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Adoption of E-Business Technologies and Suppliers Performance in Thai Automotive Supply Chains

Parveen Farooque* and Jamal A Farooque**

Collaborative efforts, economies of time and cost, competitive service quality, and technological flexibility are among the key concerns of operations for successful supply chains. Implementation of web-based technologies has contributed significantly towards the achievement of such objectives of supply chains. The present study examines the various aspects of e-business technologies adoption with reference to the first-tier suppliers associated with the automotive supply chains in Thailand. The paper also investigates the impact of employing e-business technologies on the suppliers' performance.

Keywords: *e-business technologies, automotive supply chain, performance, Thailand.*

Introduction

It is mandatory for the management of a supply chain to correctly know what product is in demand and in what quantity, the time when it is needed, the price the customer is willing to pay, and what is expected regarding product quality and customer service. In order to satisfactorily address such issues, every firm participating in the chain has to manage its functions, resources, activities, and information in an effective and efficient manner. The use of electronic devices and web-based technologies improves the quality of the desired communication and collaboration along a supply chain. The use of electronic technologies and the Internet by a supply chain for business transactions and interactions makes it an

e-supply chain and the business activities are referred to as e-business. This paper is based on a study of the first-tier suppliers of the automotive supply chains in Thailand. The essence of the paper lies in studying the e-business scenario and determining the impact of the e-technologies adoption on the performance.

Automotive industry in Thailand is the third largest of the country contributing about 12% in the gross domestic product. Many world-known brands like Ford, General Motors, and BMW have shown their presence in Thailand. The Japanese car manufacturers, in particular, are well established there with names including Mazda, Toyota, and Nissan. According to the Japan Automobile Manufacturers Association (JAMA), the quality of

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automotive parts in Thailand is the highest among the Southeast Asian countries. Over 125 countries import automotive products from Thailand, the seventh largest automotive exporter and the fourteenth largest automotive producer in the world (www.boi.go.th, 2009). With particular attention to the 5 countries in the association of Southeast Asia, the Thai automotive industry has outperformed the others (Malaysia, Indonesia, Philippines and Vietnam) in nearly all aspects of the business (Wad, 2009).

Literature Review

Operations planning, logistics, warehousing, sales and marketing, procurement, and distribution are among the core processes and functions of a supply chain (Croom, 2005). Mechanisms for the flow of information and transfer of funds are added to this framework to enable a supply chain to operate. With the advent of the internet, many web-based technologies have been developed and applied to improve the performance of supply chains. As a result of this, the term e-business has emerged. Literature defines e-business in different ways and reports various benefits of e-technologies for supply chains. Johnson and Whang (2002), for instance, have divided e-business applications into three categories, namely, e-commerce, e-procurement, and e-collaboration, whereas, the classification adopted by Cagliano *et al.* (2005) includes e-commerce, e-procurement, and e-operations.

A brief summary of the previous work on e-business and the related issues is as follows- constructs of e-business (Lee and Whang, 2001; Be Boer *et al.*, 2002; Frohlich and Westerbook, 2002), information sharing in supply chains (Cachon and Fisher, 2000; Jap and Mohr, 2002; Moinzadeh, 2002), impact of e-business technologies on supply chain operations (Cagliano *et al.*,

2005; Mufatto and Payaro, 2004; Lancioni *et al.*, 2003; Basu and Siems, 2004; Tan, 2001; Lancaster *et al.*, 2006; Kehoe and Boughton, 2001; Yin and Khoo, 2007), and a literature review on e-business and supply chain research (Johnson and Whang, 2002). The references mentioned in this section represent only an illustrative list of the studies on this subject. It is, however, reflected from the literature that little attention is paid on examining the scenario of e-business implementation at the suppliers' end of automotive supply chains.

Methodology

Though e-business technologies make supply chains lean and efficient, companies need to answer several questions before adoption of such technologies (Boone and Ganeshan, 2007). The answers must justify the purposes and benefits of adopting e-business technologies, identify suitable technologies, define the scope of their use, and explain the company's technological environment. Four areas are identified by Boone and Ganeshan (2007) where e-business technologies have a significant impact on supply chains-product design, collaboration, management cycle, and contribution of each firm in the chain towards costs and benefits.

With this background the present paper attempts to (i) examine the status of e-business technologies adoption with reference to its purposes, technologies, concerns, and benefits (ii) investigate the impact of e-business technologies on the performance, and (iii) to study whether the company's size and annual turnover also influence this performance. The focus of the study has been on the first-tier suppliers situated in and around Bangkok. A structured questionnaire, with mostly close-ended questions, was administered to the respondents either personally or through mail depending on the efforts required

to contact them. To begin with, a pilot survey was conducted on 11 conveniently accessible manufacturers of automotive parts and components. Out of 340 first-tier suppliers (www.thaiautoparts.or.th), 68 could be contacted on a random basis for actual data collection. This number was considered appropriate as it represents 20% of the population. In all 49 questionnaires were received and 37 were found suitable for further analysis after their scrutiny and editing. The first objective is achieved using descriptive analysis of the data, whereas, correlation analysis is performed for the second objective of the study. The data are then processed using t-test to find the answer of the third objective.

