Applying the strategic alignment model to business and ICT strategies of Singapore's small and medium-sized architecture, engineering and construction enterprises

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The concept of strategic alignment advocates that decisions on business strategy, information and communication technology (ICT) strategy, business infrastructure and ICT infrastructure need to be coordinated in order to better realize the benefits from ICT investments. In Singapore, there is a 10-year plan presented by the government to transform the sector of small and medium-sized enterprises (SMEs), and ICT is identified as an area for SMEs to acquire new capabilities. In this context, the strategic alignment framework is used to evaluate Singapore's small and medium-sized architecture, engineering and construction enterprises on their current practices in the ICT domain. An industry-wide postal survey, adopting the IT Barometer questionnaire and applying stratified sampling, obtained 84 responses out of a total of 754 companies contacted. Of the 84, 67 responses were further stratified by size and annual turnover, according to the SMEs definition, to allow a closer examination of each strata or class. Both qualitative and quantitative methods of analysis are used, and the main findings of the research are: (1) targeted schemes need to be set up to address the specific needs and concerns of the micro and small enterprises as distinct from those of the medium-sized enterprises pertaining to building ICT capability; (2) the two common alignment perspectives adopted by the larger 'designer' and 'builder' SMEs are 'strategy execution' and 'competitive potential'; and (3) the medium-sized 'designer' and 'builder' enterprises are shown to favour technology leadership and customer satisfaction, respectively, as their niche performance criteria for the strategic use of ICTs.

Keywords: Business strategy, information and communication technology strategy, strategic alignment, small and medium-sized enterprises, Singapore construction industry

Introduction

Research on the use of information and communication technologies (ICTs) by small and medium-sized enterprises (SMEs) in building construction had found that they in general do not consider such technologies as strategic to their business (Sarshar and Isikdag, 2004; Acar *et al.*, 2005). Hence, the extent of their usage had been also found to be limited. Broadly, Luftman and Oldach (1996, p. 4) had observed that the general lack of strategic application might be due to the practice whereby decisions of ICT strategy, intended to translate business strategy into an ICT infrastructure that allows the enterprise to

compete effectively, are often made after the decisions on business strategy. They advocated that four sets of decisions need to be coordinated, and classified them as business strategy, ICT strategy, business (or organizational) infrastructure and ICT infrastructure. Following this concept, Voordijk *et al.* (2003) translated the logical links or 'fits' among these sets of decisions into factors for success or failure of an enterprise resource planning (ERP) system implementation in a large construction firm. Their study reinforced the concept of strategic alignment with empirical evidence to show that the success of ERP implementation depends on consistent patterns between IT strategy and business strategy, IT maturity and the strategic role of IT, and the implementation method and organizational change.

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As strategic resources, ICTs are regarded as not only providing a means for functional integration but as an opportunity to enhance the competitive capability of the firm. When explained in the context of Porter's generic strategies, the importance of a strategic alignment is evident where enterprises choose to use ICTs to achieve cost leadership, or support a differentiation strategy, or support a niche strategy (Boddy *et al.*, 2002). Consequently, without this alignment, enterprises may end up deploying 'technology for the sake of technology's or for the sake of some future promise rather than for current business needs' (McClimans, 1995, p. 31). It often translates into the firm not having derived real benefits from ICTs to justify further investments, whether they are measured in productivity or profit terms. While technology 'suffers the blame', a deeper understanding of the problem would point to a lack of coordination between the (strategic) role of the technology and the (strategic) need of the business. Another common scenario, especially among the SMEs in the construction industry, is the practice of using ICTs to computerize the administrative functions, such as book-keeping and invoicing, rather than exploiting them to improve on the technical and business functions (Acar *et al.*, 2005; Goh, 2006). The reasons often cited by such companies are insufficient awareness, for instance, not knowing what IT can do for their business, lack of skilled personnel and specialist services (Goh, 2004). They point to the same cause which is a lack of coordination among the four sets of decisions as earlier mentioned by Luftman and Oldach (1996).

Singapore's *SME 21: Preparing SMEs for the 21st Century*

In early 2000, the Singapore government presented a 10-year plan for the development of the SME sector. It is the second major policy document on SMEs, *SME 21: Preparing SMEs for the 21st Century* (Productivity and Standards Board, 2000). The main challenge is to transform the SME sector from one that has a 'weak entrepreneurial culture, insufficient management know-how and professionalism, shortage of professional and technical manpower, insufficient use of technology, outmoded, unproductive methods of operation, limited ability to tap economies of scale and small domestic market' into one that is made up of world-class entities with attributes of 'professionally managed organization, excellence in process and customer service management, capabilities to create new knowledge and technology to develop high value-added products and services and ability to compete globally'.

