

*Full Length Research Paper*

# Knowledge sharing in a fragmented construction industry: On the hindsight

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The main motivation behind this study is to ascertain the factors that inhibit and facilitate knowledge sharing among fragmented firms in a construction industry context. By and large, the augmentation of small and medium enterprises (SME) vis-à-vis to the tapering of the large ones causes fragmentation of construction industry. With the lack of collaboration between firms, knowledge sharing might be difficult to achieve. An initial literature review has been undertaken and in-depth interviews with top management individuals have been conducted to explore how project teams share their knowledge within a fragmented environment. The results uncovered five main factors of knowledge sharing: Working relationships, nature of the shared knowledge (Unintimidating Knowledge), policy and procedures, contract, and power. Inter-alia, other factors collected from the reviewed literature: Information communication technology (ICT), partnering, and knowledge management (KM) will be used to build up a conceptual model, which facilitates knowledge sharing in construction. For the purpose of validity and generalization, the model will be tested in a quantitative study in future research.

**Key words:** Fragmentation of industry, knowledge sharing, small and medium enterprises, Malaysia, construction industry.

## INTRODUCTION

Since construction of projects require a plethora of stakeholders, it is difficult for the construction firms to accumulate knowledge over time especially if the relationship between those stakeholders is not good. Besides, this relationship is temporary in nature, which can pose a serious problem in knowledge harvesting and continuous learning (Drejer and Vinding, 2004). The structure of construction industry is so long described as fragmented. Fragmentation happens when the number of small firms increases while their average size decreases (Gonzalez et al., 1998). Fragmentation leads to unclear role of learning in construction organizations; this is because fragmentation reduces mutual knowledge capturing and sharing, inhibits knowledge production and limits learning and innovation solutions (Dave and Koskela, 2009; Vock, 2001; Na et al., 2007; Egbu, 2006; Hertog and Brouwer, 2001). Identifying the factors that facilitate knowledge sharing in this environment is

important. This is because knowledge is one of the most significant factors of project success and achieving competitive advantages (Sense and Antoni, 2003; Koskinen, 2000).

The aim of this paper, therefore, is to identify the enablers of knowledge sharing among construction firms within this milieu. The following sections highlight the phenomena of knowledge sharing and fragmentation in more details. The remainder of this paper is research methodology, results and discussion and finally a conclusion.

## KNOWLEDGE SHARING

The practice of transferring and sharing knowledge in construction industry has been well documented from different perspectives and discipline include for example:

1. Organizational learning and knowledge management in projects (Williams, 2008).
2. Networks for transferring knowledge from project to

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another (these include formal and informal networks) (Landaeta, 2008).

3. Practice for distribution knowledge (database of lesson learned) (Williams, 2008);
4. Communities of practice (formal and informal networks; social interpersonal process) (Ardichvili et al., 2003; Williams, 2008).
5. Facilitating factors and hinders (lack of IT, organizational structure, organizational culture, and communication) (Williams, 2008; Malone, 2002; Knaseder et al., 2003).

Factors that facilitate knowledge sharing in construction industry attained much concern. Newell et al. (2002) emphasized on the role of social models and the development of project documentation of process knowledge, while ICT tool would help in transferring knowledge across projects. Issa and Haddad (2008) highlighted three main factors of knowledge sharing in construction companies which include culture, IT (computer-supported collaborative work), and mutual trust. An appropriate organizational culture is an important factor in enhancing mutual trust, which in turn enhances knowledge sharing while IT will assist in sharing certain knowledge but it will not motivate people to share their knowledge (Issa and Haddad, 2008).

Kotnour (2000) indicated the tools that support sharing knowledge across projects, namely: IT and employee groups aimed at sharing knowledge across the organization. In addition, in small-to-medium enterprises (SMEs), Hari et al. (2005) found that knowledge capture depends on the vision and flair of the owner/partners of the firm. It is also determined by the culture, structure, people, finance and technology. There are some problems associated with knowledge and learning in SMEs. For instance, there is a lack of awareness of knowledge capture processes, challenges and benefits in SMEs (Hari et al., 2005). Commonly, small firms are characterized by their discontinuity of knowledge creation (Page et al., 2004).

