

Knowledge Management for Global Competitiveness: Comparative Case Studies in Construction Industry

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ABSTRACT: Construction projects require an exchange of data, information, and knowledge to solve complex problems. Oftentimes problems on one project are similar to those encountered on other projects. As a result, some construction firms seek to capture and reuse knowledge through knowledge management (KM) practices and technology systems. Small to medium sized enterprises (SME) in the United States often have fewer resources devoted to KM practices than their larger counterparts. This study examined select construction firms in the Southeastern United States for commonalities and differences in KM practices. A qualitative, multiple case study approach was adopted using multiple sources of evidence; specifically an open-ended survey questionnaire, semi-structured interviews, and a review of documents and technology systems. While much literature on the benefits of KM practices exists, this study suggests that SME in the U.S. construction industry are not well aware of KM as a competitive strategy and disparities in KM practice exist between SME and large construction firms. Additionally, larger construction firms may not be utilizing KM practices to the full benefit throughout the project life cycle.

KEY WORDS: Knowledge Management, Organizational Learning, Construction Industry, Small-Medium Enterprises

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I. INTRODUCTION

The U.S. construction industry is known to be a dynamic and highly competitive business environment. To maintain a competitive advantage, many construction firms seek ways to differentiate themselves from the competition. One strategy is to increase the company's intellectual capital through knowledge management (KM) practices. Knowledge management has become an increasingly important strategy for business organizations in many industries; including banking, aerospace, pharmaceutical, manufacturing, and legal (Dalkir, 2011). However, KM as a strategy is yet to be adopted by the United States construction industry. Due to the complexity and dynamic nature of large construction projects, it is of critical importance for experiences and lessons learned from past projects to be stored as organizational knowledge to be resourced at a later date (Tupenaite, Kanapeckiene, and Naimaviciene, 2008; Kanapeckiene, Kaklauskas, Zavadskas and Seniut, 2010). As project teams transfer from project to project and, often from company to company, they take with them a large cache of useful experiences and knowledge. KM provides for both tacit and explicit knowledge to be captured and reused on like scenarios.

Much of KM research in construction has been focused outside of the United States, including Nigeria (Kasimu, Amiruddin, & Abdullah, 2013; Alhaji, Amiruddin, & Abdullah, 2013), Malaysia (Noordin, Buranuddin & Kana, 2012), Spain (Furcada, Fuertes, Gangoellis, Casals, & Mararulla, 2013), Taiwan (Lin, Wang, & Tserng, 2006), the Middle East and Africa (Amahd, 2010), Turkey (Kale, & Karaman, 2012; Kale, & Karaman, 2011), Australia (Maqsood, Finegan, Walker, 2006) and the UK (Amahd, 2010; Bhargav, & Koskela, 2009; Robinson, Carrillo, Anumba, & Al-Ghassani, 2005). While some case studies have included construction firms within the U.S. (Javernick-Will, 2012; Hallowell, 2012), they were primarily focused on multi-national construction firms or large and medium sized construction or engineering firms (Carrillo & Chinowsky, 2006). A review of literature did not reveal any prior research into the KM practices of small construction firms in the United States.

As the U.S. construction industry looks towards competitive differentiation through added value, many companies will need adjustments in their business strategies, company culture, KM practices and procedures in order to develop appropriate strategies for developing value through intellectual capital.

II. OVERVIEW OF KNOWLEDGE MANAGEMENT

In recent years, much discussion has surrounded the transition from an industrial economy to the emergence of the knowledge economy. Where many skilled workers were once needed, in today's competitive economy, only a few might be required to perform the same task. As more work is done with less people, the loss of a critical project team member is likely to result in a loss of organizational knowledge. Knowledge management has been around for several years. However, its application in the construction industry is relatively young. As we know, so much knowledge is gained by the time construction projects are completed. Unfortunately, most of these knowledge are lost as project parties involved move on to other projects. Oftentimes, the lessons learned or mistakes made are not documented or shared. Consequently, the same mistakes made on previous projects are repeated on new ones. As the average tenure of the construction employee becomes short-lived, it becomes critical for construction firms to understand their organizational knowledge assets and manage them effectively.

Today, an abundance of data and information is made available through information and communication technologies (ICT). Anyone with Internet access is able to look up information; yet, the need still exists to differentiate raw data and information from useful knowledge. Davenport and Prusak (1998, p2) outline the differences between data, information, and knowledge as follows:

“Data - A set of discrete, objective facts about events.

Information – A message, usually in the form of a document or an audible or visible communication.

