# Knowledge Management in Small and Medium Architecture, Engineering and Construction Firms in Turkey

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**Abstract:** This paper explores the extent to which small medium Architecture, Engineering and Construction firms (AEC) in the construction sector implement knowledge management (KM) approaches. Using data from semi-structured interviews of twenty-eight AEC firms operating in the construction sector, KM needs and challenges are analyzed and discussed. Breakdown of SME's into micro, small and medium sub-categories reveals that the management of, in particular, tacit knowledge becomes complicated as firms grow in size. Results show that microenterprises to a great degree do not experience problems in the effective management of knowledge due to the organizational context where owner managers retain total control of the business. The most significant problem areas in the small and medium categories, on the other hand, emerge during conversion of tacit knowledge into explicit, followed by the unorganized storing of digital folders by employees and in accommodating heavy e-mail traffic. Thus, best practices aligned with the needs of firm size are recommended.

**Keywords:** Knowledge Management, Construction sector, Turkey, Firm size, SMEs.

## 1. Introduction

Construction is a knowledge intensive and project-based sector where projects differ by their size, technology, complexity, and budget (Hari, Egbu and Kumar, 2005). The diversity of project types and characteristics constitute one of the key features of construction projects; the uniqueness. Unique projects require a strong collaboration among diverse groups of professionals and project teams. However, combined with the "tensions between the temporary projects and the permanent organizations" (Pemsel et al., 2014) managerial and governance complexities emerge in project-based industries (Pemsel et al., 2014). In particular, project teams encounter significant problems in managing project knowledge due to unsystematic KM practices (Schindler and Eppler, 2003; Abdul-Rahman, Wang and Malay, 2012). According to Loforte Ribeiro and Timóteo Fernandes (2010), KM based problems borne from ineffective knowledge sharing, capturing, storing and reusing lead to unforeseen costs in construction projects. Poor KM practices have also been reported to cause delays in project schedules (Abdul Rahman et al., 2008) and reduced quality of products (Kim, 2014a).
Knowledge in the construction sector is mainly based on the experiences of professionals. Although the sector is seemingly using explicit knowledge such as drawings, specifications, documents and timelines, tacit knowledge which represents experiences and perceptions of individuals (Koskinen, Pihlanto and Vanharanta, 2003) remain as one of the unresolved KM issues. Previous studies in the field have focused on capturing lessons learned from previous projects (Todorović et al., 2015), storing and reusing knowledge (Shokri-Ghasabeh and Chileshe, 2014; Ferrada et al., 2014; Lee and Egbu, 2007; Hari, Egbu and Kumar, 2005), the process of creating knowledge and innovation (Durst, Edvardsson and Bruns, 2013; Emmitt, Pasquire and Mertia, 2012; Xiao and Boyd, 2006), sharing knowledge (Beylier et al., 2009; Capo-Vicedo, Mula and Capó, 2011; Park et al., 2013), and effect of KM on project performance (Reich, Gemino and Sauer, 2014; Robinson, Carrillo and Anumba, 2004).

Several previous studies have argued that large-scale construction firms to a large extent develop their own KM systems (Kale and Karaman, 2012; Kim, 2014b; Pellicer et al., 2014; Venkateswaran and Aundhe, 2013). SMEs on the other hand, do not have formal KM strategies (Coyte, Ricceri and Guthrie, 2012). As a driving force for national economies, SMEs constitute approximately over 90 percent of all OECD member countries' enterprises (Wee and Chua, 2013) and thus effective management of knowledge has substantial importance in promoting growth. However, KM systems have not still become widespread due to perceived complexity, high costs and poor functionality (Wong and Aspinwall, 2005; Durst and Edvardsson, 2012; Park et al., 2013). Research in this regard shows that there is still a lack of understanding about the needs of SMEs in managing knowledge (Durst and Edvardsson, 2012). In particular, there is a lack of understanding about capturing tacit

knowledge (Boyd, 2013). Previous research about KM practices in Turkey focus on the state of the art situation in KM systems use and the problems experienced by SMEs (Acar et al., 2005; İpçioğlu and Çelik, 2008; Bozbura, 2007). These studies have also emphasized the need for further research regarding KM practices in construction SMEs. Thus, it is of significant importance to identify the needs and common problems encountered in managing knowledge in construction SME's.

The present paper aims to increase our understanding of current KM practices adopted in the AEC industry in Turkey, to identify problems and to determine the needs of construction organizations in managing knowledge. In this regard, two research questions have been identified for the purpose of investigating the KM related attitudes of SMEs active in the building construction industry in Turkey.

