ABSTRACT

For the past decade, innovation in construction has been a topic of interest for many academicians and industry practitioners. In particular, numerous studies have investigated the influential factors which can lead to successful innovation outcomes for organisations striving to excel in their particular industry. However, the majority of existing research models tended to depict the effects of macro-level variables on innovation outcomes yet overlooked the potential mediating role of intra-organisation dynamics, especially of organisational climate. This paper attempts to overcome these deficiencies by building a more robust model that accommodates the numerous variables which encapsulate the collective innovation climate of an architecture and engineering design (AED) firm. The developed conceptual model includes the hierarchical key enablers of innovation diffusion, namely, organisational culture, leadership and team climate. Fostering such innovation enablers should undoubtedly deliver outcomes for AED firms in terms of state-of-the-art technology utilisation, best-practice design solutions and other products of innovation. Moreover, AED firms that proactively implement strategies for accommodating innovation should also experience improvements in business performance. Ultimately, the competitiveness of AED firms in the knowledge economy will depend on their ability to embrace technological and organisational changes while fostering and supporting dispersed teams.

Keywords: Architecture and Engineering Design, Innovation Diffusion, Organisational Culture, Team Climate Inventory

1. INTRODUCTION

To many organisations, innovation is considered to be a *sine qua non* for their business success and proliferation in the current competitive, complex and capricious environment. Evidence can be seen from the rapidly changing industries such as information technology, automobiles, biotechnology, etc. where innovation is a prescription not just for organisations to succeed but to survive in their particular industry. In construction, despite being seen as a mature industry in which changes are developing slowly, innovation is needed to form the backbone of a company’s strategy in order to accommodate rapid changes embodied in complex products and processes (Manseau, 2005; Slaughter, 2000). In this vein, the internal dynamics of construction organisations must be such that they are flexible, adaptive, and responsive to change (Steele and Murray, 2004). A great deal of research has
attempted to study the key to success of construction innovation by focusing on the macro-level factors that affects innovation. However, there is still a limited number of empirical studies focusing on intra-organisation dynamics which could potentially regulate the effectiveness of innovation. Moreover, despite the fact that architecture and engineering design (AED) is one of the most critical processes in the construction project life cycle, innovation in this specific area has remained largely unexplored. It should also be noted here that, although there are some recently developed models which evaluate the innovation climate of a firm and the resulting business outcomes, such models seem incongruous in construction, especially in the AED context. To overcome these deficiencies, a model for innovation diffusion evaluation is required, particularly for AED organisations.

2. CONCEPTUAL MODEL DEVELOPMENT

Researchers have suggested the importance of various factors that potentially affect innovation in an organisation such as leaders, champions, organisational culture and climate, group processes and resources (King and Anderson, 1990). In construction, many research studies have also postulated the importance of these factors by demonstrating some certain organisational behaviours and characteristics which influence innovation in construction (e.g. Dikmen et al., 2005; Steele and Murray, 2004). These factors were integrated and commonly used for developing instruments for measuring organisational climate for creativity and innovation (e.g. Amabile et al., 1996; Ekvall, 1996; Siegel and Kaemmerer, 1978).

The aforementioned organisational factors are undoubtedly crucial as antecedents to innovation. However, the process of achieving effective innovation diffusion is far more challenging to realistically model and evaluate for AED organisations because of the impact of numerous other complex social-psychological factors. Moreover, it is the dynamics of these factors that constitute certain social process in the organisation which is, in fact, one of the major elements in Rogers’s (1983) theory of innovation diffusion. Therefore, to adequately evaluate innovation diffusion, it would be sensible to understand the relational behaviours of these factors in addition to the identification of organisational factors affecting innovation. Based on these premises, a conceptual model has been developed to evaluate innovation diffusion by focusing on the dynamics of social factors within the organisation. Essentially, this conceptual model attempts to understand the relationship between three major social-psychological factors, which generally exist in an organisation and potentially influence the diffusion of innovation, including organisational culture, leadership and team climate. Figure 1 illustrates the proposed model with hypotheses developed for future research.

3. CLIMATE FOR INNOVATION

Over the past 30 years, various definitions of climate have been put forward. Among them, as summarised by Anderson and West (1998), two main approaches have received considerable support – the cognitive schema approach and the shared perceptions approach. The former focuses on individual perception of proximal environments (i.e. psychological climate) while the latter emphasises on the shared perception regarding organisational practices, policies and procedures (i.e.
organisational climate). In fact, these two approaches are not mutually exclusive. When appropriately operationalised, psychological climate can be aggregated to represent organisational climate, alternatively referred as “collective climate” (Joyce and Slocum, 1984).

