Using e-business to enable customised logistics sustainability

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Abstract

Purpose – This paper seeks to analyse and propose how e-business can be coupled with different logistics strategies to achieve customized logistics sustainability (CLS).

Design/methodology/approach – In this paper, a conceptual model for CLS has been developed and, using four cases from industry, the model is further enhanced and validated.

Findings – Three main streams in supply chains, namely collaboration, dissolution, and innovation, are identified in a customised logistics domain. In each of the three streams, e-business and relationship configurations are discussed in detail. Using four case examples, the research presented in this paper demonstrates how e-business performance has hindered or improved the performance of customised logistics provision. A performance measurement (PM) system (efficacy, effectiveness and efficiency (E^3) to evaluate the CLS has been proposed.

Research limitations/implications – The E^3 PM system development in this paper is based on current research on performance in the literature. Using the case examples, the application of E^3 has been explored. Further research on testing E^3 as a good PM system in supply chains using empirical data is desirable.

Practical implications – The paper attempts to provide a guiding framework for practitioners on how to align and design different e-business linkages with different customers.

Originality/value – There has been considerable research on how e-business can be deployed by a focal company in supply chains in order to support its B2B collaboration with key customers and suppliers. There is little research on e-business's potential in dealing with dynamic, unpredictable and sometimes sporadic customer demands. The research presented in this paper attempts to fill this gap by proposing a structured model incorporating different logistics streams, and a PM system for CLS.

Keywords Customization, Logistics data processing, Electronic commerce, Modelling

Paper type Case study

Introduction

Today's markets are increasingly complex and dynamic. Traditional logistics seems to focus on providing a one-size-fits-all delivery service in order to achieve maximum cost efficiency but largely neglects different requirements from different customers. Fuller *et al.* (1993) suggests that the logistics problem of "averaging" results in a situation where "some customers who need specialized products are often underserved, while customers for commodity-like products are overcharged". Torres and Miller (1998)

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suggested that logistics operations should be aligned with customer segments to gain higher market penetration, greater customer loyalty, and profitable growth. The emerging argument is that companies need to build the ability to continuously deliver customised logistics to serve the whole base of customers effectively and efficiently. This ability is hereafter termed customised logistics sustainability (CLS) which refers to the organisation's capability to design, modify, configure, reconfigure and innovate its business processes to produce customised logistics service.

In the current highly competitive environment, there is no doubt about the importance of e-business in the ultimate success, and in some cases even the survival, of any logistics operation (Bowersox and Daugherty, 1995) and initiatives such as just-in-time, time compression, mass customisation, direct marketing, lean and agile (Leagile) supply, collaborative planning forecasting and replenishment (CPFR), vendor managed inventory (VMI), efficient consumer response (ECR), and cross docking. More specifically e-business can facilitate the effective information change and removal of non-necessary players in the supply chain helping in minimising well-known problem of "Forrester's bullwhip effect" (Lee *et al.*, 1997). E-business in the literature is viewed as backbone and nerve system of the supply chain business structure and an essential enabler of logistics activities (Gunasekaran and Ngai, 2004). In this paper, we define e-business as a wider concept that embraces all aspects relating to the use of information technology in business.

However, there are quite a number of issues cited in the literature (Ballou, 2001) with regard to e-business's poor performance, even failures, for example, lack of integration between e-business and business models, lack of proper strategic planning, insufficient application of e-business in virtual enterprise, and inadequate implementation knowledge of e-business in supply chain management. Often-conflicting objectives of members and the evolving dynamic structure of the supply chain also pose challenges for effective implementation of e-business. Figure 1 shows the findings of a cause and effect analysis and factors leading to an ineffective e-business performance in current practices. It has been found that this ineffectiveness has led some companies into serious difficulties, thus struggling for survival in today's fierce competitive market (Jharkharia and Shankar, 2005).

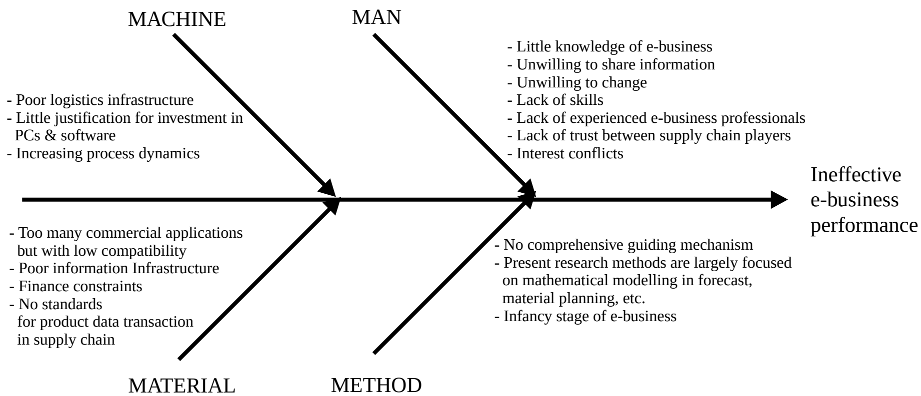

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Figure 1. Cause-effect analysis of ineffective e-business performance

The conceptual model

In order to improve the effectiveness of e-business implementation in supply chains, we have proposed a conceptual model (Figure 2) as guiding framework for an organisation to utilise e-business's full potential, and to construct and deliver CLS in supply chains. This model proposes three different approaches or streams responding to different customer requests and demand patterns based on Pires *et al.* (2001): "Collaboration", "dissolution" and "innovation".

