

行政院國家科學委員會專題研究計畫 成果報告

我國跨國企業在兩岸物流發展模式之探討

計畫類別：個別型計畫

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執行期間：92年08月01日至93年07月31日

執行單位：國立交通大學交通運輸研究所

計畫主持人：馮正民

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計畫主持人：馮正民教授

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執行單位：國立交通大學交通運輸研究所

中 華 民 國 93 年 8 月 31 日

行政院國家科學委員會專題研究計畫成果報告

我國跨國企業在兩岸物流發展模式之探討

Exploring Cross-Strait Logistics Development Model for Taiwanese Multinational Corporations

計畫編號：NSC 92-2415-H-009-003-SSS

執行期限：92年8月1日至93年7月31日

計畫主持人：馮正民 國立交通大學交通運輸研究所教授

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一、中文摘要

面對經濟全球化的發展，過去十多年跨國企業紛紛改造其產銷供應鏈作業與流程以提昇競爭力。在此一趨勢下，許多我國的跨國企業陸續前往中國大陸投資設廠生產，以取得具比較利益的生產要素資源。同時，物流業者也做了相當大的改變為企業提供必須的服務。雖然我國的跨國企業目前在兩岸有此發展，惟以往對於中國大陸物流服務及其市場現況，以及物流服務與企業供應鏈調整兩者間關係的研究文獻並不多。

基此，本研究針對前往中國大陸營運的我國跨國企業與物流業者進行物流需求與績效調查，調查分析結果將有助於瞭解廠商在大陸營運所面對的物流環境，也可提供學者與物流業者作為後續研究及業務規劃之參考。

本研究首先蒐集兩岸物流發展的各式文獻資料，其次，針對前往大陸營運的我國跨國企業及物流業者進行調查，以獲取兩岸物流發展現況的相關資訊。調查回收的資料除應用一般統計檢定方法檢定分析外，為能同時處理影響廠商物流需求、供應鏈調整、及全球運籌規劃決策潛在變數（latent variables）間之複雜關係，本研究亦以多變量分析方法進行分析。

本研究深入探討我國跨國企業供應鏈作業績效與物流服務效能之間的關係，並進一步釐清受限於兩岸目前政治情勢而對跨國企業供應鏈作業成本、前置時間、及

存貨水準造成的影響。最後，亦針對未來值得繼續研究的課題與方向提出建議。

關鍵詞：兩岸物流、供應鏈、跨國企業、物流業者

Over the past decade, multinational corporations (MNCs) have reshaped the processes and activities of their supply chains to enhance competitiveness by the increasing globalization of economy. Based on this trend, many manufacturing enterprises of Taiwan advanced into Mainland China to capture the comparative advantages of production input factors such as cheaper labor and raw material cost. Taiwanese logistics service providers have also been rapidly transforming under the circumstances. However, few studies discuss the existing status of logistics operations in Mainland China as well as the relationships between logistics service availability and the supply chain adjustment.

Under these circumstances, this research is therefore to investigate the demand and performance of Taiwanese firms invested in China on key logistics capabilities. The results of the research foster a greater understanding of the logistics capabilities of Taiwanese MNCs as well as help logistics researchers and practitioners identify the capabilities that are associated with enhanced logistical performance in an international setting.

This research first collected logistics development data profiles of both Mainland China and Taiwan, and then designed and conducted a questionnaire survey to examine the operations information of Taiwanese MNCs and logistics service providers. From the survey, this research applied statistical methods for describing and analyzing these multivariate observations and an ANOVA analysis had been established to estimate the complex relationships among latent variables affecting logistics service decision-making, supply chain adjustment, and global logistics strategy planning.

This research tried to identify the relationship between logistics service capability and a MNC's supply chain operating performance, and to clarify the influence of existing political constraints across the Taiwan Strait on the cost, lead-time and inventory level of activities and processes of supply chain. In addition, this paper also highlighted gaps in the literature and issues for future research.

Keywords: *cross-strait logistics, supply chain, multinational corporation (MNC), logistics service provider*

二、緣由與目的

本研究延續之觀察與分析發現我國廠商（尤其是製造業廠商）在目前的全球供應鏈佈局下的供應鏈變革決策，包括「空間」與「時間」的調整，相當程度都受到「中國大陸」此一因素的影響。

中國大陸對各國企業而言，是一個全新、尚未開發的投資市場，它有便宜的勞動成本與生產資源，擁有十億的消費人口，以各國對大陸的投資而言，自 1996 年以來，每年各國的平均投資均高達 400 億美元以上，其中，僅香港、美國、及台灣就佔了將近二分之一，台灣的投資金額可能還保守低估。事實上，過去十餘年來我國許多勞動密集的中小企業陸續轉向勞動密集、生產資源豐富、成本低廉、且市場潛力極高的中國大陸尋求發展，逐漸形成中、上游產業在臺灣，下游產業移往大陸的產業佈局。

不過，上述的產業佈局也由於大陸市場的不斷成長、直航問題無法解決導致產品總生產成本增加等原因而發生改變。一些中、上游產業也陸續轉移至大陸。綜合經濟部、陸委會及主計處的統計資料顯示，我國企業前往大陸投資之件數與金額每年均在持續成長中。

另一方面，近年來中國大陸也相當強調發展物流基礎設施建設，其中特別以幹線鐵路、高速公路、樞紐機場、國際航運中心為重點。此外，在電信服務的提供方面，目前大陸已有電信網路骨幹光纜超過 30 萬公里，基本上屬於以光纜為主、數位微波和衛星通訊為輔的大容量數位幹線傳輸網路，其覆蓋範圍包括全國主要城市和 90% 的縣級市及大部分鄉鎮，並與世界主要國際資訊網路連結。

在總體物流發展方面，2001 年中國大陸的 GDP 為 9.59 億人民幣，商品零售總額為 3.76 萬億人民幣，生產資料銷售總額為 5.5 萬億人民幣，進出口總額超過 5000 億美元，在此一規模的經濟活動下，同時形成龐大的物流需求。

雖然我們可以發現國內企業到大陸投資的情形已相當普遍，這些廠商在中國大陸的子公司或製造工廠已成為整個企業供應鏈的一環，其次，近年來中國大陸在物流與運輸基礎建設上，亦有相當的發展。然而整體而言，由於大陸投資經營環境複雜，我國廠商前往大陸投資者多以製造業為主，在整個產銷的供應鏈體系中，物流服務的水準、能否滿足廠商供應鏈作業的需求，均攸關整體供應鏈的運作效率。

在前述的研究背景下，本研究以我國跨國公司的觀點比較分析兩岸物流的現況與發展，利用問卷與實地調查的方式，蒐集兩岸物流發展的基礎資料，再據以比較分析目前兩岸物流發展的現況與未來的展望，俾做為政府部門、民間企業、以及運輸物流業者，從事兩岸物流規劃之參考。本研究的研究目的如下：

- (一) 經由資料蒐集與問卷調查，比較分析兩岸物流發展政策的差異、物流的發展現況與未來的發展趨勢，並分析影響兩岸物流發展因素之異

- 同。
- (二) 瞭解影響我國企業前往大陸投資設廠在物流方面所遭遇的困難與問題。
 - (三) 調查各產業廠商在兩岸的產品產銷通路模式及供應鏈規劃有無不同。
 - (四) 瞭解我國物流業者前往中國大陸發展的原因，是否隨著時間而有所差異。
 - (五) 探討物流業者在兩岸經營模式的差異。
 - (六) 分析兩岸物流服務供給特性，包括：硬體基礎設施、業者作業方式、政策與法令等；以及兩岸物流服務需求特性，包括：國際物流與國內物流現況、對物流服務需求特性(如時間、速度、包裝、數量、服務水準要求等)的差異。並據以分析兩岸物流服務供給特性與不同企業供應鏈規劃方式間之關聯性。
 - (七) 提出我國運輸物流相關產業發展的機會與挑戰，供我國企業從事國際分工調整供應鏈作業，以及政府部門進行政策規劃時之參考。

三、研究內容、成果與討論

(一) 研究內容

本研究的主要內容，分述如后。

1. 資料蒐集分析與我國跨國企業在兩岸之發展

為了對物流相關問題有進一步的瞭解，本研究首先對企業進行跨國營運、物流服務委外的原因、以及兩岸物流業者之經營方式作簡要之說明，並回顧相關研究論著。經由分析發現，在目前我國企業的發展情況下，物流服務仍有相當多的發展空間，不同的產業別需要不同的物流整合系統，業者多根據本身的產業特性，結合當地的環境與政策，發展出合適的物流經營管理模式。

2. 兩岸物流現況與政策分析

本研究針對兩岸物流發展現況與物流政策之演變發展作一比較分析，分析項目包括：物流業的發展過程、物流業的現況分析、台灣於大陸之產業佈局、大陸制定

之海峽兩岸管理辦法、物流政策發展、加入 WTO 後的影響以及物流業所面臨的問題等。

3. 分析比較兩岸物流經營模式、服務特性差異分析

由於本研究之目的在探討企業於台灣和大陸兩地經營時之差異，研究範圍包括台商投資最多的上海、江蘇、廣東、福建等地區，同時選定物流業、資訊電子業、化學製品業、塑膠製品業、金屬基本工業等五個業別的台商企業進行調查分析。主要的研究方法係採問卷調查及深入訪談的方式進行，調查的對象分為物流業者及製造業廠商。

問卷內容包括基本資料、物流作業方式、服務項目、政府政策及環境對企業的影響、以及業者經營遭遇的物流障礙等。問卷除了基本資料外，均採五點量表方式表示。

此外，本研究利用變異數分析法(ANOVA)進行差異性分析，主要分析內容包括：物流業於兩岸間差異性分析、製造業於兩岸間差異性分析、製造業各業別間差異性分析、以及物流業與製造業間差異性分析等四項。同時，利用迴歸方法進行關聯性分析，以了解兩岸政府政策與環境因素對物流業與製造業物流運作之影響。最後，本研究選擇五家代表性業者進行深度訪談，以進一步了解業者目前於兩岸運作的實際狀況及其公司未來的發展。受訪業者包括歲航國際有限公司、環世國際物流股份有限公司、沛榮國際股份有限公司、大榮汽車貨運股份有限公司及中菲行航空貨運承攬股份有限公司。

4. 我國運輸物流相關產業發展機會與挑戰

本研究根據問卷調查及深度訪談分析結果，提出業者於兩岸從事企業經營以及提供物流服務時所面對的問題，並據以發現未來發展之機會與挑戰。

5. 相關政策建議

最後，本研究針對現況問題為政府與業者之因應對策研提建議，亦嘗試整合前述調查之發現，規劃未來物流業前往大

陸發展之經營策略，以供政府與物流業者參考。

（二）研究成果

目前大陸企業在商品的整個生產銷售過程中，加工和製造的時間約佔 10%，而物流過程則幾乎消耗了 90% 的時間，加上大陸逐漸利用本身的生產條件優勢，成為「世界工廠」，其內需市場與外銷市場的物流需求甚為龐大，可預見物流業在大陸應有很大的發展空間。此外，目前台灣有近六萬家的企業前往大陸地區投資經營，此一趨勢仍在持續成長，本研究遂針對兩岸同時經營的物流業與製造業廠商進行調查分析，以瞭解兩岸物流發展的現況與未來之展望。

另一方面，本研究發現目前到大陸投資經營的物流業者主要是國際貨物承攬業，以安排國際貨物運送為主。在兩岸安排處理的貨物中，目前以「Port to Port」之型式為最多，而「Door to Door」的型式亦有漸增的趨勢。在企業客戶大陸內陸之運輸服務需求方面，業者主要採外包的方式，為客戶提供服務。目前國內到大陸投資內陸運輸服務的業者並不多，只有大榮汽車貨運公司在大陸投資成立連運物流有限公司提供內陸貨物配送服務；不過由於受到大陸外商不能購置車輛的政策限制，因此連運物流公司以經營倉儲配送方面的業務為主，車輛的運送服務亦採外包形式在運作，與該公司在台灣自購車輛自行經營管理的作業方式差異極大。

在貨源方面，根據本研究之分析，製造業者在台灣平均有 28% 的貨物運送是公司自行處理，73% 的貨物委託給物流業者運送。在大陸的台商製造業廠商平均亦有 28% 的貨物運送是公司自行處理，63% 的貨物委託給大陸當地物流業者運送，而 9% 的貨物是委託給台商所經營之物流公司運送。可見台商企業有很大比例的貨運需求會委外給物流業者來處理。

由於本研究所訪談的台商物流業者到大陸的投資時間並不長，發展初期主要是服務台灣原有的企業客戶，調查結果亦顯示仍以台商企業的客戶所佔比重最多。而

大陸方面製造業只有很少比例的貨物是委託台商物流業者運送，其主要原因可能是由於目前到大陸投資的物流業者並不多，且台商物流業者某些業務受到大陸政策限制，因此，製造業廠商之貨物運送以委託給大陸當地物流業者的比例較多。

業者在所有進出口貨物的安排運送過程中，有四成左右的貨運量需要經由第三地轉運，且兩岸間的貨物運送受政府政策影響需經第三地作中轉，仍是很強的物流障礙。由本研究對物流業者所作的深度訪談發現，業者在安排兩岸間的貨物運送時，對華南地區的貨物大多是以香港為中轉地，而華中或華北地區的貨物則是利用日本的石柵島或韓國的釜山中轉。此外，境外轉運中心亦見成效，是福建地區轉口貨物的另一物流路徑選擇，大陸地區經台灣轉運（或加工後再出口）的貨物可從大陸廈門和福州地區直航進入高雄境外轉運中心內，以不通關、不入境方式，再經海運或空運轉運到各目的地國。

就業者於兩岸運作環境條件之差異性而言，在其經營項目及安排貨物運送上並沒有顯著的差異性，有差異的是由於台灣地區資訊技術、網路化系統較先進、普及，在採用 INTERNET 和 EDI 方式作訂單處理方面明顯多於大陸方面。在倉儲方面，兩岸雖都是採租用方式，但台灣以自行經營管理倉儲較多，大陸則受限於資金與人力的不足，倉儲以委外管理為主。同時，到大陸投資的台商普遍認為，在大陸與客戶間之交易信用風險偏高、缺乏網路化服務、跨區配送的問題、規費成本過高、以及資訊的即時性與準確性低、政府對車輛的管制等問題均造成台商（尤其是台商物流業者）在經營上的不便。