According to Figure 1, a collective climate for innovation encompasses the perceptions of three hierarchical levels of organisational climate which are management level, supervisory level and peer level. These three climate levels are represented by the terms organisational culture for innovation, leadership for innovation, and team climate for innovation, respectively.

**Organisational Culture for Innovation**

Given the fact that consensus is not easily achieved among researchers, it is not unusual that the terms “climate” and “culture” have been used synonymously, and are sometimes overlapped (Patterson *et al.*, 2005). Since both terms are used in this paper, it is important to differentiate between the meanings of them. The term organisational culture is used here to represent a set of perceived norms and routines, resulting mainly from collective management practices manifested in an organisation. Noting that, unlike the climate which is in the foreground of member’s perceptions, culture in this regard is more in the background and defined by beliefs and values which form an integral part of the general functioning of the organisation (Burke and Litwin, 1992). Essentially, exploring into an organisational culture can help explain employee’s perception of organisational climate (Patterson *et al.*, 2005).

During the past decade, research on innovation has demonstrated a number of cultural factors that lead to creativity and innovation in organisations. Four factors, which are creativity stimulation and encouragement, freedom and autonomy, recognition, and resource allocation, have been commonly addressed in the literature as innovation-
conducive cultures. Table 1 describes organisational culture for innovation sub-factors and their associated references.

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<tr>
<th>Sub-factor</th>
<th>Description</th>
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<tr>
<td>Creativity stimulation and</td>
<td>Concerned with the culture that stimulates and encourages creativity in terms of degree of flexibility, risk propensity, and encouragement in the organisation.</td>
<td>Amabile et al., 1996; Ekvall, 1996; Siegel and Kaemmerer, 1978</td>
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<td>Freedom and autonomy</td>
<td>Concerned with the extent to which an organisation allows members to have choice in how to carry out their work.</td>
<td>Amabile et al., 1996; Ekvall, 1996; Patterson et al., 2005</td>
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<td>Recognition</td>
<td>Concerned with the extent to which people are recognised for their innovation efforts and achievement</td>
<td>Amabile et al., 1996; Chandler et al., 2000; Scott and Bruce, 1994</td>
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<tr>
<td>Resource allocation</td>
<td>Concerned with the perceived availability of resource in terms of training, manpower, time and money set aside for innovation activities</td>
<td>Chandler et al., 2000; Martins and Terblanche, 2003; Scott and Bruce, 1994</td>
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Empirically, perceived innovation culture has been found in many studies to be associated with other elements in the proposed model. Scott and Bruce (1994) in their study of engineers, scientists and technicians employed in a large R&D facility found that perceived organisational support for innovation (characterised by flexibility, creativity encouragement, freedom and recognition) is positively related to innovative behaviour. By adapting Scott and Bruce’s measurement, Park et al. (2004) and Dulaimi et al. (2005), in their recent series of study, found that resource supply influences the championing behaviour of construction project managers, and is a motivator of construction project team members which drive innovation effort in team. Furthermore, they also found a significant relationship between perceived support for innovation and level of innovation in construction projects.

Leadership for Innovation

Leaders and champions are commonly identified as crucial players for the success of innovation in construction projects (Nam and Tatum, 1997). Among many theories of leadership, transformational leadership (Bass and Avolio, 1994), change-oriented leadership (Yukl et al., 2002), innovation championing (Howell and Higgins, 1990), and leader-member exchange (LMX) (Graen and Uhl-Bien, 1995), have been recognised as relevant to innovation and creativity in organisation. By reviewing these theories, it is found that there are compatibility and similarity among the underlying concepts. Therefore, relevant factors from each leadership style have been synthesised into four factors characterising innovation-conducive leaders including encouraging and stimulating innovation, providing and inspiring vision, individualised support, and teamwork development. Table 2 details sub-factors of the leadership for innovation along with their associated references.

Relationships between leadership styles and perceptions of innovation climate have been identified in past empirical studies. Tierney (1999) found a positive link between the quality of LMX relationship and employees’ perception of change-conducive climate. Scott and Bruce (1999) also found significant and positive
relationships between the quality of LMX relationship and perceived innovation-supportive climate as well as between the quality of LMX relationship and innovative behaviour. In addition, many authors have also suggested that there is an influence of transformational leadership on team climate for innovation (e.g. Dackert et al., 2004; Pirola-Merlo et al., 2002).

