

## E-supply chain operational and behavioural perspectives: an empirical study of Malaysian SMEs

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A review of the literature suggests that much of the existing e-supply chain adoption literature is not firmly grounded in theory. Where many previous studies have identified technology as the key determinant, we argue that *operational* and *behavioural* perspectives should be duly taken into consideration while adopting e-technology. Therefore, inspired by the systems engineering principles, we propose a generic framework for evaluating business performance of e-supply chain companies. A questionnaire was designed and survey data from 208 Malaysian SMEs was collected. Structural equation modelling (SEM) was employed to test the impact of *Supply Chain Strategy*, *E-Business Adoption*, and the interaction of these constructs, on overall *Business Performance*. With regards to the *operational* perspective the results suggest that *E-Business Adoption* relates more positively to *Business Performance* compared to *Supply Chain Strategy* construct. Also, *Technology Capability* scored relatively higher compared to *Organisational Capability* and *Attitudinal Capability*. Overall *Supply Chain Relationship* (*behavioural* perspective) demonstrates a relatively weak result. Our findings suggest that where Malaysian SMEs are technology orientated, however, they need to develop efficient logistics networks to cater for a geographically dispersed population. Also, they need to pay serious attention towards ‘softer’ issues, in that to bring about attitudinal changes that allow developing closer collaboration with their supply chain companies. We argue that *operational* and *behavioural* perspectives can be embedded within the systems engineering principles that provide necessary theoretical underpinning for conducting such a research. The empirical findings provide useful guidelines for SMEs that wish to embark upon an e-business adoption journey. Furthermore, the measures produced here can be used as a benchmarking exercise for the SMEs who have already adopted e-technology.

**Keywords:** e-supply chain; systems engineering; e-business adoption; network organisation; structural equation modelling; SMEs

### 1. Introduction

Recent years have witnessed the worldwide adoption of Internet technology for achieving cost savings, improving customer service, promoting innovation and taking advantage of new business opportunities (Wagner *et al.* 2003). Studies indicate that

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technology diffusion among knowledge intensive SMEs have been difficult (see for example, McCole and Ramsey 2005, Ramsey *et al.* 2005). Chapman *et al.* (2000) argue that SMEs are considerably lagging behind against their larger counterparts in using Internet related facilities in business operations. Other studies have found that SMEs are only half as likely to be using email; and for micro companies the figure is even worse (Hsieh and Lin 1998, Chapman *et al.* 2000).

Zmud (1980) suggests that lack of appropriate resources prevent SMEs in overcoming performance gaps; and limit their ability to exploit new opportunities. Sato *et al.* (2001) cite the main obstacles in adopting e-business as technical, as well as managerial and cultural. Thong and Yap (1995) argue that technical knowledge and attitudes of the CEO have a strong impact on successful technology adoption. Additionally, Culkin and Smith (2000) suggest that poor understanding of the relevant laws (e.g., intellectual property) is perceived to be a major hurdle to adoption. This paper provides a critical review of the available e-business literature to identify theoretical gaps. Based on the literature review, we identify *operational* and *behavioural* perspectives that form the basis of a conceptual framework for understanding e-supply chain adoption and success. We show that how these perspectives relate to the well established 'systems engineering' principles of *technology*, *organisation*, and *people*.

We also describe the results of the empirical study conducted to test our proposed framework using data from 208 Malaysian SMEs. Malaysia has been developing its information highway capacity since the late 1990s. This is realised through the investment of RM 40 billion (approximately £5.9 billion or USD 10 billion) to establish the Multimedia Development Corporation (MDC). Multi-media Super Corridor (MSC) is one of the key initiatives of MDC (Low *et al.* 2000). The purpose of MSC is to enable Malaysia to leapfrog into the information age and to create an environment that will attract inward investment, thereby making Kuala Lumpur a 'regional information hub' (Mohamad 1998, p. 55). Oh (2000) reported that the registration of Malaysian commercial websites had doubled within a few years since the development of MDC. At the start of this decade (year 2000) Multimedia Super Corridor (MSC) launched six-flagship projects, namely: electronic government, multipurpose card, smart schools, tele-health, R&D clusters, and e-business. Out of these, e-business has attracted overwhelming attention from the local businesses.

## 2. E-technology adoption: a literature review

Evidence from the literature suggests that where technology is considered the main determinant for e-business adoption, many companies have adopted e-business without thinking through its *operational* and *behavioural* impacts that subsequently led to failures (Dutta and Biren 2001, Gunasekaran *et al.* 2002, Marshall and Mackay 2002). The subsequent subsections review the works of various authors – believed by the present authors – that have had a major influence in developing the *operational* and *behavioural* perspective in this discipline. Through a careful content analysis relevant key factors are identified that contribute towards the success or failure of e-supply chain adoption.

### 2.1 Supply chain strategy (*operational perspective*)

The importance of web-based technologies to support company e-supply chain operation is widely acknowledged by academics and practitioners (Skjoett-Larsen 2000, Porter 2001,

Sanders and Premus 2005). E-technology enables information to be readily available and easily dispersed among the supply chain members for speeding up various logistics management activities such as order exchange, inventory management, and delivery schedules (Grossman 2004). This allows for greater integration and collaboration across e-supply chains (Lancioni *et al.* 2003, McIvor and Humphreys 2004, Cagliano *et al.* 2005). Frohlich and Westbrook (2001) claim that increased information exchange enhance supply chain integration, that lead to developing relatively stronger relational ties among the supply chain members.

