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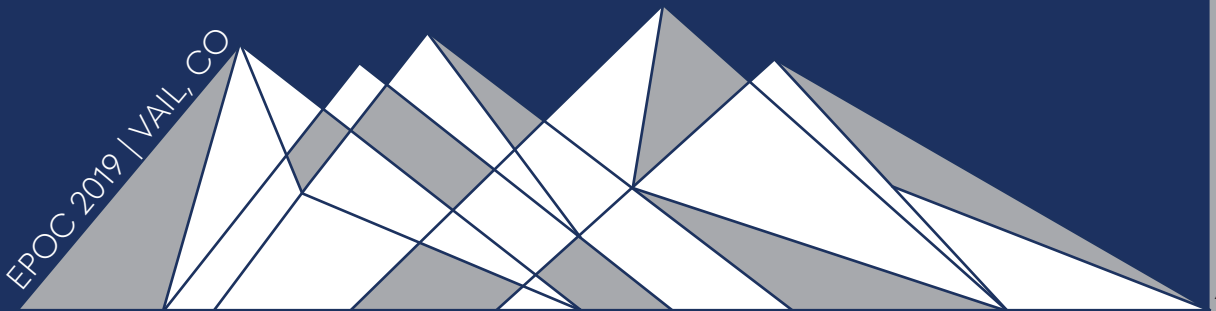

ORGANISATIONAL AMBIDEXTERITY FOR RADICAL INNOVATION ADOPTION IN BUILT ENVIRONMENT SMES

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ABSTRACT

Built environment organisations adopt innovations to address complexities and uncertainties within built environment operations. However, some innovations are too radical to master due to changes they bring, especially to the built environment Small and Medium-sized Enterprises (SMEs). The built environment SMEs do not possess enough personnel with adequate competences in adopting radical innovation. Organisational ambidexterity is a possible solution, especially in the phenomenon of Building Information Modelling (BIM), a radical innovation adopted amongst built environment organisations. Using case study methods and BIM adoption among built environment SMEs as the research setting, the study looks into Project-Based learning (PBL) mechanisms of project team to investigate how organisational ambidexterity can assist built environment SMEs in radical innovation adoption. Through ambidextrous PBL mechanisms, radical innovation-related knowledge can be simultaneously learned by individuals, as well as refined cross-projects and within organisations. The paper also highlights the importance of having personnel with adequate competences of adopting radical innovation to assist others and the creation of a knowledge sharing culture in project teams. The study is ongoing. Practically, the study recommends project managers and senior managerial personnel to place more attention towards the adjustment and creation of ambidextrous PBL mechanisms. Theoretically, the research expands on current BIM, organisational ambidexterity, PBL, and radical innovation adoption researches.

KEYWORDS

Building Information Modelling (BIM), organisational ambidexterity, Project-Based Learning (PBL) mechanism, and radical innovation adoption.

INTRODUCTION

Innovation adoption assists built environment organisations in countering complex and uncertain challenges abundant in built environment operations (Sakhrani et al. 2017; Slaughter 2000). However, for built environment Small and Medium-sized Enterprises (SMEs), some innovations are too radical to comprehend. The built environment SMEs do not employ enough personnel with adequate competences of

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adopting radical innovation (Egbu 2004). *Organisational ambidexterity*, or the balance mix of *exploration* and *exploitation* can alleviate in successful radical innovation adoption (Eriksson 2013; Levinthal and March 1993). Exploration is when organisations experiment with foreign events, while exploitation concerns routine refinement and re-alignment of organisational processes and operations (Brady and Davies 2004; Levinthal and March 1993). Innovation-related knowledge is usually lost and hidden at a project level in the built environment (Aouad et al. 2010; Ozorhon 2013).

Learning in projects, or Project-Based Learning (PBL) refers to knowledge acquisition of individuals, projects, and/or organisations from a project level (Williams 2008). Organisational ambidexterity can be thoroughly studied by assessing systems that foster learning in project teams, or PBL mechanisms. Studies on this is limited. Amongst many radical innovations adopted by built environment organisations, Building Information Modelling (BIM) is the most prominent (Ghaffarianhoseini et al. 2017; Miettinen and Paavola 2014) and is used as the research setting.

