ASSESSMENT OF UNCERTAINTY MANAGEMENT APPROACHES IN CONSTRUCTION ORGANIZATIONS

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ABSTRACT

Previous research has indicated that in about 85% of the projects, the managers underestimated the extent of uncertainty at the start of a project. Since then limited research has been conducted to study the uncertainty climate in Architecture, Engineering, and Construction (AEC) organizations. The primary goal of this research was to assess the orientation of construction organizations towards managing uncertainty. A Working Climate Survey (WCS) was used to measure two aspects of uncertainty, namely, personal and work environment uncertainty. Analysis of the responses of 61 construction industry professionals from a wide spectrum of companies indicated the possibility of some correlation between demographic items and results of the study. It was also found that creating the right environment for employees is the first essential step necessary to embrace uncertainty followed by training the employees. Moreover, an improvement in the percentage of responses in dynamic climate was found when only the companies that practice any of the lean construction principles were considered separately from the entire sample. Based on the findings of the research, guidelines for embracing uncertainty in the project and production management phases are developed and presented.

KEY WORDS

lean construction, construction uncertainty, embracing uncertainty

INTRODUCTION

The world was shocked when Einstein discovered the theory of relativity. Einstein proved that the Newtonian laws were not applicable in all cases/conditions (Einstein, 1919). This just accentuates the point that everything that we believe today as accurate and true may not necessarily be so tomorrow. In our endeavor to create business models and quantify everything with numbers, the construction industry lost track of the unpredictable nature of construction projects.

Construction organizations face a lot of inherent uncertainties propelled by either external or internal sources (Bjorn et al., 2004). The external uncertainties includes events such as uncertainty in the competitive bidding process, soil conditions, contract documents, weather patterns, material

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procurement, productivity on-site, safety issues, local infrastructure or utility changes, city/county/province code regulation changes, continuity of project finance, political changes in the country, inflation, variations in currency rates, war, etc. The internal sources of uncertainty could include events such as uncertainty related to the respective organization's goals, competence, financial soundness, changes to the management or staff etc. In addition, disputes arise due to a wide range of issues such as contractual rights and responsibilities, non-performance, delays, non-compliance, etc., which make the construction organization more vulnerable to never ending changes. It is therefore paramount to first assess the current approaches undertaken by the A.E.C. (Architect, Engineer, Contractor) industry in managing the plethora of uncertainties found in the current practices of construction.

In a study conducted by Howell and Ballard (1994), 175 project managers from a broad spectrum of project sizes and types were surveyed to find the state of uncertainty at the beginning of a typical construction project and were also asked to report on their recent projects as opposed to their typical projects from the past. The research found that in 85% of the projects, the managers had underestimated the extent of uncertainty and also that the problems they didn't know about were bigger than the problems they knew about. The results were disturbing and compelling.

Numerous case studies have illustrated a common form of uncertainty faced by managers, referred to as known unknowns (Hopkins, 2005). These are predictable forms of uncertainties with a very low probability of occurrence, for which it is possible to have some contingency planning. However, the most challenging form of uncertainty, commonly referred to as unknown unknowns are very difficult to predict. Events like an economic recession, war, Tsunami or earthquake are very hard to predict and plan for. So how do we brace ourselves by devising a plan B or C, to counter such uncertainties?

Traditionally, and as of yet, all industries have been following risk management philosophies to account for the "known unknowns" (foreseen uncertainty with a low probability of occurrence) and the "unknown unknowns" (unforeseen uncertainty which was never thought of having a chance to occur). The risk management literature focuses on treating risk as a threat and tries to avoid it by assessing the probability of occurrence (Ward and Chapman, 2003). It has been proved from case study results (Hopkins, 2005), that in lieu of avoiding uncertainties; it would be more beneficial if the organizations are structured or develop a platform for embracing uncertainties (Clampitt and DeKoch 2001).