在公司經營與貨物運送的過程中，物流業認為政府政策面與環境面對其較有影響的因素包括：台灣方面「政府未設置物流專責機關」、「兩岸直航」、「通關程序簡單化與效率化」以及「物流專業人才的培育」等；大陸方面「政府未設置物流專責機關」、「兩岸直航」、「物流標準化、自動化的推動與使用」、「資訊化與網路化」、「通關程序簡單化與效率化」以及「物流專業

人才的培育」等。

在兩岸加入 WTO 後，可使法令得到鬆綁，消除關稅與貿易的障礙，對貨物的流通效率將可望提昇，國與國之間的貨物流通將變得快速，使得兩岸經貿亦可望有良性的互動關係。

在業者到大陸投資物流事業的經營策略建議方面，本研究認為目前台灣多屬於中小型的企業，為了因應全球化的發展趨勢，有能力與國外大型業者競爭，適度的合併、合作與策略聯盟是台灣物流業於未來兩岸經營發展的必然趨勢。一方面可利用台灣的優勢，配合並強化自身的行銷能力，使台灣接收來自世界各地的訂單，產品則在大陸作加工製造；另一方面，由兩岸經營的物流業者將兩岸間的物流體系串聯起來，將產品運到往世界各地，利用兩岸角色分工，使台灣發展成為全球運籌中心。

(三) 討論

除上述之研究成果外，整體而言，由於大陸地區面積廣大，各地法令規章各有不同，本研究受限於時間及經費，未能全面整理，建議後續研究可對大陸各地之法令規章分析彙整，俾供欲前往大陸投資的企業參考。本研究分析對象僅限於同時在兩岸經營的台商業者，未來亦可考量擴大產業別調查分析，以臻週延。

受限於問卷回收樣本數，本研究未能對製造業四種業別之廠商需求與營運模式再作差異分析，建議後續研究針對不同業別企業進行探討，以了解不同業別在物流運作上所存在差異。由於本研究問卷回收率較低，因此只有作變數異分析與迴歸分析，未能使用線性結構 (Linear Structural Relations, LISREL) 方法進行分析，建議後續研究仍可朝此一方向進行，以有效釐清多個變項間的因果關係。

四、計畫成果自評 (研究成果發表)

本研究與「跨國製造業廠商供應鏈規劃模型與策略之研究—以台灣資訊電子業為例 (NSC 91-2415-H-009-005-SSS)」，係

連續性研究，研究內容與原計畫相符，已達成預期之目標，研究成果部份已發表或投稿於國內外相關學術期刊，臚列如后。

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以製造業台商之觀點比較分析兩岸物流發展之障礙 Cross-Strait Comparison of the Barriers of Logistics Development by Viewpoints of the Taiwanese Manufacturing Enterprises*

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摘 要

過去十幾年來，由於大陸市場持續開放，許多台商紛紛轉向資源豐富、生產要素成本低廉，且擁有廣大市場的中國大陸尋求發展。本研究以台商的觀點探討業者在兩岸的經營現況，分析目前兩岸物流運作是否有顯著差異，以及政府政策對運作方式的影響。本研究之調查分析係以同時於兩岸經營的物流業與製造業為主，研究範圍則選定佔台商投資業者最多的江蘇/上海、廣東、福建等地區。回收的問卷透過變異數分析及關聯性分析比較兩岸物流服務發展特性。最後，提出未來業者欲前往大陸發展之物流經營策略建議。

關鍵詞：物流服務、兩岸物流

ABSTRACT

In the past decade, many companies in Taiwan advanced into the Mainland China and enjoyed economic advantages such as cheap but good labor force and inexpensive price of land. The study conducted a questionnaire survey on the Taiwanese logistics companies and manufacturers between Taiwan and the Mainland China to investigate their current logistics operations. The researched area includes Taiwan, Jiangsu/Shanghai, Guangdong, and Fujian. By means of the questionnaire and face-to-face interviewing survey to the logistics companies, the major results of the study are summarized. Finally, the study proposes logistics operational strategies for both logistics and manufacturing companies that will advance into Mainland China.

Keyword: Logistics services, Cross-Strait Logistics

壹、前 言

由於大陸市場持續開放，生產要素充裕、具成本優勢、且擁有廣大市場，許多台灣的製造業廠商紛紛轉向中國大陸發展，根據投資中國雜誌社的調查，截至2001年底止，已有近六萬家企業前往大陸地區投資設廠，投資總額約達1,400億美元。僅以2002年1月至6月由經濟部投資審議委員會核准的廠商對大陸間接投資案件，亦達256件，金額為8.02億美元；與2001年同期比較，件數增加62.3%，金額增幅更高達141.96%。另就兩岸經貿活動來看，2001年兩岸貿易總額為312.5億美元，較前一年增加了21%，佔台灣對外貿易總額的10.8%。由以上數字可看出，國內企業到大陸投資經營事業不但已相當普遍，且兩岸之間的貿易總額亦極為龐大。

不過，目前在中國大陸企業之供應鏈製程中，平均製造作業時間僅佔10-15%，而物流過程卻消耗了八成以上的時間，由於企業競爭已是整條供應鏈的競爭，物流服務能否配合遂成爲關鍵成功因子，台商於大陸從事製造生產活動，在緊迫的供應鏈時間要求下，大陸地區的物流環境與服務能否提供適當的支援，遂成爲大多數台商關切的重點。基此，本研究遂以製造業台商的觀點，分析比較兩岸物流服務是否有顯著之差異，亦嘗試分析兩岸政策及總體環境是否能滿足企業物流的需求。

有關物流服務的效能將直接影響企業競爭力的觀點，已由多位學者在研究中得到確認(Christopher, M., 1998)。事實上，Chia, K. C.等人(2002)即曾指出一般台商資訊電子業者對於物流服務的需求，就運輸時間而言，平均約介於1.6天至5.9天之間，且愈趨近生命週期衰退期階段的產品，愈需要以更快的速度對顧

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客的需求作出回應。Lehmusvaara, A. (1998)、Hill R. M. (1996)、Cohen, M. A.等人 (1997) 以及Takayasu, K. 等人 (1995) 均曾以實證方式對相關產業進行研究, 得到類似的結論。此外, Yoo, Y. J.等人 (2002) 則曾以南北韓間的跨境製造業廠商的運作為例, 指出兩韓間實際運作的困難, 在於其中物流服務無法及時滿足廠商需求所產生的問題, 當然, 其中亦牽涉官僚體制的影響。

事實上, 就兩岸目前的物流發展觀察, 由於並無定期直接的運輸服務, 目前的作法, 某種程度上應該屬於一種以供應鏈導向 (supply chain-oriented) 的物流供給服務, 其間為了滿足企業生產流程的產銷需求, 跨國業者、物流與運輸業者均以滿足供應鏈運作之所需為首要之務, 儘可能為企業提供快速便捷的服務 (Chia, K. C.等人, 2003)。當然, 就物流工作究竟應由廠商自行負責, 還是採取委外 (outsourcing) 的方式處理, Boyson, C.等人 (1999) 的研究認為將物流活動委外的利基在於: 降低成本、提升競爭力、改善服務水準等, 該研究發現若企業的物流活動並非其主要核心業務, 且物流活動造成營運的主要問題, 或是該公司準備進行供應鏈再造 (reengineering), 都是將物流服務委外處理的時機。邱顯明等 (2001) 則以「資源基礎觀點」分析影響台商物流策略的因素, 該研究認為卓越的物流能力將成為企業的核心能力, 進而提升顧客價值、創造競爭優勢。

基於上述背景, 加以近年來台商前往中國大陸投資發展已相當普遍, 兩岸物流發展的差異如何? 大陸地區的物流環境以及兩岸間物流服務的提供, 究竟可否滿足企業營運的需求? 都是相當有趣且以往文獻較少探討的課題, 同時, 對台商經營環境條件的釐清亦有價值。以往對於台商的物流需求、大陸地區物流服務的發展均囿於調查不易進行, 而缺乏系統性的分析, 有鑑於此, 本研究以同時於兩岸均有營運的台商企業為對象, 希望藉以蒐集資料, 比較分析兩岸物流的發展現況與展望, 作為業者未來在兩岸營運發展的參考。本文第二節將先針對兩岸物流發展在基礎建設、政策與法令、未來發展計畫等方面進行比較; 第三節說明本研究的分析方法; 第四節以台商實際營運狀況為例, 說明製造業台商的兩岸物流作業模式與需求特性; 最後, 根據蒐集資料的分析以及對台商實際作業需求的瞭解, 提出兩岸物流作業改善策略, 並對政府、企業、以及物流業者作出建議。

貳、兩岸物流之發展

一、物流服務的發展

(一) 物流業的發展過程

1. 台灣方面

對於台灣流通業之發展過程, 根據蕭百宏 (1996) 的研究整理, 台灣流通業之發展可分為萌芽期、戰國期、理性盤整期及規模整合期等四個階段。在萌芽期, 各企業紛紛成立物流部門, 甚或是由物流部門發展成專業的物流公司, 惟本階段尚屬摸索、嘗試錯誤的階段, 政府也不瞭解這個行業, 在政策上的輔導措施與法令規範均不足。戰國期各家公司為求快速成長、爭取業務, 以削價、同行挖角等方式競爭, 常常由於不同屬性之客戶貨品影響物流系統之運作而降低效能。進入理性盤整期, 各家業者開始過濾客戶貨品之屬性, 甚至會推薦不適合本身運作之客戶給同行承接, 形成較為理性的互動。最後, 在規模整合期業者間慢慢朝向規模整合與共同配送發展, 「資源共享」即係為達成整體產業合併或整合, 甚至異業策略聯盟的最終目標。

2. 中國大陸方面

中國大陸從 1979 年引入現代物流概念到全面發展, 大致經歷了三個階段 (2002 年中國物流年鑑):

- (1) 計劃經濟下的物流 (1950 年至 1980 年代初): 在此階段中國實行的是高度集中的計劃經濟體制, 1963 年中國物資部門設立了統一管理中轉供銷倉庫, 此後, 全國商品的物流活動基本上是由各級物資儲運公司和商業儲運公司承擔。此時物流活動僅限於對商品的儲存和運輸。
- (2) 有計劃的商品經濟下的物流 (1980 年代初至 1990 年代初): 在此階段開始從計劃經濟逐步向市場經濟過渡, 隨著產品和服務的商業化與市場化, 競爭日益加劇, 企業開始意識到現代物流的重要性。此時物流活動已不限於商品的儲存和運輸, 而開始注重系統運作, 包括運輸、倉儲、包裝、裝卸、流通加工在內之物流系統整體效益。
- (3) 社會主義市場經濟下的物流 (1990 年代中期迄今): 隨著經濟開放、資訊技術普及、消費者的要求增加, 企業為提升其競爭力, 開始重視物流服務。政府亦逐漸對一些老舊的倉儲、運輸企業進行改造。此時中國市場上出現了四種不同形式的物流服務企業, 第一種為商業、物資儲運企業經過重組改造, 利用原有倉儲設施建設商品物流配送中心, 向客戶提供物流配送服務; 第二種為交通運輸企業和貨運代理 (含聯運、集裝箱) 企業透過擴大業務經營範圍, 開展「戶到戶」運輸, 進而轉向為客戶提供部份物流服務; 第三種為工業生產企業自行成立的物流部門, 自己全部承擔原物料和成品的物流服務; 第四種為少數專業物流服務企業, 對客戶提供專業物流服務。

(二) 物流業現況分析

1. 台灣方面

台灣土地面積小，臨海港口多、人口密集較高，陸上運輸距離與時間很短，以公路運輸為主，配送點集中度高，加上經濟高度發展，物流特性屬於少量多樣多點的配送模式，所配送的商品以 3C 產品、化妝品、日用百貨及一般食品類較多。

根據經濟部商業司委託工研院（2002）針對國內 20 家物流業者所作的調查，顯示目前國內物流業者之資本額多在 5,000 萬元以下，以小中型企業為主，且多為區域型物流。而物流業者的分佈狀況，將近有 85% 的廠商總公司設立在北部，且以分佈在台北市，台北縣與桃園縣最多；倉儲分佈則是以林口、桃園為最多，佔 42%。由營運項目來看，有 85% 廠商提供全島運輸與倉儲保管之物流服務，流通加工或地區性配送服務也有 70%，顯示境內物流業者主要之物流服務項目包括長短程運輸、倉儲保管，以及流通加工等。

2. 中國大陸方面

中國大陸在傳統體制的影響下，企業普遍採取「大而全」、「小而全」的經營組織方式，採購訂貨、運輸、包裝、倉儲、加工配送等環節互為獨立、分割的經濟活動，尚未形成一體化物流。相當多的企業內部倉儲、運輸等物流設施一應俱全。惟隨著中國大陸對外開放，進入中國市場的外資企業在帶來投資和技術的同時，也帶來了物流的變革。根據中國倉儲協會（2001）的調查，目前生產企業和商業企業的外包物流主要集中在市內配送、單純倉儲和幹線運輸。生產企業的外包物流中，單純倉儲佔 21%、幹線運輸佔 36%、市區配送佔 28%、包裝佔 4%；商業企業的外包物流中，單純倉儲佔 37%、幹線運輸佔 21%、市區配送佔 43%、包裝佔 14%。而物流業未來計劃向客戶所提供的物流服務項目亦是以倉儲保管（35%）、幹線運輸（34%）、包裝加工（30%）及市區配送（30%）為主，其次為代收貨款（19%）、代為報關（19%）及物流信息管理服務（19%）。同時，生產企業和商業企業物流主要以「分包」為主，即將不同功能的業務分別委託給不同的企業，同時，目前中國物流企業多數仍以局部的、分段的物流服務為主，能夠提供全過程物流服務的企業仍然不多。在運輸方式方面，大多以公路運輸、鐵路運輸或兩者相互搭配使用為主，平均而言，公路運輸佔 63.3%、鐵路運輸佔 48.1%、複合運輸佔 22.8%、航空運輸佔 15.2%、水運佔 5.1%。