In this context, the *SME 21* report specifically mentioned that the knowledge-based economy is dramatically changing the economic landscape. The growth in ICTs is transforming the way companies do business and the manner in which businesses relate to customers, suppliers and competitors. Hence, it was emphasized that size is no longer a limiting factor for SMEs in the new economy as the Internet is helping to level the playing field and making it easy for SMEs to compete with established players.

Motivation of the research

From related studies, Goh (2004 and 2006) had concluded that there needs to be an in-depth study of the relationship between business strategy and ICT strategy for construction sector companies in Singapore. While the general findings had pointed to the problem of companies having a weak link between the two types of strategies, a deeper investigation revealed that the same companies had also acknowledged a strategic need for a stronger link in order to drive ICT adoption further.

Research objectives

Hence, this paper sets out to:

(1) examine the current practices of the micro, small and medium-sized enterprises in the construction industry in acquiring new capabilities through ICTs with the aim of transforming themselves into world-class companies; and
(2) apply the strategic alignment model (SAM) to better understand the current practices of the medium-sized enterprises towards maximising the potential of ICTs as strategic resources.

Structure of Singapore's construction industry

According to Harvie and Lee (2002), there is no regional, or indeed global, consensus on the definition of an SME. They explained that SMEs' definitions differ widely, depending on the phase of economic development as well as prevailing social conditions. Hence, a number of indexes are traditionally utilized to define SMEs: number of employees; invested capital; total amount of assets; sales volume; and production capability.

The classification by number of employees and annual sales is used by the International Finance Corporation (2002), World Bank Group, Small and Medium Enterprise Department, as a 'broadly consistent' definition of SMEs. In its classification, a micro enterprise is one that has up to 10 employees and total annual sales of up to US$100,000; a small enterprise has up to 50 employees and total annual sales of up to US$3 million; and a medium enterprise has up to 300 employees and total annual sales of up to US$15 million.

Adapting the International Finance Corporation's classification to examine the structure of the SME sector of Singapore's construction industry, the composition (relevant information extracted from the construction working group report of the Ministry of Trade and Industry, 2001) can be described as 68% of the total number of enterprises employ fewer than 10 persons and have an annual turnover of up to US$500,000; 24% employ 10 to 49 persons and have an annual turnover of up to US$3 million; and 7% employ 50 to 299 persons and have an annual turnover of up to US$30 million. In other words, only 1% of the total number of enterprises employs 300 persons or more and has an annual turnover of over US$30 million.

Strategic alignment model (SAM)

The concept of strategic alignment is primarily based on the notion that information systems must match business strategy in order to forge a strong competitive edge and bring powerful solutions to real-world problems (Luftman, 1996). As Izanec (1997) puts it, the SAM's basic premise is that traditional analysis has tended to concentrate on either the extent to which infrastructure and processes support a company's strategy (strategic fit) or the extent to which ICT approaches support the business approaches (functional integration). However, Henderson *et al.* (1996) argue that a company must consider both 'strategic fit' and 'functional integration' to fully develop its competitive potential. Hence, the concept of strategic alignment is based on two building blocks: strategic fit and functional integration. And, within each block, there are the external and internal domains.

In the business strategy field, the external domain is the arena in which the firm competes and is concerned with business scope decisions, distinctive competency decisions and governance decisions. This domain is termed as 'business strategy'. Correspondingly, the internal domain is concerned with choices that define the administrative structure, the design or redesign of critical business processes and the acquisition and development of human resource skills. This domain is termed as 'organizational infrastructure and processes'. In the ICT strategy field, the external domain is concerned with how the firm is positioned in the ICT marketplace in respect of its technology scope, systemic competencies and ICT governance. This domain is termed as 'ICT strategy'. Again, correspondingly, the internal domain is concerned with how the ICT infrastructure should be configured and managed in respect of its architecture, processes and skills. This domain is termed 'ICT infrastructure and processes'. Research has shown that effective management of ICT means achieving a balance among the choices made across all four domains—business strategy, ICT strategy, organizational infrastructure and processes, and ICT infrastructure and processes.

