivity/ Optimization | 10 | 16 |
| Technology/ Innovation | 11 | 3 |
| Project/ Quality Management | 12 | 19 |
| Procurement | 13 | 21 |
| Computer systems/ Expert Systems | 14 | 14 |
| Legal/Contracts | 15 | 12 |
| Facilities Management | 16 | 20 |
| Scheduling | 17 | 7 |
| Sustainability | 18 | 13 |
| Heavy Civil Const. | 19 | 21 |
| Training/ Human Resources | 20 | 1 |
| Industry Overview | 21 | 11 |
| Globalization | 22 | 5 |

There were approximately 23% of the themes that were given rankings within two positions by both industry and researchers which demonstrates favorable efforts by researchers. However the most popular research topics showed no correlation to the industry ranking. This was proven by conducting a Pearson correlation test.

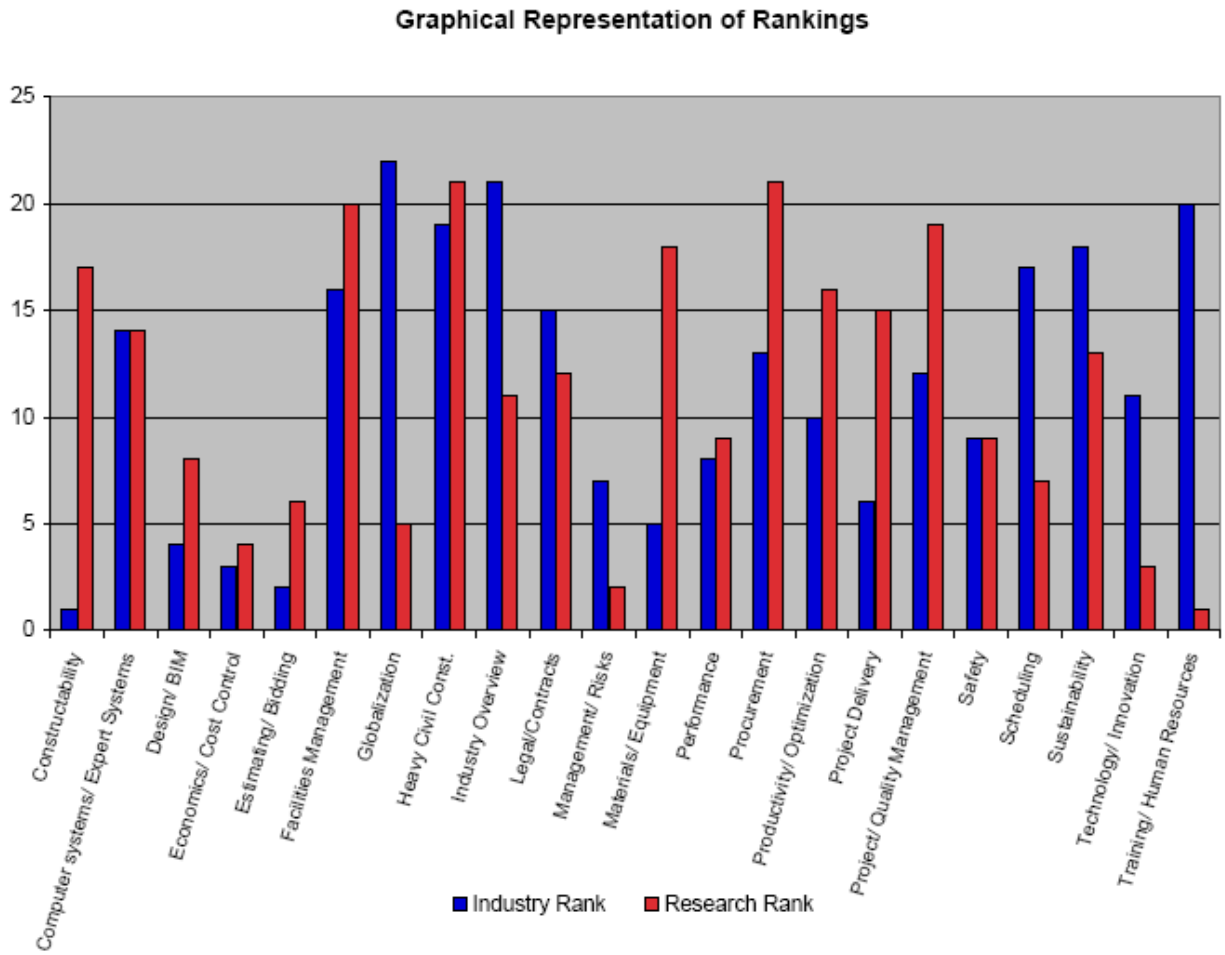


**Figure 4-2: Graphical Representation of Comparison Rankings**

## 4.7 *Pearson Correlation Test*

A Pearson correlation test was run on the results to see if any correlation existed between the research ranking and industry ranking. The Pearson correlation coefficient is a measure of the correlation (linear dependence) between two variables *X* and *Y*, giving a value between +1 and −1 inclusive. A value of 1 implies that a linear equation describes the relationship between *X* and *Y* perfectly, with all data points lying on a line for which *Y* increases as *X* increases. A value of −1 implies that all data points lie on a line for which *Y* decreases as *X* increases. A value of 0 implies that there is no linear correlation between the variables. The correlation coefficient was found by the use of the correlation function in the Excel spreadsheet. The data indicated no correlation existed (r= .04160152) therefore, the null hypothesis was rejected.