Knowledge – A fluid mixing of framed experiences, values, contextual information, and expert insight that provide a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of those who know. In organizations, it often becomes embedded not only in documents or repositories, but also in organizational routines, processes, practices, and norms (as cited in Dalkir, 2010, p. 60).”

It is largely recognized that “much of an organization's valuable knowledge walks out the door at the end of the day” (Dalkir, 2011, p. 2). In many construction firms, knowledge workers are often considered to be senior managers employed in varying roles. These knowledge workers bring valuable insight and experiences to the organization that can be used to solve problems and increase productivity. Small to mid-sized firms (SMF) rely on the knowledge embedded in senior managers for successful project outcomes and therefore would be desirable to develop systematic ways to capture and reuse this embedded knowledge as organizational knowledge.

Prior research concerning KM practices in large construction firms highlights KM as a valid form of increasing intellectual capital. However, in the United States, large construction firms account for less than 5% of all US construction firms (Associated General Contractors of America, 2013). Sparrow (2001) suggests that large business practices should not be imposed on small firms noting that while “methods in small firms might appear ‘informal’, they have often been found to support quite sophisticated decision-making” (p.4). With the majority of KM research focusing on practices of large firms; it is reasonable to suggest that demonstrated KM practices and methods may not be useful to SMF without considerable adjustments.

Knowledge Management Cycle

KM revolves in cycle with various phases. These phases include the capture, creation, codification, sharing, accessing, applying, and reuse of knowledge in an organization. The components of KM cycles were precursors to the development of a framework for understanding how information becomes knowledge asset in an organization. Knowledge management cycle starts with knowledge capture and codification. It is important to understand the distinguishing characteristics of each processes involved in knowledge capture and knowledge codification. Usually tacit knowledge is captured and explicit knowledge is coded. In today's world economy, an organization's knowledge base becomes its vital competitive advantage over others. Thus, understanding how to elicit tacit knowledge to create new knowledge that is subsequently coded for immediate or future sharing is essential for organizational survival.

Knowledge sharing deals social aspect of knowledge. One thing is to capture and codify knowledge; however, the information is useless if it is not shared among company employees. There are many ways to share knowledge among company employees. Researchers have used “social construct” and “Community of Practice (CoP)” theories to discuss various ways knowledge can be shared among company employees. In particular, the evolution of CoP in an organization and its key components have been found to be beneficial to the development of social capital. The role of organizational culture in KM cannot be overemphasized. For employees to embrace KM sharing, KM must be an integral part of the organizational culture. Thus, it is important for organizations to create an environment that fosters knowledge sharing among the employees. Knowledge application is a final step in knowledge management cycle. After knowledge has been captured, coded, and shared, it must be applied in a practical form. Knowledge Management can only succeed if the knowledge is utilized. For knowledge to be useful, it must be applied to the appropriate workers in a manner that

makes sense to them. People must understand how to use the knowledge with the understanding that using it will lead to an improvement in their work.

To be relevant in today's global competitiveness, construction firms must leverage Knowledge Management as a driver for innovation. The relationship between knowledge management and innovation has been well documented. The ability of construction firms to innovate will depend on their willingness to adopt KM and other available resources. Knowledge is a key resource to an organizational innovation. Thus, construction firms must be prepared to make appropriate changes that will embrace KM as part of their strategic alignment.

Aim of the Study

This limited qualitative case study was conducted to assess the current KM practices among select number of construction firms in the Southeast United States. The study was to serve as a starting point for discussions on ways small and medium sized construction firms can better utilize KM practices to capture and reuse project knowledge. Using a multiple case study approach, this study examined the KM practices at one large international construction firm and three small-to-mid sized construction firms (SMF). The researchers were interested in finding answers to the following questions:

1. How is project knowledge captured and reused in the selected firms?
2. What KM technologies and practices are being employed?
3. How is a KM culture encouraged?
4. How is return-on-investment (ROI) of KM systems determined?

III. METHODOLOGY

This study investigated the current knowledge management practices of three small to medium size commercial construction firms in the Southeastern United States and compared their practices to the KM practices of a large international construction firms operating in the same geographic area. Of particular interest was to assess how these firms capture and reuse project knowledge. A multiple case study approach was adopted using cross-case analysis. Senior managers were identified to complete an initial open-ended survey questionnaire. The open-ended survey questionnaire results were compiled in a table and examined for reoccurring themes, differences, and commonalities. Semi-structured interview questions were developed from the compiled questionnaire data. Semi-structured interviews are common in qualitative research to allow the interviewers choice in word equivalencies and to use probing questions. The use of probing questions can be used to increase the reliability of the data (Barriball& While, 1994). Finally, interviewee's comments were supported by examination of documents and databases of each company involved in the study.

