

Project Learning Enablers within Fragmented Construction Projects

Ali Mohammed Alashwal¹

Abstract: Many studies have affirmed a negative influence of fragmentation on learning and knowledge sharing in construction projects. However, the literature overlooked enablers of learning within this context. The purpose of this paper is to explore the factors that facilitate project learning and ways to negate any unbecoming effects of fragmentation. Qualitative study used to explore the enablers through interviews administered to 11 top management individuals working in different construction projects in Malaysia. The findings revealed the following factors: participation, relationships, togetherness, and roles of project leader and coordinator. The role of boundary objects was also highlighted including information technology (IT), contract and procedures, drawings, specifications, and reports. The outcome of this paper initiates the development of a model for better knowledge creation and sharing in construction projects. The significance of this model stems from its ability to connection both the characteristics of construction project and project learning theories using the enablers. It is envisaged that future work will be to confirm the model in a quantitative study.

Keywords: Boundary objects, integration, knowledge sharing and creation, team learning

I. INTRODUCTION

Harvesting knowledge in projects is vital, especially in construction projects which are unique, complex, and involve numerous specializations [1]. Project learning was defined as teams' actions to create and share knowledge within and across projects [2]. Project learning offers several advantages for individuals, teams, and organizations. In construction projects, learning is the key for continuous development and survival of a project-based organization. Learning can reduce repeatable mistakes and 're-inventing the wheel'. It has numerous benefits as shown in Table 1.

TABLE I
 BENEFITS OF PROJECT LEARNING FOR ORGANIZATIONS

Benefit	Reference
Competitive advantages of firms	[3, 4]
Success and improvement factors of project-based organization	[5, 6]
Maturity of project-based organization	[7]
Short- and long-term goals of companies and respond to uncertainties and environmental pressures	[8]
Better project performance, delay and project failure mitigation, and less total cost of projects	[2, 9-11]
Offset the limited career span of employees	[12]
Quality decisions through knowledge gain and experience accumulation	[13]
Improve innovations in projects	[1, 4]

Fragmentation is a unique characteristic of construction projects and industry. This term has been used to describe two phenomenon; fragmentation of industry and fragmentation of projects. Fragmentation of the industry implies the segregation of companies into small firms, which influence the industry's structure [14-17]. On the other hand, fragmentation of project is the

disintegration of construction processes, information and specializations [18, 19]. The current paper focuses on this level of fragmentation as it has a direct and negative impact on construction project performance [20, 21]. The benefits of learning highlighted previously can be difficult to achieve due to fragmentation. Numerous authors have argued that fragmentation has a negative influence on learning and knowledge capturing, sharing, and production in construction projects [22-27]. Regardless of this recognition, there is still lack of studies that investigate how to facilitate learning considering fragmentation in construction projects. Therefore, the purpose of this paper is to explore the enablers of project learning within fragmentation using qualitative investigation. Based on literature review, the next section discusses factors that mitigate fragmentation and, at the same time, facilitate achieving better project learning.

II. OVERCOMING FRAGMENTATION AND ENABLING LEARNING

Coordination and collaboration are two main factors that lessen the negative impact of project fragmentation [20]. In addition, overcoming boundaries among project team and promoting innovative procurement methods are also other approaches to mitigate fragmentation. Besides, integration of project team seems to have a significant role in promoting learning within this context. Trust, good communication, and good relationships are three main factors that determine team integration [21, 28, 29]. Information communication technology (ICT) and knowledge management may reduce fragmentation and enable team integration. Example of 'tangible' elements that facilitate integration are: 'Integration Toolkit' and computer integrated construction (CIC) [30, 31]. Furthermore, boundary objects and boundary-crossing may overcome fragmentation's impact and enable project

¹ Senior Lecturer, Department of Quantity Surveying, Faculty of Built Environment, University of Malaya, 50603, Kuala Lumpur, Malaysia. Email: alialashwal@um.edu.my

learning. The role of boundary object in this regard is explained in the following paragraphs.