二、物流政策與法令

近年來，台灣相當強調物流的發展，就政策推動而言，主要的政策如下：

- (1) 境外航運中心的成立：為發展台灣成為亞太營運中心，強化台灣與大陸經濟活動的物流服務，1995 年成立「境外航運中心」，並通過「境外轉運中心設置作業辦法」將「境外航運中心」定義為「在台灣地區之國際商港相關範圍內，以不通關、不入境方式，從事大陸地區輸往第三地或第三地輸往大陸地區貨物之轉運及轉運作業相關之簡單加工之區域」。
- (2) 全球運籌發展計畫：隨著經濟成長、供應鏈觀念之演進、資訊與通訊技術之進步，企業國際化與自由化的發展趨勢，2000 年積極推動「全球運籌發展計畫」。全球運籌發展計畫有兩項目標：一是消除企業發展全球運籌管理過程所遭遇之相關問題，俾成為國際供應鏈之重要環節；二是發展高附加價值的轉運服務，其基本精神在使企業產品下單、供應、運輸、銷售等跨國經貿活動，都能快速便捷地在台灣完成。其策略方向則從健全全球運籌管理相關之「電子商務」、「實體物流」及「基礎設施」等三方面做起。
- (3) 自由貿易港區的規劃：自由貿易港區的意義及定位係在國際海空港管制區內或毗鄰地區劃設一管制區域，區內貨物如果不進入國內市場，則採自主管理，而且貨物得在高度自主管理制度下，於區內從事儲存、轉運、加值等作業。規劃的目的為：延伸全球運籌發展，持續推動自由化、國際化工作；活絡港口、機場相關範圍營運效益，促進我國高附加價值貿易活動之發展；提供商務人士自由進出港區的便利，塑造國際企業設立營運中心的環境。

而在大陸方面，近年來，大陸方面對於物流政策的推動亦相當積極，例如，在「十五」計畫中明確設定了物流發展的總目標、並提出「關於加快我國現代物流發展的若干意見」，各地方政府亦分別提出地方物流發展政策。

此外，兩岸物流發展均受到加入世界貿易組織（WTO）的影響，包括：兩岸經貿交流有一規範性架構可循、雙邊貿易將繼續擴大、貿易摩擦可能增加、預期更多外資會進入大陸市場，而兩岸雙向投資也將增加、兩岸產業可能呈現競爭又互補的複雜局面等。在大陸加入 WTO 後對台商的影响方面，大陸加入 WTO 後，針對國內政策法規、管理體制進行大幅調整及改革，加上關稅的減讓、逐步取消非關稅措施等，不但對大陸企業造成衝擊，亦影響台商在大陸的經營環境。在物流服務方面，市場開放的承諾服務包括：包裝服務、快遞服務、分銷服務、海運及其附屬服務、內河運輸、航空運輸、鐵路運輸和公路運輸服務及運輸附屬服務。

三、兩岸物流發展問題比較

(一) 台灣方面

1. 用地取得不易：現代化物流機能涉及大量、多種物品之處理，必須利用寬廣的土地作業，加上配送頻繁，其位址以設在高速公路交流道或主要幹道鄰近之土地為宜。惟受限於相關法令與土地稀少的背景，用地取得仍然不易，成本極高。
2. 政府法令仍未盡完善：由於物流業係新興行業，物流市場相當混亂，目前法令明文規定之「物流中心」，是指設立於港口或機場附近之保稅倉庫，物流中心內全部為進出口貨物。與一般業者的「物流中心」主要以銷售物流為主，營業項目包括商品之採購、保管、暫存、接單、揀取、分類、流通加工、配送等，兩者定義並不一致，法令與實務產生落差。
3. 政府部會間協調不易：物流為一整合性的活動，在定位不明的狀況下，涉及的主管機關較其他行業多，在缺乏有效率的協調下，影響物流產業的發展。
4. 物流人才缺乏：以往較缺乏物流經營觀念，並未積極培育物流管理專業人才，目前供給仍有不足。

(二) 中國大陸方面

1. 物流專業化的觀念仍有加強的空間：受到長期計劃經濟和「重生產、輕流通」、「重技術、輕管理」、「重硬體、輕軟體」觀念的影響，許多企業從採購到銷售過程的物流活動仍依靠內部組織自行完成，物流專業化運作比例尚低。
2. 物流基礎設施尚待完善：交通運輸基礎設施總體規模仍然很小，現代化物流集散和儲運設施亦稍嫌不足，缺乏能夠有效連接不同運輸方式的大型綜合貨運樞紐、服務於區域或城市內的物流基地及物流中心等現代化物流設施，影響物流集散和運輸效率的提昇。
3. 物流技術、設備比較落後：物流設備標準化程度低，物流包裝標準與物流設施標準間仍缺乏有效地銜接，阻礙了物流機械化和自動化水準的提高，影響了運具的裝載率、裝卸設備的荷載率以及倉儲設施的空間利用率。企業物流資訊管理和技術缺乏資訊平臺，訂單管理、貨物跟蹤、庫存查詢等物流資訊服務功能較弱，影響了物流效率和服務質量的提高。
4. 條塊分割的管理體制阻礙了物流發展：物流業涉及多個政府部門，每個部門又都自成體系地實行層級管理，使得部門間、地區間的權責難以有效合作和協調。由於行業和地方保護的存在，跨區域、跨行業的物流系統運作困難，物流企業運營許可的審批程序十分複雜，跨區運輸過路費用過高，都是物流發展的負面因素。
5. 物流人才短缺：相關單位及機構近年雖已積極推廣現代物流觀念，但現代物流專業知識仍未普遍建立，相關人才亦非常缺乏。

參、台商物流調查與樣本分析

一、問卷調查之進行

由於本研究之目的在探討企業於台灣和大陸兩地經營時之差異，研究範圍包括台商投資最多的上海、江蘇、廣東、福建等地區，同時根據經濟部投審會調查的大陸投資行業別排名，選定物流業、資訊電子業、化學製品業、塑膠製品業、金屬基本工業等五個業別的台商企業進行調查分析。

問卷內容包括基本資料、物流作業方式、服務項目、政府政策及環境對企業的影響、以及業者經營遭遇的物流障礙等。問卷除了基本資料外，均採五點量表方式表示。本項調查對於物流業除了基本資料，如：成立時間、經營規模、起源本業、配送商品項目及客戶源、到大陸投資的原因等之外，物流服務之作業方式則分別由接單方式、國內貨物配送方式、國際貨物進出口方式等方面進行探討。對製造業企業之問卷除基本資料外，包含公司本身是否設有物流部門、物流作業成本佔營運成本之比重、以及自行配送／委託配送所佔之比重等；其次，問卷內容也包括政策環境之影響，以及在大陸營運所遇到的障礙等。

在問卷設計完成後，經兩次試調，據以修正問卷內容，隨即於 2001 年 12 月以郵寄及電子郵件的方式進行調查，為使問卷回收率提高，在問卷發出後，並以電話方式確認，同時，於 2002 年 1 月間進行第二次的郵寄調查，2 月間安排廠商深入訪談。

在總樣本數方面，由以往研究發現，關於物流活動之問卷調查，回收率通常都相當低，尤其是採用郵寄方式進行，可能更不理想，因此，本次調查仍針對全部母體全數寄發問卷。調查母體係以全國工業總會所編印的台商名錄為準，計有物流業 30 家，製造業 1075 家。本次調查問卷回收情形，物流業者的問卷共發出 30 份，回收 26 份，其中有 2 份無效問卷，有效問卷 24 份，有效回收率為 80%；製造業廠商共寄出 1075 份，回收 53 份，有效問卷 43 份，有效回收率不高。

二、調查限制

本項調查之進行囿於兩岸現況之隔閡，而造成部分限制，譬如：由於大陸政策規定，非經批准並由特定單位代為發放，否則不得進行問卷調查，因此本研究之問卷只寄送到台灣母公司，對於大陸當地實

際運作情況可能有落差。同時，由於企業配合意願不高，防衛性作答的情況無法完全避免的情形下，使得問卷回收情形不佳，影響計量分析工具之應用，分析結果亦可能產生落差。

三、樣本基本特性分析

本研究對物流業調查之有效回收問卷計 24 份，根據回收問卷的分析結果顯示，物流業包含貨物承攬業（45.8%）、第三方物流（29.2%）、海運業（12.5%）、空運業（8.3%）及第四方物流業（4.2%）。關於物流業之起源本業方面，在第三方物流業中，57%的業者起源於一般運輸業，29%的業者一開始就經營第三方物流，14.3%的業者係起源於其他公司內所設立的物流部門；而在第四方物流樣本之起源本業則為貨物承攬業。

以物流業之成立年資來看，台灣的物流業者主要集中在 20 年左右，其中成立 15 年以上之業者佔了 62.5%。而在大陸投資時間則集中在近 5~10 年間，佔 45.8%，見表 1。以員工人數來看，台灣公司與大陸公司之員工人數以 300 人以下佔最多的比例，分別為 58.3%和 78.3%，而台灣公司員工數略多於大陸分公司地區。以營業額來看，台灣公司營業額以新台幣 1 億元以上佔最多（70.8%），而到大陸投資後營業額則以新台幣 1000~5000 萬所佔最多（37.5%），其次為新台幣 1 億以上（33.3%）。由此可見，無論是由員工人數，或是由營業額來看，大陸分公司之公司經營規模仍比台灣母公司經營規模小，其原因可能是由於業者均以台灣起家，而且受政府政策因素影響限制所致。當然，目前兩岸貨幣價值，物價水準亦有差異，這些因素都必須適度予以考慮。以車輛數來看，台灣公司和大陸分公司均以沒有自購車輛所佔比例最多，而有車輛之業者也多集中在 20 輛車以下，業者之車輛運送採外包方式為主。以業者所設立之倉儲數來看，台灣公司以擁有 5 個以下之倉儲者所佔最多，其次就是沒有設立倉儲者，而大陸分公司則是以沒有設倉儲和倉儲在 5 個以下者所佔比例較高，一般而言業者到大陸投資所設之倉儲數較台灣為少。

本研究製造業問卷回收有效問卷計 43 份，其中資訊電子業佔 53.5%、金屬基本工業佔 18.7%、塑膠製品業佔 9.3%、化學製品業佔 18.6%。製造業之樣本中，關於成立年資、員工人數、營業額、自有車輛數、以及自設倉儲點等基本資料，見表 2。

表 1 物流業樣本企业之基本資料

台灣部門

成立時間	樣本數	%	員工人數	樣本數	%	營業額	樣本數	%	自備車輛	樣本數	%	自有倉儲	樣本數	%
5年以下	3	12.5	100人以下	6	25.0	1000萬以下	2	8.3	沒有車輛	9	40.9	沒有倉儲	7	33.3
5年以上~10年	3	12.5	101~300人	8	33.3	1001~5000萬	5	20.8	20輛以下	8	36.4	5個以下	11	52.4
10年以上~15年	3	12.5	301~500人	5	20.8	5001萬~1億	0	0.0	21~50輛	1	4.5	5~10個	1	4.8
15年以上~20年	4	16.7	501~1000人	2	8.3	1億以上	17	70.8	100輛以上	4	18.2	10以上	2	9.5
20年以上	11	45.8	1000人以上	3	12.5									

大陸部門

成立時間	樣本數	%	員工人數	樣本數	%	營業額	樣本數	%	自備車輛	樣本數	%	自有倉儲	樣本數	%
5年以下	8	33.3	100人以下	12	54.2	1000萬以下	4	16.7	沒有車輛	13	61.9	沒有倉儲	7	33.3
5年以上~10年	11	45.8	101~300人	6	26.1	1001~5000萬	9	37.5	20輛以下	3	14.3	5個以下	7	33.3
10年以上~15年	2	8.3	301~500人	3	13.0	5001萬~1億	3	12.5	21~50輛	4	19.0	5~10個	3	14.3
15年以上~20年	2	8.3	501~1000人	2	8.7	1億以上	8	33.3	100輛以上	1	4.8	10以上	4	19.0
20年以上	1	4.2	1000人以上	0	0.0									

資料來源：本研究調查整理。

肆、台商物流作業與需求特性分析

一、台商物流作業分析

（一）物流業

就投資方式而言，外資到大陸地區投資經營方式有「三資」，分別為獨資、合資與合作。大陸在加入 WTO 以前明文規定，外資經營物流業不能以獨資方式進入大陸市場，而合資經營時，合資之中方企業出資比例須超過 51%。因此台商於大陸投資多是以合資與合作之經營方式，其中以合資方式佔 79%，比例最多。台商和大陸地區企業合作時，通常是以設立辦事處的方式經營。而投資地區方面，台商以江蘇/上海地區投資經營之業者佔最多，約 87.5%，其次，分別為廣東地區（54.2%）、福建地區（29.2%），而同時在以上三個地區均有投資經營的業者佔 26.0%。

在配送的商品方面，物流業者於台灣、大陸所配送之商品種類並沒有很大之差異性，前五名分別是 3C 產品、日用品、零配件、原物料及服飾等，見表 3。在合作客戶群方面，台灣公司配送的商品主要來自於製造商委託，其次依序為經銷商委託、供應商委託、零售商委託、消費者委託；而大陸分公司亦以製造商委託為主，其次為經銷商、供應商、零售商、及消費者委託。物流業者前往大陸投資的原因，主要仍著眼於市場廣大、擁有國際化發展潛力、公司佈局考量、物流市場剛起步具有商機、對兩岸三通的

期望以及原有客戶群移往大陸發展等，見表 4。同時，由於中國大陸土地面積廣大，政府部門之間、地區之間又各自有不同的法令規章，缺乏有效的協調，使得台商在大陸地區經營受到相當的阻礙。根據本研究對物流業經營障礙調查發現，業者面對最嚴重的物流障礙分別為：政府法令對運輸車輛的管制、規費成本過高、政府部門權責劃分不清、資訊的即時性與準確性低、跨區配送的問題以及缺乏網路化服務、與客戶間的信用風險等。