(1) Is there a significant difference between SMEs of different sizes in terms of their current KM systems use and methodologies adopted?
(2) How do KM problems experienced in SMEs change according to the classification criteria?

The paper is organized into three main sections. First, an extensive literature review of KM studies in construction is presented, then research methodology and design are explained. The next section provides results of interviews followed by a thorough discussion of problem areas and recommendations. The final section of the paper provides conclusions and implications.

## 2. Literature Review

Knowledge is the ability to understand information which is acquired through education or experience. In another sense, knowledge is explained as being aware of something, reaching a truth or an influence through deduction. Polanyi (1996) described knowledge by categorizing it into two sub-groups; explicit and tacit knowledge. Explicit knowledge is a codified knowledge which is formal and tangible. On the other hand, tacit knowledge is often subconscious and internalized. Human experiences are good examples of tacit knowledge. Basically, tacit knowledge is what is in our heads, and explicit knowledge is what we have codified.

Knowledge is considered to be an important asset for organizations (Turner, 2014). KM is an approach for firms to use their organizational knowledge effectively in new projects, and produce innovative information. Knowledge is seen as an important resource for competitive advantage in construction enterprises (Egbu et al., 2005; Ahmad et al., 2008; Chen and Fong, 2013). KM plays a significant role in innovation (Venkateswaran and Aundhe, 2013; Kamara et al., 2002), in improving work performance (Venkateswaran and Aundhe, 2013; Reich, Gemino and Sauer, 2014), in building customer satisfaction (Lee and Egbu, 2007) and in maintaining an effective working environment. Indirect positive effects of a successful KM system include reduced project durations, decreased costs, and increased quality (Shelbourn et al., 2006; Park et al., 2013).

The construction sector is often described as a knowledge-intensive industry (Egbu and Robinson, 2008) and projects involve various professional project teams. Knowledge and team-based structure of the sector requires the use of effective KM systems (Scully and Khosrowshahi, 2011). Although research reveals that there is an increasing awareness of KM in the construction sector, many difficulties are faced in managing knowledge and in general firms do not implement systematic KM. Several reasons exist for poor KM practices in the sector. While the lack of firm resources stand out as one of the most prominent obstacles ((Oke, Ogunsemi and Adeeko, 2013), other types of barriers such as lack of employee time and lack of clear guidance (Ferrada et al., 2014; Shokri-Ghasabeh and Chileshe, 2014) and poor management support are also identified to contribute to the inefficiency of KM practices.

Research has also proved that KM challenges vary according to firm size. The study by Shokri-Ghasabeh and Chileshe (2014) which focuses on the barriers to capturing lessons learned in the Australian construction sector showed that the first barrier was the lack of employee time irrespective of firm size. However, lack of the resources was only observed to be a barrier for small size firms, whereas it was among the least ranked by large contractors.

A distinction can also be observed between the KM practices of enterprises operating in different service areas of the sector. In design firms, knowledge creation takes place at each step of the project design. Each project requires a unique design solution and each detail should be redesigned according to changing needs. As a

result, it becomes hard to use explicit knowledge from previous projects (Styhre, 2011; Demian and Fruchter, 2006). In contracting firms however, professionals working in construction sites need to create new knowledge from project changes and past mistakes (Senaratne and Sexton, 2008) although this is not always possible. For example, Ferrada et al. (2014) studied KM practices in construction sites for medium sized construction firms in Chile and found that lessons learned from previous projects are often lost due to the lack of time and organizational procedures. According to the authors, this type of knowledge cannot be captured and stored by the professionals and as a result, firms miss the opportunity of using this information in preventing mistakes in new projects.

Difficulties in capturing and sharing tacit knowledge is another factor that contributes to poor KM implementations. Forcada et al. (2013) emphasize that lack of knowledge management and in particular, the difficulties associated with managing tacit knowledge leads to costly mistakes in the Spanish construction sector. The authors suggest that changes in organizational culture are critical for an effective KM. Senaratne and Sexton (2008) bring a new perspective to project changes by providing knowledge-based explanations to change problem-solving in construction teams. The authors studied how firms manage project changes and unfolded the underlying learning processes. Results revealed that after project changes, professionals use meetings and face to face dialogues to solve problems. However, they found that professionals can only focus on explicit knowledge, while knowledge about problem solving stages stay tacit and these stages could not be documented. The authors thus relate repeated mistakes in projects to the difficulty of sharing tacit knowledge and suggest that codifying learning processes could be useful in this respect. Similarly, Scully and Khosrowshahi (2011) indicate that 80% of tacit knowledge in projects cannot be converted to explicit knowledge and active sharing of this knowledge could help firms increase their learning.