By comparing cases of BIM adoption in built environment SMEs, this study examines PBL mechanisms of teams to investigate how project level organisational ambidexterity can support the built environment SMEs in radical innovation adoption. The next section of this paper defines relevant concepts and its theoretical background. Afterwards, it presents the research methodology, preliminary data and findings, and discussion. Lastly, it concludes on both practical and theoretical discoveries.

BUILT ENVIRONMENT INNOVATION ADOPTION

INNOVATION ADOPTION WITHIN BUILT ENVIRONMENT ORGANISATIONS

Built environment organisations need to master innovations to compete in a fast-changing market environment (Crossan and Apaydin 2010; Pichlak 2016) and cope with challenges of complex and uncertain built environment operations (Sakhrani et al. 2017; Slaughter 2000). Innovation adoption refers to successful introduction and implementation of new products, production methods, processes, and/or sources of supply (Hidalgo and Albors 2008; Pichlak 2016). Notwithstanding, some innovations are too radical to comprehend, especially for built environment SMEs (Loosemore 2015; Sexton and Barrett 2004).

Radical innovation completely outdates existing working paradigms and generates changes to every system within adopting organisations (Slaughter 2000). Built environment SMEs are technologically weak, contain insufficient investments, and slight in management experience (Egbu 2004). SMEs can also adopt innovations instantaneously if there exist connections between a) the innovation and b) the organisational resources and competences they possess (Sexton and Barrett 2004; Tulenheimo 2015). However, radical innovations or any innovations that require extra investment, produces excessive risks, and far too alien tend to be discarded (Davis et al. 2016). Learning within and from project teams is crucial to sustaining radical innovation adoption (Hartmann and Dorée 2015; Starbuck 1992).

INNOVATION LEARNING IN PROJECTS

Innovation and innovation-related knowledge are mostly hidden and co-developed at a project level by project teams (Aouad et al. 2010; Brady and Davies 2004; Bresnen et al. 2005). Learning is a social process, where a unit of an organisation such as an individual, project team, or department, is affected by experience or knowledge of other units (Bartsch et al. 2013; Prencipe and Tell 2001). The built environment is knowledge-based (Starbuck 1992). If properly managed, knowledge can be a significant organisational resource to innovation adoption (Crossan and Apaydin 2010; Egbu and Robinson 1998). Individuals gain competences of an innovation by learning its related and embedded knowledge (Gopalakrishnan et al. 1999). Learning accommodates two main processes of *exploration* and *exploitation* (Levinthal and March 1993).

Exploration is the pursuit of new knowledge (Levinthal and March 1993). It is the behaviour in which an organisational unit examines new and unfamiliar events (Brady and Davies 2004). Exploitation engages routine behaviour in refining, re-aligning, and improving existing processes and operations (Brady and Davies 2004; Eriksson 2013). Effective learning and adoption of innovations in organisations demand *organisational ambidexterity*, a harmonise mix of exploration and exploitation (Eriksson 2013; Levinthal and March 1993). Exploration and exploitation can be assessed by investigating PBL mechanisms of project teams.

PROJECT-BASED LEARNING (PBL) MECHANISM

PBL mechanism refers to a system that assists project team members in learning (Udomdech et al. 2018). PBL mechanisms can be evaluated by looking into relationships amongst a) project knowledge practices, knowledge practices used by project teams in capturing and transferring knowledge and learning and b) project influencing attributes, contextual aspects of a project team to learning (Reich et al. 2012; Udomdech et al. 2018). Project knowledge practices contain three approaches which are: a) codifiable approach, concerning practices that deal with learning of explicit knowledge; b) un-codifiable approach, including practices that support tacit knowledge learning; and c) mixed approach, dealing with practices that foster learning of both knowledge types (Udomdech et al. 2018). Table 1 explains different approaches of project knowledge practices and their relevant practices.

Table 1: Approaches and relevant practices of project knowledge practices (Udomdech et al. 2018).

