The strategic importance of tacit knowledge management activities in construction

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Abstract

Purpose – Tacit knowledge is perceived as the most strategically important resource of the construction organisation, and the only renewable and sustainable base for its activities and competitiveness. Knowledge management (KM) activities that deal with tacit knowledge are essential in helping an organisation to achieve its long-term organisational objectives. The purpose of this paper is to provide empirical evidence for the stronger strategic role of tacit KM in comparison to explicit KM.

Design/methodology/approach – A questionnaire survey was administered in 2005 to a sample of construction contractors operating in Hong Kong to elicit opinions on the internal business environment, intensity of KM activities as executed by targeted organisations, and contribution of these activities to business performance (BP). A total of 149 usable responses were received from 99 organisations representing about 38 per cent of the sampling frame. The statistical analyses helped to map the reported KM activities into two groups that, respectively, deal with tacit and explicit knowledge. The sensitivity to variations of organisational policies and strength of association with BP in relation to the two groups of KM activities were also compared empirically. A total of 15 interviews with the managerial and professional staff of leading contractors was undertaken to provide insightful narratives of KM implementations.

Findings – The effective implementation of organisational policies, such as encouraging innovations and strengthening strategic guidance for KM, would facilitate human interactions of tacit KM. Higher intensity of activities in managing tacit knowledge would ultimately help the organisations to achieve economic gain in the long run.

Originality/value – The stronger strategic role of tacit KM is empirically investigated and established within the context of construction organisations.

Keywords Knowledge management, Tacit knowledge, Strategic management, Balanced scorecard, Construction industry, Hong Kong

Paper type Research paper

Introduction

Knowledge management (KM) is a recent and evolving practice for construction organisations (Robinson *et al.*, 2005). Within the construction context, the KM process has been perceived as the combination of a series of activities for identifying, capturing, sharing and using knowledge (Palmer and Platt, 2005). The ultimate aim of this process is to leverage organisations' intellectual capital to achieve organisational objectives (Cavaleri, 2004; Sveiby, 1997). Two broad types of KM activities have been reported as being applied by construction organisations (Bresnen *et al.*, 2003). Activities focusing on tacit knowledge address the storage of knowledge in human minds and its transfer

through direct human interactions; whilst those focusing on explicit knowledge stress the codification of knowledge, and are primarily concerned with its retention and circulation within the organisation via the application of information and communication technology (Fernie *et al.*, 2003). Previous studies (Egbu *et al.*, 2003; Fong, 2005; Peansupap and Walker, 2005; Stewart *et al.*, 2004; Tserng and Lin, 2004) revealed that construction organisations are better equipped with strategies revolving around explicit knowledge captured and leveraged using information technology (IT) tools. These include the intranet, document management systems, groupware and online collaboration tools or project extranet. Nevertheless, the organisations have less systematic approaches for managing tacit knowledge (Woo *et al.*, 2004). The limitations of an IT-based view of knowledge capture and codification have long been emphasised, since the processes of knowledge capture, transfer and learning in construction project settings relies heavily upon social patterns and practices. These project specific practices focus on establishing a shared system of meaning for understanding, accepting and deploying tacit knowledge (Bresnen *et al.*, 2003).

The importance of tacit knowledge in relation to organisational performance and achievement of competitive advantage is well recognised (Baumard, 1999). In construction, the relevance of tacit knowledge to organisational performance has also been reported (Fernie *et al.*, 2003; Pathirage *et al.*, 2007). Nevertheless, the strategic role of tacit knowledge in helping organisations to achieve long-term objectives is relatively unexplored (Pathirage *et al.*, 2007). While an increasing number of construction organisations now perceive KM as an integral aspect of business improvement, there are major difficulties associated with its application, such as establishing a strategy that balances the resources in managing both tacit and explicit knowledge and evaluating its benefits (Robinson *et al.*, 2005).

Organisational learning (OL) occurs when individuals within an organisation experience a problematic situation and inquire into it on the organisation's behalf (Argyris and Schön, 1978). It is perceived as a cognitive process that results in new knowledge being created (Sun and Scott, 2003). An inherent feature of both KM and OL is the sharing of ideas to create and develop new knowledge, enhanced by conducive organisational structures and culture and supported by an effective KM system (Pemberton and Stonehouse, 2000). As Szulanski (2003) pointed out, during the OL process, evolving productive knowledge embedded in individual skills and in technological artefacts is increasingly better coordinated through complex and partially tacit social arrangements, yielding smoother and more productive collective activities. Such a combination of productive knowledge is referred to as an organisational routine. Knowledge-related activities are seen as fragmented, distributed and embedded in organisational routines. Thus, these activities may be seen as a manifestation of organisational knowledge (Szulanski, 2003). Accordingly, the strategic role of tacit knowledge can be reflected by activities that deal with this type of knowledge.

This paper reports a research study that aims at revealing the strategic importance of tacit KM activities within the context of construction organisations. The findings of the study shed light on the above issue through empirically comparing the strategic roles of the two types of KM activities, which, respectively, deal with tacit and explicit knowledge, in terms of their contribution to business performance (BP). In the paper, the strategic importance of tacit knowledge is reviewed, and a theoretical framework of KM process is proposed. The empirical study process is reported and the findings are

presented to reflect the comparative stronger association of tacit KM activities with variations of organisational policies and BP. The narratives about KM activities within the context of construction operations are also presented to illustrate the qualitative insights of the statistically identified associations. Finally, general conclusions are drawn and implications for construction organisations are suggested.

Strategic importance of tacit knowledge

The knowledge-based view of firm argues that knowledge implies sustainable heterogeneous resource distribution, and is deeply idiosyncratic and hard to transfer and imitate (Venzin *et al.*, 1998), and consequently posits that the knowledge-based asset may produce long-term sustainable competitive advantage (Sanchez, 2001). Accordingly, knowledge is defined as a justified belief that increases an entity's capacity for effective action; it can be viewed as a valuable strategic asset in the form of organisational capability with the potential for influencing future actions (Nonaka and Takeuchi, 2004).

Knowledge is typically classified as either tacit or explicit. Tacit knowledge, which draws on the accumulated experience and learning of a person (Debowski, 2006, p. 18), is developed from direct experience and action; highly pragmatic and situation specific; subconsciously understood and applied; difficult to articulate; and usually shared through interactive conversation and shared experience (McAdam *et al.*, 2007). The most frequently used epitomes of tacit knowledge are intuition, skills, insight, know-how, beliefs, mental models and practical intelligence (McAdam *et al.*, 2007). Explicit knowledge, on the other hand, is transmittable in formal, systematic language; and can be conceptualised and stored in information systems (Nonaka and Takeuchi, 2004). Within the organisational setting, there are two major forms of explicit knowledge: declarative knowledge, sets of principles and facts, which can be explained to others; and procedural knowledge, which enables the application of processes (Debowski, 2006, p. 15).