**Table 2 Leadership for innovation sub-factors**

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<tr>
<td>Encouraging and stimulating innovation</td>
<td>Concerned with the degree to which a supervisor inspires, seeks out, promotes and support creative idea and innovative approach in solving problems</td>
<td>Bass and Avolio, 1994; Howell and Higgins, 1990; Yukl et al., 2002</td>
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<tr>
<td>Providing and inspiring vision</td>
<td>Concerned with the extent to which a supervisor creates, communicates and inspires a shared vision</td>
<td>Bass and Avolio, 1994; Podsakoff et al., 1990</td>
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<tr>
<td>Individualised support</td>
<td>Concerned with the quality of supportive relationships between a supervisor and subordinates</td>
<td>Graen and Uhl-Bien, 1995; Tierney, 1999</td>
</tr>
<tr>
<td>Teamwork development</td>
<td>Concerned with the degree to which leaders involve team members and share information and resources when making decisions</td>
<td>Bass and Avolio, 1994; Podsakoff et al., 1990; Yukl et al., 2002</td>
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**Team Climate for Innovation**

Since teams have become an important building block in organisations, understanding factors that hinder and foster creativity and innovation in teams is of utmost important (Nijstad and De Dreu, 2002). Teams are particularly important for construction organisations where business survival relies upon the ability to integrate dispersed knowledge, skills and abilities (KSAs) of project team members. Basically, by combining KSAs of individual with different perspectives and backgrounds, teams provide ideal conditions for stimulating creativity and innovation via social and psychological processes (Bain et al., 2001). As a result, focusing on teams and creating necessary condition for them is one mean by which innovation can be fostered in organisations (Mohamed, 2002). Despite this, the study of innovation climate at team level has not received adequate attention. This point has been well taken by Anderson and West (1998) who point out that there has been a paucity of research that addresses the work group or team as a level of analysis distinct from the wider organisation or the individual. They further assert that an appropriate level to analyse the perception of climate is the proximal work group.

To study the innovation climate at team level, this paper adopts the model for team climate for innovation presented by West (1990). The author proposed the “four-factor theory” which basically outlines four essential climates for innovation including vision, participative safety, task orientation, and support for innovation. This theoretical model subsequently led to the development of the instrument for measuring climate for innovation in teams namely “Team Climate Inventory (TCI)” (Anderson and West, 1998). Table 3 describes team climate for innovation sub-factors and their associated references. According to past empirical studies, team climate for innovation was identified as a predictor of innovation outcomes by many authors. For example, in a study among work groups of a U.K. oil company,
Burningham and West (1995) found an association between team climate and innovative ideas. Another finding that suggests the important role of team climate is that of Pirola-Merlo et al. (2002), they found that team climate mediates the relationship between leadership and performance among the members of R&D teams.

Table 3 Team climate for innovation sub-factors

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<tr>
<td>Vision</td>
<td>Concerned with the establishment of a team’s clearly defined and shared vision that provides focus and direction to team members as a motivating force at work</td>
<td>Anderson and West, 1998; West, 1990</td>
</tr>
<tr>
<td>Participative safety</td>
<td>Concerned with the degree to which involvement in decision making is motivated and reinforced without fear of criticism among team members</td>
<td>Anderson and West, 1998; West, 1990</td>
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<tr>
<td>Task orientation</td>
<td>Concerned with the degree of shared concern with quality of task performance in relation to shared vision or outcomes among team members</td>
<td>Anderson and West, 1998; West, 1990</td>
</tr>
<tr>
<td>Support for innovation</td>
<td>Concerned with the degree of expectation, approval and practical support of attempts among team members to introduce new and improved ways of doing things</td>
<td>Anderson and West, 1998; West, 1990</td>
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4. INNOVATION DIFFUSION OUTCOMES

Innovation diffusion is defined by Rogers (1983, p. 34) as “the process by which an innovation is communicated through certain channels over time among the members of a social system”. In addition, innovation diffusion involves the process of either adopting or generating the innovation (Gopalakrishnan and Damanpour, 1994). Thus, this paper focuses on evaluating the outcomes of innovation diffusion process in terms of: (1) the utilisation of state-of-the-art technologies (e.g. CAD, VR), and pioneered methods or concepts (e.g. green design, value-based design) that facilitates the design activities and practices; and (2) innovative design products or solutions (e.g. awarded design, flexible design). Table 4 describes the sub-factors of innovation diffusion outcomes and their relevant references.