Approaches of project knowledge practices	Relevant practices
Codifiable approach	External knowledge sources Project documentations Research and development Standardised operations and manuals Shared knowledge repositories
Un-codifiable approach	Creation of a knowledge team Incentive schemes Informal meetings Mentoring Partnership

	Recruitment and reassignment of project members
Mixed approach	Assignment of knowledge management personnel Post project reviews Professional networks Promotion of knowledge sharing culture Trainings and workshops

Project influencing attributes act as facilitators of project knowledge practices (Reich et al. 2012; Udomdech et al. 2018). They can be categorised into five themes, where each contains its own supporting attributes (Udomdech et al. 2018). The five themes are: a) qualities of a sender, concern individual capabilities in forwarding knowledge; b) qualities of a receiver, involve individual capabilities in absorbing knowledge; c) project team relationships, refer to shared understandings and ties between team members; d) project team context, imply contextual aspects of a project team such as project culture, resources, and structures; and e) project operational context, entail operational attributes of a project to learning such as similarities and timescales of a project (Udomdech et al. 2018). Project team relationships, project team context, and project operational context directly facilitate and influenced by project knowledge practices of teams (Udomdech et al. 2018). Table 2 expands upon project influencing attributes and their supporting attributes.

Table 2: Project influencing attributes and their supporting attributes (Udomdech et al. 2018).

Themes	**Topics**	**Supporting attributes**
Qualities of a sender	Transferring capacities	Existing abilities of an individual to realise values and purposes of knowledge, as well as take opportunities to accurately document and store such knowledge.
	Willingness to share	Resources such as time in capturing knowledge, workloads of the sender, and legal issues associated to knowledge captured.
Qualities of a receiver	Absorptive capacities	Abilities to identify the value of new knowledge, assimilate it with existing knowledge, and apply it to commercial ends.
	Knowledge quality	Usefulness, expiration, and fragmentation of captured knowledge.
	Motivation to absorb	Resources such as time in learning, workloads of the sender, and legal issues associated to knowledge captured.
Project team relationships	Cognitive aspects	Shared representations, interpretation, and system of meanings among team members.
	Relational aspects	Network ties with current and former project team members based on trust, cooperation, and communication.
	Temporal aspects	Disruptive experience and connection of team members from previous projects.
Project team context	Project climate	Senior management support, knowledge sharing culture, and no-blame culture where social barriers in learning are blurred and learning in projects is structured.
	Project resources	Costs and investment made by a project to capture and transfer knowledge and modify existing business processes.

	Project structure	Formalisation, centralisation, integration, and stratification of a project and clearly defined roles and responsibilities.
Project operational context	Project similarities	Similarities of projects, tasks, and problems found.
	Time urgencies	Differences in timescale of projects, tasks, and urgencies of problems encountered.

BUILDING INFORMATION MODELLING (BIM) AS AN INNOVATION

Amongst many radical innovations within built environment industry, BIM is the current trend adopted by most built environment organisations (Ghaffarianhoseini et al. 2017; Miettinen and Paavola 2014). BIM is chosen as it technologically, procedurally, and politically (Succar and Sher 2014) integrates entire project information into a digital platform for all project team members to access and/or operate on (Miettinen and Paavola 2014; Udomdech et al. 2018). BIM assists in hindering complex and uncertain issues found from built environment operations (Miettinen and Paavola 2014; Santos et al. 2017). It is a radical challenge for built environment SMEs as it completely renders existing working paradigm obsolete (Eadie et al. 2015; Migilinskas et al. 2013). BIM is heavily used during the design phases of a project, where designers and engineers are the first to operate on BIM in the adoption (Ding et al. 2015; Eadie et al. 2015; Ghaffarianhoseini et al. 2017). Skills and abilities of individuals to execute BIM-related tasks, or individual BIM competences are the key element to successful BIM adoption of an organisation (Dainty et al. 2017; Succar and Sher 2014). Using BIM as the evincing innovation, this paper poses the research question: *"through the study of PBL mechanisms, how can organisational ambidexterity at the project level assist the built environment SMEs in radical innovation adoption?"*

RESEARCH METHODOLOGY

COMPARATIVE CASE STUDY

The paper compares cases of different PBL mechanisms within project teams from various built environment SMEs adopting BIM. The study stands on constructivist ontology, as well as constructivist epistemology. An acquisition of innovation-related knowledge is personal, and relies heavily on social and contextual aspects of an organisation (Bartsch et al. 2013; Bresnen et al. 2005). Referring to Yin (2014), the unit of analysis of this research is a BIM-operating project team within a design and engineering SMEs consultancy. A BIM-operating project team is a project team that functions entirely on BIM. Design and engineering consultancies are types of organisation that primarily adopt BIM (Ding et al. 2015; Eadie et al. 2015). Informants of this study are designers and engineers working hands-on with BIM. These include project roles such as architects, designers, and engineers. One consultancy represents a case. Selected design and engineering consultancies contain from 10 to 250 personnel to be considered SMEs (European Commission 2009).