The "collaboration" approach is suggested where customer demand remains sufficiently stable, or changes in predictable ways. An organisation may choose to forge highly specific and efficient process linkages and information exchange mechanisms with selected partners (Gosain *et al.*, 2004). Hence, the long-term relationship with those customers is built by creating a strong bond. Investing in electronic data interchange (EDI) with some major customers to achieve seamless and timely information change is one way to support this approach. When those customers' needs change over time, the logistics processes should be gradually modified to ensure tight inter-organisation collaboration.

The "dissolution" approach is adopted in order to respond to seasonal and/or sporadic orders from the customers in the more dynamic environment. These customers account for around 20 per cent of the total demand to the company. The customers are normally small-medium sized and their demands tend to change more quickly and unpredictably. Therefore, the organisation needs to effectively and quickly reconfigure its business processes almost on every new request, producing the service desired. Then once the request is fulfilled, the task ends. The main characteristic of the relationship is

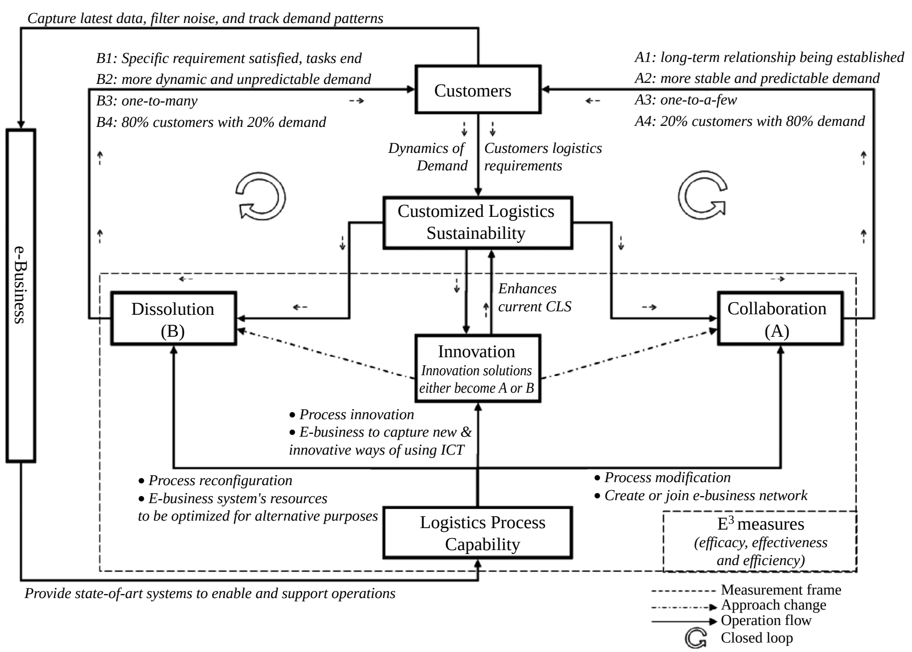

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Figure 2.
E-business enabled sustainable customised logistics model

one-to-many. E-business enabled "modular" processes play a key role in constructing such low-cost connectivity. Companies do not need to create strong and specific information linkages with those customers, but they do need to build sufficient e-business capacity either in house or using neutral web-based system to be flexible and responsive. Online retailing or spot purchasing of commodity-like products are typical examples under this category. In the literature, there are many articles on practices and research focused on "collaboration" but the research on the "dissolution" approach has been largely neglected. The latter is more challenging for an organisation in terms of developing successful CLS because the company involved needs to be more agile and efficient in its logistics operation. This creates more system complexity in supply chain design and implies higher risks of failure.

The "innovation" approach is essential when there is a need for radical changes for an organisation to gain or regain competitive advantages. Typical examples of this approach are National Bicycle's postponement strategy and Dell Computer's mass customised direct marketing model. Innovation in logistics could give organisations distinct advantages to outperform business rivals. The innovation approach could be later transformed into "collaboration" or "dissolution" and it will in turn enhance the current CLS.

Successful adoption of all three types of approaches will enable CLS to be achieved by the organisation. We propose this conceptual model which is consistent with existing research (Bask and Juga, 2001; Clemons *et al.*, 1993) where it has been argued that with the advances in information and communication technology, companies can now achieve close electronic relationship linkages in a flexible and economic way. Enabled by such linkages, the companies could build up their logistics operation flexibilities through (re)configuration and modification of different functional processes. This ability is referred here as logistics process capability which operationalises CLS. In the literature, the integration of different e-business models to logistics processes has been seen as one of critical success factors (Shi and Daniels, 2003).