RESEARCH GOALS AND OBJECTIVES

The goal of this research was to develop a framework for assessing the approaches of construction organizations towards managing uncertainty. The following objectives were pursued:

1. Developing a methodology for assessing the approaches of construction organizations towards embracing uncertainty.

2. Design and conduct a survey to assess trends in embracing uncertainty.

RESEARCH SCOPE

The scope of this research was restricted to analyzing the attitude or approach of construction professionals and/or organizations towards managing uncertainty. This research does not quantify uncertainty or propose solutions to manage any particular kind of uncertainty. The target population for the study included managers and professionals in the AEC (Architect, Engineer, and Construction) industry, which included residential, commercial, industrial, and infrastructure projects. The sampling method used for this research was simple random sampling.

RESEARCH TOOL: UNCERTAINTY MANAGEMENT MATRIX

The research tool used for this study is the uncertainty management matrix which was constructed by Clampitt et al. (2000), on the basis of a working climate survey. The development of the original working climate survey spanned several years and involved three phases. It was designed by Clampitt and DeKoch (2001) to study how employees and organizations manage uncertainty. Moreover, the original working climate survey was modified to make it more applicable to construction settings for this research. Depending on the organizational and personal uncertainty scores obtained from the survey analysis, a corresponding part of the matrix space was assigned for every respondent, as indicated below in Figure 1.

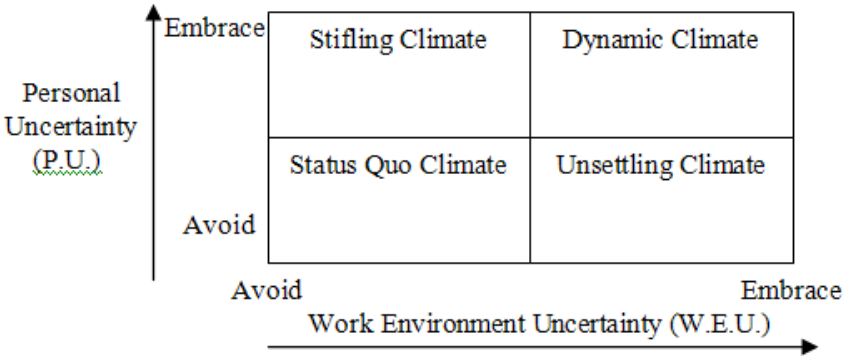

Figure 1: Uncertainty Management Matrix Model
(Source: Clampitt and DeKoch, 2001)

The four climates produced from combining the two dimensions of P.U. and W.E.U. are (Clampitt and DeKoch, 2001): Status quo climate (where employees want very few surprises and they rarely get them), Unsettling climate (where employees become unsettled and overwhelmed by the chaotic work environment), Stifling climate (where employees embrace uncertainty but their organization does not do so) and Dynamic climate (where both employees and organization embrace uncertainty).

SURVEY RESULTS AND DATA ANALYSIS

DATA COLLECTION

The survey was posted online at www.hostedsurvey.com and participation of subjects was solicited through an email announcement to various construction industry list serves and personal contacts in the industry which referred to the URL where the survey was hosted [Survey location: http://www.hostedsurvey.com/takesurvey.asp?c=CWCS06&test=true]. The responses were all originating from individuals in the United States. The announcement was sent to about 800 subjects. A total of 103 responses were received in the reasonable time frame that was set for the survey to be online. Of these, 42 responses were neglected as they were either incomplete or were not from current practitioners. The responses were from a broad range of companies; small to large corporations with a good mixture of non-management, lower management, middle management and top management respondents, the data collected can be considered as a reasonably good representation of the AEC industry.

PRIMARY DATA ANALYSIS

The data collected from the survey was imported to MS Excel for data analysis. The uncertainty management matrix created using the personal uncertainty scores (PU) and the work environment uncertainty scores (WEU) scores is presented in Figure 2 and Table 1. The average of PU scores was 58.36 with a standard deviation of 7.90. The average of WEU scores was 53.39 with a standard deviation of 8.89.