Essentially, the SAM works on achieving integration of the business and ICT domains at two levels—the strategic level, looking at the link between business strategy and ICT strategy, and the operational level, looking at the link between organizational infrastructure and processes and ICT infrastructure and processes. In order to operationalize the model, one of the four dominant alignment perspectives can be taken. The first perspective is 'strategy execution' where the business strategy is the driver for both organizational and ICT infrastructure design choices. Here, the role for top management is strategy formulator, that is, to articulate the logic and choices pertaining to business strategy and the role for information system (IS) management is strategy implementer, that is, to efficiently and effectively design and implement the required IS products and services to support the business strategy. The second perspective is 'technology potential' whereby the business strategy is also the driver. It involves the development of an ICT strategy in response to a business strategy and using the corresponding choices to define the required IS infrastructure and processes. This perspective, in essence, requires that executives understand the impact of business strategy on ICT strategy and the corresponding implications for IS infrastructure and processes. The third perspective is 'competitive potential' and the ICT strategy is the driver. It is concerned with the exploitation of emerging ICT capabilities to impact on new business products and services, influence the key attributes of strategy, as well as develop new forms of business relationships. Specifically, this perspective allows the modification of business strategy through emerging ICT capabilities. Finally, the fourth perspective is 'service level'. With the ICT strategy as the driver, it focuses on the need to build a world-class IS service organization with customer satisfaction as the defined performance criterion. Basically, this perspective is anchored by choices that define the external dimensions of the ICT strategy. It requires a systematic

analysis of the ICT markets in order to choose the required IS infrastructure and processes and, correspondingly, develop the customer-oriented organizational infrastructure. The interactions of the domains in each of the four dominant alignment perspectives are illustrated in Figure 1.

## Sampling and data collection

The IT Barometer project aims 'to create a method and perform a survey for measuring the use of IT in the construction industry' (Samuelson, 2002, p. 1). It had been used in some Nordic countries, namely, Sweden, Denmark and Finland since 1997 (Samuelson, 1998; Howard and Samuelson, 1998; Howard *et al.*, 1998; Samuelson, 2002; and Howard *et al.*, 2002). In 2003, the IT Barometer survey was conducted in Singapore and the original format of the questionnaire was largely adopted except for small changes to suit local variations.

The stratified sampling method had been used in previous studies (Samuelson, 2002; Bäckblom *et al.*, 2003; and Acar *et al.*, 2005) to investigate ICT usage within the construction industry. Similarly, this survey targeted the primary strata or categories of companies in the construction industry, namely, architecture, engineering, quantity surveying, property development, construction, product manufacturing and supplies, and multidisciplinary. The questionnaire was sent to a total of 754 companies that had been pre-selected by size,

except for architecture and engineering whereby all companies registered with the relevant professional body or association were involved as their numbers are small. The general rule for the pre-selection is to involve the larger companies based on turnover and number of employees for categories where there are numerous companies. In other words, this pre-selection strategy implied that a weighting need not be used to normalize the data and yet the goal of an aggregated response could be achieved that represents the whole industry. Also, decision makers (e.g. managing director or general manager) in the companies were targeted owing to their understanding of the business and its operations as a number of questions in the survey required a strategic response. A breakdown, by category, of the survey responses is shown in Table 1.