Hicks *et al.* (2007) developed a metaphor to describe knowledge within an organisational context. They stated that explicit knowledge is like an island surrounded and supported (given meaning) by the tacit knowledge sea. Further, they argued that tacit knowledge is needed to create, execute and maintain explicit knowledge, and to select an appropriate computer program, data set, sequence of functions to perform, and produce the output and analysis. Stacey (2001) further pointed out that any explicit, procedural or narrative knowledge can be no more than a resource called upon in the thematic patterning of experience, a tool used in communication interaction. Organisational knowledge lies, instead, in the themes that continuously reproduced that pattern of the experience of being together (Stacey, 2001). Hence, the articulation of tacit knowledge is a key factor in the process of creating new knowledge, which is usually driven by organisational intention to develop its internal capabilities to meet both current and future needs (Nonaka, 2004).

Strategic management acknowledges the importance of tacit knowledge in developing and preserving rents, or in the protection of an organisation's core capabilities from competitors' covetousness (Baumard, 1999, p. 212). Such competence is the ability of an organisation to sustain coordinated deployments of assets and capabilities in ways that help the organisation achieve its goals (Sanchez, 2001). The concept of competence, which embraces factual knowledge, skills, experience, value

judgments and social networks, is the best way to describe knowledge in the business context (Sveiby, 1997, p. 38). As human competence cannot be copied exactly and is transferred by doing (Sveiby, 1997, p. 39), context-specific, tacit knowledge embedded in complex organisational routines and developed from experience, tends to be unique and difficult to imitate. To acquire similar knowledge, competitors have to engage in similar experiences, which takes time (Gottschalk, 2005, p. 56). Hence, tacit knowledge is perceived as a strategic lever in a conflict situation, since it enables an insurmountable barrier to be erected against an adversary: namely, the impossibility of its substitution or imitation, or at least of the high cost of doing so (Baumard, 1999, p. 220). Therefore, tacit knowledge is considered as the most strategically important resource of the firm, and the only renewable and sustainable base for an organisation's activities and competitiveness (Nonaka and Takeuchi, 2004).

Tacit knowledge within construction organisations
Throughout the whole life cycle of a construction project, construction companies rely on employees' experience, professional intuition, and/or other forms of tacit knowledge to accomplish satisfactory work (Woo *et al.*, 2004). Tacit knowledge is applied in both technical processes, which are often highly labour-intensive and management processes, which focus more on problem solving (Robinson *et al.*, 2005). Because of the orientation towards unique projects, most knowledge in the construction industry is experience-based and tacit, and is embedded in the minds of professional and operative workers. This means the potential for improving site management practices depends heavily on the right combination of knowledge and experiences (Mohamed and Anumba, 2006).

As knowledge is continuously reproduced and transformed in relational interactions between individuals, the knowledge assets of an organisation lie in the pattern of relationships between its members and are destroyed when those relational patterns are destroyed (Stacey, 2001). Construction organisations operate with a special project-based structure, which is constantly changing with project delivery cycle; this dynamic structure limits the organisations' capacity to facilitate knowledge flows through interactions and transactions between individuals and the organisation, and consequently inhibits their ability to form a "cognitive structure" favourable to learning and sharing tacit knowledge (Blayse and Manley, 2004; Fong, 2005). It has been reported that construction organisations have experienced difficulties in implementing systematic approaches for the retrieval and sharing of tacit knowledge (Woo *et al.*, 2004), even though human interactive approaches, such as knowledge sharing network, brainstorming and post-project review, were reported as the most common approaches for sharing tacit knowledge within organisations (Egbu *et al.*, 2003; Robinson *et al.*, 2005).

In order to effectively utilise tacit knowledge within construction organisations, it is necessary to provide an empirical understanding of the stronger strategic role of this type of knowledge. However, due to the invisible nature of knowledge, especially tacit knowledge, it is hard to measure (Stacey, 2001). As KM activities could be perceived as a manifestation of organisational knowledge (Szulanski, 2003), and it is what organisational members actually do that determines organisational capability and, ultimately, the performance of the organisation (Szulanski, 2003), the strategic contribution of a certain type of knowledge, tacit or explicit, can be reflected through

the activities that deal with it. This fact was fundamental to the development of the theoretical framework described below.

Theoretical framework

The first phase of this research project has provided empirical evidence for a theoretical framework of the KM process (Chen and Mohamed, 2007, 2008a, b). This is shown in Figure 1, where the internal business environment of a construction organisation influences KM activities, which interact with each other and form a strategic KM cycle that contributes to long-term organisational objectives.

The above discussion of the literature suggests that the strategic roles of KM activities, dealing with either tacit or explicit knowledge, could be revealed by the degree to which they are influenced by the internal business environment, and most importantly by their contributions to BP that help to achieve long-term organisational objectives. From this perspective, building on the findings of the first research phase, and focusing on the relationships between the intensity of KM activities with the internal business environment and with BP, this study is designed to empirically compare the strength of the relationships of the KM activities. It aims to identify the stronger strategic roles of tacit KM activities that are:

- encouraged by organisational policies; and
- have a strong positive contribution to long-term economic gain.

In order to fulfil this research objective, two hypotheses were tested:

H1. Intensity of tacit KM activities is more sensitive to the variance in organisational policies compared with that of explicit KM.

H2. Intensity of tacit KM activities is associated with BP more strongly than that of explicit KM.

The hypotheses were investigated based on the theoretical framework empirically developed during the first phase of the study. The framework contains a total of seven constructs. The KM activities, classified into four strategic dimensions as suggested by Abou-Zeid (2002), constitute the four KM constructs, defined as: "Responsiveness to
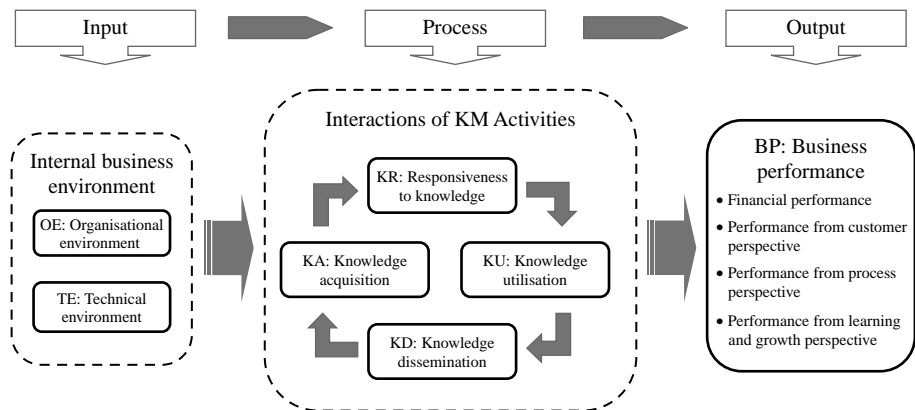
Figure 1.
Theoretical framework

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knowledge" (KR), responding to the various types of knowledge an organisation has access to, in its business environments (Darroch, 2003); "knowledge acquisition" (KA), seeking and acquiring knowledge from the external environment and creating new knowledge based on existing knowledge within the organisation (Darroch, 2003; Gold *et al.*, 2001); "knowledge dissemination" (KD), creating and maintaining structures, systems and processes for sharing knowledge, and for retaining knowledge within the organisation (McCann and Buckner, 2004); and "knowledge utilisation" (KU): utilising knowledge in real-life situations (Gold *et al.*, 2001).