表 2 製造業樣本企業之基本資料

台灣部門

成立時間	樣本數	%	員工人數	樣本數	%	營業額	樣本數	%	自備車輛	樣本數	%	自有倉儲	樣本數	%
5年以下	1	2.3	100人以下	18	41.9	1000萬以下	0	0.0	沒有車輛	10	23.3	沒有倉儲	1	2.3
5年以上~10年	4	9.3	101~300人	9	20.9	1001~5000萬	5	11.6	20輛以下	31	72.0	5個以下	41	95.4
10年以上~15年	9	20.9	301~500人	7	16.3	5001萬~1億	8	18.6	21~50輛	2	4.7	5~10個	1	2.3
15年以上~20年	11	25.6	501~1000人	4	9.3	1億以上	30	69.8	100輛以上	0	0.0	10以上	0	0.0
20年以上	18	41.9	1000人以上	5	11.6									

大陸部門

成立時間	樣本數	%	員工人數	樣本數	%	營業額	樣本數	%	自備車輛	樣本數	%	自有倉儲	樣本數	%
5年以下	17	39.5	100人以下	12	27.9	1000萬以下	2	4.7	沒有車輛	5	11.6	沒有倉儲	2	4.7
5年以上~10年	16	37.2	101~300人	13	30.1	1001~5000萬	9	20.9	20輛以下	38	88.4	5個以下	40	93.0
10年以上~15年	10	23.3	301~500人	6	14.0	5001萬~1億	6	14.0	21~50輛	0	0.0	5~10個	1	2.3
15年以上~20年	0	0.0	501~1000人	6	14.0	1億以上	26	60.4	100輛以上	0	0.0	10以上	0	0.0
20年以上	0	0.0	1000人以上	6	14.0									

資料來源：本研究調查整理。

在客戶訂單處理方面，台灣公司與大陸分公司皆以「傳真」與「電話」方式接受訂單為主，利用「EDI」、「網際網路」方式較少。惟可能由於台灣資訊技術仍較普及，調查結果亦顯示出台灣公司以「EDI」、「網際網路」接受訂單較大陸分公司使用比例多。

在國內物流配送方面，所採用的方式為「由供應商自行將貨物運送至物流公司之倉儲（或物流中心），經由集中處理（加工、分揀、包裝…）後，再由物流公司安排運送至需求客戶手中」，此種運送方式的主要原因可能由於本研究之回收問卷以貨物承攬業佔最大比重所致。

在進口方面，業者在台灣是以「安排貨物由國外港口（或機場）運送至國內港口（或機場）」（Port to Port）之形式為主，而在大陸則再加上「安排貨物由國外供應商運送至國內需求客戶」（Door to Door）之形式。

在所運送之進口貨物中，台灣與大陸兩地區需要在倉儲（或物流中心）內集中處理（如：簡單加工、組裝、分揀、包裝…）的貨物，分別佔貨物總進口量的 48.3%和 40.0%；而進口的貨物中，需經過「第三國/地轉運」之貨物，分別佔貨物總進口量的 38.3%和 35.0%。

在出口方面，業者在台灣和大陸均以「安排貨物由國內港口（或機場）運送至國外港口（或機場）」之方式為主。在運送之出口貨物中，台灣與大陸兩地區需要在倉儲（或物流中心）內集中處理（如：簡單加工、組裝、分揀、包裝…）的貨物，分別佔貨物總出口量的 44.0%和 40.8%；而出口的貨物中，需經過「第三國轉運」之貨物，分別佔貨物總出口量的 42.5%和 40.0%。

表 3 物流業之配送商品種類

配送商品種類	台灣			大陸		
	物流業家數	百分比	排序	物流業家數	百分比	排序
常溫食品	12	50.0%	5	10	41.7%	6
冷凍食品	6	25.0%	11	6	25.0%	9
3C產品	21	87.5%	1	18	75.0%	1
日用品	14	58.3%	2	14	58.3%	2
服飾	12	50.0%	5	13	54.2%	5
化妝品	9	37.5%	8	8	33.3%	8
藥品	7	29.2%	9	5	20.8%	10
書籍	7	29.2%	9	5	20.8%	10
傢俱	11	45.8%	7	10	41.7%	6
零配件	14	58.3%	2	14	58.3%	2
原物料	13	54.2%	4	14	58.3%	2

資料來源：本研究調查整理。

表 4 物流業前往大陸投資原因及遭遇之困難

大陸投資原因	樣本數	百分比	排序	物流障礙	平均數	排序
大陸市場廣大	17	70.8%	1	政府對車輛的管制	1.7917	1
大陸勞務成本低廉	6	25.0%	10	土地使用的限制	1.1250	10
大陸土地成本低廉	6	25.0%	10	政府部門權責劃分不清	1.5417	3
大陸資源豐富	6	25.0%	10	交通公共建設不足	0.7917	15
台灣經濟不景氣	9	37.5%	7	物流基礎建設不夠完備	1.2500	8
文化上的優勢	6	25.0%	10	跨區配送的問題	1.2917	5
台灣政策開放	4	16.7%	14	規費成本過高	1.7500	2
大陸政策開放	7	29.2%	9	缺乏網路化服務	1.2917	5
對兩岸三通的期望	11	45.8%	5	資訊的即時性與準確性低	1.3750	4
原有客戶群移往大陸	11	45.8%	5	與客戶缺少電子資料交換系統	1.2083	9
公司佈局考量	15	62.5%	3	難以取得想要的資訊	0.9167	13
大陸地理位置具轉運優勢	9	37.5%	7	客戶難以尋找	0.5417	16
大陸物流市場剛起步，具有商機	14	58.3%	4	與客戶間之交易信用風險	1.2917	5
大陸擁有國際化發展潛力	17	70.8%	1	產品配送過程中人為的損耗與破壞	1.0000	11
				車子的損壞率高	0.8333	14
				配送時效緩慢	0.9167	12

資料來源：本研究調整理。

(二) 製造業

本研究調查中，製造業中自行成立物流部門之業者佔了 32.6%。而在物流作業成本佔營運成本的比重方面，有 88.4%的業者物流作業成本佔營運成本 20%以下，同時，百分之百的製造業樣本之物流成本佔營運成本比重均在 30%以下。由貨物運送主體來看，在台灣方面，平均有 27%的貨物是由製造商自行運送，73%的貨物委託物流公司來運送；在大陸方面，平均有 28%的貨物由製造商自行運送，63%的貨物委託給大陸當地之物流公司運送，另有 9%的貨物是委託給台商所經營的物流公司運送。由此可見，製造商於兩岸時，貨物運送均以委外為大宗，大陸分公司之物流委外則是以大陸當地物流公司為最多。主要原因可能是因為調查當時前往大陸經營之台商物流業者並不多，而且台商在營運上受當地政府相當多的限制。

以製造業在大陸所遇物流障礙來看，其影響程度較大者依序為：與客戶間之交易信用風險、缺乏網路化服務、規費成本過高、跨區配送的問題、以及資訊的即時性與準確性低、物流基礎建設不夠完備、與客戶缺少電子資料交換系統。與物流業所不同的是，物流業在營業上較關切政府對車輛的管制與政府部門權責劃分不清，而製造業則較注重與客戶間之交易信用風險及缺乏網路化的服務等。

對製造業之貨物運送方面，本研究分別由業者之原物料採購運送、半成品運送、以及成品運送三方面進行分析，發現業者在原物料之採購運送方面，台灣公司與大陸分公司均以供應商處理所佔比重較多，委託物流公司處理次之，由公司自行處理所佔比例最小。在半成品之運送方面，台灣公司與大陸分公司均以公司自行運送與委託物流公司運送為主，但公司自行運送略多於委託物流公司，其次，依序為供應商處理及由需求客戶負責。而成品之運送方面，台灣公司與大陸分公司均以委託物流公司運送所佔比重較多，委託物流公司處理次之，由需求客戶處理最少。

當業者之貨物需要集中處理（如：分揀、包裝...）時，調查結果顯示，台灣公司與大陸分公司均是以在業者自己倉庫內自行處理為主，少部份是經由物流公司之倉儲內處理。

製造商業者在進口貨物之物流服務規劃方面，調查顯示由供應商負責安排運送業務較多，製造商之台灣部門與大陸分公司所做之安排均是以「由國內港口（或機場）到其公司倉庫」這一段所佔比例最多，且採單一運輸方式委託給物流公司來處理。

在出口貨物方面，調查顯示由製造商負責安排運送業務較多，台灣公司是以「由其公司運送到國外港口（或機場），採複合運輸方式委託給一家物流公司專責服務」所佔比例最多。而大陸分公司則是以「由其公司運送到國外需求客戶倉庫，採用複合運輸方式委託給一家物流公司專責服務」所佔比例最多。

二、物流服務與需求特性交叉分析

對於物流服務與需求特性之交叉分析，本研究利用變異數分析法（ANOVA）進行差異性分析，包括：物流業於兩岸間作業之差異、製造業於兩岸間作業之差異、以及物流業與製造業間差異性分析等，限於篇幅，本文僅列舉分析結果較為顯著的項目。

(一) 物流業於兩岸間作業之差異分析

首先，探討同時於兩岸提供服務的物流業者，在「服務項目」、「訂單處理方式」、「國內貨物運送方

式」及「貨物進出口方式」上，是否有顯著的差異性。分析結果發現，物流業目前所提供之服務項目以及未來著重發展的服務項目，在台灣和大陸並沒有顯著差異性。在台灣市場，物流業未來的業務重心依序為：協助客戶操作物料採購及進貨、協助客戶作促銷活動、提供和海關電子資料交換（EDI）連結、提供整體運輸鏈之電子商務連結、提供驗貨作業。在大陸市場，未來的業務重點與台灣地區相同。此外，在「訂單處理方式」、「國內貨物運送方式」、以及「貨物進出口方式」上，業者在台灣與大陸經營亦沒有顯著差異。

（二）製造業於兩岸間之作業差異分析

關於同時於兩岸營運的製造業者，在「被提供之服務項目」、「訂單處理（下託運訂單）方式」、「貨物進出口方式」、及「原物料之採購、半成品、成品運送以製造業廠商自行處理、委託物流公司處理及供應商或需求客戶處理方式」等，其間是否有顯著的差異性。

分析結果發現，業者目前接受之服務項目以及未來希望得到的服務項目，在台灣和大陸並沒有顯著差異性。在台灣市場，發現製造業廠商未來希望得到的服務項目包括：在行銷業務方面，能協助客戶操作市場調查、協助客戶收取貨款之服務；在配送業務方面，能提供店內產品的陳列（上架）；在資訊科技方面，能提供即時貨物追蹤系統、提供和海關電子資料交換（EDI）連結、提供整體運輸鏈之電子商務連結；在海關業務方面，能提供驗貨作業；對物流業之其他項目方面，希望物流業未來能提供客製化服務、提供整合型物流服務、具備國際化服務能力、提供創新服務的能力。

在大陸市場，則製造業廠商未來希望得到的服務項目包括：在行銷業務方面，能協助客戶操作物料採購及進貨、協助客戶操作市場調查、協助客戶作促銷活動、協助客戶收取貨款之服務；在配送業務方面，能提供揀貨及包裝服務、提供流通加工服務、提供配送及發貨中心服務、提供店內產品的陳列（上架）、提供門及門的售後服務（退貨、維修…）；在資訊科技方面，能提供庫存管理系統、提供即時貨物追蹤系統、提供倉庫保全監控系統、提供和海關電子資料交換（EDI）連結、提供整體運輸鏈之電子商務連結；在海關業務方面，能提供報關服務、提供驗貨作業；其他尚有能提供客製化服務、提供整合型物流服務、具備國際化服務能力、有提供創新服務的能力、希望物流業能以策略聯盟方式提供全方位服務、培養優秀的物流專業人才等。

在「訂單處理方式」方面，僅在「電子資料交換（EDI）方式處理訂單」一項有較顯著性差異，某種程度說明了由於台灣地區資訊化、標準化較普及，製造業廠商以 EDI 方式下託運訂單在台灣比在大陸地區普遍。在「貨物進出口方式」、「原物料之採購、半成品、成品之運送由製造業廠商自行處理、委託物流公司處理及供應商或需求客戶處理方式」等方面均無顯著差異。

（三）物流業與製造業期望差異分析

此一部分旨在探討「物流業者未來希望提供之重點服務」與「製造業廠商希望得到的服務以及訂單處理方式」上是否有顯著差異。分析結果發現存在顯著差異的項目，在台灣方面包括：「協助客戶收取貨款之服務」、「提供流通加工服務」、「提供報關服務」以及「物流業能實施策略聯盟提供全方位服務」；在大陸方面包括：「協助客戶收取貨款之服務」及「物流業能實施策略聯盟提供全方位服務」等。雖然物流業與製造業在這些項目上有較顯著之差異，但調查分析發現，其原因可能係物流業未來希望提供的服務遠高於製造業廠商期望得到之服務所致。

此外，在訂單處理方面，採用電話方式、網際網路（INTERNET）方式與電子資料交換（EDI）方式，在台灣與大陸亦有顯著差異。其中，以電話方式者，台灣與大陸均為製造業採用比例多於物流業；以網際網路（INTERNET）與電子資料交換（EDI）者，則台灣與大陸均為物流業採用比例多於製造業。

三、政策與環境對物流服務之影響

關於此一部份的分析，首先將利用主成份分析求出物流運作方式內，每一個構念之總指標，然後利用所求出之每一構念總指標分別對政府政策及環境影響之每一項因素作迴歸分析，以了解其間之關連性。分析之前，亦針對回收之問卷進行信度分析（Cronbach α ）。限於篇幅，以下亦僅針對檢定顯著之變數加以說明。

在物流業「國內貨物配送方式」上，具顯著的變數，台灣與大陸均為「政府推動物流活動標準化的作業程序」。以「國際貨物運送方式」構念來看，台灣方面顯著的變數有「政府成立專責管理部門」、「政府開放兩岸直航」、「境外轉運中心的成立」、「通關程序的簡單化及效率化」；大陸方面顯著的變數有「政府成立專責管理部門」、「通關程序的簡單化及效率化」。

其次，在製造業「國際貨物運送方式」上，台灣方面顯著的變數有「物流投資之法令政策的放寬」、「土地取得的相關法令推動」、「政府對物流的認知與推動」、「提供物流專業人才的培育」等；大陸方面顯著的變數有「物流投資之法令政策的放寬」、「政府對物流的認知與推動」、「政府推動物流活動標準化的作業程序」、「網路化、資訊化及自動化的推動」、「提供物流專業人才的培育」及「機場聯外道路之強化」等。