According to Yin (2014), qualitative case study research is appropriate when;(1) the questions under study are of a "how" or "why" nature;(2) involve a contemporary issue; and (3) when the relevant behaviours to the phenomenon cannot or should not be manipulated. Additionally, Yin (2012) and Eisenhardt (1989) note the importance of specifying the unit of analysis in qualitative research. The research questions led to the obvious unit of analysis for this study to be the construction organizations. To provide an overview of knowledge management within the firm, key individuals were selected within each organization, based on length of tenure and authority within the firm. In all cases, the respondents were senior level managers.

Limitations

The views expressed by the interviewees may be limited to their job functions, which could reflect their personal bias. Another limitation of the study is in regards to the geographic location of each case organization. All cases were located in the Southeastern United States and may not be representative of all construction firms in the United States. Additionally, some interviewees required the researcher to ensure their confidentiality regarding KM output and archives, which enabled the researchers to become more intimate with the data but confined in their ability to disclose the details.

Case Study Procedures for Validity and Reliability

Borrowing from the jurisprudence domain, Taylor et al. (2011) suggests case study researchers must demonstrate an "air of reality" towards satisfying the burden of proof through utilizing multiple sources of evidence, creating a chain of evidence, and reviewing draft case results with key case participants. To maximize construct validity, the procedures used in this study sought multiple sources of evidence from each unit of analysis. A minimum of two sources of evidence was sought from each case through an open-ended questionnaire and semi-structured interviews. Additionally, each interviewee provided the researcher access to confidential and non-confidential artifacts, documents, and databases as evidence of KM practices.

IV. FINDINGS

Case #1: A Large International Firm

The initial data submitted by the large international firm revealed an established KM system and a thorough understanding of KM practices. This firm employs approximately 58,000 employees worldwide with reported local annual market revenue of \$500 million and \$5.8 billion worldwide. The respondent held the position of Vice President of Preconstruction. Although the respondent was not aware of the theories and terms of KM, he presented evidence of many adopted KM practices that address many of the suggested influences of KM. As an example, the firm uses subject matter peer groups, known as “Communities of Practice” in KM literature, but the case firm named them “Centers of Excellence”. The centers are organized by industry sector (e.g.; healthcare, aviation, sports construction, higher education, and sustainability). These centers are synonymous to communities of practice found in many KM models. Individuals that hold a commitment to maintaining sound and reliable knowledge are identified to lead each center. Access to the knowledge for each center is restricted to only those involved in the center’s specific discipline; however, access can be granted by a request and by demonstrating a need for the information, such as for an upcoming project.

Each Center of Excellence contains project costs benchmarks, case studies on standardized templates, sector trends and reports. Strengths and areas of opportunities are tracked, reported, and disseminated to the center’s members. Much of the knowledge contained in the centers is considered proprietary to outside members. On the conditions of confidentiality, the researcher was granted access to sample documents, benchmarks, case studies, and announcements from the Healthcare Center of Excellence. Additionally, the benchmark case study fostered a knowledge sharing culture by publicly acknowledging individuals that use center information to win a new project through “It’s a Win” bulletins. “It’s a Win” bulletins are emailed company-wide and describe the method of project delivery, costs, team members, and industry sector. Contributors are formally recognized on these bulletins. An informal practice of tacit knowledge transfer is demonstrated by pairing seasoned managers with newer employees. When asked how the firm acknowledges KM users during the construction phase the interviewee stated,

“That’s where I believe we fail. When I was filling out your survey I realized this was an area for improvement. Our current practices are heavily used during preconstruction but once concrete hits the ground it’s every person for their self.”

Case #2: A Small to Midsized Firm

Case #2 employs between 21-50 people and reported local annual market revenues of \$80 million. The respondent held the position of Chief Executive Officer. The firm demonstrated early adoption of KM practices by investing in KM technologies and establishing a culture of knowledge sharing through the establishment of a “Cultural Enhancement Group”. The cultural enhancement group uses employee leaders to organize social events and identify news that should be shared company wide. A heavy emphasis on the transfer of project knowledge between construction phases (e.g.: design, preconstruction, construction, closeout, and operations) was reported. When asked about tools used for knowledge transfer, the respondent indicated a reliance on checklists, procedures, and a shared network drive (intranet) along with record keeping and document software (Prolog); however, the firm has been investigating other KM systems for future purchase. The respondent’s reported barriers to knowledge reuse included workers keeping documents stored in emails, not entering the information in the systems, and busy workloads. No metrics were reported to assess prior information reuse.