Result and Discussion

Analysis and Interpretations

The analysis has been divided into 3 sections- e-business parameters, e-business vis-à-vis performance, and company size vis-à-vis performance.

E-Business Parameters

The three major aspects of e-business implementation, namely, the purposes for which companies use web-based technologies, the technologies they use (referred to as technological drivers), and the barriers (referred to as concerns) of e-business implementation are examined in this paper. Each of these aspects is measured, analyzed and discussed as below.

(a) Purposes of e-business: Based on the studies available in literature (Cagliano *et al.*, 2005; Croom, 2005), 12 factors were identified as the most common purposes for which companies use one or more e-technologies towards e-business implementation. The respondents were asked to rank them on a 12-point scale of

importance, most important (1) to least important (12). Dividing the total score of a factor by the number of respondents yields its average score on the 12-point scale. The lesser the average, the more important the factor has been as a reason to opt for one or more e-technologies. The 12 purposes and their relative importance are shown in Table 1. Making communication channels effective has been found as the foremost objective behind adoption of any e-business technology. The other purposes that follow are improvement in the system of order processing and tracking, up gradation of production planning and scheduling, development of technical knowledge and learning, and enhancement in the system's flexibility to bring the required changes in the components design. Supply chain management and integration and management of distribution channel have been among the least important reasons to implement e-business for the suppliers under study. The results indicate that the suppliers adopt e-business mainly to improve communication along the supply chain, followed by for engineering and production related purposes, cost and revenue optimization, and improvement in the external linkages.

Table 1. Purposes of E-Business

Flexibility in components design	4.68
Inventory management	4.57
Management of distribution channels	10.76
Order processing and tracking	2.16
Production planning and scheduling	2.89
Technical knowledge and learning	4.51
Logistics management	6.86
Customer service and support	8.81
Sales management	6.35
Communication channel	1.54
Procurement process	7.80
Supply chain management and integration	10.60

(b) Technological drivers of e-business: Ten most popular technologies of e-business were identified through literature review

(Lancaster *et al.*, 2006; Croom, 2005; Patterson *et al.*, 2004). The responses on the adoption of each technology were collected using a binary scale (1= adopted, 0= not adopted). The adoption rate (Table 2) has been worked out for each technology (total score divided by the number of respondents) to know its utility in e-business as perceived by the responding companies. After the internet (adoption rate 100%), which is being used for visiting web sites and emailing, the computer-aided design (CAD) has facilitated e-business the most. Next to CAD are enterprise resource planning (ERP), Intranet and electronic data interchange (EDI). Relatively newer technologies and mechanisms like global positioning systems (GPS), customer-relationship management (CRM), middleware systems, and extensible markup language (XML) have got low positions on the adoption scale (only 11%-16% suppliers are using these technologies). These observations are consistent with the previous findings (Cagliano *et al.*, 2005; Lancaster *et al.*, 2006), particularly in the context of automotive industry.

Table 2. Technological Drivers of E-Business

Technological Driver	Adoption
Enterprise resource planning	0.49
Electronic data interchange	0.27
Extensible markup language	0.16
Computer-aided design	0.68
Customer relationship management	0.11
Email and websites (Internet)	1
Intranet	0.49
Extranet	0.27
Global positioning systems	0.11
Middleware systems	0.11

(c) Concerns of e-business: Discussions held with the experts and a study by Tan (2002) have lead to the identification of eight barriers as the major concerns of e-business companies. The respondents have indicated, using a 4-point scale, the strength of each concern (1= weakest and

4= strongest). This has been found that IT infrastructure poses least resistance to e-business implementation, whereas, the limited use of e-business on the downstream and upstream sides has been the strongest barrier. This implies that the first-tier suppliers are well equipped for e-business implementation but they are reluctant to do so as they do not find their partners prepared for this. The other concerns and their relative strength (total score divided by the number of respondents) are shown in Table 3.