According to Styhre and Gluch (2010), knowledge sharing is defined as one of the most complex social processes in today's industry. Various methods exist for the sharing of knowledge in construction enterprises, ranging from meetings to work reports, communication tools, technical project documents and computer-based systems. Despite the well-known benefits of using databases to minimize KM problems, research reveals that databases are of limited use in construction. Xiao and Boyd (2006) emphasize that in the construction sector, it is hard to use databases to reach useful knowledge when needed due to the nature of the working environment where it is not always possible to use databases and propose a learning methodology and process for organizational learning.

The construction sector, with its strong backward linkages with other sectors in the economies, is recognized to play a key role in economic growth (Gundes, 2011). The construction industry is seen as a craft base industry (Stinchcombe, 1959; Rooke and Clark, 2005). The structure of the industry resembles a hierarchical pyramid, where the upper part consists of large-scale construction companies and the base is composed of relatively smaller size enterprises, in particular sub-contractors. Sub-contractors are architecture, engineering, construction, and craft base firms with sizes ranging from micro, to small, and finally to medium . In this regard, SME's, which consist of an overwhelming majority of all enterprises in most countries and employ the majority of workers, are of particular interest in promoting development.

SME's present several characteristics that differentiate them from their larger counterparts such as informal organizational structures, lack of resources, the presence of owner-managers and the provision of service to small markets with a limited customer portfolio. These characteristics of SME's generate well-known difficulties in a number of areas, however, coupled with the unique and project-based nature of the construction sector, problems get worse. In particular, the project based environment requires SMEs to build a different collaborative working structure for each new project. Project schedules, costs, teams, and technologies change according to project size and type, therefore a different managerial strategy should be adopted for new projects. In this regard, SMEs are reported to experience difficulties in capturing the knowledge (Egbu, Hari and Renukappa, 2005), reusing learned lessons (Emmitt, Pasquire and Mertia, 2012), learning from problems (Xiao and Boyd, 2006) and sharing knowledge among project teams (Alashwal, Rahman and Beksin, 2011; Capo-Vicedo, Mula and Capó, 2011). Park et al. (2013) argue that the main barriers for effective KM in construction SMEs are to capture the knowledge from professionals, to code it using communication tools and to reach it when needed. Thus, the authors proposed a web-based construction knowledge management portal (CKMP) in order to capture the knowledge, store it and share it on the web with other SMEs from the sector. Lee and Egbu (2007) designed an IT-based construction site diary for

professionals. The purpose of this study was to capture learned lessons from professionals with an easy audio-text diary and share among the web with other professionals from the firm.

Research in the area emphasizes that managing both tacit and explicit knowledge is important for project performance (Gemino, Reich and Sauer, 2015). As knowledge in the sector largely depends on the experiences of the professionals and these cannot be captured as explicit information, the only way of sharing experiences is through face to face communications, meetings, and storytelling. However, professionals in SMEs usually have to deal with many tasks at the same time and all KM related activity is perceived to be a time loss. In such an environment, reusing this experience in new projects requires continued access to certain individuals; however, this is almost always limited due to busy working schedules.

According to Durst and Edvardsson, (2012) more studies are needed for KM in SMEs, taking into account country differences, and heterogeneity between SMEs generating from size and idiosyncratic characteristics of industries. Although studies exist on the use of information and communication technologies (ICT) (Acar et al., 2005; Cakmak and Tas, 2012; Sarshar and Isikdag, 2004),knowledge management practices (Kale and Karaman, 2011), on capturing knowledge in large construction companies (Kivrak et al., 2008), and on the impact of national culture on knowledge sharing (Kivrak et al., 2014) for the Turkish construction sector, the current use of KM practices and problems experienced within the SMEs have not yet received considerable attention from researchers.

## 3. Methodology

The qualitative research method was selected in this study in order to provide an in-depth understanding of KM approaches and problems experienced by the Turkish AEC sector professionals. A semi-structured interview method was adopted in order to understand the current KM implementation structure and challenges observed in the construction industry. Convenient and purposed sampling methods were used to identify the sample group in order to reach informational saturation. According to the busy schedule of the AEC professionals interviews conducted over the telephone.

As Turkish Construction sector was taken as a case in the present study, first there was a need to identify the state-of-the-art situation in the sector in order to clarify the interview structure. Therefore, 7 pilot interviews were conducted. The sample group in pilot interviews not only included SME's, but also large-scale enterprises. This was done purposefully as large scale and small/medium scale enterprises are continuously in close interaction due to the need for collaboration in construction projects. Thus, the identification of additional KM challenges and requirements borne from these relationships was necessary.