Case study

Four real world case examples from the authors' action research are discussed in this section, in order to demonstrate why utilisation of different e-business models is the key to building logistics process capability thus leading to sustainable customised logistics.

Two case examples – dissolution stream

The main objective of the case examples is to provide evidence to support the structure of the proposed model shown in Figure 2 and to discuss the impact of e-business on CLS. This section will focus on the "dissolution" stream, whereas the next section will discuss two brief case examples on the "collaboration" stream. We will discuss the former in more detail, as this has not been fully addressed yet in the literature.

An onsite supply chain diagnosis method termed "Quick Scan (QS)" was deployed. QS is a valuable tool for collecting rich and highly valid research data (Towill *et al.*, 2002). Three main data collection techniques are adopted to triangulate the research findings (Naim *et al.*, 2002):

(1) *Process mapping.* To outline the current order-to-delivery process with material and information flows.

(2) *Interview*. To understand current issues and practices in individual supply chain management functions.

(3) *Quantitative data analysis*. To analyse supply chain management performance in terms of lead time, inventory turnover and delivery cost.

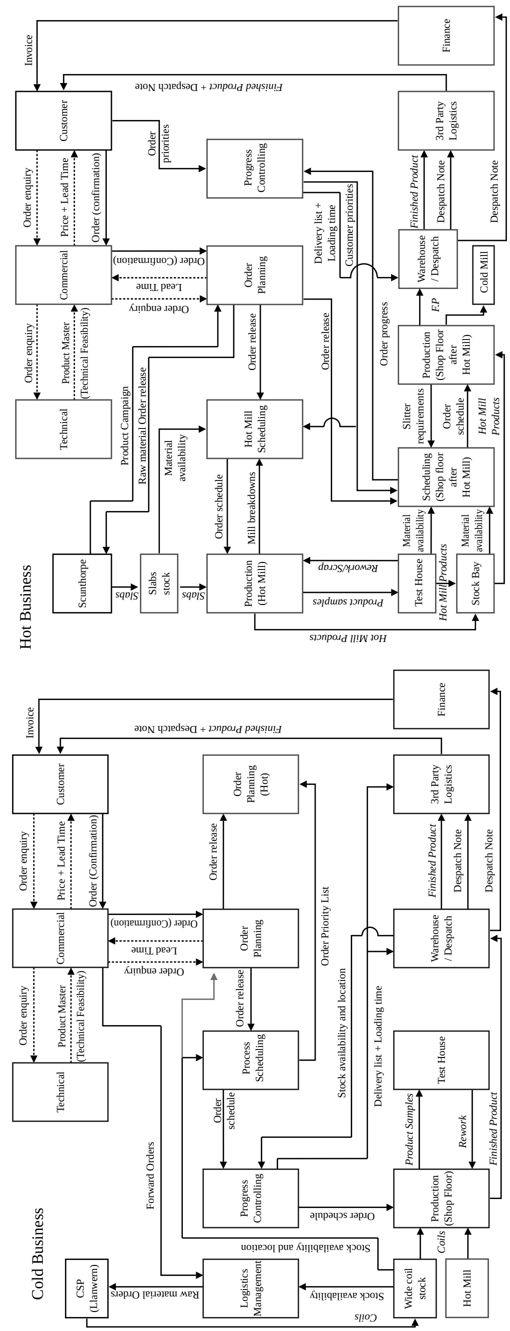
Two cases presented here are from different industry sectors: the first company is one of the leading European manufacturers in the steel industry and the second is the leading retailer in the food industry. The QS research has been conducted at each of their business units. Apart from the different nature of the industry, the two business units (hereafter as Company A and B) have the following similarities:

- being a "small unit" under one big organisation (like "SMEs") with a relatively small revenue contribution to the organisation, but having great potential for growth;
- having many small orders with frequent deliveries;
- having relatively specialized products and logistics requirements; and
- being under high pressure in serving a large spread of customers in terms of time and cost.

Considering their business characteristics, the right approach (stream) for both companies is "dissolution". The key to success is determined by how quickly and economically the logistics processes can be reconfigured fulfilling the diverse demand.

Company A has under-performed for a few years and has been unable to make profit. This is largely because the company has been unable to cope with the fast changing demand from the customers; there is a lack of effective management of its internal processes and it has limited power in gearing raw material suppliers effectively into its supply chain. The small orders for a large variety of products plus intensive market competition urged the organisation to put "flexibility" as highest priority and even compromise over the cost. Unfortunately the business still loses money and is seen by customers as not flexible enough in terms of delivery performance.