The internal business environment is represented by two constructs, namely the "organisational environment" (OE), which covers organisational culture (value and principles) and organisational climate (rules, policies, procedures, structure, incentive systems, etc.); and the "technical environment" (TE), which refers to the technological infrastructure and its ability to respond to the increasingly dynamic work environment.

The balanced scorecard (BSC) was adopted as a measurement framework for the BP construct, as the BSC is widely considered a suitable measurement framework for KM programmes (Chen and Chen, 2006); indeed construction organisations have favoured the BSC for strategic management (Bassioni *et al.*, 2004); and within the construction context, the performance of KM activities can be better evaluated by a systematic framework developed and based on the strategic map of the BSC (Yu and Chang, 2005). The BP construct was operationalised by the variables representing four different perspectives (Kaplan and Norton, 1996): the "financial perspective" measures economic consequences of actions already taken; the "customer perspective" measures the organisation's performance within the target market segments; the "business process perspective" measures the internal-business-process derived from the explicit strategies the organisation has developed to meet shareholder and target clients' expectations; and the "learning perspective" measures the infrastructure (people, system and organisational procedures) the organisation has built to create long-term growth and improvement.

Methodology

A cross-sectional study design was used to provide a snapshot of the KM process within construction contracting organisations operating in Hong Kong in 2005. The conceptualisation and operationalisation of the KM constructs were based on basic measurable items already tested in previous empirical studies (Darroch, 2003; Gold *et al.*, 2001). Whilst many of these items were adopted in this study, others have been slightly modified in view of the findings of relevant construction-specific studies (Egbu *et al.*, 2003; Kululanga *et al.*, 2002). As many approaches exist to evaluate the impact internal and external business environments have on BP, this study selected a combination of normative and comparative judgement approaches. This is because together they represent the "means" and "ends' (or process and output) views of evaluating the BP improvement due to KM implementation. Interested readers are referred to Chen and Mohamed (2007, 2008a) for more details on construct formation. In addition, the operationalisation of the KM constructs was completed through a pilot questionnaire survey administered to a sample of 43 managerial and professional staff members from large- and medium-sized contracting organisations operating within Hong Kong. Based on this pilot study, items with very low-implementation levels (i.e. "plan to implement"

or "not implemented") were excluded, leaving a total of 41 items to operationally define the four KM constructs (Chen and Mohamed, 2005; Chen *et al.*, 2005).

Following the pilot study, data were gathered over a period of several months via a mail questionnaire, developed based on the operational definitions of the constructs. The purpose of the questionnaire survey was to elicit opinions on the internal business environment, the intensity of KM activities and the BP of targeted organisations. In the questionnaire, five-point Likert scales were used to measure the operationally defined items of the constructs within the proposed theoretical framework. The details of the scales and survey questions are presented in the Appendix. The questionnaire was pre-tested with ten Hong Kong local contractors. The data collection process began after the questionnaire have been finalised, and were based on the pre-test feedback.

Large- and medium-sized construction contractors represent the theoretical population because first, they perform construction works and deliver final products within project-based environment; second, they provide a relatively better environment for KM compared to small organisations (Robinson *et al.*, 2005). The sampling frame comprising 260 contractors was randomly drawn from two trade directories, i.e. the *List of Approved Contractors for Public Works* (The Environment, Transport and Works Bureau (ETWB), 2005), and the *Members List* of the Hong Kong Construction Association (2005). The two trade directories effectively represent the theoretical population. The self-administered questionnaires were mailed or delivered in person to the managerial/professional staff member(s) within the targeted organisations.

Valid responses were provided by 99 companies, representing about 38 per cent of the sampling frame. A total of 149 usable responses were received, representing a response rate of 29.9 per cent, which, according to Sekaran (2000, p. 234), is acceptable. The responses were considered a good representation of the opinions of the population, since, at the time of the survey, the majority of the respondents were middle-aged, well-educated, experienced and knowledgeable about the operations of the companies they were serving, aware of local market dynamics and forces, and representatives of organisations with diverse annual turnovers. The demographical information of the survey respondents is summarised in Table I.

In parallel to the survey, a total of 15 semi-structured interviews were undertaken with the managerial staff members representing 12 contractors, to provide insights into the topic under investigation. Secondary qualitative data sources, such as local news and corporate web sites, annual reports, news magazines and other publications of the interviewed companies, were also consulted, concurrently with the interviews.

Data analysis

This study incorporated both exploratory and confirmatory analyses in summated scale development and relationship identification. First, the exploratory factory analysis (EFA) was applied to determine how and to what extent the measurement variables were linked to their underlying factors for each construct; then confirmatory factor analysis (CFA) was employed to confirm the structures of the summated scale. Based on these scales, correlation and regression analyses were performed to explore the relationships between the factors of the constructs, and to identify, within each construct, the factor that had the strongest relationships with those factors under the other constructs. Then a structural regressional (SR) model was used to simultaneously estimate a series of separate, but interdependent, multiple regression equations

Demographic information of the respondents	Frequency	Percentage
Age		
More than 40 years	117	78.5
Educational background		
A bachelor degree or higher	123	82.6
Position		
Top management	48	32.2
Senior professional staff members	70	47.0
Professional industry experience (mean = 21.1 years, median = 23.0 years, SD = 7.4 years)		
More than ten years	136	91.3
Years working for the company (mean = 10.4 years, median = 9.0 years, SD = 7.0 years)		
More than five years	113	75.8
Company categories		
Local contractors	92	62.6
Branches or subsidiary companies of overseas corporations	32	21.8
Branches of state-owned enterprises of the People's Republic of China	23	15.6
Company annual turnover		
Less than HK$100 million	35	23.5
HK$100-500 million	34	22.8
HK$501-1,000 million	18	12.1
HK$1,001-5,000 million	33	22.1
> HK$5,000 million	26	17.4

Table I.
Demographic information
of survey respondents

(Hair *et al.*, 1998, p. 584), representing the potential statistical causal links between more active factors in the three components of the theoretical framework, meanwhile to identify the variables that provide the strongest support to the existence of these relationships.

Data examination, EFA and correlation and regression analyses were performed by the Statistical Package for Social Sciences Software (Version 12.0). Version 5 of analysis of moment structure, the structural equation modelling (SEM) software, was used to perform the CFA and SR model analysis. In this study, the maximum-likelihood estimation (MLE) was adopted as an estimation method for SEM analysis, since MLE is the preferred method for most model fit indexes, particularly when sample size is relatively small (Shah and Goldstein, 2006). Data screening techniques were applied to all variables to assess their distribution to ensure that normality and linearity were reasonably upheld (Tabachinick and Fidell, 2001). Only, six cases were identified with a proportion of missing values larger than 5 per cent, and were subsequently deleted from the data file, leaving 143 cases for further analysis.

Measurement scale development
EFA was adopted for identifying the structure among the set of measurement variables for each construct and also for data reduction. Checks were undertaken to ensure that factorability was upheld for all factor analysis scenarios. With the sample of 143, a factor loading of 0.50 and above was considered significant at the 0.05 level to obtain a power level of 80 per cent (Hair *et al.*, 1998, p. 112); thus, variables having

a factor loading of less than 0.50 were eliminated. The cumulative percentage of total variance extracted by successive factors for the seven constructs were over 50 per cent, which are considered satisfactory solutions in social sciences (Hair *et al.*, 1998, p. 104). Since the constructs were conceptually defined, based on a combination of the literature review and previous empirical studies, the factors' scales were considered to have face validity (Hair *et al.*, 1998, p. 117).