In addition, SMEs are suffering of the lack of awareness of knowledge capture process, challenges and benefits (Hari et al., 2005). There is a need to accentuate the complex social and technological nature of knowledge capture in construction SMEs (Hari et al., 2005). Smaller firms are generally less aware and less likely to utilize the management practices (Dart et al., 1990). Regardless of the role of information communication technology in spreading knowledge and learning, however, the adoption level of ICT in Malaysian SMEs is still low (Elias, 2007). Lastly, small construction firms lacks experiences and do not have adequate resources or the capacity to learn effectively (Tan and Elias, 2000). From this review, it can be concluded that there has been a little attention to study the enablers of knowledge sharing considering some of the construction's characteristics, that is, fragmentation.

## WHAT IS FRAGMENTATION?

Industry-level fragmentation occurs when the number of small and medium-sized enterprises increases and the number of the large firms decreases. In this situation, enterprises usually have no significant market share, unable to influence considerable outcomes for the industry and unable to establish intra-firms networks (Langford and Male, 2001; Gonz'alez et al., 1998; Winch, 2010; Garcia, 2005; Vlies and Maas, 2009). On the other hand, specialization can cause 'concomitant problem' of knowledge sharing in and between firms, besides, the knowledge created in specific contexts is, to some extent, "situated" and much experiential knowledge created in practice remains tacit so is difficult to transfer (Demaid and Quintas, 2006). Fragmentation occurs due to the industry's unique characteristics and due to other reasons. Here, only the reasons related to construction characteristics will be discussed. Construction building is client dependent and the product is situated in a certain location and required further production (Langford and Male, 2001; Seymour, 1987). Hartmann and Caerteling (2005), on the other hand, emphasize on the relationship between fragmentation (referred to as decoupling of construction services and process) and three criteria:

Client dependency, location dependency and weather-influenced activities.

These criteria lead to client-control of demand and construction process, and seasonality. Constructional task dependency on client and location results to three aspects: Transaction uncertainty, transaction complexity, and post-contract asset specificity (redeployed of asset). The first aspect leads to fragmentation while the other two aspects lead to the need for coordination and integration (Hartmann and Caerteling, 2005). Murdoch and Hughes (2008) argue that the large number of diverse skills, professions, specialists and suppliers cause fragmentation. They identified the reasons of why specialization and professionalization lead to fragmentation as the relationship between professionals is temporary and they have different objectives. Lastly, Seymour (1987) relates fragmentation to two reasons:

First, the product needs further process of production and second, the contractors and sub-contractors are likely to specialize in specific areas according to the demand because "...knowledge may not be readily transferable between different types of construction without some cost (in either time lost acquiring expertise or buying is the necessary skills..." (Seymour, 1987: 64).

## IMPACT OF FRAGMENTATION

Generally, fragmentation has a negative impact on the

construction industry and projects. As a critical barrier to change, fragmentation can inhibit knowledge production that lead to the low level of productivity (Oragne et al., 2005; Egbu, 2006). Fragmentation of the industry and the ad hoc-based working nature of small firms lower the rate of learning in these firms (Tan and Elias, 2000). The impact of fragmentation on knowledge and learning generally includes:

1. Eliminates learning and innovation solutions (Hertog and Brouwer, 2001);
2. Hampers the useful experience and know-how to be used sufficiently during the planning process (Vock', 2001) and knowledge capturing and sharing (Dave and Koskela, 2009);
3. Lowers the intention to invest in innovation and hinders the mutual sharing of information and knowledge (Na et al., 2007);
4. Fragmentation as one of the characteristics of construction inhibits knowledge production that lead to the low level of productivity (Egbu, 2006); and
5. Lastly, fragmentation causes numerous contracts and points of information exchange (Tijhuis and Maas, 1996), which make information integration more complex and difficult to achieve.