在針對製造業貨物運送自理與委託物流公司、供應商或需求客戶處理進行關連性分析時，結果顯示，業者在台灣與大陸自理與委外均是有顯著負相關的，合理地反映了當委託物流公司的業務增加時，業者自理的業務就會減少的特性。

在製造業貨物自理與委託物流公司有顯著負相關的情形下，本研究進一步針對業者自理構念、委託物流公司構念與政策環境面因素分別進行關聯性分析發現，以業者貨物自理構念來看，台灣方面逐一分析時，顯著的變數有「網路化、資訊化及自動化的推動」、「基礎建設的強化」、「機場（或港口）聯外道路的建立」三項；在大陸方面，只有「政府成立專責管理部門」有顯著影響，而且影響是負的。

以業者將貨物委託物流公司的構念來看，台灣方面逐一分析顯著的變數有「政府成立專責管理部門」、「政府推動物流活動標準化的作業程序」兩個變數，但在對兩個變數同時進行考量時，則均不顯著；在大陸方面顯著的變數有「政府成立專責管理部門」、「政府推動物流活動標準化的作業程序」及「現有基礎建設的強化」三個變數，對三個變數同時進行考量時，仍然顯著者為「政府推動物流活動標準化的作業程序」、「現有基礎建設的強化」，其中，「現有基礎建設的強化」的影響是負相關。

經由以上分析結果可以看出，以製造業而言，政府政策面及環境面對其有顯著影響的主要因素，台灣與大陸相同者為國際貨物運送時之「提供物流專業人才的培育」；不同者在台灣部門為業者自理時的「機場（或港口）聯外道路的建立」因素；在大陸部門的業者自理時「政府成立專責管理部門」，以及在委託物流公司處理時的「政府推動物流活動標準化的作業程序」、「現在基礎建設的強化」等因素。

伍、兩岸物流作業改善策略之研擬

一、兩岸物流經營環境的問題現況與改善策略

根據本研究的分析與訪談發現，當前兩岸物流發展相同的問題包括：政府對自有車輛的限制、政府應成立物流專責部門、兩岸三通的問題、通關作業的簡單化與效率化、缺乏專業人才的培育等。其次，在大陸地區還有：物流標準化／自動化的推動與使用、資訊化／網絡化的應用、跨區配送的問題、與客戶間的信用風險等問題。

針對上述問題，本研究分別提出改善之策略，包括：

（一）對政府的建議

1. 在「政府對車輛的限制」方面，建議政府放寬對車輛載貨噸數的限制放寬，並准許大型車輛夜間可以進入市區行駛。同時，注意物流業市區停車問題，包括路邊暫停時間的限制、停車空間的規劃，對於已規劃好的裝卸貨停車空間，應有效管理。
2. 在「政府應成立物流專責部門」方面，由於物流業涉及跨部門業務，建議政府成立一個物流專責部門主管物流業務，一方面對物流業制定統一的法令政策，另一方面亦有統一窗口，協助提升整體的運作效率。
3. 在「兩岸直航」方面，建議兩岸應積極協商開放直航。
4. 在「通關作業簡單與效率化」方面，建議政府應積極與外國簽訂雙邊相互承認協議，避免貨物受到雙重檢貨，以增加貨物的通關效率。

（二）對業者的建議

1. 在「政府對車輛的限制」方面，對於車輛不能跨區使用或大型貨運車進入市區的限制，建議業者可與多家不同類型的貨運業者（如小型車業者、領由跨區行駛執照的業者等）合作完成貨物的運送。
2. 在「物流專業人才的培育」方面，建議業者除應積極提昇自身專業外，亦應對員工工作制度化的在職訓練培訓。
3. 在「物流標準化、自動化的推動與使用」方面，建議應建立標準化的作業流程、表單處理系統及自動化的裝卸與運送機具，除可提升自身的工作效率外，亦可與其他業者共同協作，獲取整合效益。
4. 在「資訊化與網絡化」方面，建議業者在資訊技術、網路、以及應用管理軟體，一定要作適度的投資，俾建立穩固的物流資訊網絡體系，由於國際運輸是兩端或多端的運輸，此一改善對整體物流服務品質的提昇，將可產生倍數效益。
5. 在「與客戶間之信用風險」方面，建議業者應採正規方式投資經營，避免風險，此外亦應進行徵信工作，尋求信譽良好的合作伙伴與客戶。

二、未來經營策略

物流是人類經濟活動極為重要的一環，物流通路如果能做好，將是一無限的發展空間。台灣物流發展較早，目前已近飽和狀態，近年來，大陸政府亦相當重視物流的發展，因此目前於兩岸經營的台商未

來均將重心放在大陸地區。以下則針對分析結論提出投資物流經營策略，供業者參考。

(一) 物流業未來經營策略

根據本研究調查結果顯示到大陸投資經營的物流業者均屬於經營規模較大的企業，而國內目前之物流業以中小型企業居多，於大陸市場所能提供的服務較為有限，可能亦無力與其他業者競爭，而且在全球化的趨勢下，國際分工越來越細，未來客戶所需要的是「Door to Door」型式的整合性服務，因此國內業者應以合併或協作方式進軍大陸市場，方能為客戶提供全方位的物流服務。

對於在大陸經營物流服務的營業執照問題，可在進入大陸市場時，找信譽良好、具有實力的中方業者合資經營，透過合作機會申請營運執照。在選擇投資地區方面，業者須先考量自己可利用的資源所在，如原有的客戶群、合作對象等，據以選擇自己適合投資的地點。

此外，物流業者可與上、下游客戶實施策略聯盟，建立夥伴關係，為企業提供供應鏈一體化的物流解決方案，以提昇供應鏈整體效率為目標。為因應全球化的發展趨勢，業者亦應在資訊軟、硬體方面作適當的投資，一方面可透過資訊科技整合公司內部的作業流程，另一方面可應用電子商務整合上下游客戶，建立良好的互動連繫。

(二) 台商企業物流策略

1. 建立長期的合作關係：一般而言，企業原有運輸部門僅能維持內部的運輸，而對於更大範圍的跨國、跨省、跨市或跨地區的運輸，還是需要委託給物流公司來處理。因此，可選擇合適的物流業者及其相關之上、下游廠商，以策略聯盟方式建立長期的合作關係，由物流業為公司從原物料之採購、運送到產成品的銷售、配送過程作整體規劃，而企業內部則專注於核心競爭力的提昇。
2. 加入物流協作組織：加入物流協作組織，以利貨物配送，例如，企業以會員方式加入協作物流網，此網路扮演平台角色，藉由比較會員需要的物流起迄地點、時間來訂定總運輸策略。
3. 發展三角貿易：在目前的客觀環境下，兩岸三地可發展三角貿易，利用適當的分工，創造多贏局面。

陸、結論與建議

近幾年來，中國大陸利用本身的生產優勢，逐漸扮演著「世界工廠」的角色，台商也有近六萬家進入大陸市場投資發展，其間不論是在大陸地區內的物流需求、大陸對外的國際物流、以及兩岸之間的貿易物流需求，均係確保商業體系產銷運作順利進行的關鍵要素。本研究以同時在兩岸經營的台商實際面對的物流環境與服務品質為重點，除蒐集相關統計資料外，也進行一項大規模的調查，據以分析兩岸物流發展現況及其中隱藏的潛在問題。

本研究發現在目前兩岸提供直接物流服務，仍有障礙的情形下，許多固定頻次的物流與運輸服務均不可得，然而，對許多企業而言，全球供應鏈運作的需求又極為迫切，因此，物流服務幾乎都以廠商供應鏈之運作需求為導向—即「供應鏈導向之物流服務」，此種運籌模式在未來應該仍是一主要的物流服務型態，提供物流服務的業者，可多投注於此一型態之相關服務的開發拓展。

當然，由於大陸地區幅員廣大，物流活動多受地方政府法令規範，本研究受限於時間與經費的限制，未能有一全面性的比較整理，是後續研究可以再進一步加強的；基於同一理由，本研究對於研究範圍與研究對象，亦有其侷限性，雖目前的研究分析結果已可大致呈現兩岸物流發展亟待改善的課題，惟後續若條件許可，仍應持續、擴大研究規模，當有助於政府部門及業者作出更正確的決策。

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DEVELOPING SUPPLY CHAIN-BASED LOGISTICS SERVICES ACROSS THE TAIWAN STRAIT – AN EMPIRICAL ANALYSIS OF THE IT INDUSTRY

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ABSTRACT

Recently, many production systems are being multi-nationalized by the globalization of industries. Based on this worldwide trend, many Taiwanese enterprises advanced into Mainland China and they could enjoy comparative economic advantages of production input factors. But the reality is that they could not make the most use of such advantages because of the inefficient operation of supply chain and the slow administration process of Mainland China. This paper explores the practical problems of supply chain operations of the enterprises that advanced into Mainland China and suggests an improved supply chain-based logistics services framework to deal with such problems.

Keywords: *supply chain, logistics, IT industry, the Taiwan Strait*

INTRODUCTION

Over the past few years, manufacturing firms have rearranged the processes and activities of their supply chains to enhance competitiveness by the increasingly globalization of economy. Global competition has imposed tremendous pressure on manufacturing firms to transform and adjust their supply chain operations. Based on this trend, many Taiwanese enterprises relocate their supply chain activities as manufacturing factories were advanced into Mainland China to capture the comparative advantages of production input factors such as cheaper labor force and raw material costs, etc. For those enterprises, the output of a primary manufacturing factory in Mainland China may simply be the input for a subassembly factory of the enterprise located in another country. The semi-finished products may be transported back to Taiwan for final assembly, then re-export to foreign markets. In recent year, a large portion of the outputs from each subassembly factory may conveyed directly to the final assembly factories in locations near the marketplace. Due to the increased global competition, the explosion in customer services and economic structural transformation, such trend of international division of labor between Mainland China and Taiwan has expected to be continuously accelerated. Under this circumstance, logistics has been rapidly transforming as a key success factor for the business global operation. However, the overall China-Taiwan supply chain operation is still inefficient since the poor logistics linkages caused by the political barriers across the Taiwan Strait. See figure 1.

This study was conducted in the Taiwanese IT (information technology) enterprises,

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which is one of the major manufacturing industries in terms of gross output and export value. In 1999, Taiwan was the third largest IT products manufacturer in the world, next to the US and Japan, capturing major share in the global markets for monitors, scanners, keyboards, notebook PCs and other computer peripherals. An important factor in Taiwan's IT development has been the outreach of its constituent firms starting from the late 1980s, with their outward investment initially being directed towards Southeast Asia, and more recently towards Mainland China. (Feng et al., 2000) In order to take advantage of the international division of labor, Taiwan has continuously shifted its low-end IT production to bases offshore, and as a result, Taiwan's offshore IT production constituted almost half of its entire production in 2001, with Mainland China being the major designated production region. Owing in part to this kind of supply chain dispersion adjustment, China is already Taiwan's third largest trading partner in the world and the biggest source of trade surplus.

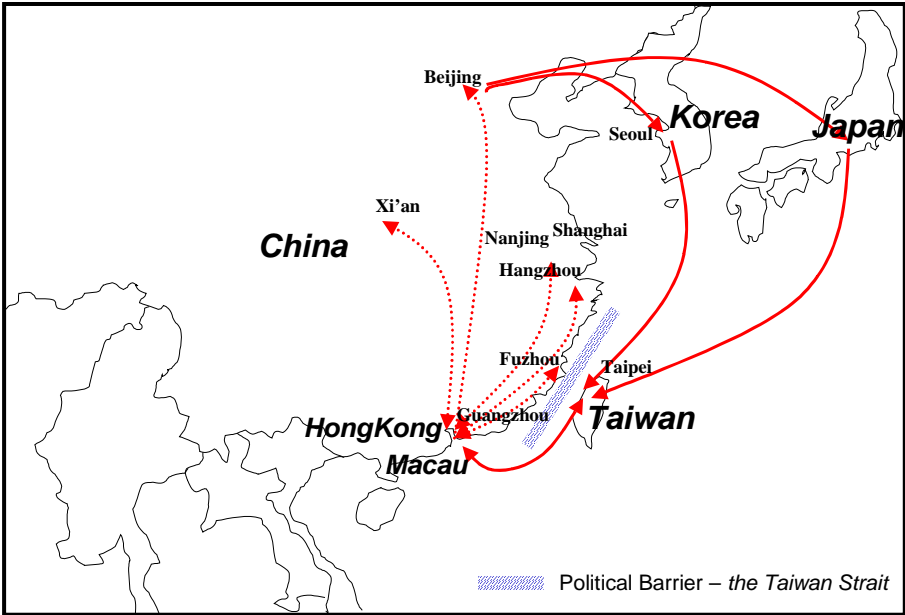


Figure 1. The political barriers across the Taiwan Strait

For the enterprises that advanced into Mainland China, the success of supply chaining depends on the development of reliable logistics services. IT enterprises that advanced into China mainly deal with shorter life cycle products, and the most important success factors for such items are the timely production and the right supply. To meet such requirements, the reliable services of the logistics providers are essential.

The main objective of this article is to carry out an investigation into the division of labor investing in Mainland China by Taiwanese IT manufacturing firms, to clarify the meaning and roles of supply chain-based logistics service, and to integrate implementation of logistics as well as supply chain operation in a cross-border environment. In order to provide a detail picture of existing supply chain and logistics operations, this study also reviews the experiences of multinational companies and a simple questionnaire survey was conducted from September 2001 to March 2002.

This paper is structured into five main sections. The next section provides the background on trade between Taiwan and China. The third section reviews existing logistics

services across the Taiwan Strait and introduces the IT manufacturing firms' transport demand currently. The fourth section provides a framework and identifies key methodological considerations for conducting empirical research on the issue of supply chain-based logistics services. Fifth section presents a summary and some conclusions we can draw from the work in terms of moving towards a disciplinary approach to logistics services.