Table 3. Concerns for E-Business

Technological Driver	Adoption
Enterprise resource planning	0.49
Electronic data interchange	0.27
Extensible markup language	0.16
Computer-aided design	0.68
Customer relationship management	0.11
Email and websites (Internet)	1
Intranet	0.49
Extranet	0.27
Global positioning systems	0.11
Middleware systems	0.11

E-Business vis-à-vis Performance

The literature reports encouraging outcomes of applying e-business technologies by supply chains under the headings like e-business benefits and impact of e-business (Tan, 2001; Basu and Siems, 2004; Patterson *et al.*, 2004; Lancaster *et al.*, 2006). These outcomes, in fact, represent different performance indicators of those supply chains. The 12 performance indicators have been identified (Table 4) to measure the impact of e-technology adoption on the performance of the responding companies. The respondents have rated their performance on a 10-point scale (1=poorest, 10=best) against each indicator twice - before and after implementing e-business. A positive difference of the 2 ratings for a favorable indicator (like competitive position) or

a negative difference for an unfavorable indicator (like cost of information) reflects an improvement in that particular aspect of performance. For example, the e-business adoption by the sample companies has resulted in an (average) increase of 4.08 points (on the 10-point rating scale) in their profitability and a reduction of 5.60 points in the cost of information (Table 4). According to the findings, the e-technologies applications have reduced the cost of information remarkably, followed by improvement in the level of integration with the upstream partners, and reduction in the order-ship-bill cycle time. The least impact of e-business is reported on the procurement costs.

Since the ultimate objective of e-business is to improve the supply chain performance, a bivariate correlation analysis is performed to relate the purposes, drivers, and concerns of e-business with the performance indicators. Only statistically significant correlations (at either 5% or 10% level of significance) are discussed in this section (Table 5). Out of the 12-performance indicators, 9 have got statistically significant relationships with as many as three purposes, 3 technologies, and 4 concerns. As can be interpreted from this table, managing the flow and storage of materials through e-business has particularly resulted in enhanced productivity and reduced costs of inventory

and procurement. It is interesting to note that a reduction in the cost of inventory has been reported as a result of better sales management rather than the inventory management. Domination of the inventory cost of finished goods over that of other inventory items might be responsible for this result as the finished goods inventory is closely linked with the efficiency of sales management.

As expected, there is positive significant relationship between customer relations management and market accessibility. The role of global position systems, used in e-supply chains for material tracking, has been significant in improving the competitive position and enhancing the level of integration with the upstream. The correlation coefficients of the use of middleware with the level of integration in the supply chain and the order-ship-bill cycle are easily understandable as middleware is applied to integrate two or more systems.

Regarding the impact of the respondents' concerns over e-business implementation, the most affected performance indicators are the order-ship-bill cycle, costs of information and inventory, and level of integration with the downstream members.

These findings, however, do not suggest that only the abovementioned nine indicators of performance represent the benefits of

Table 4. Performance Indicators and Improvement Scores

S.No.	Purpose/Technology/Concern	Performance Indicator	Correlation Coefficient
1	Inventory management (P)	Productivity and dependability	0.39
2	Sales management (P)	Inventory cost	-0.327
3	Procurement process (P)	Procurement costs	-0.382
4	Customer relationship management (T)	Market accessibility	0.406
5	Global positioning systems (T)	Competitive position	0.362
6	Global positioning systems (T)	Integration with upstream	0.372
7	Middleware (T)	Integration with downstream	0.327
8	Middleware (T)	Order-ship-bill cycle	-0.327
9	Lack of e-business use by suppliers and customers (C)	Order-ship-bill cycle	-0.363
10	High cost of e-business implementation (C)	Cost of information	-0.382
11	Low realization of e-business benefits (C)	Cost of information	-0.372
12	Lack of compatibility with changing technologies (C)	Inventory cost	-0.404
13	Lack of compatibility with changing technologies (C)	Integration with downstream	-0.401

e-business. Also this may not be concluded that companies implement e-business only to focus on inventory management, sales management, and procurement process. The technologies and concerns having significant relationships with different performance indicators should also not be mistaken as the only important technologies and concerns. The results indicate that the e-business parameters appearing in the left column of Table 5 need more attention of the first-tier suppliers of automotive parts. This is likely to improve their performance as well as the performance of the respective supply chains.

Company Size vis-à-vis E-Business Performance

The majority (around 83%) of the sample respondents manufactures and

supplies auto parts and accessories. The rest deals with dies, tools and lubricants. All the establishments have joint ventures with foreign companies. Nearly two-third businesses were established between 1971 and 1990 and the others are either older or younger than them. The companies are designated as small or large depending upon the number of their employees (1-400=small and over 400=large). The ratio of small to large has been 0.85. Regarding the annual turnover, this has been reported that 38% have 500 million Baht or more, whereas, the rest do a business below 500 million Baht. A t-test of two independent samples is performed to investigate whether the size and annual turnover of a company have any influence on e-business success. The null hypothesis states that the benefits of adopting of e-business technologies are same for small and large companies.