Table: 1 – Percentage responses in each climate

Number	Climate	Total Count	Percentage
1	Dynamic	42	68.85
2	Unsettling	4	6.56
3	Status Quo	1	1.64
4	Stifling	14	22.95

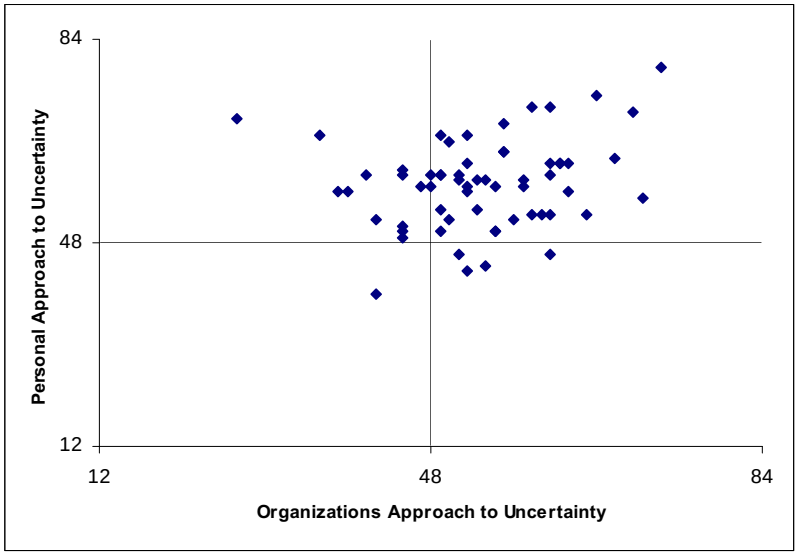

Figure: 2 – Uncertainty Management Matrix

SECONDARY DATA ANALYSIS

RELATIONSHIP BETWEEN CLIMATES AND DEMOGRAPHIC ITEMS

This particular secondary analysis compared the various demographic responses received in the survey (see Jayaraman 2006). Although the limited sample size did not allow any conclusive statistical correlations, the results provided potential leads.

1. **Gender:** The research found that females have lower percentage of representation in dynamic climate (10% difference) as compared to males.
2. **Sector of construction:**The respondents from the industrial sector had a substantially lower representation in the dynamic climate as compared to the other sectors of construction like residential, commercial, and heavy/highway.
3. **Work Experience:** A gradual increase in the percentage of dynamic climate representation was observed with the increase in work experience of the respondents in a particular company. However for individuals with greater than 30 years experience, the percentage representation in dynamic climate was much lower.
4. **Revenues:** Significantly lower percentage of responses in dynamic climate were recorded for companies with revenues greater than 1 billion as compared to companies with revenues less than 300 million or between 300 million and 1 billion.
5. **Age:** It was also observed that the age group 46-55 has a much higher percentage of responses in dynamic climate than other age groups.

RELATIONSHIP BETWEEN CLIMATES AND OUTCOME VARIABLES

Some questions in the survey were used as survey outcome variables. Theses variables are analogous to dependent variables which translate into results for this particular secondary analysis. The mean scores of outcome variables in different climates revealed that even if only an organization embraced uncertainty, it fosters more job satisfaction and commitment of employees to the organization. It was observed that an unsettling climate had the highest average mean scores followed by dynamic climate for all the outcome variable questions. Moreover the respondents in the unsettling climate were least cynical with organization followed by respondents in dynamic climate.

The ideal condition is when both the employees and organization are ready to embrace uncertainty. Hence if organizations have completed the first step by embracing uncertainty, then they should train employees as well to do the same for achieving the ideal condition (dynamic climate). This would create a win-win situation where both the employees and organization have a matching work style.

COMPARISON BETWEEN TRADITIONAL AND LEAN CONSTRUCTION

The PU and PEW scores for respondents from companies adopting lean construction practices were calculated separately form the 61 responses. A total of 25 responses received had claimed to practice lean principles to varying degrees. The remaining 36 responses were considered as traditional companies. The result of this secondary analysis is shown below in Tables 2 and 3.