Many researchers have extensively examined the impact of organisational factors on innovation and technology adoption (Fjermestad 2003, Grandon and Pearson 2004). The key factors influencing Internet technology adoption within a supply chain are classified as internal and external environments, firm and individual conditions, and domestic and international involvement (Lewis and Cockrill 2002, Moini and Tesar 2005). There are other studies that examine the perception of management towards IT adoption (Taylor and Murphy 2004). Whereas, Patterson *et al.* (2003) develop a managerial model representing the factors that influence the supply chain technology diffusion process. Studies conducted by Croteau and Bergeron (2001), and Croteau *et al.* (2001) examine the strategic value and adoption of e-business as perceived by top managers in small and medium sized enterprises (SMEs). By identifying factors that are critical for integrating e-business, owners and top managers can formulate appropriate strategy to ensure e-business success (Vijayasarathy 2004).

## **2.2 E-business adoption (behavioural perspective)**

E-business adoption is measured by the extent to which Internet technologies are diffused in routine activities and processes of a business (Chatterjee *et al.* 2002). This would facilitate customer-facing activities, including product or service sales, distribution, after-sales support, product testing, and market research. Researchers have outlined organisational factors as important determinants for e-business adoption (Tornatzky and Fleischer 1990). The key factors identified include characteristics such as size, industry type and business scope (Zhu *et al.* 2004, 2006). Hult *et al.* (2004) suggest that information orientation and technological innovation could significantly reduce information asymmetry and significantly influence e-business adoption. However, there is very limited research addressing the relationship between information orientation/asymmetry and technological innovation/integration on e-business adoption (Hsieh *et al.* 2006).

Tiessen *et al.* (2001) found that technical capabilities facilitated firms' e-business adoption. Successful e-business adoption requires adjustments in the business processes and the ability of a firm to modify and master the technical aspects of Internet technology (Attewell 1992). Therefore, training availability and high level of technical expertise have been identified as a necessary condition for technology adoption (Robey *et al.* 2002). Some studies (Zhu *et al.* 2004) identified the lack of technical expertise as a key inhibiting factor toward e-business adoption.

However, there are only a few empirical studies examining the 'behavioural perspective' of technology adoption. For example, Hsiu and Lee (2005) show how technology adoption would facilitate learning and knowledge management within the organisation. Damodaran and Olpher (2000) have identified knowledge transfer, knowledge integration, and practical application of knowledge as the main elements for developing

'external' capabilities. Bong *et al.* (2004) argue that knowledge assets and knowledge management mechanisms are essential for successful technological and organisational innovation. Whereas, Caloghirou *et al.* (2004) argue that the readiness and openness towards knowledge sharing among business partnerships are important factors in improving business performance and encouraging the adoption of e-business. Hussain and Hafeez (2008, 2009) employed eight organisational metaphors to examine *attitudes* and *behaviour* of key stakeholders while Internet technologies are adopted in public sector organisations. Their longitudinal studies suggest that the key stakeholders *attitudes* and *behaviour* shifted over a period as a result of organisational factors. The implication for managers who are in charge of managing IS-led change is they could use appropriate metaphors in their discourse to explain the need for (*attitudinal*) change; and thereby motivate the stakeholders by affecting their interpretive schemes. Furthermore, the metaphors can help to legitimate the need for the change and to increase stakeholder ownership of change, thereby enhancing the chances of success.

### 2.3 Business success (performance measures)

Marshall *et al.* (1999) define performance measurement as '...the development of indicators and collection of data to describe, report on and analyse performance'. Neely *et al.* (1995) see performance measurement as 'the process of quantifying the efficiency and effectiveness of action'. Sanders and Premus (2005) argue that performance measurement is a complex issue that incorporates economics, management, and accounting disciplines. Zhu *et al.* (2004) have stressed that companies need to develop an appropriate system in order to support a wide range of performance measures.

Using Kaplan and Norton's (2004) balance score card, we have identified tangible and intangible measures to evaluate business performance (Hafeez *et al.* 2002b, 2006a). Owing to Eikebrokk and Olsen's (2005) categorisation, we identify three types of performance measures to examine the perceived benefits of e-supply chain adoption. These include *Financial Measures* (FM), *Efficiency Measures* (EM) and *Coordination Measures* (CM). *Financial Measures* are further defined as increased sales, increased market share and increased international operation or sites (see Table 1). *Efficiency Measures* are elaborated under business efficiency improvements, productivity improvements, and internal process efficiency. Whereas, *Coordination Measures* are decomposed into improved customer service/coordination, procurement coordination and transaction coordination. Table 1 gives a summary of the key studies that have inspired our work with regards to performance measure classification.

We have further categorised these measures under '*operational*', and '*behavioural*' dimensions. In order to conduct a qualitative comparison of different published studies (that helped to develop this classification) we make use of a subjective assessment procedure as suggested by Hafeez *et al.* (2006a). We evaluate the relative importance of each of the measures (or its subcategory) proposed by a representative author on a five point subjective measurement scale. Each author records 'no mention', 'low emphasis', 'medium emphasis', 'high emphasis' or 'substantially high emphasis' for each measure (see Table 1). Such a subjective procedure has helped us to gauge the relative merits of each of the performance measure criteria (and its sub-criterion) in a qualitative way. For example, we know from Table 1 that overall performance measures relate better to *behavioural* perspective (indicating more scores against 'high emphasis' and 'substantially high

Table 1. A subjective assessment of e-business performance measures.

Performance measures		Operational perspective				Behavioural perspective			
		Representative authors				Representative authors			
		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Financial Measures (FM)	Increased sales								
	Increased market share								
	Increased international sales								
Efficiency Measures (EM)	Business efficiency improvements								
	Productivity improvements								
	Internal processes efficiency								
Coordination Measures (CM)	Improved customer service/coordination								
	Procurement coordination								
	Transaction coordination								

Note: Key: no mention; low emphasis; medium emphasis; high emphasis; substantially high emphasis.