The relations between the observed measurement variables and the underlying factors, identified by the EFA, were postulated a priori and then tested by the CFA (Byrne, 2001, p. 6). The CFA model of each construct was then evaluated by statistical means to determine the adequacy of its goodness of fit to the sample data. The fit indexes presented in Table II indicate a very good overall model fit of the final CFA models of the seven constructs. The values of Hoelter's critical N (CN) at the 0.01 level exceeded 200, indicating an adequate sample size (Byrne, 2001, p. 87). Meanwhile, the analyses showed sound feasibility of parameter estimates, which were statistically different from zero at the level of 0.05. The correlation values between factors were much less than the high limit of 0.85, indicative of good discriminant validity (Kline, 2005). Modification indexes also presented the absence of factor-cross loadings or error covariances. The reliability coefficients of all scales were above 0.80 reflecting very good consistency (Kline, 2005). In view of the foregoing, the measurement scales represented by the final CFA models were considered to have good validity and very good reliability to measure the constructs in the subsequent multivariate analysis. The measurement scales of the seven constructs (OE, TE, KR, KA, KD, KU and BP) are summarised in the Appendix.

The analysis identified two factors for the OE construct: "organisational creative environment (OEc)", representing innovation policies, and "organisational supportive environment (OEs)", representing strategic guidance to KM and communication style; and a single factor (TE) for the TE construct, as described before, representing the technological infrastructure and its ability to respond to the increasingly dynamic work environment.

The analysis reflected that the participating organisations adopted the KM activities in the following manner:

- Responding to two broad types of knowledge: knowledge about market, and technological changes over the long run (i.e. "response to market knowledge (KRm)"), and that of the short-term needs of current clients (i.e. "response to clients' needs (KRc)").

- Acquiring two major types of knowledge: the knowledge about market trends (i.e. "market knowledge acquisition (KAm)"), and about the company's financial situation (i.e. "financial knowledge acquisition (KAf)").

- Disseminating two distinctive types of knowledge, tacit and explicit knowledge, respectively, (i.e. "tacit knowledge dissemination (KDt)" and "explicit knowledge dissemination (KDe)").

- Utilising knowledge to manage challenges in a competitive environment (i.e. "KU").

The analysis also revealed that the common and latent properties of the BP factors were in line with the dimensions of the BSC (i.e. "performance from customer

Table II.
Reliability and model fit indexes of the final CFA models

Model fit indexes (value representing a well-fitting model)[a]				Constructs				
		OE	TE	KR	KA	KD	KU	BP
Model fit indexes[a]								
χ^2		30.798	13.102	13.237	29.808	16.941	2.751	35.334
Normed chi-square: χ^2/df	(1.0-2.0)	1.185	1.456	1.655	1.569	1.303	1.376	1.104
Degree of freedom (df)								
Probability level (p)	(>0.05)	0.236	0.158	0.104	0.054	0.202	0.253	0.314
Root mean square residual (RMR)	(<0.05)	0.032	0.025	0.020	0.031	0.029	0.009	0.021
Goodness-of-fit index (GFI)	(>0.90)	0.953	0.970	0.971	0.953	0.967	0.991	0.953
Adjusted goodness-of-fit index (AGFI)	(>0.90)	0.919	0.930	0.923	0.911	0.929	0.955	0.920
Normed fit index (NFI)	(>0.90)	0.939	0.964	0.968	0.922	0.951	0.988	0.933
Comparative fit index (CFI)	(>0.95)	0.990	0.988	0.987	0.969	0.988	0.997	0.993
Root mean square error of approximation (RMSEA)	(<0.05)	0.036	0.057	0.068	0.063	0.046	0.051	0.027
Reliability								
Cronbach's alpha		0.858	0.869	0.840	0.810	0.835	0.850	0.826

Sources: [a]Byrne (2001); Hair *et al.* (1998); Kline (2005)

perspective (PC)", "performance from process internal business process perspective (PP)" and "performance from learning and growth perspective (PL)").

Relationship identification
Correlation analyses confirmed the existence of associations between the factors of the theoretical framework (significant at the 0.01 level, two-tailed). Stepwise regression analyses were subsequently undertaken to reveal the predicting power of the factors. The analyses identified nine active factors (OEc, OEs, KRm, KAm, KDt, KU, PC, PP and PL). Their scales demonstrated, more strongly, the existence of the relationships proposed by the theoretical framework. Hence, these nine factors were of better nomological validity when compared to those of the other factors (Hair *et al.*, 1998, p. 118; Peter, 1981). To illustrate, KRm, KAm, KDt and KU were more sensitive to the variation in the factors of the internal business environment, in particular, OEc and OEs. These four KM factors also predicted more, and were more sensitive to, the variance of other KM factors (under the constructs other than their own). Meanwhile, KRm, KDt and KU could be used to predict the variance of PP and PL.

Based on the findings of the regression analyses, an initial SR model was formed by the active factors in the KM process framework, i.e. OEc and OEs in the contextual input; KRm, KAm, KDt and KU in the KM process; and PC, PP and PL in the performance output. The objective was to link the operational definitions of the factors to the theoretical framework for the appropriate empirical test (Hair *et al.*, 1998, p. 596). A fitting process was undertaken to remove misspecifications in both the measurement and the structural portions to achieve a final fitted SR model (Kline, 2005, pp. 216-18), as well as the insignificant links (represented by regression weights of *p*-value larger than 0.05). In the final SR model, the estimates of both regression weights and variances were statistically different from zero at the level of 0.01. Figure 2 shows the significant relationships (with standardised regression weights). Meanwhile, the final SR model presented absolute fit indexes ($\chi^2 = 210.311$ with degree of freedom (df) of 198; $p = 0.261$; GFI = 0.885; AGFI = 0.854; RMR = 0.039), incremental fit indexes ($\chi^2/\text{df} = 1.062$; NFI = 0.856; IFI = 0.990; TLI = 0.988; CFI = 0.990), and parsimonious fit indexes (RMSEA = 0.021) which were indicative of a good fit to data (Byrne, 2001, pp. 81-6).

The final SR model revealed that KM factors interacted with each other and functioned as mediators between OE and BP factors. This means that the internal business environment affects BP indirectly, through the KM activities. The model also shows that the tacit KM activities, represented by the indicators in the final SR model (KA13, KA14, KR6, KR8, KD2, KD3, KD5, KU2 and KU5), were especially sensitive to the variations in internal policies, interact more actively with each other, and make stronger contributions to BP. To illustrate, the activities of responding to market knowledge and disseminating tacit knowledge were most sensitive to the variations in the OE. Meanwhile, KDt and KU positively contributes to the BP from both the process and learning perspectives, which are represented by the "leading" performance indicators that drive other performance indicators (Kaplan and Norton, 1996). The findings reflected the critical role of KDt in linking the OEs and the foundation of the performance indicators of the BSC.