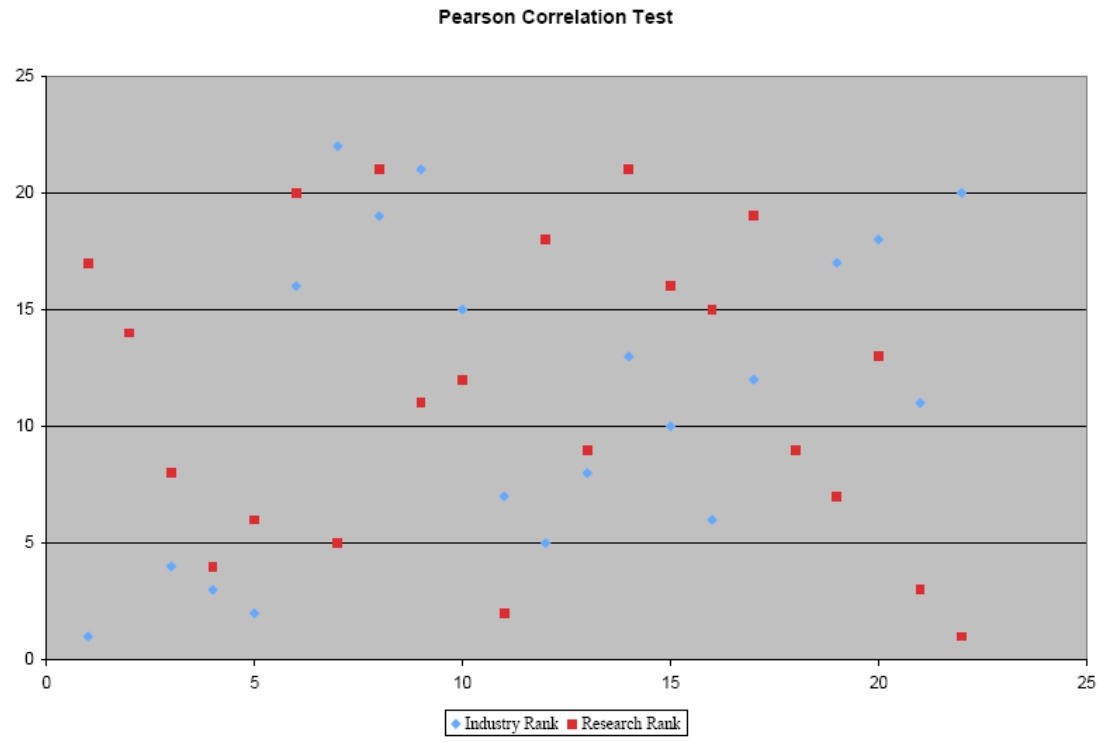


**Figure 4-3: Pearson Correlation Graph**

# 5 CONCLUSION

The purpose of this study was to compare popular research themes to a ranking by construction professionals. This comparison was utilized to view whether the themes that were most commonly being researched were directly correlated to the perceived needs of the construction industry. The null hypothesis was there is no difference between the priorities of construction-related research and the needs of the construction industry. The results of the study rejected the null hypothesis. It is astounding the there was no correlation between what investigators are researching and the needs of construction professionals. Through the review of literature it was clear that research is a key principle to advancing industry. Traditionally there was disconnection in the construction industry between researchers and other construction professionals. The construction industry invests very little into research and development as compared to other industries and the lack of support has hampered the relevance of the research. This study was not designed to understand the reason for inadequate support for construction research, but to compare rankings of importance. This study was designed to determine if the research being done was what was most important to construction professionals.

Information from the study of research journals indicates that training and human resource was a leading theme in research. This is likely an indication that educators were conducting research in areas for the improvement of their work in academia. Research conducted towards the education and training of students in the construction industry is

understandably a focus for educators because of their interest in improving their techniques and collaboration with colleagues. However the ranking from industry professionals indicated that training and human resources was not their most important theme. In contrary the industry has ranked training relatively low on the list. This finding may represent that industry believes that training and human resources are being adequately studied and the results are well received. Further research on this topic though beneficial would not produce the returns that studies in other areas would produce.

Findings in this study demonstrated that construction professionals believe that more research should be completed in the area of constructability, or the ability of a project to be built. Perhaps trends in the construction industry have demonstrated that more attention should be given to integrate the construction processes in design development. Studies of constructability reviews, plans and process analysis should be conducted by research professionals to provide information that can be used to develop results. With feedback from the industry valuable research on the theme of constructability should be conducted. The findings from this research demonstrate that much of the research emphasis (research fads) of academia is not what is important to the construction professionals.