5. BUSINESS PERFORMANCE

Since innovation is a key to survival to many organisations, effective innovation that contributes to the significant performance improvement of the firm must be ensured. Thus, evaluating the efficacy of innovation should take into account factors that indicate the competitiveness of the organisation relative to innovation efforts. One mean by which the assessment of organisation’s competitiveness can be achieved is to look at the business performance, which can be measured in a number of ways. Table 5 presents sub-factors which are used to measure business performance along with their associated references. Generally, it has been anticipated that business performance will be improved with the presence of innovation. This notion has been
attested by past empirical studies which identified a relationship between innovation and organisational performance (e.g. Han et al., 1998; Agarwal et al., 2003)

Table 4 Innovation diffusion outcomes sub-factors

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<th>Sub-factor</th>
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<th>References</th>
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<tr>
<td>Innovation utilisation</td>
<td>Concerned with the degree of utilisation of state-of-the-art technology and pioneered theories or concepts that facilitates the design activities and practices</td>
<td>Kale and Arditi, 2005; Manley and McFallan, 2003; Mohamed, 2002; Tang et al., 2003</td>
</tr>
<tr>
<td>Innovative design products</td>
<td>Concerned with the level of innovativeness of the design solutions</td>
<td>Ng and Chow, 2004; Tang et al., 2003</td>
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Table 5 Business performance measures

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<tr>
<td>Financial performance</td>
<td>Concerned with the level of profitability, turnover growth, and market share</td>
<td>Darroch, 2005; Kale and Arditi, 2003</td>
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<tr>
<td>Business competitiveness</td>
<td>Concerned with the degree of business competitiveness in terms of reputation and ability to gain new contracts</td>
<td>Kale and Arditi, 2003</td>
</tr>
<tr>
<td>Client satisfaction</td>
<td>Concerned with the level of client satisfaction</td>
<td>Agarwal et al., 2003</td>
</tr>
<tr>
<td>Goal achievement</td>
<td>Concerned with the degree to which the firm’s most important goals are being met</td>
<td>Darroch, 2005</td>
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6. RESEARCH HYPOTHESES

As illustrated in Figure 1, a number of relationships between model constructs may exist and should be investigated. In total, seven hypotheses, representing the relationships between constructs of the proposed innovation diffusion evaluation model, have been developed:

- H1: Organisational culture for innovation positively influences leadership for innovation
- H2: Leadership for innovation positively influences team climate for innovation
- H3: Organisational culture for innovation positively influences team climate for innovation
- H4: Leadership for innovation positively influences innovation diffusion outcomes
- H5: Organisational culture for innovation positively influences innovation diffusion outcomes
- H6: Team climate for innovation positively influences innovation diffusion outcomes
- H7: Innovation diffusion outcomes positively influence business performance

At present, work is underway to ascertain the validity of the factors and relationships illustrated in the proposed model. A questionnaire is being carefully developed based on the extensive review of existing literature and past empirical studies. The complete
questionnaire will be administered in Australia, targeting design team members’ of various AED firms. The questionnaire will contain a number of statements reflecting the model constructs and respondents will be requested to rate the performance of individual innovation enabler and outcome variables. Following the questionnaire dissemination and data analysis, a series of case studies with specific AED firms in Australia will be conducted to confirm the validity of the model.

7. SUMMARY

Despite numerous studies addressing construction innovation, academicians and practitioners still lack a comprehensive understanding on how intra-organisational factors can lead to effective innovation diffusion. However, one finding that is consistently supported in the literature is that innovation diffusion must be implemented within a climate that is perceived by employees to be supportive. Furthermore, innovation activities tend to engage complex social-psychological processes in an organisation. Therefore, a robust innovation diffusion evaluation model needs to encapsulate the dynamics between the organisational culture, leadership, and team climate that capture the collective climate for innovation. The proposed model developed in this paper should enable AED organisations to understand, through the eyes of their team members, the dynamics of their existing conditions and desired outcomes. Moreover, the model should expound on the competitiveness of AED organisations by reflecting their abilities to effectively embrace technological and organisational changes. This could guide the organisations to develop prudent strategies for accommodating innovation to achieve short-term goals and, ultimately, to sustain long-term competitiveness.

8. REFERENCES


West, M. A. (1990), 'The social psychology of innovation in groups', in M. A. West and J. L. Farr (eds), Innovation and Creativity at Work, John Wiley & Sons, Chichester, pp. 309-333.