Figure 3 shows the relationships between the active factors (of better nomological validity) confirmed by the final SR model, and those between the passive factors, which
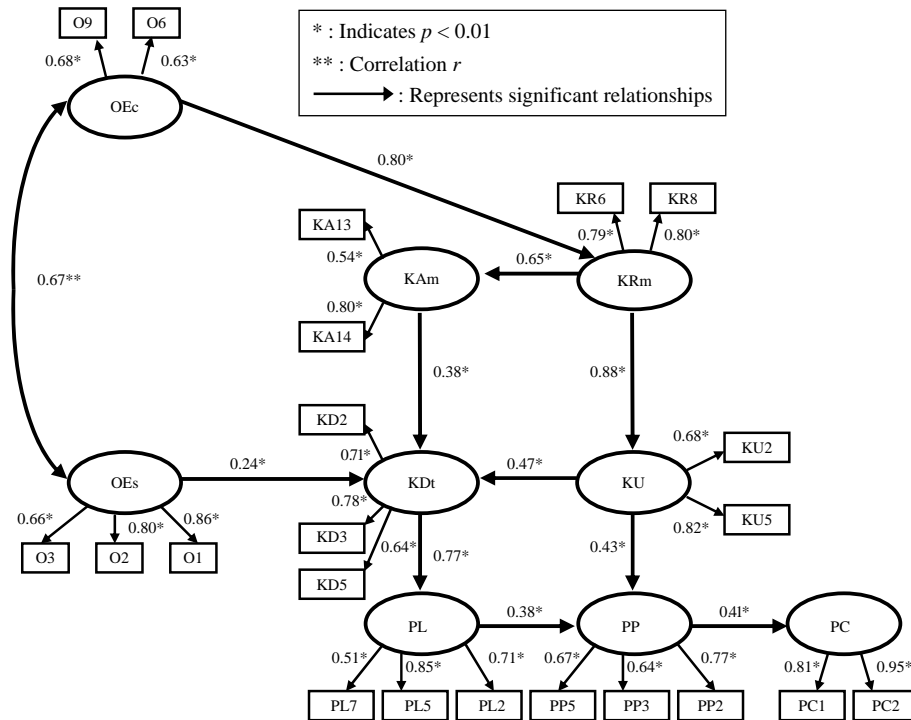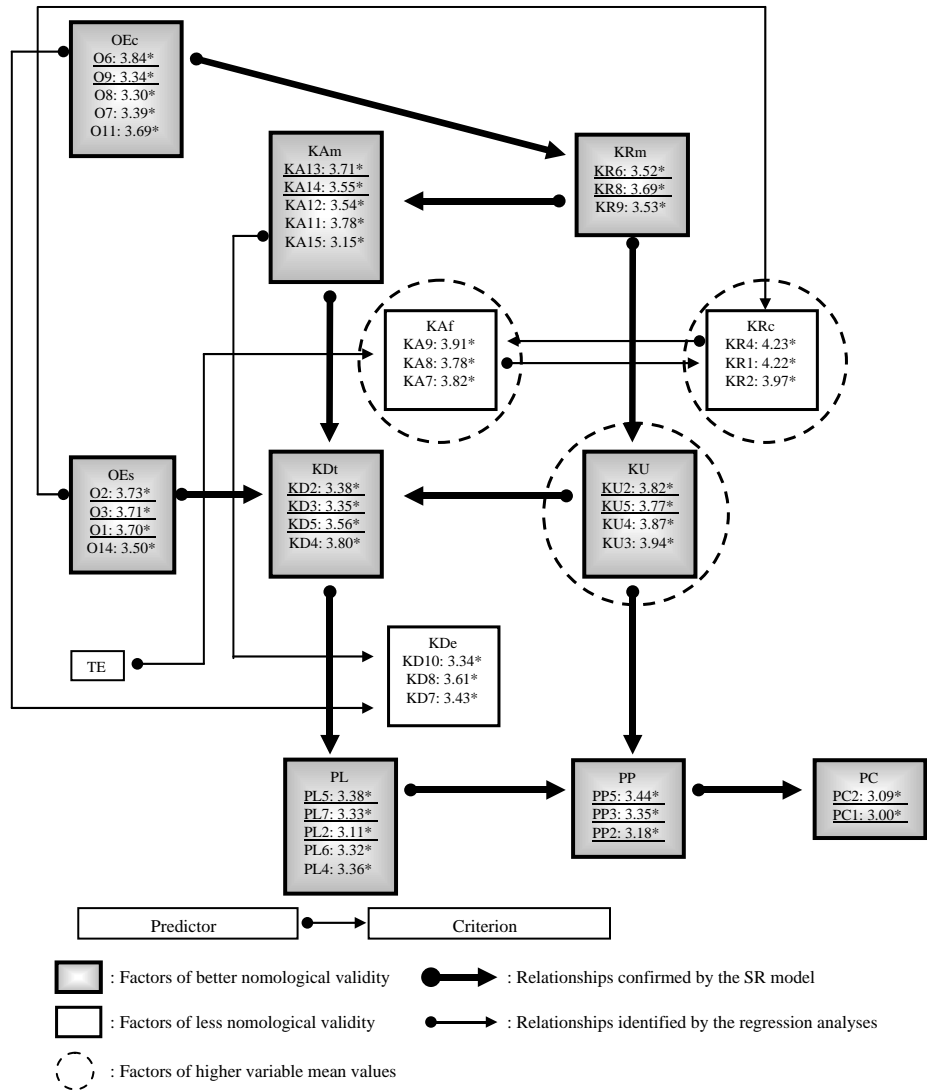
Notes: OEc: organisational creative environment; OEs: organisational supportive environment;
KRm: responsive to market knowledge; KAm: market knowledge acquisition; KDt: tacit knowledge
dissemination; KU: knowledge utilisation; PC: performance from customer perspective; PP: performance
from process perspective; PL: performance from learning perspective

Figure 2.
Final SR model with
standardized regression
weights

were only supported by the regression analyses. In order to reveal the strategic roles of
the KM activities, the OE, KM and BP factors are presented with the mean values of
their measurement variables mapped within them.

As Figure 3 shows, three passive KM factors (KAf, KRc and KDe) were
comparatively less sensitive to the variations of the internal business environment, and
their association with the BP factors were also not as strong as those of the active KM
factors. It appeared that KAf and KRc were also quite isolated from other KM factors,
since they only had predicting power over each other's variance. This is arguably due
to the common focus of KAf and KRc on short-term business objectives, such as
managing their financial knowledge of current business operations, and responding to
clients' needs on the projects under construction. The mean value of these two factors
revealed that KAf and KRc had a higher level of implementation, and performed with
the highest intensity. In other words, at the time of this study, within the sampled
contractors, KM activities focused on managing financial information and clients'
requirements of current, on-going projects, and serving the short-term business
objectives. KDe represents the activities that specifically deal with explicit knowledge,