DATA COLLECTION

Works presented in this paper is ongoing. The research focused on three cases from the aim of eight to twelve, or until it reaches data saturation. Details of collected are described in Table 3.

Table 3: Description of case studies.

	Case 1	Case 2	Case 3
Number of informants	1	1	1
Roles of informants	Building services engineer	Architect and BIM manager	Architect and BIM project leader
Organisational types	Building services engineer	Architecture	Architecture
Organisation sizes	Medium	Small	Small
Project types	Commercials and offices	Residentials and mix-used	Offices, co-working spaces, and renovations
Assigned identifier of informants	ID 1 BSE01	ID 2 ARC01	ID 3 ARC01

Informants were interviewed through semi-structured interview approach. Semi-structured interview approach allow researchers to gain relevant insights, as well as permits additional exploration to emergent findings (Mohd Noor 2008). The interviews were based on questions such as the following:

- Could you please provide basic information of yourself, this organisation, and projects you are working on?
- Can you please explain how BIM was adopted within the organisation and your projects?
- Within this project, what are knowledge practices used to transfer and learn BIM-related knowledge?
- Amongst all mentioned knowledge practices, which is the most effective, which follows, and why?
- What influencing attributes within your project team affects the mentioned knowledge practices and how?
- Which of the mentioned project influencing attributes affects most to your learning of BIM, which follows, and how?

DATA ANALYSIS

The interviews were anonymously recorded, transcribed, and imported into NVivo qualitative data analysis software. Supporting elements to project knowledge practices and project influencing attributes were primarily coded into nodes (Saldaña 2015). Afterwards, relationships between nodes were coded to generate initial understanding of PBL mechanisms of each case. Through abductive reasoning approach, PBL mechanisms found were analysed to the theoretical background of organisational ambidexterity. The cases were compared to foster insights to the research question posed.

PRELIMINARY DATA AND FINDINGS

CASE 1 FINDINGS

The first case was a medium-sized building services engineering consultancy that had adopted BIM since 2005. The organisation adopted BIM from its operational and cost-saving benefits in the construction phase. The informant from case 1, or ID 1 BSE01 highlighted PBL mechanism 1a (Table 4) as the most eminent for project team members in learning BIM. PBL mechanism 1a contained project knowledge practices of recruitment and reassignment of project members. The relevant practice found was to ensure a balance mix of personnel that can assist others on BIM and those with inferior BIM competences. ID 1 BSE01 stated *"..., the project team is comprised of the right mixture of those who needs supervision on BIM and those that can supervise ... technicians are then distributed across the office into different team and then the dynamic suddenly changed."* ID 1 BSE01 explained further that this PBL mechanism is facilitated by and contain positive influence on project climate of knowledge sharing culture, relationships, and shared understandings of different project personnel. ID 1 BSE01 added *"..., you have to bring them together and form a culture of knowledge sharing. You need to create a culture of people not working against each other. The idea was more like making sure that everyone is moving together, ..."* ID 1 BSE01 found the learning of BIM to be more individually on the job, rather than through classrooms or formal trainings. It was added *"..., I believe that 70% of that happens on the job. 10% to my mind, is through classroom. Classrooms have that particular function where you get a whole room of people together, and you get them really excited. They will learn very little, and what they learn they will forget tomorrow."* PBL mechanisms found were summarised in Table 4.

Table 4: Case 1 PBL mechanisms.