Post-survey verification of results

A post-survey verification of the results of the IT Barometer 2003 survey was undertaken through the Construction Industry IT Standards Technical Committee in June 2004. This industry-wide committee had been set up by the Standards, Productivity and Innovation Board (SPRING Singapore) in collaboration with the Infocomm Authority of Singapore (IDA Singapore) in 1998. Views were solicited from members of the committee on the key findings. Their feedback served as qualitative inputs as well as supporting the quantitative results.
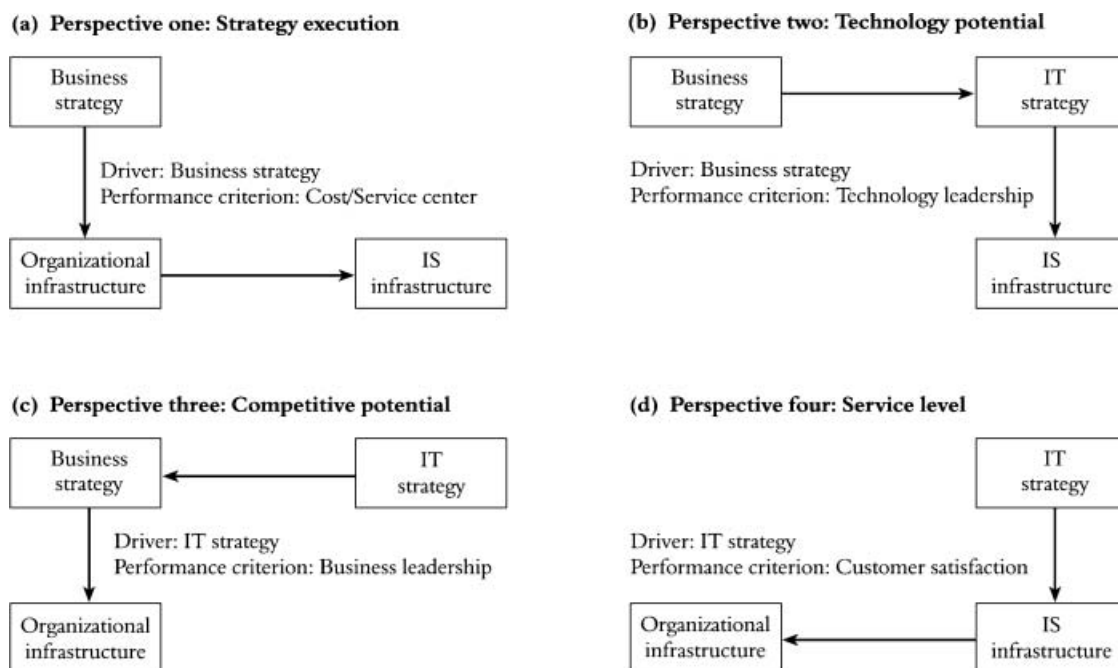
Figure 1 Four dominant alignment perspectives of SAM.   *Source:* Adapted from Henderson *et al.*, 1996.

Table 1 A breakdown of response by category, in numbers and per cent

Category	No. of targeted companies	No. of respondent companies	Percentage of respondent companies
Architecture	361	38	11
Engineering	131	15	12
Quantity surveying	19	5	26
Property development	23	2	9
Construction	129	10	8
Product manufacturing/ supplying	91	1	1
Multidisciplinary	—	13	N.A.
Total	754	84	11

Note: the category 'Multidisciplinary' caters for respondent companies that belong to more than one category, for instance, engineering and construction.

Reclassification of survey responses for SMEs

The survey responses were classified by the SME definition of micro enterprise, small enterprise and medium enterprise to enable a cross-sectional analysis of the dataset. The architecture, engineering and construction (AEC) categories were selected for a detailed evaluation in view of their relatively large response as compared to the other (trade) categories of companies. The datasets of the architecture and engineering categories were combined to represent the collective response of the 'designers', while the (combined) construction and multidisciplinary categories represent that of the 'builders'. Table 2 shows a breakdown of the reclassified dataset of the SMEs.

Data analysis and results

In order to align the external and internal domains of the strategic and functional fields to achieve fit and integration, respectively, relevant questions were selected and classified according to the four domains, namely, business strategy, ICT strategy, organizational infrastructure and processes, and 'ICT infrastructure and processes. These questions are given in Table 3.

The data were analysed by using the SPSS software version 12. Descriptive statistics were generated from the 'Frequencies' and 'Descriptives' procedures on the SPSS 'Analyze' Menu. The first part of the analysis drew out the general characteristics of ICT adoption by the different SME classes for 'designers' and 'builders'. The results generally showed that medium-sized enterprises had a tendency to use ICT more intensively and strategically. This finding concurred with that of recent studies that had focused on ICT adoption by larger firms or advocated the need to look at organizational size in relation to ICT-related attitudes as there would be varying characteristics between the SME clusters (Voordijk *et al.*, 2003; Acar *et al.*, 2005).

In order to apply the SAM, the second part focused on analysing the data according to the four specified domains, namely, business strategy, ICT strategy, organizational infrastructure and processes, and ICT infrastructure and processes. Only the medium-sized enterprises were studied here. The main observations and their corresponding statistical evidence are presented in Tables 4 and 5 for the 'designer' and 'builder' categories, respectively.

Mapping of the results on to the SAM perspectives

In order to apply the framework of the SAM, the results shown in Tables 4 and 5 were mapped on to the four dominant alignment perspectives, respectively, for the designer and builder categories. The objective here is to attach statistical evidence to each of the four alignment perspectives to enable the 'best fit' to be identified for designers and/or builders. This process is illustrated below.