OEc
O6: 3.84*
O9: 3.34*
O8: 3.30*
O7: 3.39*
O11: 3.69*

KAm
KA13: 3.71*
KA14: 3.55*
KA12: 3.54*
KA11: 3.78*
KA15: 3.15*

KRm
KR6: 3.52*
KR8: 3.69*
KR9: 3.53*

KAf
KA9: 3.91*
KA8: 3.78*
KA7: 3.82*

KRc
KR4: 4.23*
KR1: 4.22*
KR2: 3.97*

OEs
O2: 3.73*
O3: 3.71*
O1: 3.70*
O14: 3.50*

KDt
KD2: 3.38*
KD3: 3.35*
KD5: 3.56*
KD4: 3.80*

KU
KU2: 3.82*
KU5: 3.77*
KU4: 3.87*
KU3: 3.94*

TE

KDe
KD10: 3.34*
KD8: 3.61*
KD7: 3.43*

PL
PL5: 3.38*
PL7: 3.33*
PL2: 3.11*
PL6: 3.32*
PL4: 3.36*

PP
PP5: 3.44*
PP3: 3.35*
PP2: 3.18*

PC
PC2: 3.09*
PC1: 3.00*

Predictor — Criterion

: Factors of better nomological validity   → : Relationships confirmed by the SR model

: Factors of less nomological validity   → : Relationships identified by the regression analyses

: Factors of higher variable mean values

Notes: *: mean value of the measurement variable (e.g. KD10), measures of better nomological validity is bold and underlined.
OEc: organisational creative environment; OEs: organisational supportive environment; TE: technical environment;
KRm: response to market knowledge; KRc: response to clients' needs KAm: market knowledge acquisition;
KAf: financial knowledge acquisition; KDt: tacit knowledge dissemination; KDe: explicit knowledge dissemination;
KU: knowledge utilisation; PC: performance from customer perspective; PP: performance from process perspective;
PL: performance from learning perspective

Figure 3.
Relationships between
factors

and were the routine activities of the sampled contractors; however, this factor appeared to have limited predicting power over the variance of the other KM factors. From the contextual input perspective, TE refers to the technological infrastructure and its ability to respond to technical change. This factor only had predicting power over one KM factor (KAf); thus the KAf appeared to be the most passive factor within the internal business environment. The effective improvement of technological infrastructures and IT-related policies seem to only increase the intensity of KM activities that deal with current business operations and serve short-term rather than long-term business objectives.

In summary, the statistical analyses mapped the KM factors into two groups. One group (KAf, KRc and KDe) focused on current business operational needs, served short-term business objectives and dealt more with explicit knowledge; the other group (KAm, KRm, KDt and KU) served the long-term development strategy, contributed to the leading BP indicators and dealt with tacit knowledge. The long-term orientated KM activities were more sensitive to the variations of the OE factors (OEc and OEs) and provided a positive influence on the development of OL infrastructure and business process. These findings supported *H1* and *H2*.

The statistical findings also suggested that, within the participating organisations, KM implementation focused on the short-term orientated KM activities. As Figure 3 shows, at the time of this study, two out of three types of short-term orientated KM activities (represented by KAf and KRc) were performed with relatively higher intensity within the sampled contractors. Meanwhile, only one (KU) out of the four types of KM activities, which contribute to the long-term organisational development, was performed at a similar level. The reason behind this could be the difficult financial position the sampled construction organisations faced during the economic downturn (2001-2004) in Hong Kong (Chan *et al.*, 2005). The collected data reflected the situation during the 2004 financial year. Owing to their resource limitations, these organisations had to focus on KM activities that mainly served short-term business objectives, especially cost control.

Interviews

To provide further insight into the phenomenon under investigation, a total of 15 semi-structured interviews were undertaken, with managerial staff members representing 12 medium- and large-sized contracting organisations. The demographic information about the interviewees is presented in Table III. These sample contractors had active operations within the Hong Kong market, and were the leading companies in their targeted market segments when the interviews were undertaken. Therefore, it was considered that these 15 interviews provided specific cases, events and actions that helped to clarify and deepen understanding on the KM process within the context of the companies that had achieved better BP. The interviewees were asked to describe KM activities and related systems (if any) being applied within their organisations, and to indicate the most important activities to their business. The interviews provided insightful narratives that explained how these leading companies aligned their long-term orientated KM activities with their strategic objectives. A concise summary of their comments is presented below, and substantiates the main findings of the quantitative study.

Demographic information	Number of interviewees	Percentage
Position		
Chairman	1	6.7
Managing director	1	6.7
Director	5	33.3
Regional branch managers	2	13.3
Project managers	3	20.0
Department managers	3	20.0
Company categories		
Geographical location origin		
Local contractors	5	41.7
Branches or subsidiary companies of overseas corporations	6	50.0
Branches of state-owned enterprise of the People's Republic of China	1	8.3
Qualification for public works (ETWB, 2005)		
Group C contractors (contract values exceeding $50 million)	7	58.3
Group B contractors (contract values of up to $50 million)	5	41.7
Specialty		
General contractors	6	50.0
Specialist contractors	6	50.0

Table III.
Demographic information
of interviewees

Interview findings
The importance of KM to business operations was acknowledged by all interviewees even though few interviewed companies had formal programs or schemes under the title of KM. Many had well-established common practices to improve BP, which, in fact, were various combinations of different categories of KM activities. Indeed, the KM activities within the interviewed companies were integrated within a wide range of business processes, providing a context for tacit knowledge exchange and an IT platform for explicit knowledge flow.

The interviews identified different kinds IT systems which were being used intensively by the companies to carry routine tasks of a variety of business processes, e.g. human resources management, financial management, procurement, project management, etc. This means that critical explicit knowledge, especially the cost-related information, was recorded and shared through these IT systems. In addition, the intranet system was widely used to disseminate updated policies, manuals and best practices, e.g. the construction method database. In view of this, it appeared that the business processes could not be performed appropriately without the IT systems; albeit most of the companies were facing challenges of integrating diverse technologies, computer programs and data sources across the internal business process, particularly under the financial resource constraint caused by the economic down-turn. This finding indicated that the IT infrastructure was essential for the day-to-day operations of the companies in managing on-going projects, whereby substantiating the findings derived from the regression analyses.

Just as Collins (2001) reported in relation to the good-to-great companies, very few of the interviewees focused much attention on the IT infrastructure of their companies,

when they addressed the importance of KM to their business, even though some companies were very technologically sophisticated and received media coverage. This phenomenon is best described by the interviewee's comment:

[...] IT system, however sophisticated it can be, can only assist us to record information of past projects, and to process the information of current on-going projects, whereas, it lacks of capacity to make critical strategic decisions for us. The real knowledge that supports this type of decisions is drawn from the experience and business-networks of our people. This (organisational) knowledge pool took years to build.

The interviewees appeared much more excited when they told stories about their "people". A CEO passionately described tacit KU in the process of gaining new contracts:

[...] It might take a relatively long time to prepare for a construction tender. Project information needs to be collected as early as the development and design phases, mainly through business networking. Joint-venture partners and major suppliers also need to be targeted before the tender is announced. Since the strategic composition of the market forces change constantly, strategic decisions are often required to be made within a very short time and are based on incomplete information. Given this, the rich knowledge and experience of our people are real attributes of right judgements. In addition, under current market conditions, cost saving through alternative designs has become the norm. This again requires very high technological competence of the tendering team to produce innovative designs, in the mean time to effectively assess and manage the potential risks associated with alternative design proposition. Furthermore, information on the Internet about our market segment lags behind market evolution. It is more about the completed works and/or closed projects; and market analysis reports, if there are any, are hopelessly out of date. Had we relied on the information published on the Internet, or by government Gazette, to run the firm, we would have had been out of business long ago.