Figure 3 shows an overview of current delivery operation for Company A. The company has two production sections: cold rolling (CR) and hot rolling (HR). First, orders are received via EDI system or by fax/e-mail by commercial department. After the approval from the technical department, the commercial department will then release the orders to order planner. Planning is done separately in CR and HR, and then passes down to both raw material suppliers and shop floor processing schedulers. Once finished products are available in the warehouse, transportation will be arranged using 3rd party logistics (3PLs) providers. From this diagram, it can be seen that the deployment of e-business applications has been very limited. In fact, the company uses only two pieces of basic systems: EDI to receive orders in the commercial department and material requirement planning in the production department. Owing to the lack of sufficient e-business applications, the order-to-delivery process is managed in a very fragmented and inefficient way. Each function is doing their own business and there is little integration between functions, let alone the external integration with suppliers and customers. The duplication in planning of CR and HR is one strong evidence of ineffective e-business. The lack of pipeline visibility of customer orders has impeded



Source: Authors *et al.*

Figure 3.
Case A simplified information flow

the performance of operational efficiency within the company and resulted in poor customer service. The problems are summarised as below:

- Lack of a customer relationship management system: leads to the poor management of customer orders, and there has been no segmentation of customers.
- Lack of a supply chain planning (SCP) system to support optimisation of scheduling: the scheduler does the planning purely based on his/her experience and it often leads to an overload of production; when dealing with a large volume of small orders, the scheduler could not develop the best possible optimised production plan as a SCP system usually does. This has a serious impact on the order processing cycle time and the capacity utilization.
- Lack of an enterprise resource planning (ERP) system integration for internal operations: this leads to the unnecessary competition for logistics resources between CR and HR sections; furthermore it presents two faces (from CR and HR) to one customer, which creates double ordering effort from the customers.
- No system integration with the 3PL: the transport manager has no visibility of the shipment status, and totally relies on the 3PL to monitor the distribution performance. The company normally can only acknowledge the problem when customers call to complain.

Overall, the one-to-many relationship discussed in the conceptual model is not managed well in this company and it is worsened by external fast-changing demand and internal ineffective operation. This clearly shows that the organisation will not be able to manage a "dissolution" approach successfully without developing efficient e-business capabilities, and hence is likely to fail to sustain its logistics operation.

Company B, on the other hand, has gained tangible benefits by embedding the e-business models into its logistics processes and developing CLS in an economic way. The business has grown in double digits rate in recent years. Figure 4 shows a simplified order-to-delivery information flow enabled by different e-business systems. Actual EPOS sales data of each store is transmitted via the store replenishment system to a central continuous replenishment system. Then store forecasts are created based on this data as well as inventory levels and other factors like promotions. The forecast is fed into the central supplier management system for final order generation. Next, the final orders are automatically sent to the depots' warehouse management system (WMS). At the same time, the orders are also downloaded into the vehicle scheduling system by the transport scheduler, in order to prepare a daily delivery schedule. The schedule is then passed to both warehouse and transport managers for loading and delivery activities, and the stores are notified as well. Once vehicles are loaded, a vehicle tracking and tracing system monitors their progresses. When vehicles are close to the delivery point, an automatic alert will be sent to the stores and advise that arrival is imminent. The stores will then prepare for the receipt of goods. Finally, once the load is received by the store, the delivery is confirmed automatically by the store replenishment system or by the store manager if stock is damaged or the incorrect quantity delivered.

The following factors are found to contribute to the success of e-business implementation:

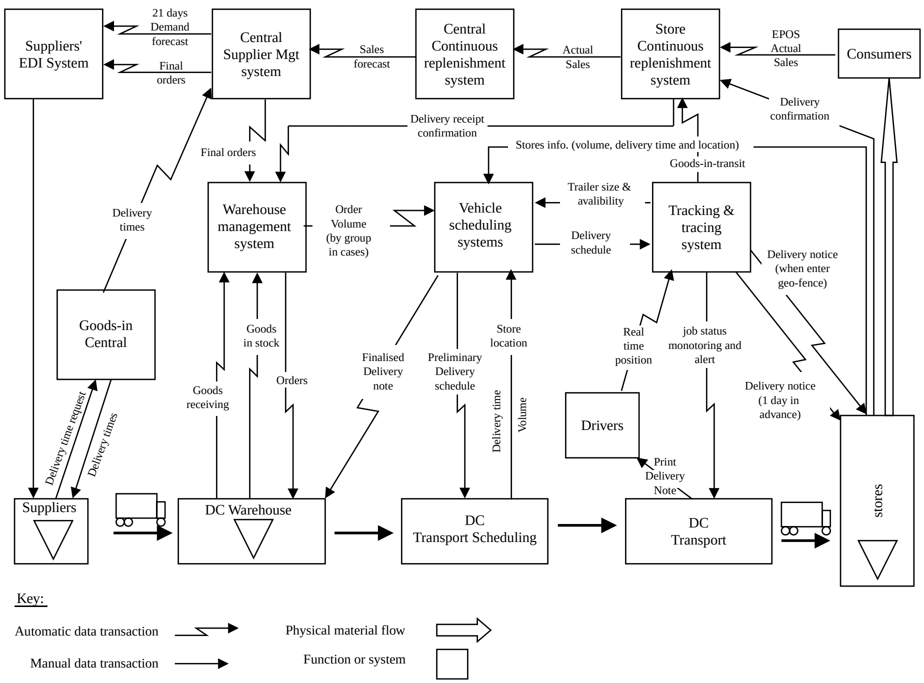


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Figure 4.
Company B simplified information flow