Authors: [1] Chaston (2001); [2] Shi and Daniels (2003); [3] Wagner *et al.* (2003); [4] Tracey *et al.* (2005); [5] Sanders and Premus (2005); [6] Kent and Mentzer (2003); [7] Kaplan and Norton (2004); [8] Zhu *et al.* (2004).

emphasis' among the representative authors compared to the *operational* perspective. Further, we see that the representative author [4] (namely Tracey *et al.* (2005)) put much emphasis on the *Financial Measures* (FM) compared to *Efficiency Measures* or *Coordination Measures*. Also we identify that *Financial Measures* are equally identified under the *operational* perspective (see works of representative authors [3] and [4]) and *behavioural* perspective (see works of representative authors [5] and [7]). However, this is not the case for the *Coordination Measures* (CM) where (with the exception of author [4]) more authors identify measures that fit under the *behavioural* perspective (see for example works of authors [5–7]) compared to *operational* perspective.

### 3. Systems engineering and e-supply chain

Systems engineering may be defined as the science of analysing the behaviour of a system (or organisation) by studying the technology, policies and management procedures (or organisational structure) and the behaviour and attitudes of the people who make up the organisation (Forrester 1961, Parnaby 1981, Towill 1993). Many past and current management initiatives such as total quality management (TQM) (Hafeez *et al.* 2006a), supply chain management (Hafeez *et al.* 1996), business process re-engineering (BPR) (Hammer and Champy 1993) are based on systems engineering principles. Systems engineering distinguishes between technology (T), organisation (O) and people (P) dimensions (or TOP dimensions in short) to help understand (the functioning and operations) of an organisation. Systems engineering emphasises the inter-connectedness of these dimensions, and suggests that change in one is very likely to have implications requiring changes in others.

We would particularly draw readers' attention towards Stevens' (1989) supply chain management integration framework based on systems engineering principles. Stevens (1989) outlines a sequence of steps for enabling companies to move from a fragmented functional organisation situation towards a fully integrated seamless supply chain (see Figure 1).

Focus of integration	Stages of integration	Supply chain characteristics	Weaknesses/strengths
Technology Organisation People	<b>Baseline (Stage 1)</b>	Reactive short-term planning, fire fighting, large pools of inventory.	Vulnerability to market changes.
	<b>Functional integration (Stage 2)</b>	Emphasis still on cost not performance, focus inward and on goods.	Reactive towards customer, some internal trade-offs.
	<b>Internal integration (Stage 3)</b>	All work processes integrated. Planning reaches from customers back to supplier, EDI widely used.	Still reacting to customer.
	<b>External integration (Stage 4)</b>	Integration of all suppliers, focus on customer, synchronised material flow, and supply chain covers extended enterprise.	Proactive to customer demand, synchronised demand flow, less trade-offs.

Figure 1. Supply chain integration framework (adapted from Stevens 1989).



For Stevens, such integration is possible through a four-stage strategy. The first step is for companies to move from 'baseline' Stage 1 (where activities are totally fragmented) to Stage 2 (that represents some coordination among activities within the same functional area). For Stevens, adopting advanced *technology* can be the main driver for attaining functional integration as identified in Stage 2 companies. Movement from Stage 2 to Stage 3 is about internal integration, where all functions – from customers to materials requirement processes of a company – are fully integrated possibly through the use of EDI. However, the principal driver to achieve this integration is through structural reorganisation, such that materials management, manufacturing management and distribution can work closely together. Studies indicate that many companies have pursued external integration while ignoring the internal organisational dimension (Barratt and Green 2001, Christopher 2005). According to Stevens flexible organisational structures are necessary for facilitating internal integration of the disparate operational functions. This may require introducing advanced technologies such as materials resource planning (MRP) system, distribution resource planning (DRP) system, and/or a fully integrated enterprise resource planning (ERP) system to allow for automating and integrating these operations (Hafeez *et al.* 1996).

However, moving from Stage 3 to Stage 4 (external integration with suppliers and customers) requires *attitudinal* and *behavioural* change among all members of the supply chain. Here the challenge for traditional supply chain companies is to actively collaborate with its external suppliers and customers by incorporating good management practices such as, developing supplier management programme, sharing orders and design knowledge and initiating open booking accounting practices, etc. These require a wholesale *attitudinal* shift from all those involved. Only then the participating companies in a supply chain would feel to be treated as 'equal' partners, and would take appropriate measures to develop 'trust' needed for further cooperation. Figure 1 illustrates the key characteristics of each of the integration stages, and identify merits for formulating a related supply chain strategy. We would further argue that many supply chains have failed to move to Stage 4 – or beyond the e-supply chain stage – for not addressing the *attitudinal* and *behavioural* perspectives as described above.

#### **4. Revisiting technology-organisation-people dimensions**

It is widely acknowledged that the use of the Internet technology is expected to increase in time (Rogers 1995). The use of the Internet can increase due to 'ripple' effect such that the level of technology adoption in a company can send positive signals to its affiliated companies in the same sector. In turn an affiliated company can influence technology diffusion along its supply chain (as a 'multiplier' effect). Also a company can influence its supply chain companies in other sectors, for example, those providing support or non-core activities, subsequently leading to 'second degree of multiplier effect'. Canepa and Stoneman (2004) reported some empirical justifications to confirm that such effects are a powerful driver for technology adoption across different sectors of the economy.

However, other researchers show that technology diffusion among industries has not been an easy task (McCole and Ramsey 2005, Ramsey *et al.* 2005). Zhu *et al.* (2003, 2004) evaluated the level of adoption of electronic business at the firm level using data from eight European countries. They considered a technology-organisation-environment (TOE) inspired framework. Their study suggests that the e-business is enabled by the

‘technological’ development such as EDI, IS and the Internet, however, is driven by ‘organisational’ and ‘environmental’ factors. Factors such as firm scope and size, consumer readiness, legal issues, competitive pressure and technology competence are also identified as ‘significant’ in e-business adoption (Keoy *et al.* 2007a, 2007b).