## PROBABLE SOLUTIONS

Regardless of the previous impact of fragmentation, literature provides some insights into how to deal with this phenomenon. The study of Forgues et al. (2009) has appointed collaboration as an entire factor to reduce the impact of fragmentation. The study proposed three main approaches to encourage collaboration: Integrated practices, integrated teams and integrated design process. The study looked into two approaches that facilitate collaboration, namely, change practice and objects to facilitate boundary-crossing. For the first approach, the scholars underpinned the activity theory to explain how to break barriers at the pragmatic level. While the situated action theory proposed to identify the ways that help in crossing the boundary between communities of practice. From there, the study proposed IT or technology as a boundary-crossing object to facilitate collaborative work and transformational learning between design team. Oragne et al. (2005) call for restructure of the industry by engendering a spirit of compromise and collaboration and provide a 'Knowledge Centre' to access the required information. Alderman and Ivory (2007: 87) stated that:

"Closely interacting firms operating in a context of trust should learn more easily and solve problems more effectively. In other words, as relationships move away from adversarialism to ones based on trust, more effective working relationships become possible. Even

partnering over a single project can bring these sorts of benefits."

Some other studies provide solutions for this problem, which seem to be, at the same time, as enablers of knowledge sharing. For example, Winch (2010) proposed business-to-business Internet-based approach. Langford and Male (2001) recommended recognizing the competitive advantages from knowledge and information based assets rather than through technology while, Liu et al. (2007) suggested building a favourable learning environment for contractors and mutual cooperation. Egbu (2006) cited the suggestion of Egan (1998) of encouraging partnering. Hartmann and Caerteling (2005) encouraged cooperation and integration among firms and project parties via both the legal and social mechanisms. Finally, Stewart et al. (2004) suggested developing the procurement using alliance-based management to overcome the IT literacy gap between the large and SMEs at the same time utilizing on-line information management system. These recommendations can be categorized into the following:

### Utilizing ICT

To utilize computer integrated construction (CIC) methods (Koskela, 1992); use construction collaboration technologies (CCT) (Hore et al., 2009); utilizing internetworking (Chan and Leung, 2004); and utilize IT (Nitithamyong and Skibniewski, 2004).

### Utilizing KM tools

To use knowledge management and innovation (Vock', 2001); and provide a 'knowledge Centre' for different firms (Oragne et al., 2005).

### Encouraging partnering

To encourage the joint to associations of engineers, architects, and construction firms (inter-sectoral collaboration) (Vock', 2001); address the problem of integration, as the procurement techniques are limited to addressing the production problem only (Naoum, 2003); motivate integration and closer cooperation between consultant and contractors (Dulaimi et al., 2002); provide clearer definition of the role of other companies through specifications and contract (Sorrell, 2003); empower the attitude of fully integration, cooperation, and trust (Tijhuis and Maas, 1996); and develop a protocol of design and construction process (Kagioglou et al., 2000). These solutions provide good aspects to deal with the problem of fragmentation per se. Nevertheless, the literature perused so far, do not offer any empirical solution for the

**Table 1.** Interviewees' profile.

Interviewee (anonymous names)	Age	Highest level of education	Position in organization or project	Years of experience
X1	40	Bachelor degree	Project manager	20
X2	38	Bachelor degree	Project engineer	10
X3	37	Master degree	Project manager	12
X4	49	Master degree	Project manager	20
X5	50	Bachelor degree	Construction manager	20+
X6	48	Bachelor degree	Director of projects	20
X7	49	Diploma	Architect	20+
X8	55	Bachelor degree	Project director	20+
X9	40	Bachelor degree	Project coordinator	17
X10	42	Bachelor degree	Project manager	15
X11	52	Bachelor degree	Project manager	25+

problem of enabling knowledge sharing within the context of fragmentation. The aim of this paper, therefore, is to identify the factors that facilitate knowledge sharing through conducting a qualitative investigation.