Table 5. Correlations between E-Business Factors and Performance Indicators

S.No.	Purpose/Technology/Concern	Performance Indicator	Correlation Coefficient
1	Inventory management (P)	Productivity and dependability	0.39
2	Sales management (P)	Inventory cost	-0.327
3	Procurement process (P)	Procurement costs	-0.382
4	Customer relationship management (T)	Market accessibility	0.406
5	Global positioning systems (T)	Competitive position	0.362
6	Global positioning systems (T)	Integration with upstream	0.372
7	Middleware (T)	Integration with downstream	0.327
8	Middleware (T)	Order-ship-bill cycle	-0.327
9	Lack of e-business use by suppliers and customers (C)	Order-ship-bill cycle	-0.363
10	High cost of e-business implementation (C)	Cost of information	-0.382
11	Low realization of e-business benefits (C)	Cost of information	-0.372
12	Lack of compatibility with changing technologies (C)	Inventory cost	-0.404
13	Lack of compatibility with changing technologies (C)	Integration with downstream	-0.401

Table 6. Statistical Results of Hypothesis Testing for Size vs Average Performance Improvement Score

Summary Statistics								
Group	Number	Mean APIS	Standard deviation					
Small	20	3.9875	0.2008					
Large	17	4.2012	0.1644					
F Statistic for Equality of Variances								
F value= 0.554; Two-tail probability= 0.46; Significance level (α)= 0.05								
t-Statistics								
Equal variances assumed				Equal variances not assumed				
t value	df	α	Two-tail prob.	t value	df	α	Two-tail prob.	
-3.500	35	0.05	.001	-3.558	34.963	0.05	0.001	

The 2 set of data are prepared to test the hypothesis- (a) company's size (small or large as defined earlier) vs average performance improvement score (APIS), and (b) company's annual turnover (below 500 million Baht and 500 million Baht or more) vs. APIS. The average performance improvement score of a company is the sum of its improvement scores on individual parameters of performance divided by 12, the number of parameters. The test statistics (Table 6) for the first set of data at 5% level of significance ($t = -3.500$ for $df = 35$ with probability = 0.001) suggest that the difference between the means of the average performance improvement score for the large and small companies (4.20 and 3.99, respectively) is statistically significant. A similar result is obtained from the other set of the data ($t = -3.259$ for $df = 35$ with probability = 0.002). Hence, this can be concluded that the larger companies are benefited more by e-business implementation than the smaller one.

Conclusion

The role of first-tier suppliers, and hence their performance, in an automotive supply chain is crucial. The better they perform, the higher would be the chain's performance. The analysis and results presented in section 4 are based on a study of the first-tier suppliers of automotive parts and accessories operating in and around the capital city of Thailand. The prime objective of this research was to examine the usefulness of various e-business technologies applied by these suppliers. In this context, the major motives behind e-business adoption and the main obstacles have also been studied. The respondents' understanding of e-business vis-à-vis e-commerce is likely to have some bearing on the responses and, hence, on the findings. Sample size is another limitation of this study. Researchers may extend the

scope of this study for more general and useful results through increasing the sample size, analyzing the individual benefits of using different e-technologies, factor analyzing the purposes, barriers and benefits to establish a model to link them together. The results are summarized below.

- E-business is mainly adopted to improve communication with other members of the supply chain followed by for the engineering and production related activities.
- Technologies like extensible markup language, global positioning system, and middleware systems are in rare use, whereas, computer-aided design, enterprise resource planning, and electronic data exchange have got extensive use as e-business technological drivers.
- Lack of e-business adoption by the downstream and upstream members restrict the use of e-business on the part of the suppliers under study. Other important concerns include high cost of e-business implementation and limited knowledge of latest models.
- Remarkable reduction in the cost of information and order-ship-bill cycle time could be achieved through e-business adoption. Not much saving is reported in the procurement costs.
- The 9 indicators of performance, as shown in Table 5, have got statistically significant relationships with as many as three purposes, three technologies, and four concerns.
- The size of a company, in terms of both the number of employees and annual turnover, makes a significant impact on the amount of improvement that can be achieved in the performance through the adoption of e-business technologies.

Successful adoption of e-technologies is a complex task. Not only an adequate infrastructure at your company is sufficient but a compatible technological environment

is required throughout the chain. That means a proper balance between the facilitators and barriers of e-business is the minimal requirement to enjoy the benefits. Mere adoption of any technology for the purpose of performance enhancement does not guarantee the desired results (Boone and Ganeshan, 2007; Patterson *et al.*, 2004). This paper is expected to provide a guideline for e-business technologies adoption to the

companies which are gearing up towards e-business or need to improve an existing set-up. The results can be used to systematically identify the needs for e-business and accordingly select appropriate technologies. Small companies need to be more careful while undergoing the e-business process as their outcomes may not be the same as those for the large ones.

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