We suggest that Stevens’ (1989) model provides good guidelines for e-business adoption. Using systems engineering principles we would differentiate contributory factors for supply chain integration into ‘hard’ (such as technology) and the ‘soft’ (e.g., relations, attitudes, etc.). Interestingly, Stevens as early as 1989, advocated that in order to achieve full integration (from Stage 1 to Stage 4) in a supply chain, the member companies need to focus on *people* dimensions. We would suggest that Stevens’ (1989) framework is equally relevant and applicable in today’s business environment where companies want to move from a traditional supply chain model to become an e-supply chain. We would further argue, therefore, that *technology*, *organisation*, and *people* (TOP) dimensions are well suited for studying the business success of an e-supply chain.

A summary of the literature review is provided in Table 2. As with Table 1, we have conducted detailed content analyses of the identified literature and extracted the key factors identified by the representative authors that have influenced e-business development and practice. We categorised these under the *operational* perspective (*Supply Chain Strategy* (SCS)) and *behavioural* perspective (*E-Business Adoption*). As well as, for each of the above two categories, we have further decomposed these under *technology* (T), *organisation* (O), and *people* (P) dimensions. For the *operational* perspective these are identified respectively as, *Technology Integration* (TI), *Organisational Integration* (OIn) and *Supply Chain Relationship* (SCR). Whereas, for the *behavioural* perspective these are identified, respectively as, *Technology Capability* (TA), *Organisational Capability* (OC), and *Attitudinal Capability* (AC). A definition of these along with relevant key factors is given in Table 2.

## 5. A theoretical framework for e-supply chain adoption

Factors identified in Tables 1 and 2 facilitate development of a theoretical framework as summarised in Figure 2. We develop a conceptual relationship among *Supply Chain Strategy* and *E-Business Adoption* constructs with *Business Performance*. Figure 2 also illustrates that within each of these constructs are embedded the ‘*technology*’, ‘*organisation*’, and ‘*people*’ (or TOP) dimensions. Clearly these constructs are inter-related, and therefore any change in one factor will have ramifications for others. We hypothesise that developments in each of the TOP dimensions (within the remit of *operational* (SCS) and *behavioural* (EBA) perspectives) are necessary for satisfactory *Business Performance* (BP). However, for the purpose of the empirical work presented here, we would ignore the interdependence of these at the conceptual level as suggested by Christopher (2005), and would treat each dimension as independent (or mutually exclusive) while postulating our research hypotheses. Therefore, we construct three main and six sub-hypotheses as given below:

**Hypothesis H1.** *Supply Chain Strategy* (SCS) is a significant determinant of *Business Performance* (BP).

**Hypothesis H2.** *E-Business Adoption* (EBA) is a significant determinant of *Business Performance* (BP).



Table 2. A clustering of key e-business factors under operational and behavioural perspectives.

	Definition	Key factors (used in the questionnaire)	Representative authors
Operational perspective <i>Supply Chain Strategy (SCS)</i>	<i>Technological Integration (TIn)</i> Firm's technology capability to support a wide variety of operational configurations to serve diverse market segments.	<ul style="list-style-type: none"> <li>• Investments for supply chain system</li> <li>• Integration of operating and planning database</li> <li>• Standardised and customised information</li> <li>• Information collection and distribution</li> <li>• Flexible organisational structure</li> <li>• Standardised supply chain practices and operations</li> <li>• Integration of individual operations channel</li> </ul>	Chopra and Meindl (2001) Christopher (2005) Earl (2000) Hafeez <i>et al.</i> (1996) Lambert and Cooper (2000) Zhao and Simchi-Levi (2002)
	<i>Organisational Integration (OIn)</i> Firm's organisational and processes capabilities to support customer requirements.	<ul style="list-style-type: none"> <li>• Time based logistics solutions</li> <li>• Clear roles and responsibilities</li> <li>• Developing and maintaining relationships</li> <li>• Risks shared and rewards</li> </ul>	Hafeez <i>et al.</i> (1996, 2006b) Keoy <i>et al.</i> (2007a, 2007b) Porter (2001) Sanders and Premus (2005) Stevens (1989)
	<i>Supply Chain Relationships (SCR)</i> Firm's competency to develop and maintain inter-enterprise dependency and principles of collaboration.	<ul style="list-style-type: none"> <li>• Time based logistics solutions</li> <li>• Clear roles and responsibilities</li> <li>• Developing and maintaining relationships</li> <li>• Risks shared and rewards</li> </ul>	Feeny (2001) Frohlich and Westbrook (2001) Narasimhan <i>et al.</i> (2006)
	<i>Technological Capability (TC)</i> Firm's IT portfolio (infrastructure and applications) to support the critical internal processes.	<ul style="list-style-type: none"> <li>• Technological innovation and integration</li> <li>• Information orientation and asymmetry</li> <li>• Adaptability of technology infrastructure</li> </ul>	Chatterjee <i>et al.</i> (2002) Cooper and Zmud (1990) Hsiu and Lee (2005) Hafeez <i>et al.</i> (2002b, 2007) Quayle (2002) Keoy <i>et al.</i> (2007b)
	<i>Organisational Capability (OC)</i> Firm's competence to learn new skills and knowledge to support e-commerce initiative.	<ul style="list-style-type: none"> <li>• Organisational learning factors</li> <li>• Organisational support and value</li> <li>• Organisational knowledge management</li> </ul>	Bong <i>et al.</i> (2004) Caloghirou <i>et al.</i> (2004) Hafeez and Abdelmeguid (2003) Lee and Brandyberry (2003) Tamimi <i>et al.</i> (2003)
Behavioural perspective <i>E-Business Adoption(EBA)</i>	<i>Attitudinal Capability (AC)</i> Firm's business partners (readiness) attitude to engage in e-business (business partners, customers).	<ul style="list-style-type: none"> <li>• Attitude to use web-based technology</li> <li>• Performance measurement</li> <li>• Sense making and response to web-based opportunities</li> </ul>	Damodaran and Olpher (2000) Hafeez and Essmail (2007) Hall and Andriani (2003) Hussain and Hafeez (2008, 2009)