## RESEARCH METHODOLOGY

A qualitative study was used to explore and identify the factors that enable knowledge sharing in fragmented construction industry. Qualitative study is useful to identify the underlying themes and phenomena, which were unable to be explained due to the limitation in literature (Creswell, 2009). As has been discussed previously in this paper, enablers of knowledge sharing within fragmented industry were still not clear in literature. It is more appropriate in qualitative study to choose participants depending on whether they are 'information rich' and relevant to the research questions (Creswell, 2008; Bryman, 2004). Hence, a purposive sampling method (Cavana et al., 2001) was used targeted top management experts who worked for minimum of 10 years in construction buildings. The number of interviews will depend on the theoretical saturation achieved (Bryman, 2004). In-depth face-to-face interviews conducted with 11 cross-section practitioners in the industry, namely: Project managers, project coordinators and consultants to obtain rich and different opinions.

The profile of the interviewees is shown in Table 1. Each interview took about 25 min as an average. In this study, the interviewees were asked questions related to fragmentation in Malaysian construction industry. Besides, they were asked to answer questions of what are the factors that facilitate knowledge sharing between construction firms working in the same project. Finally, they were required to answer questions about how to increase trust and mutual collaboration between project team. Data was analysed manually because the number of interviewees was not very big. This paper follow (Creswell, 2008) the method of interview analysis. The researchers transcribed each interview and wrote memos on the margin of the transcriptions. Then, the researchers' highlighted parts of the text that they felt it will answer the research questions. These parts of text called segments (Creswell, 2008), which contains rich information about the topic in hand. Each segment was assigned a certain code to categorize those segments. Some codes were *in vivo* codes (directly taken from the text as it is) as for example interfacing meetings. The codes were collapsed (data reduction) to come out with the themes. Codes collapse includes reducing the similar and redundant codes.

For the purpose of validity, the codes checked with three of the researcher's peers (peer review - (Creswell, 2008).

## RESULTS AND DISCUSSION

### Interviewees' perspective

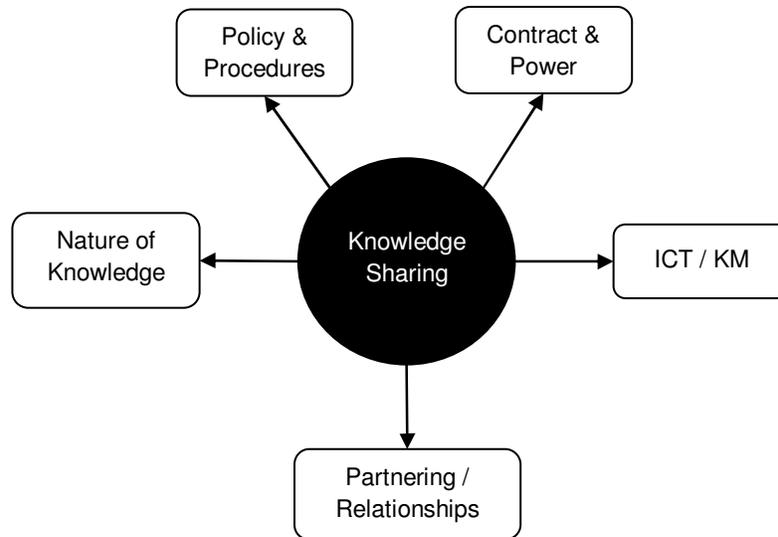
Although, interviewees aware that fragmentation cannot be avoided in construction due to specialization, some cannot see it as an obstacle for knowledge sharing. In fact, one interviewee stated that the more specialists involved in a project, the better because people can expose to different disciplines and learn better. The problem will be how to coordinate between all those people. Interviewees see no problem in sharing knowledge between specialist firms. This is because only one specialist firm will work in one project, from there; knowledge sharing is no problem, according to this interviewee.