PBL mechanisms	Project knowledge practices	Relationships	Project influencing attributes
1a	Recruitment and reassignment of project members (ensuring a balance mix of personnel that can assist others in BIM, and those with inferior BIM competences)	Facilitated by and positive influence on	Project team context (project climate and project structure)
			Project team relationships (cognitive aspects and relational aspects)
1b	Promotion of knowledge sharing culture (having enthusiastic BIM trainer during trainings and classrooms)	Positive influence on	Project team context (project climate)
		Facilitate by	Project team context (project resources)
1c	Standardised operations and manuals (BIM Execution Plan, or BEP to ensure that all personnel understand the same thing and working towards the same direction)	Positive influence on	Project team relationships (cognitive aspects)
1d	Shared knowledge repositories (a BIM knowledge pool)	Positive influence on	Project team relationships (cognitive aspects)

	Project team context (project climate)

CASE 2 FINDINGS

The second case concerned a small-sized architectural consultancy. BIM was adopted in 2007 to hinder detachment problems between 2D drawings and 3D models, as well as to enhance organisational workflow. PBL mechanisms 2d and 2f (Table 5) were emphasised. PBL mechanism 2d contained a relevant practice of internal BIM manuals, where it was considered as project knowledge practices of standardised operations and manuals. This practice was described as having positive influence on sustaining knowledge sharing culture and shared representations, interpretations, and system of meanings of BIM among team members. ID 2 ARC01 explained *"The aim here was to, if for example, you didn't know how to use BIM, and you try to set up a project for example, and there was no one else around. Technically, this gives context …, it is like, a BIM user guide, but we have just done it for our internal use."* This practice was elaborated further as being *live*. ID 2 ARC01 added *"It is a live document, so, the idea is that we are meant to review that every couple of months and see if anything has changed."*

PBL mechanisms 2f held project knowledge practices of informal meeting, or the brown bag session. This knowledge practice yields positive influence on project team relationships and project team context. ID 2 ARC01 justified *"…, so brown bag is, meaning, the American phase meaning for lunch time sort of session … someone might be researching or done something interesting, and we encourage them to just sort of … present that finding."* ID 2 ARC01 further clarified how this PBL mechanism allows cross-projects learning of BIM. ID 2 ARC01 included *"If we find elements or areas where everyone is having a problem … we are going to have a session where a person is going to present a way to do it in the brown bag session."*

In addition, ID 2 ARC01 stressed the relevance of individual BIM competences to BIM learning and adoption. ID 2 ARC02 referred *"…, since we have so much knowledge within the office, if people have problems, we just, teach on-the-go …, we like to ensure that everyone is equally and capable of doing the job …, and that everyone is the BIM manager."* PBL mechanisms discovered were explained in Table 5.

Table 5: Case 2 PBL mechanisms.

PBL mechanisms	Project knowledge practices	Relationships	Project influencing attributes
2a	Standardised operations and manuals (The use of the British Standard as an external reference document)	Positive influence on	Project team climate (cognitive aspects)
2b	Trainings and workshops (three days BIM essential course for new personnel)	Facilitated by	Project team context (project resources)
2c	Informal meeting (personnel asking one another questions across the office)	Pressured by	Project operational context (time urgencies)
			Project team relationship (temporal aspects)

		Facilitated by	Project team context (project climate)
2d	Standardised operations and manuals (internal BIM manuals, a constantly updated best practice documents explaining how to operate on BIM)	Facilitated by and positive influence on	Project team relationships (cognitive aspects)
			Project team context (project climate)
2e	Standardised operations and manuals (BEP that is constantly updated by project architects and BIM project leader)	Positive influence on	Project team relationships (cognitive aspects)
			Project team context (project climate)
2f	Informal meeting (brown bag sessions, where personnel present new findings from projects)	Positive influence on	Project team relationships (cognitive aspects and relational aspects)
			Project team context (project climate)
2g	Post project review (quarterly meeting, where personnel findings and update them into BEP or internal BIM manuals)	Positive influence on	Project team relationships (cognitive aspects and relational aspects)
			Project team context (project climate)
2h	Promotion of knowledge sharing culture (open-plan office)	Positive influence on	Project team relationships (cognitive aspects and relational aspects)
		Facilitated by	Project team context (project climate)
2i	Recruitment and reassignment of project members (having enthusiastic personnel in BIM learning within the team)	Positive influence on	Project team relationships (cognitive aspects and relational aspects)
			Project team context (project climate)
2j	Professional network (engage project personnel in conferences and BIM-related events)	Positive influence on	Project team relationships (cognitive aspects)
		Facilitated by	Project operational context (time urgencies)