On the first perspective, 'strategy execution', both categories of (medium-sized) enterprises had

Table 2 A breakdown of response by trade category and SME classification, in numbers and per cent

Category	Micro enterprise: fewer than 10 employees and up to US$500,000 annual turnover	Small enterprise: 10 to 49 employees and up to US$3 million annual turnover	Medium enterprise: 50 to 299 employees and up to US$30 million annual turnover	Total
Designers (comprising architecture and engineering companies)	31 (58%)	18 (34%)	4 (8%)	53 (100%)
Builders (comprising construction and multidisciplinary* companies)	—	6 (43%)	8 (57%)	14 (100%)

Note: The asterisk * indicates that only multidisciplinary companies that involve construction are included. In other words, those companies that deal with designing and costing/quantity surveying services or engineering and materials supplying are not included.

Table 3 Selection and classification of questions by domain

Domains	Building blocks		Selected questions
External	For strategic fit	Business strategy	(Q22) Does your workplace have a home page on the Internet?
			(Q33) In which areas does your company plan to increase the use of ICT in the next 2 years?
			(Q34) What advantages do you think ICT provides at your workplace?
			(Q35) What do you think are the greatest obstacles or disadvantages from the use of ICT at your workplace?
		ICT strategy	(Q26) Does your workplace have an ICT strategy?
			(Q27) What percentage of your annual turnover is spent on ICT?
			(Q28) Have you made investment in ICT in the last 2 years?
			(Q29) Estimate how your ICT investment will change in future?
			(Q30) How important are the listed reasons in making decisions about new ICT investments?
			(Q31) Has ICT resulted in changes in the process in the last 2 years?
			(Q32) What effect has ICT had on productivity in the last 2 years?
Internal	For functional integration	Organizational infrastructure and processes	(Q7) Do you use PCs or terminals at this workplace?
			(Q11) What percentage of the staff time involves working from home?
			(Q21) What proportion of the staff has access to the Internet from own computer?
			(Q37) What do you think of the level of ICT training for the listed types of staff in your company?
		ICT infrastructure and processes	(Q8) Which types of software are used at this workplace?
			(Q10) What percentage of the staff in your company has access to the ICT equipment?
			(Q12) Do you have a CAD software at this workplace?
			(Q16) Is design work done by hand or by software?
			(Q17) Estimate the extent to which the operations are computerized at your local workplace?
			(Q18) What proportion of the documents is sent digitally at your workplace?
			(Q19) Do you have a local area network (LAN) at this workplace?
			(Q20) Is there access to the Internet at this workplace?
			(Q23) Have you used an Internet Project Web for storage and transfer of project documents?

demonstrated alignment in respect of having used the business strategy to drive a strong organizational culture and ICT infrastructure (see D-C1, D-C5, D-C6 in Table 4; and B-C1, B-C5, B-C6 in Table 5). The performance criterion is a saving in cost, as a result of this alignment, and it can be measured by financial gains or increased efficiency of business processes (see D-E8 in Table 4; and B-E8 in Table 5).

On the second perspective, 'technology potential', only enterprises in the designer category had shown evidence of an alignment. In this case, the business strategy drives and, in response, the ICT strategy corresponds by defining the required IS infrastructure and processes (see D-C1, D-C2, D-C6 in Table 4). The performance criterion in this perspective is on achieving technological leadership by benchmarking along a set of critical measures so as to reposition the business in the digital age (see D-C4 in Table 4).

While the culture of having a formalized ICT strategy was not as strong (see D-E4 in Table 4; and B-E4 in Table 5), the designer and builder categories of

enterprises were shown to have conformed to the third perspective, that is, 'competitive potential'. In this perspective, the ICT strategy drives the business strategy by translating it into an organizational infrastructure that is geared towards ICT (see D-C1, D-C3, D-C5 in Table 4; and B-C1, B-C3, B-C5 in Table 5). Here, the performance criterion is measured by attaining market leadership in service or product or, simply, realising a competitive advantage for the business (see D-C4 in Table 4; and B-C4 in Table 5).

Finally, on the fourth perspective, 'service level', only enterprises in the builder category, but only half of those surveyed (see B-E4 in Table 5), had shown evidence of an alignment. In this arrangement, the ICT strategy would drive the formation of an IS infrastructure that corresponds to it and, as an outcome, creates an organizational infrastructure that is geared towards ICT (see B-C3, B-C5, B-C6 in Table 5). The performance criterion in this perspective is measured by customer satisfaction that is based on internal and external benchmarking, and implemented through total

