Alignment Strategies of AMT with E-Commerce Setting to Improve Business Strategy in the Supply Chain Operations Environment – An Empirical Study

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Abstract - **The purpose of this study is to explore which alignment strategies of advanced manufacturing technology (AMT) with e-commerce setting can develop adequate condition to meet different business strategies requirements in practice. This study is based on 127 Asian samples sieved from the International Manufacturing Strategy Survey (IMSS) database, and applies a hypothesis-test to infer the result. From these Asian samples, we found that the manufacturers usually adopt two business strategies such as product strategy, and high-quality product/delivery strategies to maintain or improve competitive advantage. To As to what business strategies can be successfully put into practice, the results of test indicates that two different alignment strategies of AMT with e-commerce setting can develop appropriate condition to satisfy the requirements of two kind of business strategies. Our finding provides the insight very beneficial for manufacturers to reconsider their alignment strategies of AMT with e-commerce setting to meet business strategies in different context.**

Keywords - **E-commerce, business strategy, advanced manufacturing technology, supply-chain coordination**

I. INTRODUCTION

For possessing powerful competitive ability to respond to the global market, in recent years most manufacturers try to integrate different independent firms and further form the supply-chain management (SCM) collaboration environment. The SCM model enables manufacturers to gain global competitiveness. However, SCM operational context involves the complexity of collaboration among different partner firms, and partner cooperation leads to the business strategy practice in supply-chain operational environment to develop an appropriate strategy practice if manufacturers want successfully practice business strategy in the complex supply-chain environment.

The coordination of the supply chain means the partner firms mutual continuous communication and the integration of different physical products and information flow activities in complexly supply-chain operational environment to forge a best operational environment [5] [22]. Poor coordination outcome creates serious problem such as the "bullwhip effect" [8] and leads to erratic supply-chain operations environment. Poor supply-chain operations environment will influence business strategy practice. Therefore, within-supply-chain coordination effectiveness should be assessed as very imperative if manufacturers want to pursue a successful practice business strategy in the supply chain operations environment.

To improve the efficiency and effectiveness of supply-chain coordination for establishing a best supply-chain operational environment, in recent years AMT and e-commerce have been adopted to help manufacturers to improve and integrate physical product flow and information activities between different partner firms, and further help manufacturer coordinate and establish best supply-chain operational environment.

However, different business strategies need different supply-chain practice environments. In fact, different supply-chain operations environment can be coordinated and further be developed through different alignment strategies of AMT and e-commerce to improve and integrate physical product flow and information flow activities. Therefore, different alignments strategies of AMT and e-commerce should be considered if manufacturers want successfully practice different business strategies in complex supply-chain environment.

Literature in the research area studies still lack empirical evidence of which alignments strategies of AMT and e-commerce can be used to coordinate and develop different operational environments in order to satisfy the requirements of different business strategies. For this reason, the objective of this study is to explore which alignments strategies of AMT and e-commerce can be used to coordinate and develop different operational environments in order to satisfy the requirements of different business strategies. The remaining part of this paper is as follows: First we distinguish and identify different business strategies for manufacturing firms; next we analyze different strategies of applying AMT and e-commerce setting in coordination activities; then we test which combination of alignment strategies fit which business strategy. The final part is the discussion and conclusion.

II. LITERATURE REVIEW

A. AMT Adoption for Supply Chain Coordination

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Advanced manufacturing technology is the main technical component of a Computer Integrated Manufacturing (CIM) system. The main function of CIM is to integrate manufacturing functions all the way from design/engineering, and production planning/control, to fabrication and assembly [9] whereas AMT is bolstered by information technology (IT)/control engineering and can be used to link various departments in a firm for better cooperation requirement. For example, a Flexible Manufacturing System (FMS) consisting of several sets of Computer-aided Numerical Control (CNC) machines entitles itself to work smoothly with production control process such as the Just-In-Time (JIT) paradigm. Besides, the information about current manufacturing status and work-in-process (WIP) inventory level is accessible to the other departments to facilitate managerial decisions-making and action-taking. This advantage of information-sharing communication helps in cutting down physical inventory, enhancing time-to-market, and obtaining better product quality. Thus, researchers suggested that AMT can improve the coordination efficiency and effectiveness in the manufacturing context for the better results by integrating activities that are functionally dispersed in a firm [2] [3] [14].