In the second phase, 21 professionals from construction SME's were interviewed based on a revised interview structure created from both the findings of pilot interviews and an extensive literature review. The sample group comprises firm owners and project managers with at least 5 years of work experience. All interviews were made by telephone and lasted between 30 and 60 minutes. Interviews were not recorded upon requests of respondents, thus notes were taken which were then converted into digital documents. Once the interviews were completed, the research proceeded with coding. At first, a deductive coding method was adopted to classify results according to subject categorization identified in previous literature. Secondly, an inductive coding method was applied in order to find out if any additional categories could be obtained from interviews.

### 3.1 Pilot Interviews

Pilot interviews were designed to identify the main issues that will be addressed in the final interview structure. Occupational information about the interviewees is provided in Table 1. Two firms in the sample, namely company 1 and 2 are small sized, company 3 to5 are medium sized and the remaining two firms are large scale.

**Table 1:** General information about pilot interview participants

| Interviewee | Occupation | Service Area | Position | No. of Employees |
| --- | --- | --- | --- | --- |
| PI–1 | M. Architect | Architectural design and contracting | Owner | 11 |
| PI–2 | Architect | Architectural design and contracting | Project Manager | 28 |
| PI–3 | M. Architect | Architectural design | Project manager | 63 |
| PI–4 | M. Str. Eng. | Contracting | Project Manager | 80 |
| PI–5 | M. Architect | Project management | Project Manager | 150 |
| PI–6 | Ind. Eng. | Contracting | Planning Manager | >250 |
| PI- 7 | M. Str. Eng. | Project management | Project Manager | 300 |

Several tentative results can be deducted from pilot interviews. A combined assessment of responses revealed that KM practices, needs, and problems experienced vary according to firm size and services offered. First, it was observed that 3 enterprises out of a total 7 used KM systems and one was in the phase of transition. Although both of the two small size firms reported problems in managing knowledge, they have still not adopted any KM systems. One out of three medium-size firms and both of the large enterprises in the sample use a KM system. These findings reveal that while large-scale firms have successfully established KM systems long ago, small and medium-sized enterprises, except PI 3, do not use a standardized system to manage knowledge.

Second, in order to respond to their KM needs, small firms prefer to use e-mails and server systems for sharing explicit knowledge and meetings and face to face interactions for tacit knowledge. Thus, at a first glance, one could see that smaller scale firms found low cost and low technology KM solutions more effective and suitable for sharing and creating knowledge. However, problems are reported for classifying visual documents and storing them in server systems. This problem was in particular valid for those firms which operate from multiple locations.

Third, most of the firms regardless of size have expressed concerns over information exchange between construction sites and headquarters. While KM was observed to be easier in design firms due to increased communication among teams working in the same office, it was reported to be more problematic in particular for construction firms where employees are spread among multiple locations, i.e. construction sites.

Fourth, interview results show that different types of KM solutions and problems exist for medium-sized firms where the nature of solutions depended on firms' service area. Design firms were once again reported to experience fewer problems in this respect. For example, the design office of PI-3 hired a software company to develop a KM system tailored to its own needs and currently, the system works effectively due to the determined mindset of owners. However, SMEs that provide both design and construction services face significant problems in managing knowledge between headquarters and construction sites as the latter usually functions almost as a separate and independent entity. In all of the sample firms, regular reporting from one project manager appeared to be the sole connection between sites and the head office. However, although all interviewees clearly acknowledged the possible consequences of losing key personnel in such a structure, no backup KM strategies were developed.

One of the objectives of conducting pilot interviews was to identify any additional KM requirements and difficulties borne by the collaboration between large scale and small/medium scale enterprises in some projects. However, interviews have shown that collaborative projects are not an obstacle, but instead an opportunity for SMEs for learning and establishing effective KM systems as they come with no cost and effort. As stated before, these are rather tentative results and therefore there was a further need to conduct more interviews with professionals from the small and medium-size portion of companies of the sector where real KM implementation problems exist. Therefore, based on preliminary findings from pilot interviews and an extensive literature review a final interview structure was generated (Table 4 see in the appendix). Then, 21 semi-structured interviews with professionals from the construction sector were conducted.

### 3.2 Interviews

Participants were selected according to experience in the field, position in the company and their willingness to be interviewed. The interviews were again conducted by telephone and lasted between 30 and 60 minutes. The total of 21 interviews was completed in approximately one and a half months. Table 2 shows the occupation, job title, sectoral experience and educational background of participants. As it can be seen from the table, an overwhelming majority of participants have architectural education as a background and firm owners followed by project managers predominate the 'position' field. More than half of the participants have a sectorial experience between 11 and 20 years while one-third of the participants have more than 21 years of experience in the sector.