Case #3: A Small to Midsized Firm

Case #3 employs between 21-50 people and reported local annual market revenues of \$15 million. The respondent held the position of Project Manager/Business Development. The firm demonstrated a heavy reliance on shared computer drives (intranet). The interviewee indicated that employees are responsible for placing all project documents on the shared network drive and that other employees can access the documents at their convenience. No effort is made to separate knowledge from data and information. Information and project archives are simply filed in digital form. Additionally, the interview revealed that the recent economic downturn had focused every effort on project operations and other business investments had been neglected. The interviewee noted that it is “difficult in a small company to take the time to develop a comprehensive system with limited resources.” Employees are encouraged to share experiences at project update meetings but often resort to a minimal report of facts to avoid intense scrutiny by senior management. High emphasis was placed on KM systems being easy to use and inexpensive. Knowledge is transferred from peer-to-peer by calling subject matter experts within the firm.

Case #4: A Small to Midsized Firm

Case #4 employs less than 20 people and reported local annual market revenues of \$5 million. The respondent held the position of Estimator. The firm demonstrated little familiarity with KM practices and relies

heavily on shared computer drives (intranet). Similar to case #3, the firm demonstrated a misunderstanding between knowledge from data and information by referencing project archive storage as a knowledge management system. The firm indicated project management update meetings as a primary source for knowledge transfer. Echoing case #3, case #4 reported ease of use and cost as primary drivers for KM at their firm. Knowledge is transferred from peer-to-peer by calling subject matter experts within the firm as situations arise.

V. DISCUSSIONS

This study set out to examine four research questions; 1) How is project knowledge captured and reused within construction firms, 2) What technologies and practices are being employed to cultivate KM practices, 3) How is a KM culture encouraged?, and 4) How is return-on-investment (ROI) of knowledge management systems determined?

Questions 1 – 3 could be directly answered while question 4 could not. The results of this study revealed that SME in the U.S. construction industry are not well aware of KM as a competitive strategy and disparities in KM practice exist between SME and large construction firms. Additionally, larger construction firms that have well-established KM programs may not be utilizing KM practices to the full benefit throughout the project life cycle.

Question 1: How is Knowledge Captured and Reused?

Addressing the first research question regarding the capture and reuse of project knowledge, the large firm had established cultural, structural, and technological KM practices embedded in the preconstruction process; however, it displayed limited use of KM practices during the construction and closeout phases. In comparison, none of the SME had formalized KM systems. Additionally, two of the three SME had misconceptions of the difference between capturing and reusing critical project knowledge as a separate practice from informally dumping large amounts of data and information in routine project documents on a companywide shared computer network drive.

During the preconstruction and bidding phase, the large firm relied heavily on the centers of excellence for benchmarks, case studies, and rules of thumbs while the SME demonstrated no efforts to reuse prior knowledge. During the construction phase, both the large firm and the SME relied on employees to warehouse all project documents on a shared drive and provide verbal reports in project management meeting. Carrillo and Chinowsky (2006) address two major misconceptions of KM practices in construction regarding the use of lessons learned and project intra/extranets. They argued that while both “contribute to knowledge management... they are only one specific mechanism to share knowledge”(p.4). Additionally, this study confirmed prior research regarding the use of lessons learned in small to mid-size enterprises, noting that lessons learned are disseminated in an ad hoc fashion or not at all (Orange et al, 2000). Despite advancements in KM, the SME examined in this study displayed similar misconceptions. All of them displayed an ‘ad-hoc’ approach to capturing project knowledge and typically only after a major problem has occurred.

Question 2: What Technologies and Practices are Used?

The second research question asked what technologies and practices are being used for KM. The large construction firm uses a number of technologies to collect and store knowledge such as EOS Advisor, Center of Excellence, Benchmark excel spreadsheets, JD Edwards, Primavera Systems, online company university, and other Citrix-based systems. The small firms rely on shared intranet drives, and project document management software such as Prolog. All four firms recognized the value of social interactions for the transfer of knowledge outside of information and communication technologies, however the large firm had formal social networks developed around industry specialties. When asked if the employees utilized past project documents to solve problems while in the construction phase, all cases, including the large firm, reported that it was unlikely.

Question 3: How is a KM Culture Encouraged?

