PAPERS PRESENTED ON RESEARCH TOPICS

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. 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.

Key Words: construction research, ranking, research priorities, construction industry ranking

Introduction

The construction industry is one of the largest and oldest industries in the United States (Abudayyeh et al, 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, construction is one of the least researched industries (Abudayyeh et al, 2002). Though the amount of research in the construction field has increased, it is still in need of adjustments. As it has for most of history, the construction industry has been recognized as a leading driver of the world economy, yet it was an industry noticeably missing higher education and research efforts that are common in other 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 construction 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 relative profit margins, construction firms have limited resources to support research and the less conventional results it might produce or are produced in other industries. Competition in the construction industry is so intense that companies are unable to give significant support to universities for research (Gerwick 1990a and Gerwick 1990b). It is difficult for a contractor to invest in anything that can only produce returns in the future, with the future being being defined as a

period of time of at least three years from the current date (Harris, 1992). 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.

Since the development of degree programs for construction education at the university level, both parties have benefited from the relationship. Universities fulfill 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 or a similar group of industry professionals that help shape academic policies. These groups provide, among others, significant input into the needs of the construction industry; financial aid for school clubs and activities; and 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 can be obtained for graduate students and professors that will likely benefit the construction industry.

The majority of research being conducted is done at the university level or public institutions (Warsawski et al, 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 its role, 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; and the competitiveness of the U.S. industrial sector (Prager and Omenn, 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.

The problem is that we do not know if the construction-related research being done is in alignment with the needs of industry. The purpose of this research was twofold. First, it sought to find if construction-related research is aligned with what construction professionals think is important. The second purpose was to define the most common construction-related topics so that they could then be ranked by construction industry professionals. The results of this research will provide information that can focus the effort of future construction-related research to the topics which are most important to the industry and provide researchers the information to plan future research and establish research priorities for the future.

Research Design and Methodology

A comparison study of construction research trends and rankings from construction professionals was used to explore whether the research being performed by academicians matched the level of importance to construction professionals. 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 ranking of the themes by construction professionals. The results of both studies were then compared.

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 et al, 2003). That 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 various academicians. The following is a description of each publication:

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. Starting in 1983 the journal was published quarterly and became a bi-monthly publication in 1998. 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.

Construction Management and Economics. This journal 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.

International Journal of Construction Education and Research. The journal replaced the Journal of Construction Education, which was established in 1996. 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 2010, the 46th Annual conference was hosted by Wentworth 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. The conference proceeding are archived from 1987 to the present time.

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 database 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.

It should be mentioned that the authors acknowledge that not all construction-related research is being presented in academic publications. Many academics perform company-specific construction research. The work done by academia in these circumstances is considered consulting and not research. Construction companies tend to treat any

company-specific research results as proprietary and may not allow the results to be published. While this research exists, measuring it is beyond the scope of this current research.

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 related 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 academicians with feedback from additional construction professionals. Each theme was then defined so that it was relevant to the industry and an accurate opinion could be formed by survey instrument participants. A list of themes and abbreviated definitions is as follows:

1. Computer Systems/ Expert Systems – Use of artificial intelligence to offer advice or make decisions.
2. Constructability – The ability of a project to be built, or the 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.
5. Estimating/Bidding – Judging the cost of a project and securing the work through bidding.
6. Facilities Management – Integration of multiple disciplines to maintain the functionality of a structure.
7. Globalization – International operations or influences on the construction industry.
8. Heavy Civil Construction – The construction of bridges, tunnels, and roads.
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.
11. Management/Risks – The development of programs, practices or strategies for minimizing risk.
12. Materials/Equipment – The selection of proper equipment and materials to complete construction projects.
13. Performance – Research of measurement techniques of performance of 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.
16. Project Delivery – Management, execution, and delivery 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 and duration of activities on a construction project.
20. Sustainability – Sustainability techniques, waste and reduction methods, and environmental impacts.
21. Technology/Innovation – The development and implementation of new technology.
22. Training/Human Resources – The organization that deals with human factors.

The Ranking of Construction Topics by Construction Practitioners

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 themes mentioned above.

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 database to be analyzed and prepared for further presentation. The twenty-two themes and definitions were the basis of the ranking survey.

The survey instrument had two questions. The first question required the participants to rank the 22 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 question requested the respondents to provide additional research topics.

This study was conducted using a random sampling of construction professionals throughout Northern California. A sample list was developed from the AGC of California and Associated Society of Professional Estimators members list. The survey was sent electronically to 414 construction professionals, 155 of the surveys were returned undeliverable. The construction professionals had varying positions within their respective firms directly related to construction operations. The selection of construction professionals included in this study included but was not limited to: superintendents, project managers, estimators, project engineers, construction managers, and operation managers. The sample size was limited due to the accessibility to contact information for construction professionals.

Results

Analyzing Research Journals

Four research journals were analyzed for their content relevant to 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 1. The information that was gathered from each journal included article title, year published, and author.

Table 1

Research Publications

Research Publication	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

The articles were collected in 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.