**Table 2:** Background of participants

| Characteristics | No. of Employees |
|---|---|
| *Occupation* | |
| Architect | 18 |
| Structural Engineer | 2 |
| Restoration | 1 |
| | |
| *Education* | |
| Graduate | 10 |
| Post Graduate | 10 |
| PhD | 1 |
| | |
| *Position in the Firm* | |
| Firm Owner | 10 |
| Project Manager | 8 |
| General Coordinator | 2 |
| Advisor | 1 |
| | |
| *Sector Experience* | |
| 5 - 11 | 3 |
| 11 - 20 | 11 |
| ≥21 | 7 |

Table 3 provides data about the size and service areas of participant firms. The sample includes a variety of service areas ranging from pure design to contracting and project management. As pilot interviews showed that there is a close relation between firm size and their KM implementations, the sample group is further categorized into micro, small and medium scale firms according to the categorization adopted by both Turkish government (Official Gazette, 2012) and European Commission (2015).

**Table 3:** Size and service areas of firms

| Service area | Micro | Small | Medium | Total |
|---|---|---|---|---|
| Contractor | 1 | 3 | 3 | 7 |
| Architectural Design | 3 | 1 | - | 4 |
| Architectural Design and PM | 1 | 1 | - | 2 |
| Design and Build | 1 | 5 | 1 | 7 |
| Project Management | - | - | 1 | 1 |
| Total | 6 | 11 | 4 | 21 |

The interviews were structured using open-ended questions under four themes, general information about interview participants and companies, current knowledge management systems and methodologies, knowledge management problems and opinions about knowledge management systems. The questions were intended to explore and understand the ''what'', ''how'' and ''why'' behind each KM process. Table 4 provides

data about the interview questions. Questions are designed according to the information provided form pilot interviews.

**Table 4:** Interview questions

| Section | Topic | Questions |
|---|---|---|
| **Part One:** General Information about Interview participants and Companies | Company Information | Company name / Number of employees / Company service areas |
| | Interviewees information | Name / Occupation / Position in the company / Experience in the company / Experience in sector / Education |
| **Second Part:** Knowledge Management | Current knowledge management systems and methodologies | What kind of knowledge is created in the company? |
| | | How do you share knowledge? |
| | | How do you store knowledge? |
| | | How do you adapt newcomers to the company? How do you share company information with newcomers? |
| | | Do you use old project information for new projects? |
| | Knowledge management problems | Did you experience any knowledge loss by employee turnover in the company? |
| | | What kind of knowledge management problems are you facing in projects? |
| | | What is your opinion about the underlying causes of the knowledge management problems? |
| | | What could be the solution to knowledge management problems according to you? |
| | Opinions about knowledge management systems | So far, did any firm offer your company a knowledge management system? |
| | | If yes, what type of system was it? |
| | | Did you think the system they suggest would be useful for you? Why? |
| | | If you thought, it was useful did you buy the system? Why? |

## 4. Findings

### 4.1 KM Practices in Micro Size Firms

In this study, firms that have less than 10 employees are grouped under the micro category. Three out of a total of six micro firms in our sample provide design services, two design builders and one is a contractor. While none of the micro-sized firms have adopted a systematic KM, only one of them used a server system to manage explicit knowledge. All firms stated that explicit knowledge is stored in office computers and shared by e-mails. Half of the respondents additionally stored hard copies of documents. The only contractor in the sample kept information also on web-based databases. Although the majority of companies belonging to the micro category observed no significant problems in storing and sharing of explicit knowledge, one respondent stated that they experienced knowledge loss due to computer breakdowns since they did not have any backup systems. Sharing knowledge through e-mails were also found to be problematic by one respondent from a design company as the architects raised concerns about time constraints.

In all micro-sized companies, meetings and face-to-face communication were common ways of managing tacit knowledge. Capturing and sharing of tacit knowledge was not perceived to be a real problem among the companies in this category. This was attributed to the organizational structure in micro firms where owner managers organize all job activities and thus they create, share, store and reuse their own knowledge.

There was a consensus among interviewees about the relationship between the emergence of KM problems and growth. Respondents emphasized that KM problems started to occur in particular when they attempted to get larger in size and thus when owners had to transfer some of the responsibility to workers. In this concept, two micro-sized firms pointed out that when the number of the projects undertaken in a period increased, the

firms had to hire new employees and the knowledge within the company could not then be managed as efficiently as it was before. However, this solution also did not resolve the KM problems as it was realized that a significant amount of information was lost.