CASE 3 FINDINGS

The third case was a small-sized architectural consultancy. The organisation adopted BIM in 2017 to gain more control of projects. ID 3 ARC01 initially emphasised a) individual BIM competences to BIM learning and adoption and b) having a BIM leading role within the team. ID 3 ARC01 explained *"..., if someone who is not familiar with BIM, I or someone more experience will spend more time with that person to explain how everything works internally."*

Furthermore, PBL mechanism 3i (Table 6) was highlighted. PBL mechanism 3i contained relevant practice of *happy Friday*, where it was categorised under informal meeting project knowledge practices. ID 3 ARC01 described *"... fortnightly we have, called happy Friday within the company ... we present things like, this project we*

have these problems because of this … in terms of BIM, it is just the sharing of knowledge and experience that we found it much easier than the normal way, …" ID 3 ARC01 pointed that this PBL mechanism must be facilitated by close relationships between personnel and a knowledge sharing culture to ensure that learning is echoed cross-projects and throughout an organisation. ID 3 ARC01 elaborated *"…, because you can present it to everyone, and anyone can comment … we learn more and we discussed a little bit more, so we can start to decide the new way of working."* PBL mechanisms noticed were displayed in Table 6.

Table 6: Case 3 PBL mechanisms.

PBL mechanisms	Project knowledge practices	Relationships	Project influencing attributes
3a	Post project review (semi-formal weekly project team meeting)	Positive influence on	Project team relationships (cognitive aspects and relational aspects)
			Project team context (project climate)
3b	Standardised operations and manuals (internal BIM standards, library, and manuals)	Facilitated by and positive influence on	Project team relationships (cognitive aspects)
			Project team context (project climate)
3c	Partnering (learning through working together with more experienced organisations)	Facilitated by	Project team relationships (relational aspects)
3d	Informal meetings (conversations between personnel)	Facilitated by	Project team context (project climate)
			Project team relationships (relational aspects)
3e	Standardised operations and manuals (BEP)	Positive influence on	Project team relationships (cognitive aspects)
3f	Recruitment and reassignment of project members (having BIM learning role within a team)	Positive influence on	Project team context (project climate)
			Project team relationships (relational aspects)
		Facilitated by	Project team context (project structure)
3g	Project documentations (BIM model archiving)	Positive influence on	Project team relationships (cognitive aspects)
		Facilitated by	Project team context (project resources)
			Project team relationships (temporal aspects)
3h	Trainings and workshops (outsourcing BIM teaching companies)	Facilitated by	Project team context (project resources)
3i	Informal meeting (happy Friday,	Positive	Project team

	an informal meeting where personnel share their experience)	influence on	relationships (cognitive aspects and relational aspects)
			Project team context (project climate)
		Facilitated by	Project team relationships (relational aspects)
			Project team context (project climate)

DISCUSSION

The PBL mechanisms found in the cases were further analysed as to the theoretical background of organisational ambidexterity. PBL mechanisms that relate to an individual learning of BIM were considered as exploration, while PBL mechanisms which assist project teams and organisations in refining their operations and processes were labelled as exploitation (Brady and Davies 2004; Levinthal and March 1993).

Notwithstanding, the study determines a number of PBL mechanisms to incorporate both explorative and exploitative learning processes. Categorisations of PBL mechanisms are presented in Table 7.

Table 7: Categorisations of PBL mechanisms.

Learning processes	PBL mechanisms found		
	Case 1	Case 2	Case 3
Exploration	1a, 1b, and 1c	2a, 2b, 2c, 2h, 2i, and 2j	3a, 3c, 3d, 3e, 3f, and 3h
Exploration and exploitation	1d	2d, 2e, 2f, and 2g	3b, 3g, and 3i

Despite similar project knowledge practices found from all cases, each case is unique. Whereas the presented data and findings are preliminary from an ongoing study, several points can be forwarded.