Seeing the advantage of AMT in the manufacturing workplace, some researchers [1] [10] [16] argued that the intensive employment of AMT can also underpin the coordination and integration tasks in the supply chain context to further achieve an overall competitiveness performance. An excellent example is the application of Radio frequency Identification (RFID) tag to greatly enhance the coordination and integration effectiveness among supply-chain partners [4] [11].

On the other hand, Khouja [13] studied JIT's role in the supply chain and found that JIT can improve the efficiency and effectiveness of supply-chain coordination efforts. Dyer and Ouchi [12] argued that other advanced technologies aside from JIT, to name a few, CAD/CAM systems, CNC machining centers and the like also improve collaborative relationships between upstream suppliers and the focal firm or downstream customers and the firm, for smoother physical product flow.

B. E-Commerce Setting for Promoting Coordination Performance in the Supply-Chain Context

For the past decade, the rapid advance in information technology especially the network domain, has paved the way for the successful introduction and very fast-paced growth of transactions via the e-commerce setting [17]. E-commerce originated from conventional Electronic Data Interchange (EDI), and gained ground by the means of the modern Internet or World Wide Web (WWW) to develop Business-to-Business (B2B) and Business-to-Customer (B2C) connectivity models. By the B2B e-commerce model, firms within a supply chain can share information with one another via the Internet or dedicated electronic communication lines. Therefore, many researchers took it for granted and asserted the e-commerce approach as a powerful tool in backing up supply-chain coordination and integration activities [6] [15] [20] [21] [24].

Other research literature in this domain also supported the argument that the e-commerce setting can improve the effectiveness of supply-chain coordination efforts. In fact the e-commerce improves supply-chain coordination outcomes. [19] also found that e-commerce can improve coordination mechanisms and supply-chain integration between the supplier and customer. [7] [18] indicated that through an integrated supply-chain system and the use of IT, a firm is able to combine complementary resources into a synergistic bundle that will generate more benefits for all partners. [23] argued that efficient information integration plays a key role in electronic supply-chain management. These research findings all support the effectiveness of the e-commerce setting in supply-chain coordination.

III. METHODOLOGY

This study retrieves the observation outcomes from the International Manufacturing Strategy Survey (IMSS) database resulted from a global industrial survey. The IMSS is an international cooperative research network focusing on manufacturing strategy research. It gathers data about practice and performance related to manufacturing strategy in a global setting, and data pertaining to practice in supply-chain management. In this study, we retrieved 127 Asian samples from the IMSS database for testing. Sample distribution includes China (31 samples, 24%), Israel (13 samples, 10%), Turkey (33 samples, 26%), and Taiwan (50 samples, 40%).

The purpose of this research is to explore the actual adoption of AMT and e-commerce setting in the supply-chain coordination activities, and to examine which strategy offers the best results. The operationalization variables should involve business strategy, AMT, e-commerce, and coordination actions. IMSS included eleven kinds of business strategies: offer more innovative products, offer new products more frequently, superior customer service (after-sales and/or technical support), wider product range, environmentally sound products, superior conformance quality, faster deliveries, more dependable deliveries, superior product design and quality, lower selling prices, and greater order size flexibility. For AMT, IMSS utilized ten kinds of AMT activities: stand-alone CNC machines, machining centers, automated parts loading/unloading, Automated Storage-Retrieval Systems (AS/RS), Flexible Manufacturing/Assembly Systems/Cells (FMS/FAS/FMC), computer-aided inspection/testing,