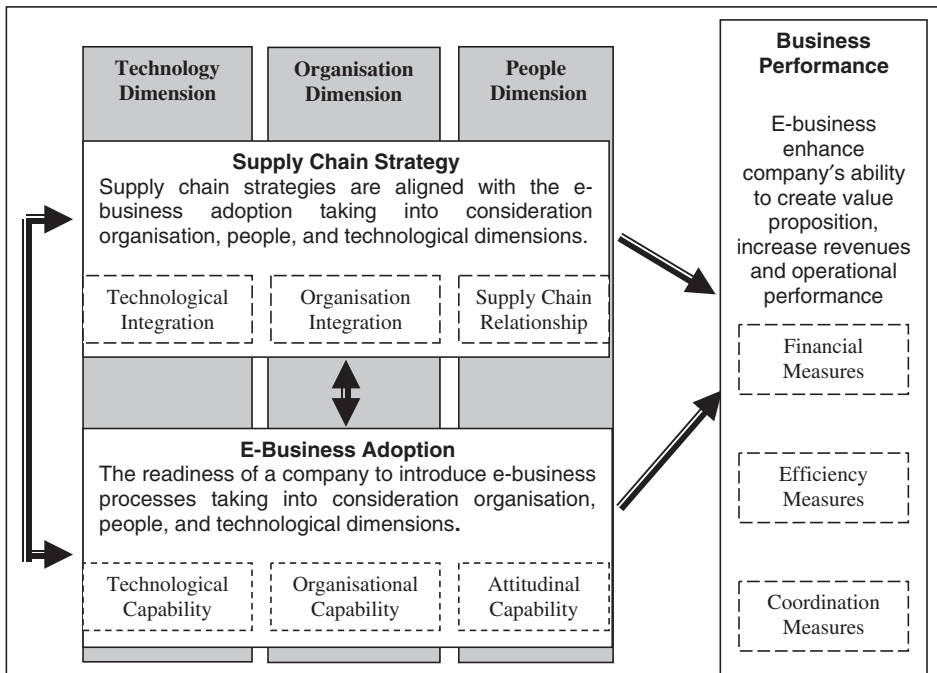


Figure 2. E-supply chain conceptual framework.

Supply chain strategies that integrate technology, organisational structure, and personnel practices are important for satisfactory business performance. The literature suggests that e-supply chain adoption can impact an employee's efficiency (Hasan and Tibbits 2000). Internal efficiency complemented by Internet technologies lead to cost control (Fillis *et al.* 2004, Sanders and Premus 2005), and even cost reduction (Wagner *et al.* 2003, Tracey *et al.* 2005).

In addition to the impacts of SCS and EBA on BP, we propose that SCS and EBA need to be integrated and aligned to impact positively on the *Business Performance* (BP).

**Hypothesis H3.** *Business Performance* (BP) is directly related to the level of mutual dependency (and alignment) between *Supply Chain Strategy* (SCS) and *E-Business Adoption* (EBA).

We further outline the six sub-hypothesis associated with the main hypothesis as below:

**Sub-hypothesis H1a.** *Technological Integration* (TIn) is a significant determinant of *Supply Chain Strategy* (SCS).

**Sub-hypothesis H1b.** *Organisational Integration* (Oin) is a significant determinant of *Supply Chain Strategy* (SCS).

**Sub-hypothesis H1c.** *Supply Chain Relationship* (SCR) is a significant determinant of *Supply Chain Strategy* (SCS).

- Sub-hypothesis H2a.** *Technological Capability (TC) is a significant determinant of E-Business Adoption (EBA).*
- Sub-hypothesis H2b.** *Organisational Capability (OC) is a significant determinant of E-Business Adoption (EBA).*
- Sub-hypothesis H2c.** *Attitudinal Capability (AC) is a significant determinant of E-Business Adoption (EBA).*

## 6. Questionnaire design and implementation

A questionnaire was designed based on variables identified in Tables 1 and 2. The structure and presentation of the questionnaire and language issues were carefully considered. Since English is the second language in Malaysia, it was ensured that each question was clear, precise, and did not confuse the reader. A five point Likert scale was used to capture the individual responses. To improve the validity of the questionnaire, a small scale pilot study was conducted before the final questionnaire was sent out for full scale study. For this study the target SMEs were drawn from sources including ABLY Internet Communication Business Directory (2006), Export Directory of Manufacturer (2006), Malaysian Business Directory (2006), and Ipoh Online (2006).

The present researchers were drawn to the desire to conduct a full scale study to provide a generalised picture of the Malaysian economy with e-business adoption. However, for practical reasons, attention was focused on companies that were identified in the literature as belonging to the leading e-business adoption sectors. These include: manufacturing, services, IT, finance, insurance and real estate, wholesale, retail trade, and 'others' (agriculture, communication, utility services, and non-classifiable establishments). These sectors have been recognised to be traditionally strong or have potential for rapid growth especially in e-business adoption (UNCTAD 2001, Daniel *et al.* 2002, Daniel 2003). The category 'others' however, represents a wider range of remaining sectors in the Malaysian economy.

It is recognised that there are a different numbers of enterprises in each sector. This research seeks to obtain an equal representation from each using a 'proportional sampling' procedure. At the first stage of the study over 1000 emails and postal requests were dispatched to the sample population asking them to participate in the survey. At the second stage a target sample size of 50 was selected for each sector from the qualified respondents (those who agreed to participate). The chosen sampling size is due to Arbuckle (2003) who specified a minimum number of cases required to ensure adequate power and validity for a particular form of multivariate analysis.