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 1. Each theme was ranked by the quantity of articles classified into that theme and not magnitude of the research done.
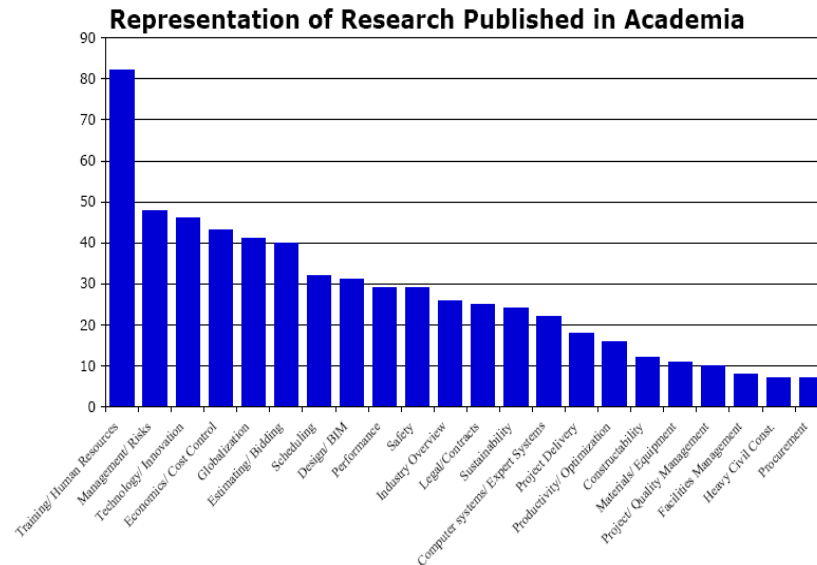
Representation of Research Published in Academia

Figure 1: Research Distribution by Theme

Comparison of Research Trends and Industry Ranking

Construction professionals were asked to rank the 22 themes by importance to the industry. The response rate was 14% among those construction professionals representing 36 respondents out of the 259 surveys electronically mailed. 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.

The theme with the highest ranking was constructability, with a mean of 4.29. 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. Table 2 represents the ranking sorted by industry rank and the corresponding link by research.

Table 2

Industry Ranking Comparison

Research Topic	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 Construction	19	21
Training/Human Resources	20	1
Industry Overview	21	11
Globalization	22	5

The results of the two studies were mixed and demonstrate that the research that is being done is not aligned with the needs of the industry. The most popular research topics showed no correlation to the industry ranking. This was proven by conducting a Pearson correlation test. The correlation coefficient was found by the use of the correlation function in the Excel spreadsheet. The data indicated no correlation existed ($r = 0.042$). Therefore, it was concluded that there is a statistical difference between the priorities of construction-related research and the needs of the construction industry. A graphical representation is given in Figure 2.
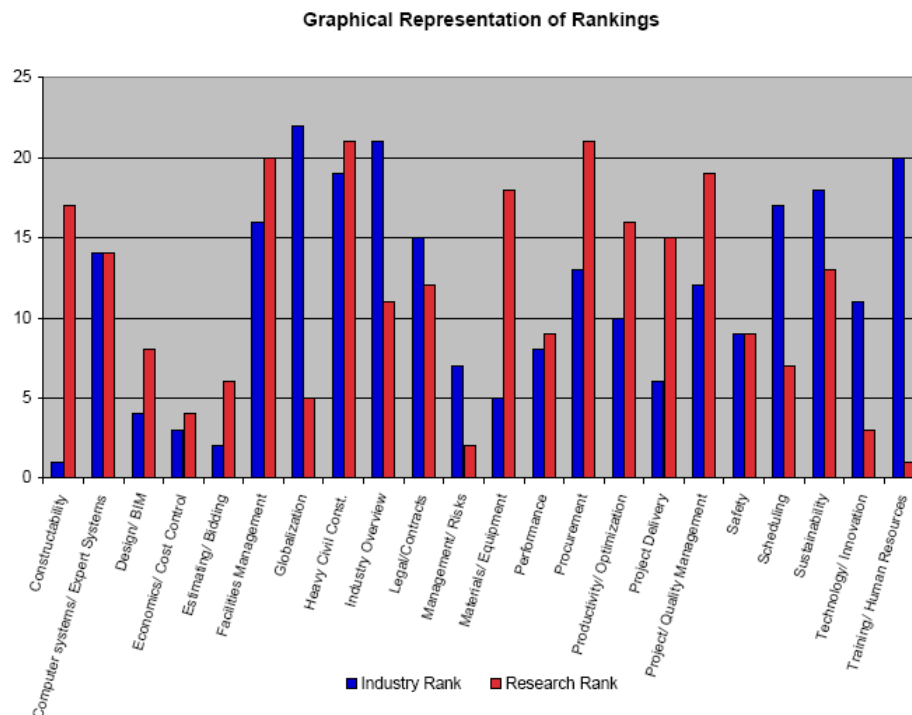

Figure 2: Graphical Representation of Comparison Rankings

Conclusions

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. This correlation does not exist for the data set analyzed. It is astounding the there was no correlation between what investigators are researching and the needs of construction professionals. Traditionally there was disconnection in the construction industry between researchers and other construction professionals. 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 indicated 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. In contrast, the industry 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.

Findings in this study demonstrated that construction professionals believe that more research should be completed in the area of constructability or similar topics regarding the ability of a project to be built. With feedback from 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.

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