product/part tracking and tracing (bar codes, RFID), integrated design and manufacturing/processing systems (CAD-CAE-CAM-CAPP), engineering databases, and product data management systems. IMSS contained eight kinds of e-commerce activities for the interaction between supplier and customer: scouting/pre-qualify, auctions, RFx (request for quotation, or proposal, or information), data analysis (audit and reporting), access to catalogues, order management and tracking, content and knowledge management, and collaboration support services. IMSS also includes eight kinds of coordination activities: share inventory level knowledge, share production planning decisions and demand forecast knowledge, order tracking/tracing, agreements on delivery frequency, dedicated capacity, require supplier(s) to manage or hold inventories of materials at your site (e.g. vendor managed inventory, consignment stock), collaborative planning, forecasting and replenishment, and physical integration of the supplier into the plant.

To ensure that the sample from the 127 firms meets the requirements, we first analyzed the validity of their content. We used a *t-test* to test content validity, and found all operationalization variables to be significant. We also used factor analysis to test construct validity. The results of factor analysis are shown in Tables Ⅰ-Ⅳ.

Aside from testing construct validity through factor analysis, the objectives of this study are to explore which alignment strategies of AMT and e-commerce can improve different supply-chain coordination activities and further develop different operational environment for different business strategies. Therefore, we further defined various business strategies, AMT strategies, e-commerce strategies, and related coordination activities from the factor analysis results. From the results of factor analysis, three business strategies were labeled: product strategy (factor 1), high-quality product and delivery strategy (factor 2), and price and flexibility strategy (factor 3). Three strategies of AMT were labeled: auto and flexible manufacturing strategy (factor 1), product computer tracking test and management strategy (factor 2), and mechanization and product-integrated design strategy (factor 3). The results of factor analysis indicated that e-commerce has only

TABLE Ⅰ
RESULT OF FACTOR ANALYSIS IN BUSINESS STRATEGY

Business strategy	Factor1	Factor2	Factor3
Offer more innovative products	0.845		
Offer new products more frequently	0.839		
Superior customer service (after-sales and/or technical support)	0.683		
Wider product range	0.673		
Environmentally sound products	0.493		
Superior conformance quality		0.840	
Faster deliveries		0.746	
More dependable deliveries		0.731	
Superior product design and quality		0.728	
Lower selling prices			0.857
Greater order size flexibility			0.446
Eigenvalue	4.364	1.433	1.131
Percent of variation	39.671	13.029	10.283
KMO		0.831	
Bartlett's Test of Sphericity		0.000	

TABLE Ⅱ
RESULT OF FACTOR ANALYSIS IN AMT

AMT	Factor1	Factor2	Factor3
Automated guided vehicles (AGVs)	0.885		
Automated storage-retrieval systems (AS/RS)	0.850		
Automated parts loading/unloading	0.707		
Flexible manufacturing/assembly systems – cells (FMS/FAS/FMC)	0.556		
Product/part tracking and tracing (bar codes, RFID)		0.770	
Engineering databases, Product Data Management systems		0.743	
Computer-aided inspection/testing		0.631	
Stand-alone/NC machines			0.854
Machining centres			0.851
Integrated design-processing systems (CAD-CAE-CAM-CAPP)			0.584
Eigenvalue	4.698	1.154	1.037
Percent of variation	46.978	11.545	10.370
KMO		0.829	
Bartlett's Test of Sphericity		0.000	

TABLE Ⅲ
RESULT OF FACTOR ANALYSIS IN E-COMMERCE

	Supplier	Customer	
E-commerce	Factor1	Factor1	Factor2
Content and knowledge management	0.869	0.852	
Order management and tracking	0.807	0.781	
Collaboration support services	0.802	0.857	
Data analysis (audit and reporting)	0.786	0.795	
Access to catalogues	0.745	0.752	
Scouting/ pre-qualify	0.721	0.646	
RFx (request for quotation, proposal, information)	0.682		0.739
Auctions	0.590		0.890
Eigenvalue	4.554	4.390	1.127
Percent of variation	56.922	54.872	14.091
KMO	0.888	0.865	
Bartlett's Test of Sphericity	0.000	0.000	