Table 4 Results of analysis of medium-sized designer enterprises by domain

Domain	Main outcome ⇒	Statistical evidence (100%=4 respondents) ⇒	Conclusion from outcome and evidence
On business strategy	The survey outcome had shown that the business strategy involved ICT and, hence, the re-engineering of those processes that had been enabled by ICT.	D-E1. 100% of the respondents had a homepage. D-E2. 75% of the respondents planned to use project webs in the next 2 years. D-E3. The respondents used ICT as a strategic collaborative tool as they regarded sharing information as the top advantage.	D-C1. A business strategy exists in medium-sized designer enterprises. D-C2. The ICT strategy responds to the business strategy.
On ICT strategy	The survey outcome had revealed that there was a weak but growing culture of having a formal ICT strategy (i.e. in written form) and the commitment to spend more on ICT was present. Their two important strategies for adopting ICT were to raise competitive advantage and gain technical leadership and, as a result, they had translated into better service levels in terms of higher quality of documents and speed of work, and increased productivity in both administrative and business functions.	D-E4. Up to 25% of the respondents had an ICT strategy in written form. D-E5. About one-third of the respondents had indicated they would spend up to 20% of their annual turnover on ICT. D-E6. 100% of the respondents had made investments in ICT in the last 2 years and 50% of them would increase their investment in the next 2 to 5 years. D-E7. 100% of the respondents noted that their ICT strategy had translated into better service levels in terms of document quality and speed of work, while complexity of processes had increased simultaneously. D-E8. 100% of the respondents also noted that their ICT strategy had translated into increased productivity, of more than 10%, for general administration, project management and design work.	D-C3. A weak but growing culture to formalize the ICT strategy is noted in medium-sized designer enterprises. D-C4. The performance criteria of the strategy are: (i) competitive advantage; and (ii) technical leadership.
On organizational infrastructure and processes	The survey outcome had shown a strong presence of an ICT culture at the workplace but relatively weaker in terms of intra- and inter-connectivity.	D-E9. 100% of the respondents had staff who used the PC at work. D-E10. Less than half of the respondents had staff who intended to work from home in 5 years' time. D-E11. 25% of the respondents had all staff who could access the Internet from their own computer. D-E12. Between 50% and 75% of the respondents had indicated the amount of ICT training was sufficient, despite some who felt it was too general.	D-C5. A strong ICT organizational culture is present (among the staff) in medium-sized designer enterprises.

Table 4 (*Continued*)

Domain	Main outcome ⇒	Statistical evidence (100%=4 respondents) ⇒	Conclusion from outcome and evidence
On ICT infrastructure and processes	The survey outcome had shown that a strong ICT infrastructure had been built and there was a growing trend towards enabling processes through ICT.	D-E13. 100% of the respondents had staff who have their own PC. D-E14. 100% of the respondents used word processing, spreadsheet and the email. D-E15. 100% of the respondents used a software for technical calculation and time planning. D-E16. 100% of the respondents used the CAD software. D-E17. 75% of the respondents had computerized their administrative functions (e.g. bookkeeping and invoicing), while up to half had computerized their technical functions (e.g. work descriptions, scheduling, costing/budgeting). D-E18. Up to half of the respondents had sent their administrative documents digitally, while a quarter had sent their technical documents digitally. D-E19. 100% of the respondents had a local area network (LAN). D-E20. 75% of the respondents had a permanent connection to access the Internet. D-E21. 75% of the respondents had used an Internet Project Web for the storage and transfer of project documents, while the remaining 25% had planned to use it in 2 years' time.	D-C6. A strong ICT infrastructure has been built in medium-sized designer enterprises.