Results from the comparison demonstrate that there are some common themes which rank high for both researchers and industry professionals. Estimating, economics, management and design were ranked in the top ten from both research results and industry ranking. It is interesting to point out that although much research has been done in these areas there is still a need for discovery and advancement in these themes. The influence of the economic times at the time of the study may have influenced the ranking from industry professionals. It is

acknowledged that this study was developed to create a ranking of themes and the opinion of the industry professionals is dependent on current issues and trends.

## 5.1 *Recommendations*

Although this study was only a comparison of industry ranking of research themes, it does indicate other ideas to advance the construction industry. Some additional efforts should be made by researchers and industry professionals to achieve additional benefits by increased collaboration. Involving the industry to determine research priorities, give feedback on education courses, and using researchers from academia to consult on projects are suggestions for increasing collaboration. The potential for mutually beneficial relationships is intriguing.

Perhaps the main implication of the study is a compilation of information that will prompt a direct communication between researchers and industry professionals. There are great possibilities available to construction companies to form partnerships with educators for research and development. There are many areas within a company that would benefit from additional analysis from outside sources such as new technology implementation, processes evaluation, and material assessment to name a few. Companies should utilize researchers to perform evaluations of their processes. Construction companies should reach out to local universities and research institutions for evaluating issues within the organization.

Industry professionals and researchers can strengthen ties to make a difference in an industry that has traditionally been deficient on research and development. The valuable expertise of a researcher can produce information and results that will advancements the industries interest in many aspects. Improvement in safety, productivity, materials and processes will be found be enlisting the expertise of research professionals. Researchers can increase the

relevance of their work by enlisting construction professionals for feedback, data, test material, and research subjects. The construction industry should support researchers in the areas or research which they are most interested. The construction professionals have responsibility to see that research needs for the construction industry is guided by them.