- Individual real-time store ordering system is able to capture sales every hour, and leads to effective demand-driven continuous replenishment.
- The central continuous replenishment system can consolidate all the orders from each store, and translate the store demand orders into a central supplier management system. Combining a number of elements like current stock, supplier's performance, demand orders, events and promotion plans and forecast, the system generates both final and forecast orders. These orders are then sent via EDI to the suppliers' information systems twice a day; at the same time the WMS is notified. The whole process requires little human intervention, therefore reducing data error and processing time.
- The WMS is a highly efficient system facilitated by bar-code technology in maintaining and monitoring the stock movement of finish goods. It also knows the dimensions of each product unit and internal capacity of a loading unit which serves as a basis for trailer loading planning;
- Vehicle scheduling system is linked with the WMS, and can produce most cost effective routes, maximizing driver and fleet capacity.
- The web-based vehicle tracking system is adopted to monitor real time status of consignments, and gives the manager whole visibility, therefore facilitating quick decision making in case of unexpected issues.

By deploying those best-of-breed systems in different functional areas, Company B is able to control its order-to-receive cycle time within three days for most grocery products. The inventory level is largely reduced with the successful implementation of cross-docking and meantime the shelf availability level is maintained at 98 per cent. Through leveraging the potential for e-business applications, Company B is able to customise its logistics operations to continuously serve the dynamic consumer demands from each of its hundreds of small stores, quickly and effectively. Therefore, the "dissolution" approach is sustained and CLS is achieved.

The two comparative examples above demonstrate how e-business should be integrated into logistics processes, to support the "dissolution" stream approach. The examples also confirm that the rapid and dynamic change in customer preference motivates the development of e-business enabled logistics process capability in an organisation. A successful organisation can quickly configure and reconfigurate the provision of its logistics operation, and failing to do so will result in the loss of competitiveness. This is shown as a continuous improvement closed loop in Figure 2.

Two case examples – collaboration stream

Under the collaboration stream, the companies are dealing with key customers. This normally implies that the close partnership is in place and information processes are tightly linked. Successful companies like Dell, Wal-Mart have demonstrated how the tight coupling of partnership, information and process could enhance the supply chain performance. However, our research finds that there are still a number of issues and the full potential of e-business has not yet been fully utilised.

Two cases presented here are from two different industry sectors: Company C is one of the independent leading European manufacturers in the steel industry and Company D is one of the leading manufacturers in the food industry. Again action research using the same methodology QS is adopted. Apart from the different nature of businesses, the two companies have the following similarities:

- big organisations with strong brand strength yet complex hierarchies;
- have world-class manufacturing technology and wide range of products; and
- are under high pressure in terms of delivery cost and customer service.

Company C has long-term relationship with one of its key customers and a 3PL company. However, the 3PL company has been struggling to deliver the products to the customer in an efficient and effective way. Typical problems are that the 3PL company has huge peaks and troughs in demand and therefore the capacity cannot be utilized and a lot of empty running exists. Short term call-offs is another challenge where notice is only given three to four hours ahead of delivery. This requires an extremely flexible operation from the 3PL company in order to respond to demand. But the 3PL company has only limited and delayed visibility of transport demand from Company C. The communication between the Company C and 3PL is via traditional modes, i.e. fax and e-mail. Lack of order processing automation adds up the administration complexities (as there are large volume of orders) and increases processing lead time. Examining further, the underlying reason for this is that Company C still holds a traditional view towards its relationship with the 3PL and positions it as a long-term yet less strategic service provider. This information asymmetry puts the 3PL in a reactive rather than proactive stance in collaboration with Company C. Hence, there are two key factors contributing to less successful collaboration between two parties: the inappropriate configuration of relationship and the absence of essential system integration.

Company D, has built up EDI systems with its key retailers and has been using them for a number of years for automatic order receipt and invoice issuing. The systems have been proved to be very efficient in assisting ECR practices. Further, the retailers also share the EPOS data with Company D. The analysis of shopping basket patterns allows Company D to better target its promotion and range decisions. CPFR is also applied to promotional products. Through tight linkage with key customers, Company D can keep abreast of changes with retailers and be more proactive to deliver the value they favour. The healthy collaboration and tight system linkage has led to continuous sales growth and high on-shelf availability.

Though downstream collaboration with key customers proves to be effective, a problem of "low responsiveness" has been found within the company and also upstream with its suppliers. A six-week planning window posed by one of its key suppliers has made the supply chain too rigid to respond to changing demand. The company has to hold a large stock of products in order to meet the retailers' requirements. The situation is worsened by its poor visibility and control over this supplier's deliveries. There is no system integration with the supplier at all, apart from e-mail and fax transmissions.