The importance of individual BIM competences to BIM adoption – All PBL mechanisms found contained an exploration process for individuals to acquire BIM-related knowledge and gain BIM competences. This aligned with Dainty et al. (2017) and Succar and Sher (2014), where individual BIM competences are key elements to successful BIM adoption. Individuals with greater BIM competences could assist those with inferior BIM competences. This was stressed primarily by ID 1 BSE01. Learning was found to be more productive on the job. PBL mechanism 1a (recruitment and reassignment of project members: ensuring a balance mix of personnel that can assist others in BIM, and those with inferior BIM competences) was underlined by ID 1 BSE01. It was supported by the discoveries of similar PBL mechanisms such as 2c (informal meeting: personnel asking one another questions across the office), 2h (promotion of knowledge sharing culture: open-plan office), and 3f (recruitment and reassignment of project members: having BIM learning role within a team). These PBL mechanisms were facilitated by a knowledge sharing culture of a project team.

The insignificance of trainings and workshops – Formal learning through trainings and workshops were inferred as ineffective. ID 1 BSE01 specifically

brought up the inferiority of classrooms. While the paper found PBL mechanisms that relate to trainings and workshops project knowledge practices from case 2 and 3 (PBL mechanisms 2b and 3h), they were not described as significant compared to other PBL mechanisms such as 2d (standardised operations and manuals: internal BIM manual), 2f (informal meeting: brown bag session), and 3i (informal meeting: happy Friday). This complimented the previous point stated.

The *ambidextrous* PBL mechanism – All cases possessed PBL mechanisms that could be identified as *ambidextrous*, having both exploration and exploitation within one PBL mechanism. PBL mechanisms 1d, 2d, 2e, 2f, 2g, 3b, 3g, and 3i (Table 7) were determined as ambidextrous. These ambidextrous PBL mechanisms simultaneously allowed individual BIM learning and support refinement of project and organisational operations. This expanded works of Brady and Davies (2004), Eriksson (2013), and Levinthal and March (1993). At the project level, organisational ambidexterity did not imply only to a balance mix of exploration and exploitation PBL mechanisms, but rather denote to a precise blend of exploration and ambidextrous PBL mechanisms. Strong relations between ambidextrous PBL mechanism and project climate of knowledge sharing culture were also found. Major activities that contributed to the creation of a knowledge sharing culture were a) having a BIM-related knowledge sources that are constantly updated (PBL mechanisms 2d and 3b) and b) containing cross-projects informal learning sessions (PBL mechanisms 2f and 3i). Both activities made PBL mechanisms ambidextrous as they foster learning and refine processes and operations cross-projects and throughout organisations. Cases 2 and 3 could be classified as *high ambidextrous*. The number of ambidextrous PBL mechanisms could also be used to sort cases and organisations. Further investigations would allow a confirmation on whether higher ambidextrous equals to successful BIM learning and adoption.

CONCLUSION

Built environment organisations adopt innovations to counter complex and uncertain challenges of built environment operations. Radical innovation adoption is excessive for built environment SMEs to master. Insufficient personnel within adequate competences to the adopting radical innovation is the main problem. Project level organisational ambidexterity is a potential solution that can be assessed by examining PBL mechanisms, systems in which individuals acquire innovation-related knowledge. Project level organisational ambidexterity allows radical innovations to be learned and adopted simultaneously in different organisational levels.

Through ambidextrous PBL mechanisms, individuals can gain innovation-related knowledge and competences while concurrently, knowledge is transferred cross-projects and refined within organisational processes and operations. The paper also emphasises how individuals with inferior innovation-related competences can effectively and informally learn from those with greater competences. It is important to have a knowledge sharing culture where radical innovation-related knowledge can be shared, discussed, and learned. The number of ambidextrous PBL mechanisms can be used to categorise organisations, where those with a great number of ambidextrous PBL mechanisms can be sorted as high ambidextrous. From this paper, cases 2 and 3 are identified as high ambidextrous, while case 1 can be referred to as low ambidextrous.

Practically, project managers and senior managerial personnel can apply these findings to adjustments of PBL mechanisms to encourage radical innovation adoption. More attentions on the formulation of ambidextrous PBL mechanisms and the knowledge sharing culture are advised. Theoretically, this study expands on literature of organisational ambidexterity at the project level. It also contributes to researches on BIM, innovation-related competences, and radical innovation adoption. Since this investigation is ongoing, later findings potentially contribute to current discoveries. Future researches on project level organisational ambidexterity itself and to different types of radical innovation adoption are recommended.

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