## 5.2 Areas of Additional Research

Individuals planning research can use this study to gather ideas for future research. The information obtained through this survey and comparison is valuable for current researchers and educators as well as future students enrolled in a research focused degree. Future students should use this study to find relevant research topics. Master's students should utilize this study for selecting topics for their thesis research. Educators can also use this study for class discussions on construction trends and issues. Additional areas of study include a study to understand the cost impact of preconstruction efforts on the overall success of a project, evaluating the stages of preconstruction such as constructability, buyout, pre-planning, estimating, and design assistance. A study should also be completed to understand how companies store, record, and track historical data. It would be interesting to find out what level of sophistication their method of storage are and if companies has established methods and procedures for tracking historical data. Additional areas of study were provide in chapter 4.4 from the responses given by construction professionals.

## 5.3 *Implications*

The implications of this study are that researchers and academia need to change their research priorities to align better with the needs of the construction industry. This study showed there was no connection between what is being researched and what industry professionals thought should be researched. This must change for research to be applicable to the industry.

The construction industry is changing at a very rapid pace. Revisiting the industry's ranking of research topics is necessary to keep topics at the forefront of research. Additionally soliciting feedback from construction professionals will forge a strong relationship between research and the industry practitioners, thus advancing the industry as a whole.

**REFERENCES**


Abudayyeh, O., A. Dibert-DeYoung, and E. Jaselskis. 2004. Analysis of Trends in Construction Research: 1985-2002. *Journal of Construction Engineering and Management* 130, no. 3: 433(7).

Anon. 1996. Assessing global research needs. *CERF Civil Engineering Research Foundation Report* , no. 5016.

Bakens, W. 1997. International trends in building and construction research. *Journal of Construction Engineering and Management* 123: 102(3).

Chinowsky, P. S. (Sch. of Civ. and Environ. Eng., Georgia Tech.), Jorge A. Vanegas. 1996. Combining practice and theory in construction education curricula. *ASEE Annual Conference Proceedings, ASEE Annual Conference Proceedings* : 747-752.

Courtney, R. Building research establishment - past, present and future. *Building Research and Information* 25, no. 5 (SEP-OCT 1997) : 285-291.

de la Garza,J. M. 2007. Sponsored Research and Its Impact on Universities, Faculty, and Journals. *Journal of Construction Engineering & Management* 133, no. 9 (09) : 708-709.

Dietz, G. H., W. A. Litle. 1976. Education for Construction. *Journal of Construction Engineering and Management* 102, no. 2: 347-364.

Flanagan, R. (School of Construction Management and Engineering, University of Reading), Weisheng Lu, Liyin Shen, and Carol Jewell. 2007. Competitiveness in construction: A critical review of research. *Construction Management and Economics* 25, no. 9: 989-1000.

Gerwick, B. C. 1990. Implementing construction research. *Journal of Construction Engineering and Management* 116: 556(8).

Gerwick, B. C. 1990. A model for construction research. *Civil Engineering (American Society of Civil Engineers)* 60: 8(1).

Halpin, D. W. (Dept. of Civil Engineering, Purdue Univ.). 2007. Fifty years of progress in construction engineering research. *Journal of Construction Engineering and Management* 133, no. 9: 635-639.

Halpin, D. W. 1993. Process-based research to meet the international challenge. *Journal of Construction Engineering and Management* 119: 417(9).

Harris, R. B. (Univ. of Michigan). 1992. Challenge for research. *Journal of Construction Engineering and Management* 118, no. 3: 422-434.

Hastak, M. (Division of Construction Engineering and Management, Purdue University), Michael A. Mullens, and Matt Syal. 2005. National housing research agenda for construction management and production. *Construction Research Congress : Broadening Perspectives - Proceedings of the Congress, Construction Research Congress : Broadening Perspectives - Proceedings of the Congress* : 163-172.