## 4.2 KM Practices in Small Size Firms

Firms that have between 10 and 49 employees are categorized as small size firms. 10 interviewees from a total of 21, work for companies that belong to the small size category. Five of these companies are design-builders, three of them are contractors and the remaining two provide design services.

Many similarities in KM practices and problems have been observed among the enterprises in this group independent of the service area. For example, an overwhelming majority of interviewees stated that no systematic KM was adopted, however, server system use was common among all firms. Most of the firms in this group also preferred to keep hard copies of documents and shared them via e-mails.

Several types of problems exist in the storing and sharing of explicit documents. Some firms complained that one file is saved several times in the system, thus leading to confusion and time loss. Others experienced knowledge losses due to computer breakdowns and difficulties in managing knowledge obtained through e-mails. However, the most significant problem appeared to be the unorganized storing of knowledge caused by individuals who fail to record files in a systematic way. In this concept, one respondent from a construction company mentioned a crisis where an employee saved construction related information on his computer and interim payment documents were lost upon his sudden leave.

The procedures for sharing of tacit knowledge within companies also showed many similarities. For example, all of the interviewees stated that they organized systematic meetings and demanded standardized documentation and report systems in an attempt to respond to their KM requirements. However, participants in this category also admitted that their efforts for creating, sharing, storing and reusing tacit information failed in many points. In this regard, a distinction has been made between the difficulties in managing explicit and tacit knowledge. While these firms could somehow manage to store explicit knowledge in a server area and share these documents through an intranet, the storing and reuse of tacit knowledge was reported to be much more problematic.

In the sample firms, knowledge creation, capturing and sharing are mostly done by the meetings and face-to-face interactions. They all try to avoid misunderstandings by talking and asking questions repeatedly. However, language differences for international companies, insufficiency of the technological base in video-conferences and the interpretation of knowledge gained from meetings remain to be problematic. While all acknowledged the necessity of recording tacit knowledge, still participant firms faced difficulties in transforming tacit knowledge into explicit. Communication with stakeholders is perceived to be even much more problematic as different parties in this group do not share a common physical space and thus they remain devoid of the advantages of working in a face-to-face setting. While project teams could interact with each other and resolve misunderstandings to a certain extent as they are in general based in the same location, this is obviously not the case for stakeholders.

An overwhelming majority of participants stated one particular problem in storing and re-using the knowledge gained from previous projects. In this regard, key personnel appeared to be of significant importance in KM among the small size segment as respondents perceived the loss of a key personnel as the loss of knowledge. Most of the firms in this group attempted to establish a documentation system in order to overcome this problem; however, they encountered severe resistance from employees using the systems. Interviewees stated that busy schedules and the lack of time were the main reasons for employees' unwillingness to use these systems.

### 4.3 KM Practices in Medium Size Firms

In the present study, the firms which have between 50 and 249 employees are categorized into the medium size group. Interviews were made by the representatives from 5 firms, 3 of which are contractors. IT system used for the management of knowledge was identified to be a common practice in medium-sized firms except for one design-builder. The storing and sharing of explicit knowledge is undertaken through server systems, e-mails, and hard copies. In this regard, several problems are reported by respondents. First, the sharing of knowledge through e-mails is reported to result in communication gaps due to the lack of follow up procedures for tracking e-mail traffic. Second, half of the respondents from this group mentioned that the biggest KM related problems in projects are caused by revisions. However, information updates about revised drawings such as revision number and date are usually not included in relevant documents, thus leading to confusion. When the respondents were asked to state the possible solutions to this problem area, they all stated that the dissemination of Building Information Modeling (BIM) throughout the sector could be a solution. However, despite efforts, the necessary infrastructure was still not established. Third, similar to small size firms, unorganized storing of knowledge appears to be problematic due to poor systematic recording by employees. In this regard, one respondent pointed out that employees were not willing to share unfinished tasks in a common digital environment.

When the firms start to get larger in size, either through new employees or larger projects, new departments, groups or project teams are established in order to increase manageability. However, in that case, communication and knowledge sharing problems start to occur between different departments and project teams. For example, several respondents from this group thought that sharing knowledge by phone and/or e-mail was not an efficient way of managing knowledge in larger-scale projects. Firms reported that they frequently encountered problems in this respect, as the necessary information was not always shared with all partners. In that case, a repeated effort was needed for sharing the same knowledge several times and thus delays occurred.

When the respondents were asked to state the most efficient ways of sharing tacit knowledge, meetings and face-to-face interactions outweighed other forms of communication. Respondents felt that the main challenge in this field was the conversion of tacit into explicit knowledge by coding and storing them in databases. These findings confirm that similar to other groups, middle size group also loses a significant amount of knowledge created by experiences. In this regard, one interviewee from a contracting company suggested that post-project meetings organized after each project could create a learning environment where employees could discuss important topics and experiences gained from the completed project in question.