Table 5 Results of analysis of medium-sized builder enterprises by domain

Domain	Main outcome ⇒	Statistical evidence (100%=8 respondents) ⇒	Conclusion from outcome and evidence
On business strategy	The survey outcome had shown that the business strategy of medium enterprises involved ICT and, hence, the re-engineering of those processes that had been enabled by ICT.	B-E1. 75% of the respondents had a homepage. B-E2. 75% of the respondents planned to increase the use of ICT for document handling as well as 75% planned to increase the use of portable or mobile systems in the next 2 years. B-E3. The respondents noted that collaborative business strategies had been advantageous in terms of achieving better communications and sharing of information.	B-C1. A business strategy exists in medium-sized builder enterprises. B-C2. The ICT strategy responds to the business strategy.
On ICT strategy	The survey outcome had revealed that the culture of having a formal ICT strategy was mixed as half had indicated they do have it in written form while, at the same time, almost half had responded they do not think it was necessary to have an ICT strategy. On their commitment to spend on ICT, the response was varied but present. Their two important strategies were to satisfy customer demand and gain competitive advantage through ICT and, as a result, they had translated into better service levels in terms of higher quality of documents and speed of work, and a reduction in mistakes in the prepared documents. There was also increased productivity in both administrative and business functions.	B-E4. 50% of the respondents had an ICT strategy in written form, while 38% had responded it was not necessary to have an ICT strategy. B-E5. The indicated percentages spending on ICT were varied, that is, from a low of 0.03% to a high of 20% of the annual turnover, and the responses were evenly spread across the range. B-E6. 75% of the respondents had made investments in ICT in the last 2 years and 63% of them would increase their investment in the next 2 to 5 years. B-E7. 88% of the respondents noted that their ICT strategy had translated into better service levels in terms of document quality and speed of work, while 50% noted a reduction in mistakes. B-E8. The respondents generally noted that their ICT strategy had translated into increased productivity, of more than 10%, with 88% for general administration, 75% for project management and 75% for site management.	B-C3. A mixed culture to formalize the ICT strategy is noted in medium-sized builder enterprises. B-C4. The performance criteria of the strategy are: (i) customer satisfaction; and (ii) competitive advantage.
On organizational infrastructure and processes	The survey outcome had shown a strong presence of an ICT culture at the work place but relatively weaker in terms of intra- and inter-connectivity	B-E9. 100% of the respondents had staff who used the PC at work. B-E10. Less than half of the respondents had staff who intended to work from home in 5 years' time. B-E11. 25% of the respondents had all staff who could access the Internet from their own computer. B-E12. About 63% of the respondents had indicated the amount of ICT training was sufficient, as compared to too low or excellent.	B-C5. A strong ICT organizational culture is present (among the staff) in medium-sized builder enterprises.

Table 5 (*Continued*)

Domain	Main outcome ⇒	Statistical evidence (100%=8 respondents) ⇒	Conclusion from outcome and evidence
On ICT infrastructure and processes	The survey outcome had shown that a strong ICT infrastructure had been built but there was a weak trend towards enabling processes through ICT.	B-E13. 75% of the respondents had staff who have their own PC. B-E14. 88% to 100% of the respondents used word processing, spreadsheet and the email. B-E15. 75% to 88% of the respondents used a software for technical calculation and time planning. B-E16. 100% of the respondents used the CAD software. B-E17. 75% of the respondents had computerized their bookkeeping function and 25% for invoicing, while 50% had computerized their work descriptions and scheduling, and 25% or less for other technical functions. B-E18. 25% or less of the respondents had sent their administrative documents digitally, while only 15% had sent their technical documents digitally. B-E19. 100% of the respondents had a local area network (LAN). B-E20. 75% of the respondents had a permanent connection to access the Internet. B-E21. Only 25% of the respondents had used an Internet Project Web for the storage and transfer of project documents but 63% had thought it would be useful.	B-C6. A strong ICT infrastructure has been built in medium-sized builder enterprises.

quality management approaches (see B-E7, B-C4 in Table 5).

In summary, the best alignments for designers and builders are shown in Table 6. In addition, the performance criterion for each alignment perspective does highlight the (designer and/or builder) enterprises' management orientation.

Discussion of main findings

Here, the discussion is structured according to the paper's objectives 1 and 2.

First, on the current practices of the SMEs in the construction industry in acquiring new capabilities through ICTs with the aim of transforming themselves into world-class companies, the research found that the needs and requirements of the micro and small enterprises, in both the designer and builder categories, to be common. Their key problems (or barriers) tended to point to costs of investment, and software extendibility and compatibility. In particular, Slyke *et al.* (2002) had attributed the many ICT-related problems that the SMEs face to a general lack of resources. These would include ICT knowledge resources, slack financial resources or slack human resources. As explained, there can be little or no means for the SMEs to innovate without resources. Welsh and White (1981) had broadly termed the lack as 'resource poverty'. Slyke *et al.* (2002) had further explained that the problem is compounded when the SMEs choose the less expensive option, that is, to utilize packaged rather than customized or hybrid systems, and without giving due consideration to the extendibility of the technology.

Hence, in due course, it might manifest software compatibility problems, incurring additional expenses if manual re-entry of data is required in order to integrate incompatible systems. Other common traits that had been found to exist in the smaller SMEs are their lesser tendency to use ICT for strategic purposes and for sharing information as compared to their larger counterparts.