Ibbs, C. W. 1990. Commercializing construction research. *Journal of Professional Issues in Engineering* 116: 1(8).

Ibbs, C. W. 1986. Future directions for computerized construction research. *Journal of Construction Engineering and Management* 112: 326(20).

Loosemore M., T. Chin Chin. 2000. Occupational bias in construction management research. *Construction Management and Economics* , no. 18 (1999) : 757-766.

Muspratt, M. A. 1984. Construction research and education. *Journal of Professional Issues in Engineering* 110: 7(12).

Oberlender, G. D. (Oklahoma State Univ, Stillwater, OK,USA). 1984. Development of Construction Reseach. *Journal of Construction Engineering and Management* 110, no. 4: 486-490.

Oglesby, C. H. 1990. Dilemmas facing construction education and research in 1990s. *Journal of Construction Engineering and Management* 116: 4(14).

Peten, G. (Arizona State University, Del E. Webb School of Construction), Anil Sawhney, and William Badger. 2002. Overview of summer research program for undergraduate students in construction. *ASEE Annual Conference Proceedings, ASEE Annual Conference and Exposition: Vive L'ingenieur* : 13003-13017.

Popescu, A., P. Radu. 2003. Building Research Skills: Course-Integrated Training Methods. *Journal of Professional Issues in Engineering Education and Practice* 129, no. 1 (January 1, 2003) .

Sawyer, T. 2002. Researchers Challenged to Improve Construction. *ENR* 248, no. 21: 50(3).

Thomas, H. R., J. H. Willenbrock. 1988. Managing construction research at universities. *Journal of Construction Engineering and Management* 114: 245(11).

Tucker, R. L. Sep 2007. Construction Industry Institute. □□. *Journal of Construction Engineering and Management* 133, no. 9: 640-644.

Varma, V. K. 2001. Undergraduate student research in construction engineering: The current status. *ASEE Annual Conference Proceedings, ASEE Annual Conference and Exposition: Peppers, Papers, Pueblos and Professors* : 10833-10836.

Warszawski, A. (Faculty of Civil and Environmental Engineering), R. Becker, and R. Navon. 2007. Strategic planning for building research-a process oriented methodology. *Journal of Construction Engineering and Management* 133, no. 9: 71

# APPENDIX A. RANKING QUESTIONNAIRE

Please rank the following research areas based on their importance to the construction industry. Click and drag items to desired place.

Computer systems/ Expert Systems – Use of artificial intelligence techniques to offer advice or make decisions.

Constructability – The ability of a project to be built, or the project management technique to review the construction process.

Design/ BIM - Design methods, activities, or techniques that are used in construction projects.

Economics/ Cost Control – Factors that influence the financial aspect of projects, and the industry as a whole. Issues such as controlling costs on projects, accounting strategies and other building economics.

Estimating/ Bidding – Judging the cost of a project and securing the work through the competitive process of bidding. Research of topics such as bidding models, estimating techniques, pricing construction projects.

Facilities Management – Integration of multiple disciplines to maintain the functionality of a structure. Research includes building life issues and construction cycles that effect the operation of facilities.

Globalization – International operations or influences on the construction industry.

Heavy Civil Construction – The construction of bridges, tunnels, and roads. Research includes topics such as infrastructure needs and techniques in civil construction.

Industry Overview – A look at the industry in general, such as the history, progress or trends.

Legal/Contracts - Studies that involve contracts, change orders, or other legal issues impacting the construction industry.

Management/ Risks - The development of programs, practices or strategies for minimizing risk on construction projects or in companies.

Materials/ Equipment- The selection of proper equipment and materials to complete construction projects.

Performance - Research of measurement techniques of performance of the various construction entities or individuals.

Procurement - The process of obtaining projects, labor, or material.

Productivity/ Optimization - The study of individual techniques and methods, or general productivity in the industry.