A boundary object can be defined as “an analytic concept of those scientific objects, which both inhabit several intersecting social worlds and satisfy the informational requirements of each of them [...]” [32]. The importance of boundary object is its ability to explain how a group can manage the discrepancy between cooperation and the divergence of viewpoints. Koskinen and Mäkinen [33] simplified this concept by indicating that boundary objects can be artefacts, documents or even vocabulary, which can help people from different organizations build a shared understanding. They classified boundary objects in construction into two types, namely: institutionalized (e.g., memos, drawings, manifestations of shared understanding, etc.) and non-institutionalized boundaries objects (e.g., factors that foster openness, trust, and togetherness, etc.). Other boundary objects include construction contract, drawings, specifications, and reports [33, 34].

Carlile [35] identified the characteristics of a good boundary object in new product development as the following: boundary object shall establish shared syntax or language for individuals to represent their knowledge, should provide a concrete means for individuals to specify and learn about their differences and dependencies across a given boundary, and shall facilitate joint transformation of knowledge. In addition, Phelps and Reddy [34] highlighted the characteristics of boundary objects in construction project that enhance collaboration between project team as follows: boundary objects shall be familiar and trusted to project team, it must be important, and it must have a power or control over the project team.

The importance of boundary objects for this study lies in its ability to explain how to overcome the boundaries and manage specialized knowledge caused by fragmentation. Breakers or boundary-crossing may help in achieving efficient collaborative teamwork. Boundary-crossing is the medium that holds boundary object. An example of boundary-crossing is Information Technology (IT) to enable knowledge sharing and generation during design process of construction and aerospace industries [20]. IT is believed to improve collaboration among the team via transformational learning [20]. Fong [36] indicated drawings and personal conversations as boundary-crossing and highlighted two boundaries within project team, namely expertise boundaries and hierarchical boundaries. The team members can consciously break down the boundaries by valuing the expertise of others and by adhering to examples set by project managers [36].

III. RESEARCH METHODOLOGY

This study opted qualitative strategy to explore the factors that enable project learning considering fragmentation. These factors will help in explaining how project learning occurs within this context. Qualitative interviews can be used to explore new factors pertaining to a phenomenon when literature is lacking such factors [37]. Data collection was performed using in-depth interviews

with individuals who were involved and possessed experience in construction building projects.

A. Sampling

The purpose of qualitative sampling is not to generalize findings to a certain population, rather to choose a ‘source of information’ to develop an understanding of the phenomenon [38]. A theoretical sampling used to discover a theory or specific concepts within a theory [39]. This sampling method is conducted based on availability of interviewees with sufficient experience. The number of interviews depends on the theoretical saturation achieved, where information start to show reputation [40]. Interviewees were identified first based on a purposive sample of construction building projects in Malaysia. The pre-set characteristics of construction projects are:

- Projects vary in type (e.g., education building, administration building, and so on).
- Projects are sizeable (i.e., value of projects is approximately 50 million Ringgit Malaysia (RM) or above, to show some complexity to test the phenomenon of the study).
- Projects vary in terms of specialist individuals involved in the production process (i.e., number of specialized firms and professions involved is not less than five during the construction stage).

Project managers and other consultants were chosen for the in-depth interviews. Project managers have a key role in defining the team structure and engendering a culture of confidence, trust, safety, and mutual respect among members [41]. In addition, consultants and other team members can provide their perceptions on how they regard learning process and fragmentation. The criteria used to select the interviewees are:

- Directly involved in the construction process and management (i.e., must have conducted at least five construction projects);
- Possess sufficient experience in construction building projects (i.e., minimum 10 years); and
- Possess experience in project review and audit (optional).

B. Choosing Projects and Interviewees

A mixture of different construction building projects can be useful to obtain comprehensive data about the subject. Six projects were selected for this purpose, namely, an administration building, a laboratory building, two hospitals, an airport, and a bank. The said projects were all in the construction stage while conducting this study. Value of these projects ranged between RM 46 - 997 million. Table 2 provides more details about these projects. Altogether, 11 interviews were conducted until the theoretical saturation achieved. Individuals approached for interviews included project managers, project coordinators, and a consultant. Some of the interviewees had experience

of more than 20 years in construction projects as shown in Table 3.