Table: 2 Lean Practices in each climate

Number	Climate	Total Count	Percentage
1	Dynamic	18	72
2	Unsettling	3	12
3	Status Quo	0	0
4	Stifling	4	16

Table: 3 Traditional Practices in each climate

Number	Climate	Total Count	Percentage
1	Dynamic	24	66.67
2	Unsettling	1	2.78
3	Status Quo	1	2.78
4	Stifling	10	27.78

A 5% improvement in the dynamic climate and 12% reduction in the stifling climate were observed amongst lean practitioners as compared to traditional constructors. However, on observing the responses it was found that a significant number of the lean respondents were practicing only few of the lean principles and the time duration over which these principles were being used is unknown. The study also indicated that the most practiced lean principle was off-site fabrication, followed by Last Planner System, Target Costing, Work Structuring, and Concurrent Engineering, in the order of popularity from highest to lowest. It was also seen that the least used practice was Daily Huddles.

It was observed that companies using more lean principles, the PU and WEU scores increased linearly. Increase in both PU and WEU scores would result in the responses moving towards the dynamic climate. It was inferred that by applying more lean practices, the companies tend to provide an environment to move towards a dynamic working climate. However, the respondents require more training to match up with the company's efforts to embracing uncertainty.

Thus it can be said that the comparison of companies that practice at least some of the Lean Construction principles to the traditional companies showed that adopting lean principles provided the employees with the right environment for embracing uncertainty. What is required beyond practicing lean is rigorous training so that employees are better prepared to deal with fuzzy and uncertain environments.

LIMITATIONS OF RESEARCH

Similar to any research, there are limitations and assumptions made in this research. It is always difficult to trust self-reported measures. It is possible that employees and managers over-estimate their abilities or their organizations ability to embrace uncertainty.

The major limitation of an online survey is the non-response factor. There would be employees or managers who do not know how to navigate in the internet or just consider the survey as not so important. Moreover, the selection process was biased, as there were no sampling frames available to get a genuine random sample. Hence the selection process was not totally blindfolded as required statistically for a random sample selection. Due to the small sample size and the inability to conduct personal interviews (due to available budget), the research was limited in the secondary analysis of variables.

CONCLUSION AND FUTURE RESEARCH

This research adapted a methodology for assessing the approaches of construction organizations towards managing uncertainty. A survey based on the original work of Clampitt and Williams (2003) was modified and made more specific for construction settings. This modified survey could be used to ascertain the working climate environment of any construction organization (Jayaraman 2006).

The knowledge gained from this exploratory study only facilitates the path to an ethnographic study, which will be much more information rich than the study presented was able to

collect. Drilling down into a cohort of companies will be the next step but finding participants will be a challenge.

A series of studies could be undertaken to understand how uncertainty can be managed more effectively in the AEC industry, such as by practicing Lean Construction.

In future, researchers could consider the following recommendations:

- From this research it has been found that companies that adopt Lean Construction practices seem to have better uncertainty embracing approach. However, the companies that claim to adopt Lean Construction should be observed to understand the intensity with which these companies adopt the practices and the length of time these practices were put in place.
- The data collected for this research indicate that communication practices and protocols play an important role in cultivating uncertainty-embracing organizational practices. Future researchers might investigate what specific supervisor behaviors build uncertainty-embracing climates.
- A bigger sample size would bring statistical validity to the results. The normal industry standards for such studies may require a 95% confidence level with a +/- 5 % confidence interval for the results. Hence future studies may also consider collecting a greater sample size that may be necessary to perform statistical analyses to understand the relationship between the PU and WEU scores and lean practices.
- The survey tool could be modified to include a section that would analyze the psychology of the respondent while responding to the survey. Since it is observed in this research that the respondents could have overestimated their personal ability to embrace uncertainty, the psychological section could provide some insights into this.
- Future researchers could also investigate the approaches of managers adopting Lean Construction principles at a personal level in their projects, even though their company does not adopt lean principles in their processes. A study should be conducted to understand how much this would help the managers in embracing uncertainty at a personal level.

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