Project Delivery – The method of management, execution, and delivery of a project as it relates to information and risk sharing.

Project/ Quality Management – The method of controlling the quality, safety and cost of a project.

Safety - The study of techniques and advances in construction safety.

Scheduling - Establishing the sequence of activities on a construction project. Researching scheduling practices or techniques.

Sustainability - Research on sustainability techniques, waste and reduction methods, and environmental impacts.

Technology/ Innovation - The development and implementation of new technology for the construction industry.

Training/ Human Resources – The organization that deals with human factors, such as motivation techniques, job skill sets, training, education, and leadership techniques.

Please provide two additional research areas that would benefit the construction industry.

## APPENDIX B. RESEARCH JOURNAL DATA

| Research Journal Data Analysis | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Topic | JCEM | CM & E | IJCER | ASCCP | Totals | % of Total | JCEM | CM & E | IJCER | ASCC |
| Training/ Human Resources | 12 | 17 | 8 | 45 | 82 | 13.5% | 5% | 8% | 27% | 37% |
| Management/ Risks | 11 | 26 | 1 | 10 | 48 | 7.9% | 4% | 13% | 3% | 8% |
| Technology/ Innovation | 26 | 9 | 2 | 9 | 46 | 7.6% | 10% | 4% | 7% | 7% |
| Economics/ Cost Control | 19 | 21 | 2 | 1 | 43 | 7.1% | 8% | 10% | 7% | 1% |
| Globalization | 9 | 32 | 0 | 0 | 41 | 6.8% | 4% | 15% | 0% | 0% |
| Estimating/ Bidding | 15 | 18 | 1 | 6 | 40 | 6.6% | 6% | 9% | 3% | 5% |
| Scheduling | 21 | 5 | 1 | 5 | 32 | 5.3% | 8% | 2% | 3% | 4% |
| Design/ BIM | 10 | 9 | 2 | 10 | 31 | 5.1% | 4% | 4% | 7% | 8% |
| Performance | 13 | 12 | 1 | 3 | 29 | 4.8% | 5% | 6% | 3% | 2% |
| Safety | 14 | 8 | 2 | 5 | 29 | 4.8% | 6% | 4% | 7% | 4% |
| Industry Overview | 12 | 8 | 0 | 6 | 26 | 4.3% | 5% | 4% | 0% | 5% |
| Legal/Contracts | 9 | 12 | 1 | 3 | 25 | 4.1% | 4% | 6% | 3% | 2% |
| Sustainability | 5 | 9 | 3 | 7 | 24 | 4.0% | 2% | 4% | 10% | 6% |
| Computer systems/ Expert Systen | 17 | 4 | 1 | 0 | 22 | 3.6% | 5% | 2% | 3% | 0% |
| Project Delivery | 13 | 1 | 1 | 3 | 18 | 3.0% | 5% | 0% | 3% | 2% |
| Productivity/ Optimization | 8 | 3 | 2 | 3 | 16 | 2.6% | 3% | 1% | 7% | 2% |
| Constructability | 9 | 2 | 0 | 1 | 12 | 2.0% | 4% | 1% | 0% | 1% |
| Materials/ Equipment | 5 | 1 | 2 | 3 | 11 | 1.8% | 2% | 0% | 7% | 2% |
| Project/ Quality Management | 6 | 3 | 0 | 1 | 10 | 1.6% | 2% | 1% | 0% | 1% |
| Facilities Management | 4 | 4 | 0 | 0 | 8 | 1.3% | 2% | 2% | 0% | 0% |
| Heavy Civil Const. | 6 | 1 | 0 | 0 | 7 | 1.2% | 2% | 0% | 0% | 0% |
| Procurement | 5 | 2 | 0 | 0 | 7 | 1.2% | 2% | 1% | 0% | 0% |
| Totals | 249 | 207 | 30 | 121 | 607 | 100% | 98% | 100% | 100% | 100% |