TABLE Ⅳ
RESULT OF FACTOR ANALYSIS IN COORDINATION

	Supplier		Customer	
Coordination	Factor1	Factor2	Factor1	Facotr2
Order tracking/tracing	0.818		0.690	
Share inventory level knowledge	0.720		0.762	
Share production planning decisions and demand forecast knowledge	0.708		0.831	
Dedicated capacity	0.591		0.653	
Agreements on delivery frequency	0.422		0.560	
Physical integration of the supplier into the plant		0.841		0.872
Require supplier(s) to manage or hold inventories of materials at your site		0.757		0.874
Collaborative Planning, Forecasting and Replenishment		0.648		0.731

Eigenvalue	3.188	1.169	3.659	1.275
Percent of variation	39.844	14.612	45.743	15.937
KMO	0.767		0.768	
Bartlett's Test of Sphericity	0.000		0.000	

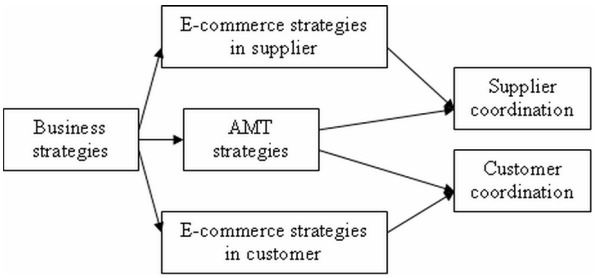

Fig. 1: Research framework

one factor: e-commerce strategy in supplier (factor 1). In addition, the results of factor analysis indicated that two factors were grouped for e-commerce in the customer: e-operations (factor 1) and e-product sells (factor 2). The results of factor analysis indicated that two factors were grouped for supplier and customer coordination: information sharing (factor 1) and integration operations (factor 2).

To ensure the validity of the results of factor analysis, we further analyzed their reliability.

The reliability results indicated that all factors had reliability in excess of 0.7, except for factor 3 of business strategy which was under 0.5, therefore we dropped factor 3 of business strategy in the following section's analysis. Based on the above measurement results and the purpose of this study, the research framework is shown in Fig. 1. This subjects to test in the following section.

IV. RESULTS AND FINDINGS

In this section we test the research framework and present an analysis of the results. We use the regression method for the analysis, and then discuss the research results and findings.

First, we tested which strategies of AMT and e-commerce alignment are selected by two business strategies. Through the results of factor analysis, we know that business strategy can be divided into two strategies: product strategy, and high-quality product and delivery strategy. In terms of business strategy and AMT, the statistical results indicate that the auto and flexible manufacturing strategy ($F = 6.349$, $p < 0.05$), product computer tracking test and management strategy ($F = 7.814$, $p < 0.01$), and mechanization and product-integrated design strategy ($F = 4.913$, $p < 0.05$) of AMT are to be shown significant with product strategy. The statistical results also indicate that the auto and flexible manufacturing strategy ($F = 9.688$, $p < 0.01$) of AMT is shown to be significant with high-quality product and delivery strategy.

In terms of business strategy and e-commerce, the statistical results indicate that the e-commerce strategies in supplier ($F = 7.736$, $p < 0.01$) and e-operations ($F = 4.312$, $p < 0.05$) are shown to be significant with product strategy. The statistical results also indicate that e-operations ($F = 3.950$, $p < 0.05$) is shown to be significant with high-quality product and delivery strategy.