TABLE 2
 DETAILS OF CONSTRUCTION BUILDING PROJECTS (PURPOSIVE SAMPLE)

No.	Project type (specification)	Value (RM million)*	Completion (%)	Contracting method
1	Administration building (10 stories)	61.0	65	Conventional
2	Laboratory building (9 stories)	46.1	7	Conventional
3	Paediatric and Obstetric Hospital (two buildings with 10 and 6 stories, respectively)	173.0	85	Conventional
4	General Hospital (13 stories)	176.0	31	Conventional
5	Airport (the buildings package only)	997.0	34	Design & build
6	Bank (1500 acre)	500.0	30	Design & build

* IRM ≈ 0.3 USD

TABLE 3
 INTERVIEWEES' PROFILE

Interviewee	Position	Education	Experience (years)
R1	Project Manager	Bachelor Degree	20
R 2	Project Coordinator	Bachelor Degree	10
R 3	Project Manager	Master Degree	12
R 4	Project Manager	Master Degree	20
R 5	Construction Manager	Bachelor Degree	22
R 6	Director of Projects	Bachelor Degree	20
R 7	Consultant	Diploma	21
R 8	Project Director	Bachelor Degree	23
R 9	Project Coordinator	Bachelor Degree	16
R 10	Project Manager	Bachelor Degree	15
R 11	Project Manager	Bachelor Degree	More than 25

C. Data Analysis

The interviewees were requested to provide their opinion on whether boundary objects (i.e. drawing, specifications, reports, and contract) enable learning of the project team. In addition, the interviewees were asked to identify other elements that may facilitate project team collaboration, integration, and learning considering fragmentation. Data analysis was conducted simultaneously with data collection. This is to explore emerging patterns and to check for theoretical saturation. Creswell [38] explains interviews analysis features as follows: it is inductive (simultaneous and iterative data analysis and collection), it involves developing deeper understanding of data (reading them several times), and it entails no single method (basically interpretive and requires personal assessment). However, the general framework of interviews analysis and interpretation

involves the following steps: preparing and organizing data, exploring and coding the database, describing findings and forming themes, representing and reporting findings, interpreting the meaning of the findings, and validating the accuracy of findings [38].

Data analysis in this study was conducted as the following. The audiotaped interviews, which took an average of 25 minutes each, were transferred into transcripts of about seven pages for each interview. Since the size of the transcripts was not very large and the desire of the researcher was to get closer to the text, a manual analysis was conducted [42]. A browsing through the whole text was conducted first to make a sense of the script. While reading through, memos on the margin of the transcript were recorded. Then, segments of the text were highlighted, which contain information that can achieve the objectives of this study. From there, codes were assigned to the segments to categorize them. Lastly, the codes were collapsed (data reduction) to develop the final themes. For the purpose of validity, peer review was conducted [38]. Three peers of the researcher checked the representativeness of codes to themes and to the research objectives.

IV. FINDINGS AND DISCUSSION

The findings of the interviews identified factors that may enable learning within fragmented projects. These factors include role of project leader, attitude of staff, inter-sectoral collaboration, and procurement method. The project leader has an important role in managing the differences between the specialized individuals within the team. The joint initiative of the associations of engineers, architects, and construction firms (called inter-sectoral collaboration) is important to deliver a single integrated product [43]. The interviewees ascertained the importance of joining such associations like the board of engineering. In addition, some interviewees highlighted the role of innovative contracting in reducing fragmentation of projects such as alliance-based contracting. This permits project stakeholders to share the fruit and ways to complete projects successfully.

As discussed previously, trust, good relationships, and communications are pivotal to the integration and collaboration of project team. Most of the interviewees realized that better relationships and solidarity among project teams increase collaboration, trust, and communication. The results revealed the following themes that stimulate these factors: participation of project team in different activities, construction contract and procedures, working environment, relationships (reinforcing two types: working relationships and human relationships), and role of project manager and coordinator. The importance of project team participation, as Phelps and Reddy [34] affirmed, lies on the familiarized boundary objects that can be trusted. Appropriate contract and proceeding systems improve relationships between the different parties in construction project. An example of proceeding system that enhances coordination is the International Organization for

Standardization (ISO) systems, which facilitate coordination works between different specializations within the project. The interviewees highlighted that there is a need to coordinate between the main contractor and sub-contractors and suppliers (vertical coordination). Better coordination among these parties will lead to better project performance. Another finding of this study shows that a better working environment, which include better facilities and support, lead to better team integration. Project environment is one of the factors that reduce boundaries between project team including mistrust, limited contacts and limited experience flow [23].