TRADE AND SUPPLY CHAIN OPERATIONS BETWEEN TAIWAN AND MAINLAND CHINA

Mainland China is Taiwan's third largest trading partner in the world, second largest export market, and fourth largest source of foreign imports. Between 1991 and 2000, the value of total trade between Taiwan and China increased by 305%, soaring from 8 billion to 32.4 billion USD. The average annual growth rate of the cross-strait trade was 23.4% for the same period, compared with 8.8% for Taiwan's total trade. In 2000, Taiwan exported 26.1 billion USD worth of goods to China and imported 6.2 billion USD worth of goods from China.

Moreover, Taiwan's exports to China are 'pulled' by the massive Taiwanese investment in the mainland. In 2001, electronic equipment and components, machinery, plastic goods, steel, artificial fiber, and organic chemicals together made up about 67% of total Taiwanese exports to China by value. These intermediate industrial goods are mainly used to support the Taiwanese manufacturing platforms in China.

According to Chinese official statistics, between 1991 and 2000, Taiwanese enterprises negotiated over 46,000 contracts and invested more than 26.1 billion USD in Mainland China. About 41.7% of Taiwan's total outbound capital flow was channeled into China. Over the past decade, Taiwanese investment in China, which began with small-scale labor-intensive investment by small- and medium-sized enterprises (SMEs), has gradually changed to large-scale capital- and technology-intensive investment by large-scale companies. According to Taiwan's Council of Mainland Affairs, more than 40% of large domestic companies (public-listed and OTC companies) have made some form of investment in China. (Schive, et al., 2001)

Because of Taiwanese firms' massive investment in Mainland China, the pattern of industrial relationship between the two economies has gradually transformed from 'vertical division of labor' to 'horizontal competition.' Over 90% of Taiwanese investment in China is in manufacturing sector. As Taiwanese industrial enterprises shift their manufacturing factories to China, they begin to produce products that directly compete with ones that are produced back in Taiwan. The IT industry is a case in point.

In earlier years, Taiwan's IT manufacturers would build up product inventories guided by forecasts of OEM orders for the year ahead. Products were then shipped from those inventories to multinationals in the U.S., Japan and Europe, which would provide distribution, delivery, and after-sales services. However, this situation has changed dramatically following the build-to-order (BTO) business model by major IT multinationals like Dell and Compaq. BTO not only allows customers to select products in a much greater range of varieties and configurations, but also enables multinationals to lower the level of inventory and significantly shorten the operating procedure of their supply chains. To ensure that product orders can be assembled and shipped within hours after received, foreign multinationals have shifted their entire inventory, delivery, and after-sales service functions to OEM/ODM suppliers. Most overseas IT production orders nowadays are routed to firms with a proven record in global logistics management like ACER and Mitac. (Chia, et al., 2002)

Under BTO model, OEM/ODM producers will ultimately have to manufacture and/or

warehouse products in locations specified by clients, in order to cut distribution and delivery times by the maximum extent possible. The upshot is that Taiwan's IT manufacturers will have to invest more heavily in global logistics if they are to remain competitive internationally.

On the whole, Taiwan seems well-positioned to meet the challenges and grasp the opportunities arising from the operation of sophisticated global logistics and supply chains. In Mainland China, IT manufacturers from Taiwan have set up a host of factories producing items ranging from computers, resistors, and scanners to motherboards, monitors, and CD-ROM drives. Larger companies have sought to diversify their investments geographically, establishing production bases simultaneously in several mainland cities along with shipment centers, sales departments, and peripheral suppliers.

According to the supply chain diversification, there are three basic operating patterns:

- (1) The components and subsidiary materials are supplied from Taiwan to Mainland China manufacturing factories and finished products are conveyed to Taiwan for exporting to the third country and selling in the domestic market.
- (2) The output (components and subsidiary materials) of a primary manufacturing factory in one country may simply be the input for a subassembly factory located in another country. The semi-finished products may be transported back to Taiwan for final assembly, then re-export to foreign markets and selling in the domestic market.
- (3) Each of the offshore manufacturing factories performed an independent operation in the supply chain and ships output to a final assembly factory in Taiwan. After final assembly, the finished products were exported to the markets.

THE CURRENT LOGISTICS SERVICES ACROSS THE TAIWAN STRAIT

Even Taiwan's increasing and big amount of investment in Mainland China and both vertical as well as horizontal division of labor have had existed, the current logistics services across the Taiwan Strait are very inefficient and inconvenient since the political barriers. The Mainland Affairs Council of Taiwan estimates officially that, by conservative estimation, more than 30,000 Taiwanese enterprises have actually begun operation in China, with more than perhaps 500,000 Taiwanese are now resident in the Mainland, running the factories these investments have built. Travelers across the Strait now number in the millions annually. However, under the political barriers, the linkages of passenger and freight transportation between Taiwan and Mainland China are currently conducted via a third country or another territory, e.g. Hong Kong and Macau.

In fact, due to the rapid economic growth and the historical/cultural closeness, World Bank had defined Mainland China, Hong Kong and Taiwan together as 'Greater Chinese Economic Area' in one of her research report in 1993. As the Greater Chinese economy continues to grow above the average pace of the global economy, the importance of the logistics role is increased substantially to the companies doing business. (Chan, 2002)

In recent years, the value of export shipments from Taiwan to Hong Kong, based on FOB (Free on Board) prices reported by the Customs Bureau of Taiwan, have substantially exceeded the value of Hong Kong's import shipments from Taiwan, based on CIF (Cost, Insurance, and Freight) prices reported by the customs office of Hong Kong. This discrepancy could be reasonably assumed to approximate the additional amount of shipping exports 'indirect' from Taiwan to the mainland without transshipment through Hong Kong.

As mentioned above, all goods flows between Mainland China and Taiwan, including all of the three kinds of supply chain operating patterns, have to be transshipped via a third place. And because of the highly efficient port facilities, the advanced logistics services, as well as

the geographical vantage, a big amount of goods transited via Hong Kong, where Hong Kong served as the most important middleman in the 'indirect' logistics between two sides of the Taiwan Strait.

Under many Taiwanese IT manufacturers' BTO business model, most of the products have entered into the maturity life cycles. Firms not only have to lower the manufacturing costs, but also have to enhance the logistics efficiency to satisfy the level of service. Any product steps in the maturity or decline stages will more rely on faster logistics services when the manufacturing locations diversify. Consequently, from Taiwanese multinational enterprises' point of view, the performance of logistics services of China is more important. However, it is estimated that logistics in China's industrial promotion take almost 80% of the whole production cycle time and 40% of general production costs. High inventory level also affects the competitiveness of firm's supply chain. The transportation and logistics sector has historically been under the control of state monopolies and its liberalization will be a complex process as it involves the coordination of intermodal transport modes both at the provincial and national level. The fact that various logistics sub-sectors are under the control of many different government bodies also does not help. Nevertheless, market competition, intensified by the participation of foreign players, will be the pivotal development of the sector and it will have strong impact on China's external trade regime and internal wholesale and retail business.

DEVELOPING THE SUPPLY CHAIN-BASED LOGISTICS SERVICES

The supply chain-based logistics services is proposed in the context of the minimization of 'total logistics costs.' In other words, the objective of developing supply chain-based logistics services is proposed to achieve system optimization.

To illustrate the basic trade-offs among a certain set of logistics costs, a continuous review inventory-transport model has been simulated. The decisions to be established in this model are the determination of response time, order size and transport alternatives, so as to minimize total logistics costs. Simulations were conducted using prototypical information to illustrate the basic trade-offs between transport system performance and total logistics costs.

Based on these simulations, the findings can be summarized as follows:

- Logistics costs were found to be most sensitive to customer service levels;
- The decrease of the lead time would increase logistics costs;
- Transport infrastructure's congestion not only reduced reliability but also increases average transit time and total logistics costs;
- Transport infrastructure improvements can reduce the transport costs, order lead time, as well as increase the reliability of logistics time.

Of course, the results from the simulations are dependent on the specific input values used. The impact of the infrastructure improvement on the overall lead time reliability, the level-of-service policies of logistics service providers, the transportation rate structure faced by enterprises, the value of the shipped products, the actual lead time and its decomposition into various components, etc., would all have an influence on the actual impact on enterprises' total logistic costs.

A logistics services planner needs to consider products features as well as logistics services requirements when deciding on the appropriate supply chain network. The various networks have different strengths and weaknesses. Most enterprises are best served by a combination of supply chain networks. The combination used will depend upon product features and the needs of the customers. (Chopra, 2003) Fast moving and emergency items are stocked locally and customers can either pick them up directly or have them shipped

depending upon the urgency. Slower moving items are stocked at a distribution center from where they are shipped to the customer within a day or two. Very slow moving items are typically drop shipped from the manufacturer and involve a longer lead time.

CONCLUSIONS

The results of the research reveal that the motives of Taiwanese IT manufacturers investing in China are market retention and a reduction in production costs, and that the direct investment by Taiwanese industries in the mainland has gradually become localized. According to the division of labor of those enterprises operating across the Taiwan Strait, from the viewpoint of manufacturing activity, whilst both vertical and horizontal division of labor exist, we find that more and more manufacturing activities are being transferred to the mainland.

Furthermore, this paper also explores the existed practical problems and limitations of the current supply chain operations of the IT enterprises that advanced into Mainland China and proposes a conceptual model to deal with the current controversy regarding supply chain collaboration and logistics service performance. The proposed model integrates both logistics and supply chain operation into a common framework. The proposed supply chain-based logistics services turned out to be effective, because it considers the process of supply chain and the major determination, such as response time, order size and transport alternatives. By the proposed supply chain-based framework, the uncertainty level is reduced owing to the reliable flow of information and materials, and the shortened delivery lead time of goods, which results in the reduction of material handling costs and the increased operating efficiency of supply chain.

Under the current political barriers across the Taiwan Strait, this article suggests the supply chain-based logistics services adjust concept to minimize the total logistics costs and improve the efficiency of supply chain operation. The investigation will be very helpful for the future advance of enterprises.

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Survey analysis of supply chain adjustment for Taiwanese information technology firms

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Owing to the globalization of industry, the explosion in customer services, and product life cycle compression, most manufacturers have been adjusting the processes and activities of their supply chains in order to remain competitiveness and optimize total profit. The objective of this study is to explore the issues surrounding the changes in manufacturing supply chains and the consequential impact on freight transport demand. A questionnaire to survey Taiwanese information technology (IT) firms was designed and conducted, to recognize in detail the changes in supply chains of manufacturers, trends in the international division of labor and the strategic adjustment of manufacturing and logistics strategies. Surveys and interviews lead to the conclusions that (1) vertical integration and international division of labor are very conspicuous among Taiwanese IT firms, (2) there are different strategies of supply chain adjustment at various stages of the product life cycle, (3) with the transformation of the supply chain, manufacturers require faster transport services, that is, the demand for air transport may increase and the demand for sea transport may decrease, and (4) once the firms decide on foreign investment, the availability of international transport service becomes one of the considerations for factory offshore relocation. However, the transport cost is not a major consideration for firms' supply chain adjustments.

1. Introduction

Over the past decade, the trends in the rapidly changing world economy have been forcing firms to reshape the processes and activities of their supply chains to enhance competitiveness (Christopher, 1998). Manufacturers are increasingly establishing new factories overseas to survive in a fiercely competitive global environment. Hence, individual firms are not only changing the origin/destination (O-D) of transport demand and modal choice, but they are also influencing overall international freight flows (Feng, et al., 2000). Under this worldwide specialization of production, transport between continents and between countries increases at a faster rate than world economic growth.

As for the supply chain, previous studies focused on movement of goods from raw material procurement to product distribution during the manufacturing process. This includes producing sequences, placing orders, inventory management, transport, warehousing and customer services. Some studies include the entire commercial process from upstream suppliers and downstream customers in the domain of the supply chain, integrating into the

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discussion of supply chains, product, service and information, production and logistics. Wyland et al. (2000) suggested a conceptual structure for supply chain management to integrate manufacturing, retailing and logistics. Cooper et al. (1997), Zinn and Bowersox (1998) and van Hoek et al. (2000) proposed the concept of postponement for supply chain operations. Furthermore, Pagh and Cooper (1998) identified four generic supply chain Postponement/Speculation (P/S) strategies, by combining manufacturing and logistics postponement and speculation. In addition, Ganeshan et al. (1999) provided a taxonomy of supply chain management research, which reviewed the studies on the conceptual perspective, evolution, categories and researched methodologies of supply chain management. Generally speaking, the concept of supply chain and logistics has been discussed for over 50 years (Ganeshan et al., 1999). However, lots of the studies focused on the analysis of business processes within individual firms. Some studies describe the changes of freight flows and the modal choice of firms in relation to changes on the supply chain.

Regarding the influence that product development has on the supply chain, most research has categorized product life cycle (PLC) into a series of stages: introduction, growth, maturity and decline (Birou et al., 1998; Wyland et al., 2000; Dicken, 1992). PLC was adopted to expound on the evolution of international production. Birou et al. (1998) indicated that PLC can reflect important characteristics of a product. Thus life cycle can be taken as an adequate tool to determine strategies for logistics, operation and purchasing. Higashi et al. (1994) also presented that the form of corporate alliance used may also depend on what stage of the PLC is involved. In addition, Pagh et al. (1998) took PLC as one of factors that could explain different adjustment strategies on the supply chain.

In freight transport studies, Qrtuzar (1990), Langevin (1996), Crainic et al. (1997), Feng et al. (2000) and Garrido et al. (2000) all provided reviews on the solution approaches in freight transport. Most of the studies indicated that current freight transport researches tend to emphasize the role and importance that freight transport plays in the overall manufacturing/distribution processes. However, some of these previous analyses of freight transport have suffered from a variety of shortcomings. First, most of these studies imply that product manufacturing is done at the factories in a concentrated area. Under the trend of globalized production, firms manufacture their products at diversified multiple-sites. Logistics operations of supply chain will determine the direction of freight transport flow. Therefore, the previous freight transport studies were difficult of reflecting current supply chain operating realities and the demands that firms currently placing on freight transport services to meet their needs. Second, earlier studies were based on only a limited amount of data, and might not have captured all the effects of firms' globalized production. Lastly, part of these previous studies underestimated the transport demand incurred by the internationalization of production activity, since they do not take into account the dynamics of the interaction between a firm's freight demand and adjustments in the supply chain's operations.