For the medium-sized enterprises, the findings were that this class of SMEs portrays its own unique set of characteristics relating to ICT adoption. Evidently, the medium-sized enterprises were most inclined towards developing ICT capability to remain relevant in a knowledge-based economy where the driving forces are globalization and technology. Specifically, they saw the advantage of sharing via e-commerce and networking for greater efficiency, the need to align their business strategy with ICT strategy for higher returns on investment, the tangible benefits of information standardization for compatible software development, and the need for customer orientation to sustain competition as well as long-term growth of the business.

Secondly, on the application of the SAM to better understand the current practices of the larger (designer and builder) SMEs towards maximising the potential of ICTs as strategic resources, the research showed clear evidence of an alignment in the perspectives of 'strategy execution' and 'competitive potential'. This finding implies that enterprises in the construction sector, like many in the other sectors, consistently apply generic strategies relating to achieving cost leadership and creating product or service differentiation in order, ultimately, to establish a niche. It is a promising sign for

Table 6 Summary of evaluation of strategic alignment for medium-sized designer and builder enterprises

Alignment Perspectives / Domains	Perspective 1: strategy execution	Perspective 2: technology potential	Perspective 3: competitive potential	Perspective 4: service level
Domain anchor (i.e. the driver of change)	Business strategy	Business strategy	IT strategy	IT strategy
Domain pivot (i.e. the area that has the problem or opportunity that is being addressed)	Organizational infrastructure	IT strategy	Business strategy	IS infrastructure
Impact domain (i.e. the area that is being affected by the change)	IS infrastructure	IS infrastructure	Organizational infrastructure	Organizational infrastructure
Empirical evidence of alignment in:	Designer enterprises and builder enterprises	Designer enterprises	Designer enterprises and builder enterprises	Builder enterprises
Performance criterion (or the management orientation)	Cost/Service centre	Technology leadership	Business leadership	Customer satisfaction

the local industry in view of the prevalent understanding that this sector invests little in ICTs as compared with the other sectors and 'few contractors are fully able to integrate ICTs with their business processes' (Acar *et al.*, 2005, p. 713). Incidentally, this research also revealed that there was a growing trend for the larger construction companies to be conscious of the need to use ICTs as well as create an organizational culture to provide quality service in order to satisfy their clients (or customers). Evidently, there had been an alignment in the 'service level' perspective. On the other hand, the larger architecture and engineering companies were more technically inclined and their alignment had been in the 'technology potential' perspective. Understandably, technical competency is key to the designing and drafting practice, and the increased precision derived from using computer-aided applications is becoming one of the main business focuses.

Conclusions

In the study, the characteristics of ICT usage by the AEC companies was compared and the alignment of business and ICT strategies of the AEC companies was examined by applying the framework of the SAM. From the main findings of the general survey as well as alignment analysis, the following key conclusions can be drawn:

(1) In the construction industry, micro and small enterprises have common needs and requirements pertaining to building ICT capability and they are quite different from the needs of medium enterprises. At the policy level, this would mean having to set up targeted schemes to address domain-specific concerns (i.e. those relating to the construction industry) as well as requirement-specific concerns (i.e. those relating to company's staff strength and sales turnover).

(2) For medium-sized enterprises in both designer and builder categories, organizational infrastructure and business strategy are two areas identified as having the problem or opportunity that can be addressed through the deployment of ICT as a strategic resource (see Table 6).

(3) For medium-sized enterprises in the designer category, technology leadership is favoured as a niche performance criterion for the strategic use of ICT (see Table 6).

(4) For medium-sized enterprises in the builder category, customer satisfaction is favoured as a niche performance criterion for the strategic use of ICT (see Table 6).

Future research can be steered in the following directions with the common purpose of verifying the conclusions derived in this research:

(1) To conduct the IT Barometer survey in different countries and apply the SAM framework to the survey results to enable a comparison between countries.

(2) To conduct the IT Barometer survey in the same country on a periodic basis and apply the SAM framework to the survey results to enable a comparison between time periods.

Essentially, with the IT Barometer project serving as the platform to apply the SAM concept within a country as well as between (or among) countries, the possibility of repeating the research over time allows for a strategic comparison of outcomes. In time, the value of this research can manifest as either a method to test for consistency of results to establish a theory; or a means to fine-tune the SAM concept so that it is better aligned with practice. At the organizational level, it is also recommended that in-depth studies be carried out to investigate how companies have used the different domains of the SAM to achieve an edge in performance. For a start and in the context of Singapore's *SME 21*, the findings of current practices would certainly aid policy makers as well as practitioners to better understand different construction sector enterprises' ICT and strategic management orientations.

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