Within the company a single ERP system is deployed for data integration across different functions. Though a number of potential benefits are expected, there are a few disadvantages introduced by this "one-size-fits-all" application. For example, it will take almost three months for the packaging department to create a new product code in the master database. Therefore, the commercial department has to plan well ahead for seasonal promotions. But the retailers are pushing the promotion cycle down to weeks. The inflexibility created by the system leads to a large amount of "dead" stock being held in Company D's warehouse. Another problem is the order cycle time. In the system, an order is processed by three to five departments before it is passed into the warehouse for physical picking. The time length can be as long as eight hours. As big retailers normally only give a two or three day time slot for delivery, this leaves a very tight delivery window for the transport department to schedule vehicles and do the deliveries. It, in turn, impacts Company D's delivery performance and customer service level.

Above two case examples illustrate that an appropriate configuration of relationship and information systems should be in place when dealing with key customers and partners. It confirms that the tight linkage of process and e-business systems is beneficial to both companies (C and D) and their key customers. However, the complexities and inflexibility created by organisations' hierarchy and single supply chain application should be minimised if it cannot be eliminated. It is also found that the whole supply chain optimisation can only be achieved when there is not only collaboration with customers but also tight integration with suppliers and the logistics service providers.

Analysis of four case examples

The four case examples discussed above are summarised in Table I. Under the dissolution stream, traditional fragmented legacy systems are no longer suitable for the contingent logistics management. Tightly integrated e-business systems prove to be the nerve centre

Streams	Case company	Characteristics	E-business effect	Current e-business status
Dissolution	A (steel manufacturing)	Fragmented systems, functions and processes	Fragmented information flow, labor-intensive data processing	Inactive
	B (food retailing)	Tightly integrated systems functions and processes	Seamless information flow, automatic data processing	Integrated
Collaboration	C (steel manufacturing)	Information asymmetry and lack of external collaboration with 3PL and customers	Information delay and limited visibility of transport demand	Reactive
	D (food manufacturing)	Information asymmetry and lack of internal collaboration between different functions	Inflexibility created deploying a large single ERP system	Proactive

Source: Authors

Table I.
Case summary

of supply chain management. This integration helps organisations to achieve real time information visibility and assists quick decision making and order processing in response to the dynamics of a large spread group of customers. Under the collaboration stream, heavily bonded investments in system and process integration do deliver tangible benefits but reduced flexibility could be the by-product of such integration.

In summary, e-business plays a critical role in facilitating and enabling the provision of customized logistics in different scenarios. Without effective e-business system in place many problems could occur as illustrated in the above case examples. A road path of e-business enabled CLS can be derived from the four cases, i.e. from inactive, through reactive, proactive to finally integrated. This raises the question of how an organisation should evaluate the performance of its e-business enabled customized logistics operations. In the next section, a measurement system is proposed to deal with this question.

An E^3 measurement system

Modern performance measurement (PM) systems are multi-disciplinary and incorporate general systems theory, organisation theory, behavioural science, operational research, economics/accounting and information technology. Throughout the 1980s and 1990s, much research has focused on the development of individual performance measures, evaluation criteria/principles, frameworks, models and PM systems (Folan and Browne, 2005; Neely, 1995). Notable contributions include Kaplan and Norton's (1992) balanced scorecard, Keegan *et al.*'s (1989) PM matrix, and Cross and Lynch's (1989) performance pyramid.

In supply chain and logistics management, different authors have discussed different measures and identified cost, customer responsiveness and flexibility as key performance measures (Beamon, 1999). Some authors have explored the development of so-called "hard" measures (such as net income or accounting figures) by using different value metrics, for example, customer value added, total cost analysis, segment profitability analysis, strategic profit model and shareholder value (Lambert and Burduroglu, 2000; Stapleton *et al.*, 2002). Others argue that financial measures might introduce short-term opportunist action and that the "soft" side of performance of customer and managerial attitudes should be taken into account (Morgan, 2004). With the development of a "process-oriented" management concept, a new emphasis on process integration has been witnessed (Kallio *et al.*, 2000). Furthermore, the ever increasing competition of "supply chain vs supply chain" has called for creative efforts to design new measures for assessing the performance of supply chain as a whole (Gunasekaran *et al.*, 2004).

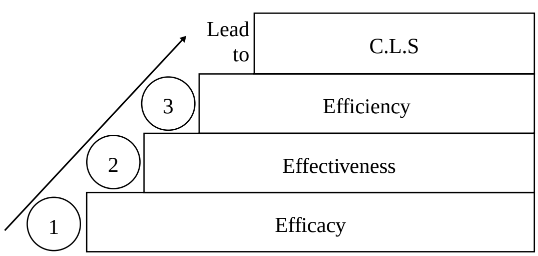
Traditional logistics approaches have been focused on five types of performance, i.e. asset management, cost, customer service, productivity and logistics quality (Fawcett and Cooper, 1998). However, as customers become more demanding, there is an additional need to focus on time-based measures. These have been amalgamated into a single measure of value by Johansson *et al.* (1993) thus:

$$\text{Value} = \frac{\text{Quality} \times \text{Service}}{\text{Time} \times \text{Cost}}$$

Several measures from each category are generally put in place to monitor and manage a variety of logistics functions including transportation, warehousing, inventory management, order processing and administration. Caplice and Sheffi (1995) claim that the performance metrics should be selected and maintained as a system, so that they complement and support each other and provide a well balanced picture of logistics process. However, despite the rich literature, refined measures to use in evaluation of CLS have not been rigorously developed.