Nevertheless, some researchers have investigated the links between supply chain restructuring and freight transport in recent years (McKinnon et al. 1996, Morash et al. 1997, Cooper et al 1998, Voordijk et al. 1999). Morash et al. (1997) indicated that transport can play a key integrative role in supply chain structures. In a globalized environment, transport's contribution to international supply chain structure takes on new and increased importance. Transport capabilities such as reliability, time compression, and just-in-time delivery must be integrated with their enabling supply chain structures. McKinnon et al. (1996) conducted a survey of changing freight transport requirements of eighty-eight manufacturers. They also found that changes in the frequency and scheduling of freight deliveries in response to tightening customer service requirements and just-in-time management appear to have become a more prevalent cause of freight traffic growth than the physical restructuring of logistics systems. Manufacturers anticipate that their freight demand will increase in line with

sales and be largely unaffected by road transport cost increases at the levels currently proposed.

Some researchers have utilized location theory and world system theory to explain industrial spatial distribution. Healey et al. (1990) indicated that world system theories explained the evolution of a world economy in terms of the international character of the capitalist system. The global distribution of a firm's operations can be explained by categorizing geographical locations by their level of economic development. The world economy is divided into a core, periphery, and semi-periphery and countries can move from core to periphery, periphery to semi-periphery, and so on. The core area is characterized by high wages, advanced technology and diversified production mix. Quite the opposite is true of the periphery (low wages, little technology, and a narrow economic base), whereas countries in the semi-periphery have a combination of both sets of characteristics exploiting peripheral countries while being exploited by core countries. Multinational enterprises have been moving standard and labor-intensive manufacturing activities from core to periphery regions, where more convenient geo-locations and transport, lower costs in labor, land and other production input factors provide a competitive advantage. Core regions are utilized mainly for R&D, finance, retailing and administration activities.

This study recognizes that most of the previous studies focus on supply chain operation, freight transport planning, spatial economy as well as their interactive relationships. However, there has been no deeply analysis for Taiwanese IT firms on the effects of freight traffic by supply chain adjustment and how these might change in the future. This paper would like to investigate supply chain adjustment factors through a survey of the international division of labor and supply chain reconstruction of information technology (IT) industry in Taiwan which aims to improve our understanding of how supply chain adjustment may affect transport demand. The findings may serve as the basis for future quantitative analysis. The first section of this article gives a brief overview of previous research. The second section identifies the problems and domains of this study. It depicts the characteristics, adjustment strategy of manufacturers' supply chain and the propositions this study tries to verify. The third section explains the design of questionnaires, survey approaches, industry selection and sample analysis. The fourth section discusses the relevant results of the survey. In order to explore the link between strategic corporate decisions, logistics development and transport implications, the fifth section utilizes Acer's experience to describe a typical Taiwanese IT firm's global logistics development. The final section will offer conclusions and recommendations for future research.

2. Problem analysis and study domain

In this section, the 'supply chain' is defined first. The objectives and strategies of a firm's supply chain adjustment are also be stated. By reviewing previous studies, the potential relationships between product development characteristics and the supply chain changes may be described. At the end of the section, the propositions for investigation are developed.

2.1. Supply chain of manufacturing industry

In recent years, much research has focused on the performance, design, and analysis of the supply chain as a whole and the effects of the rising costs of manufacturing, the shrinking resources of manufacturing bases, shorter product life cycles, and the globalization of market economies (Beamon, 1998). The supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services (Christopher, 1998). 'Supply chain management' introduces managerial components (such as planning and controls, organizational structure, information process) to the processes of supply chain operation,

handling the mutual interrelationships between upstream and downstream processes with suppliers and customers to provide lower costs and better services. Figure 1 illustrates the conceptual framework of the manufacturing supply chain. In the figure, each node is an event of supply chain activities, and the links among nodes represent the supply chain processes. Together, the nodes and links comprise the entire supply chain network. For example, the main supply chain activities of the manufacturing industry include: raw materials procurement and storage, parts manufacturing, storage of the work-in-progress, assembling for semi-finished and finished products (labeling and packaging), warehousing for finished products, retailing/distributing to customers. The semi-finished products have to be gathered at one location and assembled to become final products. This operation may take place in one factory, or in the distribution centre/local warehouse, midstream or downstream along the supply chain. The point of final assembly depends on the manufacturer's individual supply chain arrangement.

Moreover, logistics is defined as the process of managing the procurement, movement and storage of materials, parts, and semi-/finished products through the organizing and distributing channels. The Council of Logistics Management (1998) defines logistics as 'part of the supply chain process that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements'. Distribution of goods from one or more origins to one or more destinations is the core of logistics. Depending on the activities of supply chain, logistics can be segmented into three parts: 1) inbound logistics, i.e., the processes related to the raw material procurement; 2) manufacturing logistics, i.e., the processes covering the raw material/parts processing and the assembly for finished products; 3) outbound logistics, i.e., the processes that deliver the finished products to the customers as soon as the orders received. All three logistics segments demonstrate the demands toward transport services. The flow maneuver generated by the activities of logistics will utilize the existing transport networks. Main focus of this study is the downstream flow of the supply chain, from factory to end customer.

[Insert figure 1 about here.]

2.2. Supply chain adjustments

2.2.1. Purposes of supply chain adjustments

The supply chain adjustments mentioned in this article include adding, removing, relocating activities (nodes) in the supply chain. These activities' rearrangement will alter the processes (links) of the supply chain.

In general, two purposes are important in adjusting the supply chain of a manufacturing firm. First, decreasing the cost, requires that manufacturers look for inexpensive input factors to obtain comparative cost advantages, or that manufacturers obtain benefits of scale economies by concentrating the supply chain activities. Second, the enhancement of the level of customer service requires that manufacturers offer customers more options by providing differentiated and customized products as well as faster display by delivering products to markets as early as possible.

2.2.2. The basic principles of supply chain adjustments

To meet needs, firms usually rearrange their supply chain activities by means of 'centralization' or 'diversification' in space and 'speculation' or 'postponement' in time. 'Centralization' concentrates the activities of the supply chain at one site to obtain the economy of scale in manufacturing and the economy of cluster caused by the geographic proximity of upstream and downstream production. This concept reduces manufacturing logistics by concentrating manufacturing activities. For example, the process from parts manufacturing to final products labeling and packaging may be covered by the same factory.

Certain production lines may also be located within close vicinity for mass production.

As to 'diversification', firms move some activities upstream to obtain cheaper input factors for reducing the production cost. Some may move downstream to respond to customer's needs quickly. As manufacturing activities become more scattered, manufacturing logistics increases. In recent years, the international division of labor in global business has become an important 'diversification' in space for supply chain adjustment.

On the other hand, the logic behind 'postponement' is that risk and uncertainty costs are tied to the differentiation (form, place and time) of goods that occurs during manufacturing and logistics operations. To the extent that parts of the manufacturing and logistics operations can be postponed till final commitments have been obtained, the risk and uncertainty of those operations can be reduced or even fully eliminated. The notion of manufacturing postponement is to retain the product in a neutral and non-committed status as long as possible in the manufacturing process. This means to postpone differentiation of form and identity to the latest possible point. The notion of logistics postponement is to maintain a full-line of anticipatory inventory at one or a few locations. This means to postpone changes in inventory location downstream in the supply chain to the latest possible point.

The converse concept to postponement is 'speculation', which holds that changes in form, and the movement of goods to forward inventories, should be made at the earliest possible time to reduce the costs of the supply chain. Speculation makes it possible to gain economies of scale in manufacturing and logistics operations, and limit the number of stock outs. At the same time, the firm's speculations must meet the predicted market demands and customer services. Under this concept, manufacturing and logistics operations are initiated earlier according to the prediction, thus risks and uncertainties increase relatively.

Many previous studies discussed the impacts of supply chain activities' speculation or postponement adjustments on the manufacturers' production performance. Cooper et al. (1998) identified four different supply chain postponement strategies for some global brands. Zinn and Bowersox (1998) proposed five different types of postponement strategies -- four different strategies of form postponement (labeling, packaging, assembly and manufacturing) together with time postponement. Pagh and Cooper (1998) suggested four supply chain adjustment strategies, 'the full speculation strategy', 'the manufacturing postponement strategy', 'the logistics postponement strategy', and 'the full postponement strategy', after he decided to combine activities in manufacturing and logistics based on related studies.

Basically, supply chain adjustments rearrange the combinations of activities and processes. The adjustment in 'space' varies activity location and the adjustment in 'time' varies the operation scheduling of the supply chain. Moreover, the processes change along with the adjustments in the supply chain activities.

2.2.3. The relationships between product development and supply chain adjustments

Since its initial conceptualization in the early 1950s, the PLC theory has gained significant recognition as a tool for effective marketing strategy formulation and implementation. The PLC, as defined by Dicken (1992), is the growth of sales of a product from initial innovation through a series of stages, as illustrated in figure 2. When a new product has just been introduced on to the market, the total volume of sales tends to be low because consumers are unaware and not confident about the product's quality and reliability. At this stage, few competitors exist in the market therefore as long as consumers become aware of the product via its own quality and promotion, the product should enter the 'growth stage'. There is an increase in demand for the product. Other competitors may then enter the market as the demand/sales increase. Next, manufacturing techniques should stabilize under the growing competition among firms, and the manufacturing supply should reach its peak, as market growth hits a ceiling. However, when the product attains maturity demand begins to level out.

New products often appear at this stage replacing the current one, and shifting market demand, thus the sales of the old product decrease and enter the 'decline stage.' A product's life cycle is a continuous development process. The divisions on the above life cycles at various stages are conceptual but the differences in the demands, competition environments, technology developments are quite distinct.

At different stages of the PLC, a firm may have correspondingly different strategic plans for each activity in the supply chain due to the various manufacturing technologies and market needs. The life cycle period is distinct from product to product. However, there is growing evidence that PLCs are tending to become shorter, industrial customers and distributors require just-in-time deliveries, and end customers are ever more willing to accept a substitute product if their first choice is not instantly available.

[Insert figure 2 about here.]

2.3. Propositions of this research

When reviewing literature concerning the supply chain, freight transport, spatial economy and PLC concept, many discussions of manufacturing supply chain planning and principles of supply chain adjustments prevail. However, few investigations discuss the following issues: whether globalization will affect the IT firm's supply chain adjustments; if the supply chain adjustment strategy should vary with the stage of the product's life cycle; how supply chain adjustments affect the decision making of firms in modal choice and in freight transport origin/destination; while the firms adjusting the supply chain, what is the role of the availability of transport service.

Based on the previous discussion and literature review, the propositions to be investigated are as follows:

Proposition 1: Globalization of industry and changing international division of labor will induce the Taiwanese IT firms' manufacturing activities to shift to overseas countries.

Many studies recognize that firms will relocate their manufacturing sites due to cheaper raw materials procurement --- or to respond to customers' needs quickly. Especially, with the liberalization of international trade and the reduction of trade barriers, firms establish factories in overseas countries to manufacture products to meet local demand. Under this changing environment, whether the Taiwanese IT industry will undergo international collaboration, and if adjustments will follow in the supply chain is the first issue of discussion in this study.

Proposition 2A: The stage of product life cycle will indeed affect the firm's supply chain adjustment strategy in 'Space'.

Proposition 2B: The stage of product life cycle will indeed affect the firm's supply chain adjustment strategy in 'Time'.

Since the nature of the production process tends to vary according to stages in the life cycle, each stage will tend to have different production features: of technology, of market demand and of competition. Proposition 2A and 2B would like to depict the fact that for system optimization, the supply chain adjustment strategies in space and time will vary accordingly.

Proposition 3: The supply chain adjustments will affect the manufacturers' modal choice and change freight transport origin/destination.

The manufacturing industry supply chain is incomplete without transport services delivering raw materials, work-in-progress and finished products. All the adjustments in the supply chain will directly affect the manufacturer's distributing operations and then freight O-D patterns of a firm's transport demand as well as modal choice.

Proposition 4: The supply chain adjustments depend on the availability of international

freight transport services.

This proposition intends to depict that international freight transport service will not only affect the shipping time to the end customers, but also be the important factor manufacturers considered in adjusting their supply chains.

Proposition 5: The transport cost will affect the firm's supply chain adjustment.

This proposition intends to depict that transport cost will be the important factor manufacturers considered in adjusting their supply chains.

3. Questionnaire design and sample analysis

Since many of the pervious studies are quite limited by data unavailability, this study designed and conducted a questionnaire survey on Taiwan manufacturing industry in order to collect information concerning firms' supply chain adjustment strategies and obtain the relevant freight transport demand data. This section explains the rationale that was used in selecting respondents from the Taiwanese manufacturing industry, the empirical research methodology, and the characteristics of the sample.

3.1. Industry selection

Industry selection was based on three criteria. First, the industry had a representative output share in the Taiwan economy. Second, the supply chains that were utilized by firms in a particular industry had to be highly flexible to highlight the significance of supply chain changes under global conditions and the impact on freight transport. Third, the PLC of the industry had to be short to reveal the features of different life cycle stages.

According to these criteria, relevant economic data, and the Taiwan Standard Classification of Commodities, the IT industry was selected as the target industry for the survey. Investment in Taiwan IT industry has been growing rapidly and the production value has been increasing continuously. The IT industry's contribution to the total production value of the Taiwan manufacturing industrial sector was 17.9% in 1989 and 30.3% in 1998. The manufacturing industry structure of Taiwan is shown in table 1. The IT industry in this study includes information hardware (computer hardware, key components) and semiconductor (semiconductor manufacturing, semiconductor service-IC testing, semiconductor's raw materials).

In general, because IT products have shorter life cycles and the adjustment of the supply chain is more flexible, IT firms respond to the comparative advantages of input factors and the market demand quickly. Furthermore, under this quick responding business model, it is easier to investigate the interactive relationship between freight transport services and the supply chain changes from IT firms' operations.

[Insert table 1 about here.]