Subsequently, 300 questionnaires were emailed to the qualified respondents belonging to the six sectors. Our sample qualifying procedure was vindicated by the fact that overall, 208 respondents returned the questionnaire, giving an impressive 69.3% response rate reported in Table 3. The first part of the questionnaire asked the respondents to state their job title and role/position of responsibility categorised under 'IS' or 'non-IS' managers. Table 4 gives a summary of the respondent's position of responsibility. It was noted that both the IS and non-IS managers almost equally participated in the survey, therefore, the results of this study are deemed non-biased and generic on this category.

Table 3. Survey sample characteristics ( $n = 208$ ).

Sample industries	No. of respondents
Manufacturing	30
Services	28
IT	43
Finance, insurance and real estate	35
Wholesale and retails trade	32
Others (agriculture, communication, utility services, non classified)	40
Total respondents	208
Response rate (%)	69.3%

Table 4. Demographic characteristics of the participants ( $n = 208$ ).

	Posts/positions	Malaysian sample
IS	CIO, CTO, VP of IS	108 (51.9%)
	IS manager, director, planner	
	Other manger in IS department	
Non IS	CEO, president, managing director	100 (48.1%)
	COO, business operations manager	
	CFO, administration/finance manager	
	Others (IS analyst, marketing VP, other manager)	

Note: CIO – chief information officer; CTO – chief technology officer; VP – vice president; IS – information system; COO – chief operating office.

## 7. Empirical analysis

We have employed structural equation modelling (SEM) to empirically test the robustness of the conceptual framework. SEM is a multivariate statistical technique that allows for the simultaneous analysis of the first-order and second-order measurement factors (Bollen 1989). In our analysis, the first-order factors consist of multi-item measures, namely, *technological*, *organisational*, and *people* dimensions for the main constructs of *Supply Chain Strategy* (SCS), and *E-Business Adoption* (EBA). In turn SCS and EBA constructs are the second-order factors composed of the first-order ones. The dependent measure of *Business Performance* (BP) is also conceptualised as a ‘factor of factors’ including *Financial Measures* (FM), *Efficiency Measures* (EM), and *Coordination Measures* (CM), each of which is composed of multiple items. The SEM model comprising first and second order factors is shown in Figure 3.

Tucker-Lewis index (TLI) and the comparative fit index (CFI) are grouped as incremental fit indices. TLI measures the difference between the fitted (proposed) model and a baseline model such as the null model where no relations between the hypothesised variables exist. The CFI index ranges from zero to 1.00, with values close to 1.00 indicative of a good fit (Hair *et al.* 1995). The value of model parsimony indices utilised in this study includes TLI and root mean square error of approximation (RMSEA). Models that demonstrate a score less than 0.05 are considered to exhibit a good fit however, a range between 0.05 and 0.08 is considered to be acceptable (Hair *et al.* 1995).

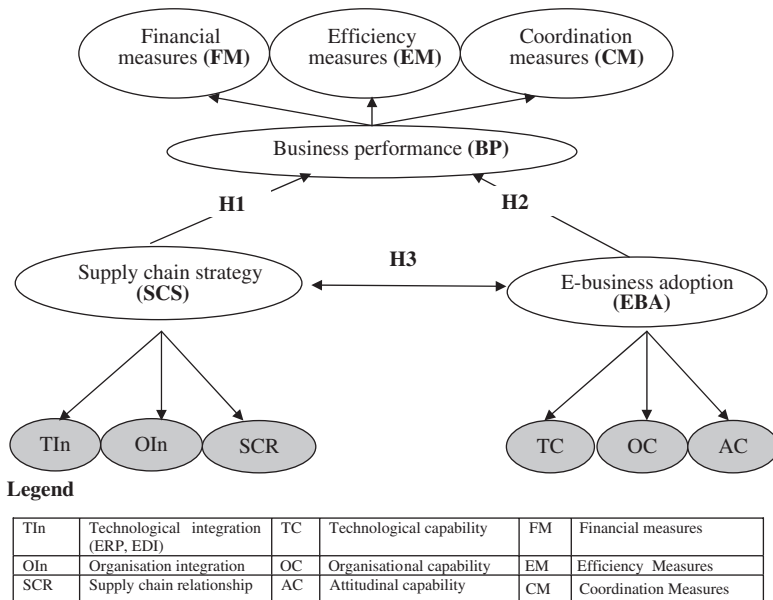


Figure 3. Hypothesised arrangements for the e-supply chain theoretical framework.

Table 5. Regression weights for hypotheses H1 to H3 (sample  $n=208$ ).

Hypotheses				Standardised weight	Standard error (SE) ( <i>c.r.</i> )
Paths coefficients					
H1	BP	←	SCS	0.26	0.09 (2.70)
H2	BP	←	EBA	0.53	0.12 (4.97)
Factor correlations					
H3	SCS	↔	EBA	0.70	0.06 (6.51)

The good fit model provides indices of  $\chi^2$  of 588.80,  $df=393$  with 72 parameters;  $\chi^2/df=1.50$ ; CFI=0.96; TLI=0.95; RMSEA=0.04. These fit indices fall in an acceptable range ( $>0.90$ ) and the RMSEA was less than 0.05. This structural model was nested within the first order model in that it had been generated by imposing restrictions on the parameters of the first order model (Fornell and Larcker 1981).

Table 5 provides the empirical results for the sample. The path coefficients of interest were generated between the independent factors ( $\xi$ , exogenous) of *E-Business Adoption* (EBA) constructs and the dependent factor of *Business Performance* ( $\eta$ , endogenous). The results suggested that EBA (H2:  $\gamma=0.53$ ;  $c.r.=4.97$ ) was a relatively better predictor of BP; compared to the SCS with values (H1:  $\gamma=0.26$ ;  $c.r.=2.70$ ). The factor correlations results between EBA and SCS also provided relatively strong values (H3:  $\gamma=0.70$ ;  $c.r.=6.51$ ).