A close examination of the resistance of employees in using KM systems revealed that the time and experience needed to use these systems accurately were the main obstacles. In this regard, the general coordinator of a contracting firm mentioned that weekly working hours in the Turkish construction sector are above the world standards. According to the interviewee, while this fact increases the attractiveness of Turkish construction companies in the global arena, it, on the other hand, contributes to the unwillingness of employees to spend time on writing reports. Thus, it was emphasized that KM systems should be very easy to use in this busy schedule of construction work.

## 5. Discussion

Interview results suggest that KM practices and problems were similar within each sub-group, namely the micro, small and medium segments of SME's. Detailed analysis of sub-categories reveals that as the size of the firms grows, the need for a systematic KM increases. The companies in the micro and small categories do not use a systematic KM. Indeed, there appears to be no real need for complex IT-based KM systems for the effective management of knowledge in the micro category as owners assume most of the responsibility and control tasks. Knowledge sharing and storage issues can somehow be resolved in the micro category which has relatively few employees and thus a hierarchical organizational structure is not needed. Few problems are encountered in this group such as knowledge loss due to computer breakdowns and heavy e-mail traffic. While the former could easily be resolved through the use of a simple internet-based system, the latter requires more radical solutions as interview results suggest that it is a common issue in all categories.

Companies belonging to the small category experience more serious problems in the effective management of knowledge mainly due to unorganized storing of knowledge by employees, followed by the difficulties in

accommodating heavy e-mail traffic. Surprisingly, the majority of middle-sized companies who have already adopted KM systems also experience similar problems. This can be attributed to the nature of these systems, which only bring partial solutions to problems, rather than providing more comprehensive solutions suited to the needs of construction SMEs. For example, respondents suggest that using these systems, schedules are prepared as if one team is only responsible for one particular project. While this assumption could arguably be valid for large-scale organizations, this is not always the case in SMEs. With a limited amount of employees, one team in construction SMEs is usually responsible for several different projects and thus emergent schedules are not realistic in practice.

In this regard, it is clear that more holistic KM approaches are required which build on existing systems by providing solutions to the fragmentation problem rather than offering SMEs new options. This may take the form of an integrated system, which, by bringing projects, site-related documents, e-mails and other digital documents together, offers a comprehensive solution to the management of explicit knowledge (Acar et al., 2005). Such systems could also offer significant gains to small size organizations as interviews revealed that similar problems occur in moving from the micro to small category. In this concept, web-based project management systems already available on the market could be useful as they are highly affordable, easily set-up and user-friendly (Udeaja et al., 2008; Park et al., 2013). However, these systems should be customized by bringing together partial solutions in order to establish a customized system tailored to the special needs of firms. At this point, it should be stated that firms need to be guided for determining the correct combination of packages offered. This help could either be provided by an individual specialized in packages offered at the market, or through simple models that lead the way for senior management. Thus, future research should focus on establishing a roadmap that supports firms in setting up integrated KM systems; taking affordability, ease of use and the need for frequent system revision into account. The latter is in particular of great importance as interviewees pointed out that KM system revisions become inevitable due to technological progress. Another important point to consider is the need for KM systems in the local language as several respondents linked the irregular and disorganized use of established systems to the fact that only systems in a foreign language are available at the market.

Findings of employee resistance in using established KM systems confirm previous studies, which suggest that lack of time is the most important reason for failure in recording necessary files and updates (Shokri-Ghasabeh and Chileshe, 2014). An additional reason that emerged from interviews is the unwillingness of employees in sharing ongoing but incomplete project files in a common digital environment (Cheng et al., 2010). Although finding a remedy to such reasoning may seem difficult as it is directly related to cultural factors (Arif, Mohammed and Gupta, 2015), strong top management support for system commitment appears to be crucial (Shokri-Ghasabeh and Chileshe, 2014). In this regard, the establishment of a reward and penalty system by the large-scale contractor in pilot interviews may provide a useful solution. This could further resolve the problems encountered in the sharing of information associated with revisions, which appears to be the most prominent problem area in the medium size category.

Regardless of firm size, meetings and face-to-face communication emerge as common ways of managing tacit knowledge (Kivrak et al., 2008; Emmitt, Pasquire and Mertia, 2012; Xiao and Boyd, 2006). While the micro category does not experience a real problem in sharing and reusing of tacit knowledge due to the owner controlled, flat organizational structure, almost all of the small and medium companies acknowledge the need for a simple way of converting tacit into explicit knowledge, but fail in this respect. Several previous studies have offered the use of audio-diaries for tacit knowledge problem in construction projects (Lee and Egbu, 2007; Lee et al., 2005). However, respondents raised concerns over their practicality in terms of time and effort needed in searching for specific project related problems, in describing the scope, and in allocating time for listening to these audio-diaries in busy schedules.