Second, we tested which strategies of AMT approach and e-commerce setting made a significant improvement in the supplier and customer coordination outcome. Through the results of factor analysis, we know that supplier and customer coordination can be distinguished based on two coordination activities, information sharing and integration operations, in supplier coordination and customer coordination. The statistical results indicate that the information sharing ($F = 17.903$, $p < 0.01$) and integration operations ($F = 12.912$, $p < 0.01$) of supplier coordination activities and information sharing ($F = 10.715$, $p < 0.01$) and integration operations ($F = 15.711$, $p < 0.01$) of customer coordination activities are shown to be significant with the auto and flexible manufacturing strategy of AMT. The statistical results also indicate that the information sharing ($F = 37.167$, $p < 0.01$) and integration operations ($F = 8.794$, $p < 0.01$) of supplier coordination activities and information sharing ($F = 20.260$, $p < 0.01$) and integration operations ($F = 9.291$, $p < 0.01$) of customer coordination activities are shown to be significant with product computer tracking test and management strategy of AMT. Finally, the statistical results indicate that only information sharing ($F = 9.999$, $p < 0.01$) of the supplier is shown to be significant with mechanization and product-integrated design strategy; the other three coordination activities of the supplier and customer cannot be improved by mechanization and product-integrated design strategy.

The statistical results indicate that information sharing ($F = 32.391$, $p < 0.01$) and integration operations ($F = 21.581$, $p < 0.01$) of supplier coordination activities are shown to be significant with e-commerce strategy in the supplier. The statistical results also indicate that the information sharing ($F = 44.929$, $p < 0.01$) and integration operations ($F = 47.099$, $p < 0.01$) of customer coordination activities are shown to be significant with e-operations. The statistical results also indicate that e-product sales cannot improve customer coordination activities. All the test results are shown in Fig. 2.

Except for e-product sales, the test results indicated that five strategies of AMT and e-commerce can be adopted to improve all coordination activities of the supplier and customer; in other words, these five strategies can develop appropriation practice environment in order to satisfy the requirements of product strategy practice. The test results also indicated that the high-quality product and delivery strategy can adopt an auto and flexible manufacturing strategy of

AMT and e-operations of e-commerce in order to improve the coordination activities of the supplier and customer to develop appropriation environment for ensuring the high-quality product and delivery strategy practice.

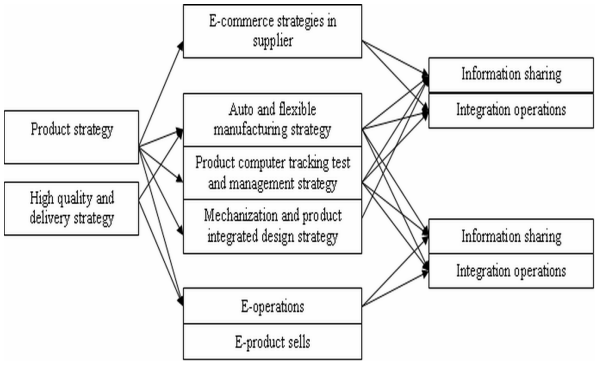

Fig. 2: Test results

V. CONCLUSION

This article makes a significant if not unprecedented contribution to the research domain of supply chain management (SCM). Most literatures in this area unilaterally put emphasis on the convergence of business strategy practice and supply-chain operations environment, whereas our study discloses the different supply-chain operations environment can be developed through different alignment strategies of AMT and e-commerce in order to satisfy different practice environment requirement of business strategies.

Under Asian samples, we found that the Asian manufacturers usually adopt two business strategies including product strategy and high-quality product/delivery strategies to maintain or improve competitive advantage. From the two successful two business strategies, we justified that Asian manufacturers adopt two different AMT and e-commerce alignment strategies to form two practice environment requirements for two business strategies. To sum up, our finding provides the insight very beneficial for manufacturers to reconsider their alignment strategies of AMT and e-commerce. for manufacturers to reconsider their alignment strategies of AMT and e-commerce.

This study just consider two business strategies, in future research, perhaps more business strategies could be considered and further explore more different AMT and e-commerce alignment strategies for more different business strategies.

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