Based on our analysis of the literature we have developed a typology, as shown in Figure 5, as the bridge to translate the strategic requirements of e-business enabled CLS into measurable objectives. We build this model upon the five-value drivers proposed by Tyndall *et al.* (1998) and then further align efficacy, effectiveness and efficiency (E^3) concept using the theory of soft system methodology (Checkland and Scholes, 1990).

Tyndall *et al.* (1998) have suggested that single measures of success like improved customer service and sales growth do not automatically equate to real market value as they often result in lower overall profitability, reduced flexibility and unfocused capital investment. Therefore, in order to achieve operational excellence, companies should systematically seek value in supply chain operations from five areas. These five areas are cost minimisation, profitable growth, working capital efficiency, fixed capital efficiency



Source: Authors

Figure 5.
E^3 measurement system

and tax minimisation. The last one is deliberately excluded in our scale development in this research as financial management is beyond the scope of this paper. Tyndall *et al.*'s point of view corresponds to the soft system thinking concept proposed by Checkland and Scholes (1990), where E^3 is proposed as monitoring and control criteria for any systematic transformation. Any conversion of input to output is judged successful or unsuccessful on the three different counts namely E^3. Efficacy addresses the criteria "Does the means work?" Efficiency is here defined as the use of resources against the results derived, where resources include not only physical machinery and materials but also information infrastructure, physical processes and human resources. Effectiveness refers to the degree to which a goal is achieved. PM is a function of these three criteria. Therefore, we argue that, to achieve CLS, companies should have the right set of e-business systems and infrastructures in place before efficiency and effectiveness can be achieved. Effectiveness means "doing the right things" while efficiency means "doing things right". Hence, effectiveness objectives should be achieved before the efficiency ones.

Under "Efficacy" we have four scales. The first two scales, i.e. "e-business reliability" and "capacity" focus on information infrastructure and look at whether an organisation has adequate information systems to provide quality information for management decision making, and enable easy communication and process coordination. In another words, this is a question about "Do we have the right information systems in place?". For example, one company has frequent multi-drops in the delivery but the scheduling system is unable to incorporate this condition and produce optimised routes. In this case, it means the information system does not work properly. Manual planning, in many cases, could not guarantee the best outcome. Hence, without the right tools, an organisation can hardly achieve any operational efficiency or effectiveness. The third scale relates to the existing physical logistics processes: how flexible and configurable these processes can be in order to respond to different customers' needs. For example, can the delivery processes in Case Company B, which were originally configured to serve big stores, be reconfigured to deliver efficiently to convenience stores? If so, high efficacy can be achieved. The last scale concentrates on human resources and on whether the team has sufficient multi-skills to undertake the variety of tasks. Multi-skilled operators are more adaptable to changing environments, thus these companies have fewer constraints to reorganise the teams and link them to necessary resources in response to process changes.

Under "Effectiveness" we focus on "profitable growth" and "responsiveness" towards changes in the environment. Any business, if it cannot generate profitable growth, is not sustainable in long-term no matter how efficient it might be. Therefore, this scale emphasises the factors which impact on how we retain existing customers and gain new customers. Those factors are listed as items in Table II. For instance, these could be:

- *New product introduction lead time.* If the lead time is too long, there are risks of losing potential customers to the competitors.
- *Customer service level.* This is a crucial indicator to help organisations to retain their existing customers.
- *Service differentiation.* Is particularly important for commodity products.

"Responsiveness" refers to how agile an organisation can be to meet the dynamic needs or react to the changing environment. A rigid supply chain cannot fully meet customers' demand.

Constructs	Scales	Items	Origin of items in scale
Efficacy	E-business reliability	Quality of information exchange Breadth of information exchange Privileged information exchanged	Chatfield *et al.* (2004), Johansson *et al.* (1993) and Malhotra *et al.* (2005)
	E-business capacity	Advance level of supply chain execution (SCE) systems Advance level of SCP systems Level of system interoperability Inter-firm information connection flexibility	Cassivi *et al.* (2004), Closs and Swink (2005), Edwards *et al.* (2001) and Gosain *et al.* (2004)
	Process modularity	Standard subprocess Adjustable subprocess Re-arrangeable Structure	Tu *et al.* (2004), Baldwin and Clark (1997) and Malhotra *et al.* (2005)
	Dynamic teaming	Multi-skill team	Tu *et al.* (2004)
Effectiveness	Profitable growth	New product introduction lead time Customer service level Service differentiation Mass customization to customer New channels innovation Perfect orders	Caplice and Sheffi (1994), Johansson *et al.* (1993), Lambert and Burduroglu (2000), Stapleton *et al.* (2002) and Tyndall *et al.* (1998)
	Responsiveness	Quick process changeovers Order flexibility Delivery flexibility Partnering flexibility	Beamon (1999) and Cooper and Muench (2000)
Efficiency	Fixed capital efficiency	Fleet utilization Physical network optimization Distribution capacity management Outsourcing and co-sourcing	Beamon (1999), Caplice and Sheffi (1994), Johansson *et al.* (1993), Lambert and Burduroglu (2000), Stapleton *et al.* (2002) and Tyndall *et al.* (1998)
	Working capital efficiency	Cycle time Inventory turns Inventory/stocking location/levels Co-managed inventory/VMI Account receivable/payables	Christopher (2005), Gunasekaran *et al.* (2004), Kallio *et al.* (2000) and Tyndall *et al.* (1998)
	Operating cost reduction	Total delivery cost Process cost Workforce flexibility and costs Complexity reduction Quality level & reverse logistics cost	Christopher (2005), Gunasekaran *et al.* (2004), Kallio *et al.* (2000) and Tyndall *et al.* (1998)