The interviews revealed that during the economic down-turn, most leading companies made an effort to keep their experienced staff, in particular project managers and chief surveyors, and chief engineers, even when their projects were completed. As a director of a large civil engineering contracting organisation commented:

Our people are the real asset (of the company). It takes at least 6 to 9 years, 2 to 3 medium to large projects, to develop a project manager who is fully competent to manage a large project; the project management team that is capable of working together under his particular leadership style; and may be most importantly, the team that concedes our corporate vision and is willing to make a contribution. This type of team is capable of turning a project into a real profit centre, and playing key roles in wining a tender, primarily due to their ability for innovation.

Also addressed on the innovation theme, a director of a local specialist contractor pointed out:

Construction is a high risk "business", each and every project is unique, and contingency is the norm. In view of this, innovation is an essential part of the (construction) operations. The profitability is largely dependent on the ability to synthesize our experiences into new solutions to reduce costs. This is particularly true during this economic down-turn.

He further pointed out that during the tight economic climate, the top management staff and key project managers of his company formed an innovation task-force to analyse and re-engineer a number of construction processes. Under the leadership of

this task-force, project teams improved the construction methods with newly invented approaches, which substantially accelerated the production rate, and reduced costs. They even designed and manufactured new equipment, based on some of the inventions, and used them at the construction sites. Their clients were both impressed by the efforts, and happy with the high quality achieved within the budget. This strengthened competence and good reputation helped them win an increased number of tenders under very difficult market conditions.

The comments given by a department manager demonstrated the importance of tacit KM in the supplier management process:

[...] We have linked our procurement database with our supplier management database. Our database is regularly updated with supplier evaluation information for quality control purposes. However, the real quality assurance is gained through the long-term partnerships with our key suppliers. Through years of trading, we have selected these quality suppliers, who have also established a better understanding of our needs, and can communicate effectively with our staff.

Qualitative insight of the SR model
The above narratives provided insightful explanations for the statistical findings, as shown by Figure 2. Thus, under the severe pressure to compete with low cost and high quality, these leading companies encouraged innovative approaches in both marketing and construction processes (represented by variables O6 and O9), as a consequence a more conducive OEc was created. Such an environment improved the implementation of marketing plans (KR6) and technological development (KR8), was reflected by the higher tender winning rate and more innovative solutions. This led to a more active level of responsiveness to knowledge in the market (KRm), where high quality was demanded by clients with almost unrealistically low budgets. Active KRm enabled a higher intensity of KU in solving new problems (KU2), and managing changes under competitive conditions (KU5). As reflected by the interviews, this was achieved through joint ventures, alternative designs, innovations and supplier involvement. The higher intensity of KU, in turn, assisted in streamlining internal processes (PP3), increasing working to schedule (PP5), and accelerating commercialisation of new innovation (PP2), whereby improved the performance indicators of the process perspective (PP).

Meanwhile, through interactions of KM activities, more active KRm helped the interviewed companies to deepen their investigations of client needs (KA13) and to gain more new business ideas (KA14) through networking. The higher intensity of these activities resulted in more active KAm, which sequentially pushed the intensity of KDt activities to a higher level. Vigorous utilisation of knowledge (KU) also increased positive input into KDt; as an interviewee noted: "[...] in terms of innovation, the more we do the more we know how to do it".

In addition, the interviews also revealed that the implementation of policies, such as establishing a vision for (O1), and committing leadership to (O2), organisational KM, and encouraging open discussion of problems/errors (O3) helped the leading companies to create a more conducive OEs. The narratives clearly showed the commitment of the companies to developing a "knowledge pool" through continuous employee empowerment and team building. The effective inter- and intra-organisational communications were also reflected by the strong business network with their industry

partners, and productive innovation processes. The policies that created the conducive OEc and OEs evidently encouraged KDt activities, especially staff mentoring and coaching (KD5), best practice recording (KD2), and business reviewing (KD3). The intensive KDt activities created a strong sense of achievement and strengthened competence, which then improved employee satisfaction (PL2) and motivation (PL5). Additionally, the ability of the information systems (PL7), especially the project management system, was improved, largely through process reengineering.

Most importantly, the improvement of the "leading" indicators of the BSC (PP and PL) was reflected by the empowered management team and workforce, as well as the re-engineered business process. Indeed, such improvements contributed positively to the performance indicators, especially from the customer perspective (PC). The outcome was a greater ability to gain contracts (PC2) and to enlarge the market share (PC1). This, as the interviewees said, helped them to achieve better profitability, and to gain advantages in an extremely competitive market. Thus, both the quantitative and the qualitative findings were in line with the arguments of Kaplan and Norton (1996).

Conclusions

This study has provided empirical evidence for the important strategic role that tacit KM plays in organisational success, especially within the construction industry in Hong Kong during a tight economic climate. The findings are in line with the arguments in the KM literature (Baumard, 1999; Nonaka and Takeuchi, 1995; Stacey, 2001), and also confirm those derived from the construction specific studies (Blayse and Manley, 2004; Hartmann, 2006; Kamara *et al.*, 2002; Woo *et al.*, 2004). It is expected that these findings would serve as a valuable reference for construction organisations to use KM strategies in strengthening their competitive advantages, in particular, when they are facing an economic recession on a large global scale.

This study found that much knowledge in the industry is experience-based and tacit, and created through sharing the duties on the sites of unique projects; and that the tacit knowledge strategy plays an essential role in managing the performance within construction organisations. Based on a sample of construction contractors, this study provided empirical insights into the earlier statement made by Stacey (2001), that the essence of KM is to manage communicative interaction, the pattern of relating between human bodies in the living present. Further, the focus of attention is on the themes that revolve around organising the complex relational process of being together in order to undertake joint actions for which an organisation exists (Stacey, 2001). As the strategic compositions change constantly in the market, as well as within the organisation, the strategic management process is driven by an intricate meshing of tacit KM activities, through the joint actions of employees, and with business partners. A wide range of themes, such as the tendering process, construction operations, and suppliers' management, etc. form the larger context within which the synergy of the actions is drawn to drive the organisations moving towards their business objectives. Hence, as the research findings of this study demonstrate, the focus of KM implementation should be on the creation of a conducive internal business environment that facilitates human interactions of tacit KM. Policies, such as encouraging innovation and employee empowerment, provide strong strategic guidance to KM implementation, just like injecting "energy" into the strategic "KM cycle". The higher intensity of these long-term orientated KM activities would ultimately help the

organisation to gain competitive advantages, even under unfavourable economic conditions. Therefore, people-centric tacit KM plays a strong and very important strategic role in helping an organisation to realise its long-term vision.