Getting people together and better offsite social activities [33] are one of the factors to enhance the relationship of the project team. Project leader, i.e. project manager, director, etc., have an influential role to attain better relationship. An important part of this role is to show a positive role model. On the other hand, project coordinator (supposed to be middle manager and multi-disciplinary individual) may also play important role in attaining better relationship. The role of the coordinator can also facilitate knowledge sharing among team members [44]. One of the finding of this study is that there exists an indirect role of non-institutionalized boundary objects in enabling project team learning. To recall, the non-institutionalized boundary objects include information technology (IT) [20], construction contract [33], and the set of drawings, specifications and reports [34]. Information technology facilitates knowledge transfer via documenting the relevant information in a database in the project. Figure 1 illustrates a conceptual model of the role of boundary objects and other factor discussed previously in enabling project learning.

The model shows fragmentation as a barrier to project learning (indicated by the negative sign). Boundary objects are believed to play an important role in reducing the differences in project team and enabling project learning (indicated by the positive sign). In addition, the integration enablers identified in this study may have an integral role in eliminating fragmentation, facilitating communication and improving trust and relationships. This, in turn, enables better learning of construction team. Subsequently, the objects and the integration enablers are considered as intervening factors that control the relationship between fragmentation and project team learning. Project team will be able to share and create more knowledge considering the factors of integration and boundary-crossing objects.

V. CONCLUSION AND RECOMMENDATIONS FOR FUTURE STUDIES

The objective of this paper was to explore factors that enable learning and knowledge creation and sharing inhibited by fragmentation of construction projects. The study explored the enablers using in-depth interviews and incorporated them into a conceptual model. The factors highlighted in the model include boundary objects, collaboration, good relationship, trust, participation, supporting environment, the role of project leader and

coordinator, procurement method, and inter-sectoral collaboration. Some of these factors have been indicated in literature such as IT and procurement method. This model contributes to the field of project learning by considering the influence of both fragmentation and boundary objects. As such, the enablers can be considered in practice to achieve learning benefits such as better project performance, continuous development and success. A quantitative study is recommended to confirm the relationship between fragmentation, project learning, and the enablers (as intervening factors) and to generalize the conceptual model to other construction projects.

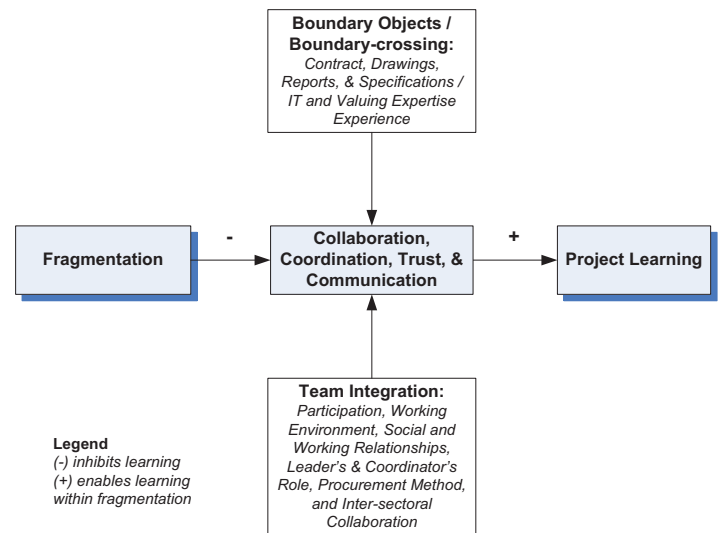


FIGURE 1: CONCEPTUAL MODEL OF LEARNING ENABLERS IN FRAGMENTED CONSTRUCTION PROJECTS

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