As far as the sub-hypotheses are concerned, the key factor weightings that had contributed to the second-order factors are as follows (see Table 6). For SCS, Sub-hypothesis H1a 'Technological Integration' (TIn) with  $\gamma=0.97$  scored marginally higher compared to H2a 'Organisation Integration' (OIn) with  $\gamma=0.96$ . However, H1c 'Supply Chain Relationship' (SCR) clearly scored low values in comparison ( $\gamma=0.67$ ).

Table 6. Second factor loadings for sub-hypotheses (sample  $n = 208$ ).

Second factor loadings (sub-hypotheses)				Standardised weight	Standard error (SE) ( <i>c.r.</i> )
H1a	TIn	←	SCS	<b>0.97</b>	0.70 (10.50)
H1b	OIn	←	SCS	0.96	(Fixed) (Fixed)
H1c	SCR	←	SCS	0.67	0.08 (8.68)
H2a	TC	←	EBA	<b>0.94</b>	0.10 (7.96)
H2b	OC	←	EBA	0.84	(Fixed) (Fixed)
H2c	AC	←	EBA	0.65	0.10 (7.01)
FM	←		BP	0.94	(Fixed) (Fixed)
CM	←		BP	<b>0.96</b>	0.07 (14.66)
EM	←		BP	0.90	0.07 (10.50)

Table 7. Model distinctiveness comparison results (sample  $n = 208$ ).

Fit indices	Model 1	Model 2
$\chi^2$	318.89	386.03
$df$	163	164
$\chi^2/df$	1.95	2.35
CFI	0.94	0.92
TLI	0.94	0.90

Similarly, Sub-hypothesis H2a ‘*Technology Capability*’ (TC) with  $\gamma = 0.94$  scored higher compared to H2b ‘*Organisational Capability*’ (OC) with  $\gamma = 0.84$ ; and H3b ‘*Attitudinal Capability*’ (AC)  $\gamma = 0.65$ . Table 7 also depicts the scores of *Business Performance* (BP) against the contributing factors indicating *Coordination Measures* (CM) with  $\beta = 0.96$  scored relatively higher; followed by *Financial Measures* (FM)  $\beta = 0.94$ , and *Efficiency Measures* (EM)  $\beta = 0.90$ . The standardised weights for the main and sub-hypotheses are summarised in Figure 4.

Kline (1998) suggests the technique of ‘two-step modelling’, in that it is always best to test the measurement model underlying a full structural equation model first, and if the fit of the measurement model is found acceptable, then to proceed to the second step of testing the structural model, by comparing its fit with that of different structural models. (Similar procedure was taken into consideration in this paper started by validation of confirmatory factor analysis (CFA) then testing the hypothesis.)

In this study the robustness of the analyses is tested by developing two alternative difference models. Following Marsh (1996) the relations and uniqueness for each of the factors in two models are examined. A schematic representation of the two models along with their description is given in Figure 5. For Model 1 covariance among different items is represented by two independent second order constructs of *Supply Chain Strategy* (SCS) and *E-Business Adoption* (EBA); where each construct represents a distinct component of the e-supply chain model. Whereas, in Model 2 (alternative difference model) covariance among the items is represented by a single second order construct; combining the first order constructs of *Supply Chain Strategy* (SCS) and *E-Business Adoption* (EBA).



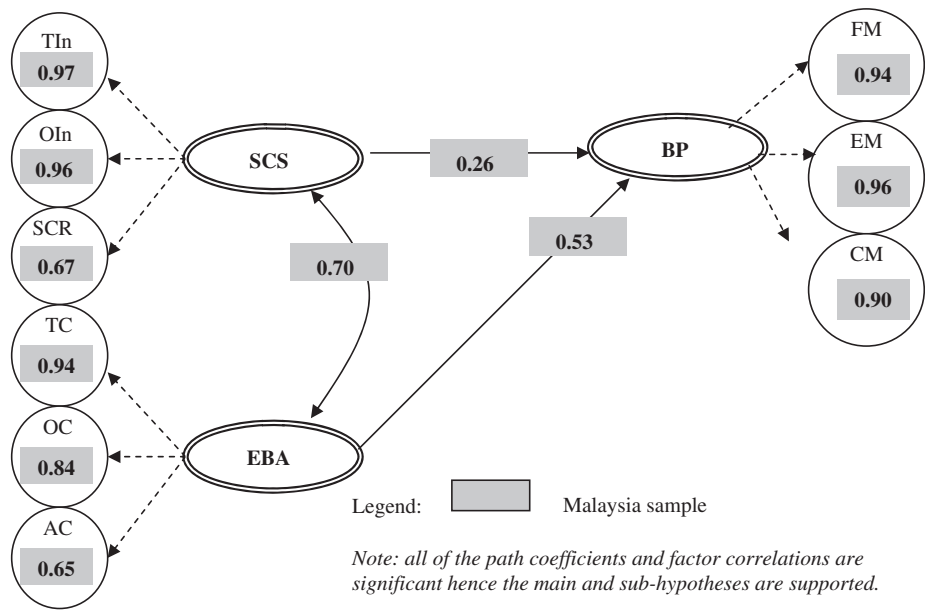


Figure 4. Standardised weights for the main and sub-hypotheses (n = 208).

Model description	Schematic
<b>Model 1:</b> Covariance among the items is represented by three second order constructs of <i>Supply Chain Strategy</i> (SCS) and <i>E-Business Adoption</i> (EBA) where each construct represents a distinct component of the e-supply chain model.	
<b>Model 2:</b> Covariance among the items is represented by one second order construct combining the first order constructs of <i>Supply Chain Strategy</i> (SCS) and <i>E-Business Adoption</i> (EBA).	
<b>Legend:</b> <i>Supply Chain Strategy</i> (SCS) <i>E-Business Adoption</i> (EBA) SCS + EBA First order factor Second order constructs	

Figure 5. A description and schematic of the alternative test models.