Another interviewee agreed that fragmentation's implications could be avoided by coordination between different people, while "the relationship between the contractor and the consultant should not be a problem (...) but in most cases between the contractor and the sub-contractors". This interviewee highlighted important point that is the need for better coordination system between contractors and sub-contractors to achieve the project.

### Knowledge sharing

The results of the in-depth interviews highlighted some factors of enabling knowledge sharing between project team in fragmented construction. These include:

1. Working relationships (or social relationships);
2. Nature of knowledge (unintimidating knowledge);
3. Policy and Procedures;



**Figure 1.** An initial model of the facilitating factors of knowledge sharing in fragmented construction industry

4. Contract; and
5. Power.

Three main solutions for fragmentation have been presented in this paper previously, these are: ICT, KM, and partnering.

One factor discovered from the interviews, which is working relationships, is akin to partnering. Working relationship is an immature form of alliance. People will share knowledge if they are 'buddies' as one project manager stated. Main contractors will develop good relationships with other sub-contractors based on previous working experience.

Collaboration between the main contractor and the trusted sub-contractor includes training and sharing of knowledge and best practice. For new collaboration, the main contractor will have an evaluation system of new sub-contractors to assess their abilities and capabilities in achieving the work and to make sure that the sub-contractor will not sub the work again to another contractor, which will increase the number of smaller firms. Contract role is vital to enable knowledge sharing. The contract will increase the trust between firms working in one project especially if they working together for the first time.

According to (Issa and Haddad, 2008) mutual trust increases knowledge sharing. However, the nature of knowledge is a significant factor in the process of sharing knowledge. One interviewee put it this way:

"People are willing to share knowledge related to complete the project unless sharing knowledge may influence the benefits of their companies."

Companies' policies and procedure system enable

project team to share their knowledge. Pan and Scarbrough (1998) cited (Issa and Haddad, 2008) indicated three main layers of KM that facilitate knowledge sharing, namely: Infrastructure (hardware/software), Infostructure (rules), and Infoculture (stock of background knowledge).

The result of this study affirm the second factor; Infostructure. The study of Thorpe et al. (2005) focused on three main areas: the influence and ability of the entrepreneur to extract, use and develop knowledge; the firm's system and the social capital that facilitate knowledge exploration (creation) and exploitation; and the government's policy towards knowledge and learning.

Power is an important aspect in facilitating collaboration and knowledge sharing between firms and individuals. There are two types of powers; one is vertical and the other is horizontal. Example of the first type is the main contractor's right to terminate any uncooperative sub-contractors. For the second type of power, it may include any element that can help in achieving collaboration between project team.

For example, drawings, specifications and reports can have a significant role in enhancing collaboration between project team if designed properly (Phelps and Reddy, 2009). One of the characteristics of these elements is Power. According to Phelps and Reddy (2009) drawing, specifications, and reports must have a power or control so project team can create the need for certain information or make easily available certain type of information. Figure 1 pictured the factors that enable knowledge sharing between project team in a fragmented construction.

The discovered factors are lacking generalizability or external validity as more cases are required to be conducted to test these factors.

## CONCLUSION

The results herein are certainly non-exhaustive as further investigation is still in full swing. A questionnaire is further fine-tuned to elicit the best answer, glean any knowledge and distil any undiscovered factors that may promote knowledge sharing in the fragmented industry. The plethora of literature reviewed highlighted several factors which may reduce fragmentation's impact and hence facilitate knowledge sharing. These factors are: Utilization of ICT, good knowledge management, encouraging partnering, and utilizing design and build contracting method. New factors have been identified and discussed which include the nature of knowledge; contract and power; and policy and procedure. Other factors: social relationship, ICT, and knowledge management confirm the findings of previous studies. It is noticed that interviewee did not highly recognize the role of partnering and this might be due to the lack of this practice among construction firms in Malaysia. However, social relationship could be immature form of alliance and collaboration between firms.

The factors of knowledge sharing in fragmented construction industry have been accumulated in an initial model, which need further investigation to confirm it.

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