Computer-based data cards, where project experiences and problems are briefly recorded, could constitute a simple and convenient way for employees to search for basic instructions on a wide range of project related topics (Carrillo, Ruikar and Fuller, 2012). Project team in this way could easily access information about past project experiences, that would otherwise disappear. In case detailed information about a particular issue is needed, then professionals could further refer to individuals in charge as their names and contact information will also be provided on cards. It would also be beneficial to include prominent information about suppliers, subcontractors and the names of individuals responsible for specific work items; as such an approach could also be useful in procurement decisions. For example, if, for any reason, senior management was displeased

with a supplier or a subcontractor in a previous project, then it may choose not to work with that party again in future projects. Alternatively, the recurrence of a poor workmanship experience in a previous project could easily be avoided by recording craftsman related information on data cards and demanding subcontractors to accomplish that specific work item with a different worker in new projects. However, to the knowledge of authors, such package programs devoted to the creation of the information cards are yet not readily available in the local market.

As far as the differences in KM needs between design and contracting firms are concerned, a distinction emerged about the rationale for knowledge creation (Forcada et al., 2013). While design firms create knowledge by providing unique design and detail solutions in each new project, contractors have to create knowledge only when project changes and problems occur during implementation. However, knowledge sharing appears to be more problematic in contracting firms as teams are physically distributed in different locations. In particular, application errors and regular reporting problems come into prominence. Resolving the former requires that on-site errors are drawn, explained in detail and sent back to the head office. Then revised drawings are produced, issued and delivered to the site. It is apparent that such an approach is time-consuming and assuming that the process may repeat several times in a typical construction project, it may result in significant project delays. Site engineers need to use or prepare a variety of documents on site such as drawings, specifications, reports etc. Although notebooks are easily accessible, they are not suitable for use on site. Thus a common practice among site engineers is to use printed sheets of paper. However, communication and coordination barriers among project teams remain. In this regard, dissemination of mobile devices would be useful for obtaining real-time information about the site and for making revised drawings available to the whole project team.

The dissemination of BIM was found to be an important factor in minimizing current KM problems in SMEs (Forcada et al., 2013). However, the necessary technological and knowledge bases for BIM systems in the Country are not fully developed and there is a lack of experience in this respect, in particular for SMEs. Thus, more research is needed on the possible impacts of BIM on KM practices in construction SMEs.

## 6.    Conclusions

The aim of this study was to assess current KM practices and to identify the problems associated with KM use in construction SME's in order to define best practice and to provide recommendations aligned to the needs of different categories of SME's. For this purpose, semi-structured interviews are undertaken with 28 professionals from the Turkish construction sector. Based on the research findings presented, several managerial and strategic implications are derived which could have the potential to contribute to an increase in KM efficiency in construction SME's.

Research findings reveal that as the size of the firms grow, the need for a systematic KM increases. The heterogeneity of firms in the AEC sector in terms of size and the services provided, causes the need for customized KM systems for the firms. However, there appears to be a need for guidance to support firms in building the correct KM systems tailored to their structure.

Construction SME's could benefit from research findings and recommendations in terms of problematic issues, solutions provided for resolving them and increased awareness on their specific needs borne from their core service area such as design or contracting. Results could also assist managers in focusing on critical areas such as the sharing of tacit knowledge and the importance of top management support for the smooth operation of KM systems.

Programs directed at providing KM solutions for the construction sector are suitable for mainly large scale and to a lesser extent for medium scale enterprises. Small organizations, in particular, find them complex and unaffordable. Most of the program recommendations in this study, on the other hand, are created for use in a wide range of sectors. Thus, it is apparent that Internet-based programs tailored to the needs of primarily small and medium construction firms are needed.

The main contribution of the paper has been a complete analysis of current KM practices and problems regarding KM use in SME's operating in the Turkish AEC industry. The present research addresses a gap of knowledge through focusing on the SME subgroup in the Turkish construction sector. Findings from the study

may further assist governments, universities and other institutions in improving the performance of construction SME's through the provision of KM training programs and support for research projects in the field. Finally, results could provide insight for future research that aims to develop suitable, efficient and innovative KM models and guidelines for SME's.

The limitations of this study are the relatively small sample size and the convenience sampling process. Thus, the findings of the study cannot be generalized to the broader Turkish construction industry, and the insights on construction SMEs should be interpreted with caution.

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