A comparison of the test results is summarised in Table 7. The results illustrate that Model 1 (with measurement loading on multiple first order factors) produced much better correlation values ( $\chi^2 = 318.89$ ) in comparison with Model 2 ( $\chi^2 = 386.03$ ) where all first order factors are loaded onto one factor. The fit indices being significant for the two

models, however, Model 1 produced relatively better fit indices ( $\chi^2/df=1.95$ , CFI=0.94 and TLI=0.94) compared to Model 2 ( $\chi^2/df=2.35$ , CFI=0.92 and TLI=0.90).

## 8. Discussion and managerial implications

This research has surveyed the ‘cutting edge’ sectors as a sample, rather including industries where there is little or no adoption. This allowed a focused study of the issues in industries where e-technology is rapidly becoming institutionalised. The theoretical model confirms that successful e-businesses require good *operational (Supply Chain Strategy)*, and *behavioural (E-Business Adoption)* constructs, and a significant mutual dependency between the two. The results confirm that *E-Business Adoption* is dependent on the implementation of a successful *Supply Chain Strategy*. This is a critical finding for the Malaysian companies as most of them would need to operate in a widespread geographical area to meet the needs of a dispersed population, many living beyond the metropolitan areas. Therefore, a good logistics operation is crucial for delivering tangible products in a short timescale.

The results also suggest that companies must pay due attention toward *organisational* and *people* capabilities for improving *Business Performance*. These capabilities are critical to have when a firm is at the planning stage, or at the initial stage of e-business adoption. This is due to the reason that for such companies most of the processes and activities may be manual with very little integration among different activities and processes (Stevens 1989). Where some previous studies have identified *Supply Chain Strategy* as the key factor (Koh and Tan 2006, Wickramatillake *et al.* 2007), our model extends this by measuring the impact of *technological*, *organisational* and *people* related issues with regards to e-technology adoption in order to become successful. Both e-businesses and conventional businesses use information technology. Our earlier findings suggest, however, that technology plays a much more critical role in the business performance of enterprises that have fully adopted the e-business model (Hafeez *et al.* 2006b). For non-adopters, the use of technology is positively related to *Business Performance*, but only modestly so; and use of technology is not part and parcel of *Supply Chain Strategy*. For adopters, the use of *technology* is a stronger determinant of *Business Performance* than *Supply Chain Strategy* (Keoy *et al.* 2007b). Results of the present study also confirm that *technology* is strongly articulated with *Supply Chain Strategy*.

However, the technology adopters are not without problems of their own. Our findings concur with the view that to be successful e-businesses, supply chain management needs to be given strategic importance (Koh *et al.* 2007). We would argue that successful business collaboration is the result of human interactions, which can be supported by IT, but not to be replaced by IT. This is important as the traditional e-business model is usually developed on the backbone of technological infrastructure, and ‘*people*’ related issues can be easily buried under the overwhelming emphasis on technological details. Technology, however, is not the most critical factor in improving supply chains. SMEs must consider relevant *attitudinal* issues as identified by Stevens (1989) to allow for e-technology to be accepted and diffused in the supply chains.

Companies strategies can be further improved by adopting new management thinking such as core competence approach advocated by Prahalad and Hamel (1990). Here companies can help to identify their core competence with regards to, for example, their technology capability, or managerial processes, and develop an efficient supply chain model by exploiting the best fit capabilities of the participating companies

(Hafeez *et al.* 2002a, b, 2007, Hafeez and Essmail 2007). Also, human dimensions can be enhanced using other proven management practices such as total quality management (TQM) practices. TQM ensures that the concept of quality improvement is not related to the production function exclusively, but is part of every activity such as, marketing, research and development, finance, purchasing, etc. The principles of TQM encourage companies to focus on 'softer' and attitudinal skills such as empowerment, working in teams, and participating in supplier development programmes in order to build closer relationships among the members of a supply chain (Hafeez *et al.* 2006a). It is the participation of all employees and the integration of technical and human capabilities that will lead to long-term business success (McAdam *et al.* 1998).

## 9. Conclusions

This paper proposes a conceptual framework to evaluate *Business Performance* of e-supply chain companies. Data from over 200 Malaysian SMEs was collected and a structural equation modelling approach was used to test the e-supply chain model. The empirical findings suggest that *E-Business Adoption* was a relatively stronger predictor of *Business Performance* compared to *Supply Chain Strategy*. We found that with regards to the *Supply Chain Strategy*, Malaysian companies put relatively more emphasis on *Technological* and *Organisation Integration* factors; and usually *Supply Chain Relationships* issues are ignored. Also, *Technology Capability* scored relatively high compared to *Organisational Capability* and *Attitudinal Capability*. Furthermore, results depict that for *Business Performance* construct *Coordination Measures* scored relatively higher followed by *Financial Measures* and *Efficiency Measures*. These results indicate, however, that where technology is still a strong determinant of *Business Performance*, *behavioural* category factors have scored low values. Clearly Malaysian SMEs need to pay more attention towards the *behavioural* dimension for a full scale e-supply chain integration.

Our findings suggest that where *technology* positively relates to *Business Performance*, companies should pay more attention towards developing an efficient logistics management operation to cater for the Malaysian population scattered in a wide geographical area. We argue that systems engineering principles – that promote the interaction among *technology*, *organisation*, and *people* dimensions – provide the theoretical underpinning for embedding the *operational* and *behavioural* perspectives to measure the *Business Performance* of e-supply chain firms. These findings are generic and therefore, could be used as guidelines for companies considering embarking on an e-supply chain adoption journey.

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