The findings recognised the positive contribution of IT infrastructure and related policies in facilitating current business operations and serving short-term organisational objectives. However, the findings also revealed the limitation of IT-based strategies and KDe in serving long-term strategic goals. The study provides further empirical support for the findings of Fernie *et al.* (2003) and Rezgui (2007); both argued that knowledge is essentially personal and cannot be separated from the knower. As the research findings demonstrated, even though, the output of a decision-making process can be externalised into explicit knowledge, in the form of reports or minutes, the process itself, by its nature, is tacit and dynamic, and can only be carried out through human interactions. IT systems record rich information about the past and on-going projects, and provide a platform for sharing and using the explicit knowledge. Importantly, it is the new tacit knowledge that guides and directs strategic decision making, which is created by the users through decoding and using the explicit knowledge in their specific decision-making context. In short, IT systems enable the strategic decision-making output to be shared in explicit forms; whilst the tacit KM activities actually carry out the decision-making process. Therefore, in order to effectively facilitate knowledge sharing, IT-based KM systems should be incorporated within a change management programme that promotes a "participatory" type of culture, while taking into account the team-based structure and discipline-orientated nature of the construction industry. In addition, IT deployment needs to be planned to serve the organisational strategic objectives.

In conclusion, the study findings demonstrated that tacit KM activities, within a wide range of management and engineering themes, carry out the tasks of, and form the context for, the strategic decision-making process of the organisation. The IT infrastructures and systems provide a platform for the explicit KM activities to record and share the outputs of the decision-making process. Consequently, an effective strategic decision-making process depends on the ability of the organisation to align its internal business environment with the KM activities and their desired BP. This means that the effectiveness of KM implementation should be evaluated from a holistic perspective. Accordingly, the measurement system needs to include the tools to identify and measure the conducive level of organisational culture and climate, the nature and intensity level of KM activities, and the BP achieved against the organisational objectives. In support of this approach, the findings of this study indicated that participating organisations have the potential to push the intensity of their long-term orientated KM activities to a higher level in order to improve BP indicators that ultimately lead to economic success in the long run. The narratives of the leading companies provide examples of why market leaders see the value in tacit KM.

Limitations and future studies

It is worthwhile noting that the findings of this study were derived from a sample of only one industrial organisation (construction contractors) from a specific geographical region, i.e. Hong Kong. The generalisability of the findings could be increased by future studies based on larger samples of participants from diverse industry sectors and cultural backgrounds. In addition, larger scope qualitative investigations could

also provide more insight into the phenomenon under investigation and further evidence for validating the statistical findings. For example, in-depth comparative case studies could be used to scale the different components of the KM process into appropriate hierarchical levels. This approach would help companies to strategically align their organisational policies and KM implementation with the desired business objectives they intend to achieve. Building upon the criteria, a benchmarking system could be developed to assist companies to undertake a KM self-assessment process, and also help to promote the best KM practices within the industry.

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Appendix. Measurement scales developed by the EFA and CFA

Constructs of internal business environment

Organisational environment (OE). Survey question. "Please indicate your opinions about the current internal organisational environment in your company. In our company [...]".

(Scale: 1 – strongly disagree, 2 – disagree, 3 – neither agree nor disagree, 4 – agree, 5 – strongly agree).

Factor 1: organisational creative environment (OEc)[1]

O8   Formal and informal innovation activities are integrated.

O7   Innovations are rewarded.

O6   Innovations to deliver better cost-effectiveness are encouraged[2].

O9   Divisions, departments, construction sites often work jointly on innovations[2].

O11   Interdisciplinary teamwork is encouraged.

Factor 2: organisational supportive environment (OEs)[1]

O1   Have shared vision for managing organisational knowledge[2].

O2   Have committed leadership to manage organisational knowledge[2].

O3   Problems/errors are discussed openly[2].

O14   Team look to see how they can contribute more to the company.

Technical environment (TE). Survey question. "Please indicate your opinions about the current internal technical environment in your company. In our company [...]".

(Scale: 1 – strongly disagree, 2 – disagree, 3 – neither agree nor disagree, 4 – agree, 5 – strongly agree).

T3   Senior management support IT development.

T5   IT applications are designed to share information across the whole organisation.

T11   Employees are trained to use IT.

T6   IT is adopted with a view to change traditional business processes.

T10   Interaction is established between end-users and IT professionals.

T4   IT is designed to aid efficient decision making.

Notes: More active factor of better nomological validity; variable of the best nomological validity.

Constructs of KM activities
Survey question. "Please indicate your opinions about the intensity of KM activities in your company. Our company [. . .]"

(Scale: 1 – strongly disagree, 2 – disagree, 3 – neither agree nor disagree, 4 – agree, 5 – strongly agree).

Responsiveness to knowledge (KR). Factor 1: response to market knowledge (KRm)[1]

KR9   Periodically reviews the likely effect of technological changes on clients.

KR6   Effectively implements our marketing plans[2].

KR8   Keeps up to date with technological developments that could affect our business[2].

Factor 2: response to clients' needs (KRc)

KR4   Responds quickly to any complaint raised by clients.

KR1   Promptly acts if clients are unsatisfied with the quality of our service.

KR2   Responds positively to changes in clients' product or service needs.

Knowledge acquisition. Factor 1: market knowledge acquisition (KAm)[1]

KA10 Actively and timely collects information about our competitors.

KA11 Drives business direction according to the changes in market needs.

KA15 Undertakes structured and meaningful market research.

KA13 Occasionally meets with major clients to find out their future needs[2].

KA14 Frequently acquires new business ideas through working with others[2].

Factor 2: financial knowledge acquisition (KAf)

KA9   Analyses regularly the financial contribution of our projects or services.

KA8   Has good financial information about our business operations.

KA7   Knows how much each of our projects costs us.

Knowledge dissemination (KD). Factor 1: tacit knowledge dissemination (KDt)[1]

KD4   Encourages open communication.

KD5   Actively encourages staff mentoring or coaching[2].

KD2   Regularly records internal best practices[2].

KD3   Frequently reviews all aspects of the business[2].

Factor 2: explicit knowledge dissemination (KDe)

KD10 Periodically circulates documents (e.g. reports and newsletters) about our business achievements to external stakeholders.

KD8 Frequently updates policy and procedure manuals.

KD7 Circulates written reports to disseminate knowledge.

Knowledge utilization (KU)[1]

KU2 Uses accumulated knowledge to solve new problems[2].

KU5 Is able to apply knowledge to changing competitive conditions[2].

KU4 Uses shared knowledge to improve efficiency.

KU3 Applies knowledge learned from mistakes.

Notes: More active factor of better nomological validity; variable of the best nomological validity.

Construct of business performance
Survey question. "To the best of your knowledge, please circle the number which you feel estimates how your company compare to the average level of immediate competitors (contractors) in Hong Kong on each item, within the past financial year."
(Scale: 1 – much less, 2 – less, 3 – same, 4 – more, 5 – much more).
Factor 1: performance from financial perspective (PF)[1]

PF2 Our average profit[1].

PF1 our average return on investment[1].

Factor 2: performance from customer perspective (PC)[2]

PC2 Ability to gain contracts[3].

PC1 Market share[3].

Factor 3: performance from internal business process perspective (PP)[2]

PP3 Streamline internal processes[3].

PP5 Increase working to schedule[3].

PP2 Rapidly commercialize new innovations[3].

Factor 4: performance from learning and growth perspective (PL)[2]

PL2 The level of employee satisfaction[3]

PL5 Employees' motivation to act in the best interest of the company[3].

PL6 Employees' freedom to take to make decisions and take actions.

PL7 Ability of our existing information system to provide rapid, timely and accurate information about market and business operations[3].

PL4   The productivity of employees.

Notes: Removed during CFA; more active factor of better nomological validity; variable of the best nomological validity.

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