The third research question asked the ways each company cultivates a KM culture. While all four respondents indicated that they felt their company does not cultivate a KM culture, the large firm and one SME displayed evidence of companywide public acknowledgement for successful knowledge reuse. Additionally, the same two firms encourage employees to engage in social interactions among like specialties or disciplines. All four firms acknowledged the benefits of KM and indicated a need for improvement in cultivating a culture of KM. High workloads and intense schedules were cited as deterrents to reliable knowledge management. As one interviewee noted, “Once the project begins, it becomes everyone for themselves. There is no time for looking up answers or documenting a lesson learned.”

Question 4: What Measures are Considered for KM ROI?

The final research question asked the respondents to shed light on what measures they use or will consider to assess a return-on-investment for KM practices. All four cases reported that no formal metrics were used but cited the reduction of mistakes, time and cost savings, ease of use, and low cost KM systems as positive measures. It is clear that much further research is needed in examining return-on-investment for KM and that the results of this study cannot conclude any definitive answers to this question.

In general, all four firms indicated low entry costs and ease of use as key drivers for KM system adoption. Further, both the large firm and SME expressed a need for KM systems that follows the preconstruction-construction-closeout cycle of construction projects. It was noted that personnel in preconstruction are often different than those involved in construction and likewise for project closeout. Between the three-phases critical information is often transferred or lost between phases. The large firm gave an example as follows:

“We recently had a project with quite a bit of delegated design. The preconstruction team picked it up and budgeted for it but, the procurement process missed it when the bid packages were awarded. It resulted in a seven figure loss for the firm and ultimately a few people will probably lose their job.”

The researchers examined project artefacts provided by the case firms and followed up with interviews to identify in which phase project knowledge is most used. Across all cases, the preconstruction phase appeared to have the most reuse of project knowledge in the form of costs, value engineering, and problems encountered. During the construction phase all firms often rely on verbal transfer of knowledge through project management meetings. While the large firm demonstrated exemplarily use of communities of practice, none of the SME employed similar activities, although one had begun to establish a companywide emphasis on culture that would lead to communities of practice. Given the limited resources and small number of employees of SME, it is understandable that CoP activities would be limited. However, further development in this arena might explore open-source CoP across the entire industry and in different locations where competition is not a limiting factor. Finally, as evidenced by the heavy reliance on “data dumps”, there is a clear lack of understanding by SME concerning the difference between knowledge from data and information. Further work is necessary to educate SME on KM practices. All firms reported that improvements are needed in the capture and reuse of project knowledge to avoid repeated problems during construction.

VI. CONCLUSIONS

This qualitative, limited case study was conducted to investigate the current KM awareness and practices in select construction firms in the Southeastern United States. Despite the recent publications surrounding KM in the business world, this study found that small to mid-size construction firms may not be aware of KM as a competitive strategy to leverage organizational knowledge. Additionally, large construction firms may not be fully utilizing KM throughout the project life cycle; instead they focus the majority of their KM practices on using knowledge to increase the win/bid ratio in the preconstruction phase. Robinson, Carrillo, Anumba, and Al-Ghassani (2005) acknowledged that KM practices should align with the strategic objectives of the company. In the case of the large firm, if the strategic objective of the KM practices were to increase the win/bid ratio, then a focus on the preconstruction phase would be best. However, all firms examined in this study indicated a desire to reduce errors and oversights during the construction phase. This suggests that current KM practices in construction are focused on winning projects; thus, additional work is needed in knowledge capture and reuse during the construction phase.

As KM practices become more prevalent, it is necessary to consider that a majority of construction firms in the United States are small businesses. According to the Associated General Contractors of America (2013), 92% of construction firms in the US employ less than 25 people. Likely due to ease of access and availability to participate in research studies, much researches in the KM domain have largely been limited to large, often international construction firms (Ahmed, 2010; Axelsson and Landelius, 2000). Egbu (2001) noted some weaknesses of SME, including their inability to fund KM initiatives and technologies, weakness in the range of specialized knowledge, and little investment in training and education. Nevertheless, the organizations' lack of formal strategies give them the opportunity to make improvements at a faster rate, improve employee engagement, and ability to react faster to market needs (as cited in Lee, Egbu, Boyd, Xiao, & Chinyo: 2006). This study revealed a need to develop cost effective and simple approaches to KM in order to strengthen the capability of small to mid-size construction firms.

Finally, this research highlighted a disparity between KM practices of the large firm and those of SME. The large firm under investigation displayed many properties of KM as a potential for project knowledge and reuse while the SME displayed a minimal understanding of KM practices. If the desire of SME is to remain competitive in the knowledge-driven economy, it is necessary to exploit organizational knowledge assets and to share cross project knowledge.

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