Source: Authors

Table II. Scale development of E^3 measurement system

Once an organisation has right tools in place, and the business develops organically, the priority becomes "Efficiency" to achieve operational excellence. Consequently, we now concentrate on "cost reduction" and "capital efficiency". This is the area where many logistics managers have dedicated their most efforts. A common problem is that "effectiveness" can sometimes be largely neglected. That is why we put "effectiveness" in higher priority. Under this category, we actively seek ways to improve our fixed and working capital such as vehicle utilisation, lead time reduction and cash flow. Cost reduction can be achieved through applying lean principles; reducing complexity, reducing both labour and process cost, and improve product quality.

Overall, E^3 provides a systematic mechanism addressing the consequent priorities in achieving CLS and the value drivers indicate what activities the companies should focus on. The combination of both provides a guiding measurement system to bring a high-level view for the management team to review and monitor their performance. Table II below lists the suggested scales based on extant literature.

Application of E^3 system and four case examples

The four case studies provide an opportunity to preliminarily validate the E^3 measurement system. It shows that to some extent, E^3 is an effective measurement system to judge how well CLS in a supply chain has been achieved.

In Company A, the poor information visibility and reliability plus low degree of automation has indicated that the company did not adopt the right tool to have sufficient "efficacy". This then directly impacted on the "effectiveness" of operation with the evidence of having little service differentiation, high-delivery cost and loss of business. The ineffectiveness in return leads to low-operations "efficiency" supported by long cycle time (eight weeks), large inventory, and unsatisfactory return on investment. Whereas, in Company B, indicators such as the high-information visibility, healthy cash flow, low level of inventory and delivery cost, have demonstrated a healthy operation management in terms of "efficacy", "efficiency" and "effectiveness".

Company C has some performance metrics in place, but focused mainly on "efficiency" not on "effectiveness". For example, as a transport measure, they use "Ready on time tonnes" but actually the customers measure performance in terms of "delivery on time tonnes". Even though the products are ready it does not necessarily mean they have been delivered to the customers. This has created conflicts between Company C and its customers. For Company D it was found that it has already put E^3 into practice to drive right behaviours in its supply chains. Having aggressive ambitions in utilising ERP and other systems to manage global operations, they have built tight information and process linkage downstream with customers. This is reflected by the continuous business growth in the past few years but the working capital efficiency like inventory turnover has suffered in compensating the priority placed on "responsiveness". Table III gives a simple summary of what has been reflected in these four companies' PM systems in terms of E^3.

Table III.
Mapping E^3 measurement prototype to four case companies

Streams	Case company	Efficacy	Effectiveness	Efficiency
Dissolution	A	✓	X	X
	B	✓	✓	✓
Collaboration	C	✓	X	✓
	D	✓	✓	✓

Discussion and conclusion

To survive and prosper in today's intensely competitive market, organisations need to leverage the potentials of e-business and build up the flexibility to deliver sustainable customised logistics. Tailored logistics service could help an organisation to achieve both cost effectiveness and systems responsiveness.

Customized logistics solutions in responding to different segments of customers require different e-business system and partnership configurations. Three approaches or streams are proposed in a conceptual model to deal with different supply chain scenarios. Previous research in the literature has focused on "collaboration" stream but little attention has been paid to the dynamic, unpredictable sometimes sporadic customer demands. We argue that both "collaboration" and "dissolution" streams have to be geared into an organisation's strategies. Only then, the CLS can be built and facilitated by e-business enabled logistics process flexibility. Organisations should also continue to seek innovative ways for the provision of customised logistics, as logistical innovations are at the core of many companies' dramatic gains in efficiency. Four case examples are presented in order to support this argument, and demonstrate how e-business performance has hindered or improved the performance of logistics operations. An E^3 measurement system is proposed as a guiding framework in order to measure how well the CLS has been achieved.

Future research is required to explore various ways at micro level to configure, modify and reconfigure current logistics process in dissolution, collaboration, and innovation streams. The E^3 measurement system proposed here needs to be further tested by using more case studies and empirical data from different sectors.

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