3.2. Research methodology

In order to explore issues of supply chain operations in Taiwanese business, a survey instrument was sent to 152 IT firms listed on the Taiwan Stock Exchange (TSE). In-depth interviews, desk and file research, cost and quantitative studies of logistics and manufacturing strategies were also conducted. The objective of the interview process was to clarify the related details of firms' supply chain adjustments and to validate findings from the survey analysis. The survey was conducted from July 1998 to September 1999. Before mailing the questionnaire, two companies were asked to pre-test the survey and to provide comments regarding the level of clarity and objectivity of the questions, the accuracy and applicability of the answer options, and the amount of time spent on the questionnaire. Suggestions were used to refine some of the questions and to add new answer options. The survey instrument was comprised of three sections. The first section contained questions asking respondents for basic

information. The second section included questions regarding the manufacturing activities of the supply chain, including, the respondents' opinions concerning, the reasons driving the decision to establish offshore factories and the number of the factories of the respondents. The final section of the instrument questioned respondents as to the strategies of manufacturing and logistics, including identification of products' characteristics and cost of logistics.

3.3. Sample analysis

A total of 45 usable surveys were returned each representing a unique firm for an effective overall response rate of 29.61 percent (i.e., 45/152). The low response rate may have been due to the very detail nature of the survey. Despite the low response rate, it should be noted that the total number of surveys returned represented a very large database for Taiwanese IT industry supply chain research.

Table 2 and 3 summarize the basic information profile of respondents from selected industries. As shown in table 2, the positions held by the people who completed the questionnaire varied from top management to supervisors and engineers. The top management positions (2.22%) included chief executive officers, whereas the senior management positions (8.89%) included general and assistant general managers, technical directors, operations managers, and plant managers. The department managers (55.56%) were derived from control and logistics engineering; product engineering; and marketing and administration personnel, while the supervisors and engineers (26.67%) included those with the responsibility of handling manufacturing activities. Finally, the last category includes the titles of executive assistant and executive secretary (6.66%). Based on the profile of the respondents, it is assumed the sample provides a representative profile and can be used to analyse the general practises and views within the Taiwanese IT manufacturing industry. Subsequent to completing the survey, five respondents were contacted for personal interviews to clarify perceived misunderstandings or misinterpretations of the questionnaire, and to get a more in-depth understanding of their opinions. Furthermore, annual corporation sales per respondent ranged from \$16 million to \$3.06 billion USD, see table 3, providing a wide coverage of the industry.

With regards to product lines, many firms carried multiple products, some of these products accounting for only a small part of the total revenue. To simplify the analysis, only the products that take up to 5 percent of the total revenue were analysed. Among the respondents, there were 11 firms that carried a single product, 14 firms that carried two products, 13 firms that carried three products, and 7 firms that carried more than four products. Most Taiwanese IT firms carried three products on average. The vertical integration in the IT industry is obvious, and the degree of specialization is high.

[Insert table 2 about here.]

[Insert table 3 about here.]

4. Survey results and analysis

This section discusses the respondents' survey results concerning supply chain adjustments in order to investigate the above propositions. In addition, it tries to identify the principles of supply chain adjustment.

Proposition 1: Globalization of industry and changing international division of labor will induce the Taiwanese IT firms' manufacturing activities to shift to overseas countries.

In order to examine the offshore relocation of supply chain activities, the respondents were asked to specify the location of their manufacturing factories. In this survey, the number of respondents and the related number of manufacturing locations were as follows: 9, 11, 11, 8,

6 respondents established their manufacturing factories at single, two, three, four, five and more different locations, respectively. The respondent's factories within Taiwan were considered as at a single location. The above offshore factory relocation illustrates Taiwanese IT firms' international division of labor. About 80 percent (36/45) of the responding companies have already relocated part of their manufacturing activities to overseas countries. The results indicate that the supply chains of respondents have already been adjusted in 'space' diversification. In the survey, 92 offshore manufacturing factories had been established by 36 of the respondents. The distribution of those offshore factories is shown in figure 3. There are 44 offshore factories in China, 13 in the US, 6 in Malaysia, 6 in Singapore, 5 in Thailand, 4 in the UK, 3 in Japan, 3 in the Philippines, 3 in Mexico, 1 in Hong Kong and 4 in other countries. Figure 4 illustrates the trend of foreign direct investment among respondents in recent years, which shows a continuous trend. In the IT products' manufacturing processes, most of the semi-products (component parts) can be independently manufactured, therefore, the supply chain adjustments are relatively flexible and the activities of the supply chain can be relocated with fewer restrictions. Taiwanese IT firms have been establishing their offshore factories to manufacture parts or products utilizing the international division of labor. The results of the survey support Proposition 1.

[Insert figure 3 about here.]

[Insert figure 4 about here.]

In addition, table 4 highlights the reasons for the respondents' to relocate their factories offshore. Respectively, about 45 percent and 16 percent of the respondents agreed that lower labor and land costs were major incentives for relocation providing long-term cost advantages. Moreover, about 3 percent of the respondents indicated that, lower tax and tariffs were the main reasons to relocate. Thus, in total about 64 percent of respondents indicated that labor and land costs as well as tax/tariffs savings were major cost considerations for the internationalization of the division of labor. Obviously, most firms desire cheaper production input factors, however some respondents indicated that other reasons instigated their location selection. The reasons included 'proximity to customer markets (24%),' 'easier to access new technologies (7%),' 'skilled labor availability (3%),' and 'others (2%).'

[Insert table 4 about here.]

This research also tries to find the relationships between the reasons and the locations of firms' foreign investment. As shown in table 5, in general, the reasons given by the respondents for establishing their factories in China and Southeast Asia were 'cheaper labor costs,' 'lower land cost,' and 'lower tax/tariffs'. On the other hand, the reasons respondents established their factories in the UK, Japan, Singapore, and the US were 'proximity to customer markets,' 'easier to access new technologies,' and 'skilled labor availability'. In the former, most of the products of offshore factories were in the 'maturity' or 'decline' stage of their life cycle, and in the later, the products were in the 'introduction' or 'growth' stage.

[Insert table 5 about here.]

In conclusion, a majority of Taiwanese IT manufacturers relocated their factories to China and Southeast Asian countries for cheaper and cost comparative advantages in production input factors, while manufacturers who established their factories in the UK, Japan, Singapore and the US cited the ability to interact quickly with customers and advanced technology as the motivating factors. Although they are both foreign direct investments, the purposes and the products' characteristics are different. Different types of geographical relocation are relevant to different stages of the PLC.

Proposition 2A: The stage of product life cycle will indeed affect the firm's supply chain adjustment strategy in 'Space'.

In order to investigate Proposition 2, this research tries to identify the interrelationship

between the manufacturing products' characteristics and the firms' supply chain adjustment strategies. There were 65 major products carried by the surveyed forty-five respondents. In the survey, the definitions of the four stages of the PLC, as shown in figure 2, were introduced to the firms, and then the firms categorized each of their product's development. As identified by the respondents, out of the 65 products, there were 2 in the introduction stage, 19 in the growth stage, 35 in the maturity stage and 9 in the decline stage.

Examining manufacturing locations, it was discovered that there are two products in the introduction stage; one product was made in Taiwan (50%) and the other was partially or fully made at an offshore factory. Out of the 19 products were in the growth stage, among which 15 products were made fully in Taiwan (79%) and 4 products were partially or fully made at offshore factories (21%). Out of the 35 products in the maturity stage, 9 products were made fully in Taiwan (26%) and 26 products were partially or fully made at offshore factories (74%). At last, out of the 9 products in the decline stage, 2 products were made fully in Taiwan (22%) and 7 products were partially or fully made at offshore factories (78%), see table 6. According to the survey results, as the life cycle proceeds, manufacturing activities shift from Taiwan to offshore factories. More generally, along with the product life stage, firms adjust their supply chain in 'space', that is, diversify to different locations instead of centralizing in Taiwan. The results of the survey support Proposition 2A.

[Insert table 6 about here.]

Proposition 2B: The stage of product life cycle will indeed affect the firm's supply chain adjustment strategy in 'Time'.

In addition, this research also investigated whether firms adopted a 'speculation' or 'postponement' strategy in 'time' in manufacturing and logistic operations.

When analyzing the data the stage of the PLC was important in determining manufacturing and logistics strategies; the results took the following pattern:

- 1) For the speculation strategy in manufacturing, there was 2 product in the introduction stage, 12 in the growth stage, 25 in the maturity stage, and 2 in the decline stage.
- 2) For the postponement strategy in manufacturing, there was 0 product in the introduction stage, 1 in the growth stage, 2 in the maturity stage, and 6 in the decline stage.
- 3) For the speculation strategy in logistics, there was 2 product in the introduction stage, 7 in the growth stage, 4 in the maturity stage, and 0 in the decline stage.
- 4) For the postponement strategy in logistics, there was 0 product in the introduction stage, 3 in the growth stage, 26 in the maturity stage, and 7 in the decline stage. See table 7.

[Insert table 7 about here.]

Following the survey results, four types of 'time' adjustments are seen applied by Taiwanese IT firms. (1) For products in the introduction stage, 'speculation' strategy or no action is taken in manufacturing and logistics. However, the feature is not significant due to a lack of samples. (2) 'Speculation' strategy or no action is mostly applied on products in the growth stage for manufacturing and logistics. (3) For products in the maturity stage, most of the firms apply the 'speculation' strategy in manufacturing, while some take no action. In logistics, they tend to use the 'postponement' strategy. (4) For the products in the decline stage, the 'speculation' strategy is taken in both manufacturing and logistics.

Due to the limited number of surveyed respondents, the statistical significance test is not applied on the questionnaire results. In particular, there were too few samples of products in the 'introduction' and 'decline' stages. However, this survey offers considerable support that supply chain adjustments in 'time', are functions of the PLC. Proposition 2B is supported.

Proposition 3: The supply chain adjustments will affect the manufacturers' modal choice and change freight transport origin/destination.

In the manufacturing supply chain network, freight transport demand occurs when materials, works-in-process, and finished products are moving among nodes. It includes 'inbound logistics,' 'manufacturing logistics,' or 'outbound logistics' as mentioned in previous sections. The supply chain adjustments of the firms in this survey may be divided into 'space' and 'time'. The influences that the supply chain adjustments have on freight transport will be discussed for both approaches.

As to the 'space' adjustments, the respondents' diversified their supply chain activities to different locations through the establishment of offshore factories. Due to the supply chain manufacturing activity dispersion and relocation, new freight transport demand was generated. The origin/destination pairs of freight transport varied as those supply chain activities shifted in 'space.' The products' weight and value also changed within the supply chain activities' movement.

As to the 'time' adjustments, manufacturers applied 'speculation' or 'postponement' strategies to manufacturing and logistic operations according to the stages of the PLC. If manufacturing activities were speculated, which is traditionally the method most often used by firms (Pagh et al., 1998), all manufacturing operations would be performed prior to the product being differentiated by location. Thus the inventory for supply chain increases but the impact on freight transport demand decreases. If postponement was applied, firms choose faster transport services to compensate for the loss in time caused by the postponement of operations in manufacturing. If speculation is applied to logistic operations, no significant impact on freight transport demand and the speed of transport services is observed. However, when logistic operations were postponed, manufacturers may have had to use faster transport services to compress shipping time. In general, supply chain adjustments affected the shipping time and the modal choice. Manufacturers tend to select faster transport services to compensate for the shortened response time. For such cases, transport costs are usually not major considerations. On the other hand, 'speculation' strategy provides longer response time, firms may select less speedy and transport services with cost advantage.

Table 8 shows data from respondents about the average lapse of time from receipt of a customer's order through to delivery (i.e. response time), average transport time, and modal choice. The results of the cross-analysis for average response time and products' life stages, at 'introduction,' 'growth,' 'maturity,' and 'decline' was 8.2 to 8.5 days, 6.9 to 7.5 days, 4.9 to 5.1 days, and 5.3 to 5.4 days, respectively. The average transport time was 7.2 to 7.5 days, 5.7 to 5.9 days, 3.5 to 3.6 days and 1.6 to 1.8 days, respectively. In modal choice, most of the respondents used airfreight transport services; only a few products were transported by sea freight. For most of the IT products, the transport cost accounts for a low portion of the sale price. Different manufacturing/logistics strategies were adopted in relation to the different stages of the PLC, and the status of products differed with the time that orders were received. The survey discovered that the products in the 'introduction', 'growth' and 'maturity' stages were completely finished when the orders were received, but the products in 'decline' stages were still works-in-progress.

[Insert table 8 about here.]

From the results of the survey, the supply chain 'space' adjustment indeed affected the freight transport origin/destination. Newly induced transport demand was generated by the fragmentation of the supply chain's manufacturing activity. As to the 'time' adjustments in supply chains, if 'speculation' was adopted, there was no significant impact on the transport demand. If 'postponement' was adopted in manufacturing or logistics, to compress the response time, firms chose a faster transport mode. Under this changing trend, the faster transport services increased and the slower transport services decreased.

Proposition 4: The supply chain adjustments depend on the availability of international

freight transport services.

As shown in the analysis, the respondents adjusted their supply chain in ‘space’ and/or ‘time’. This research also investigated the impact on supply chain adjustments with transport services availability in the two approaches mentioned above.

In the survey, respondents were posed with the following question, ‘*In selecting the region/country for offshore manufacturing factories, would you consider the availability of the international transport services in that foreign country?*’ None of the 36 respondents with overseas factories considered the availability of international transport services as an important decision-making factor. However, as the questionnaire moved to the question, ‘*In selecting the city for the establishment of a new factory, would you consider the availability of international transport services in that city?*’ There were 32 respondents out the 36 who took this consideration seriously. It seems that the availability of international transport service did not affect the decision making for international division of labor but it was an important factor for selecting factory sites. It has been found that today’s international freight transport network has been well-developed at the country/region level, but not every city has been well-linked/served.

If firms adopted a ‘postponement’ strategy in ‘time’ adjustment, the average transport time ranged from 1.6 to 3.5 days. See table 8. Therefore, we may conclude that if no fast transport service is available in a region, it would be impossible to ship products on time and the ‘postponement’ strategy could not be applied to supply chain adjustments.

According to the above analysis, the availability of transport services seemingly does not constitute a reason for firms to relocate manufacturing factories to other countries. But once the relocation decision is made, the availability of international freight transport services becomes an important decision-making factor in selecting the relocation cities. In ‘time’ adjustments for the supply chain, availability of fast transport services is a necessary condition for firms to adopt the ‘postponement’ strategy.

Therefore, the information from this survey offers partial support for Proposition 4. The results for space adjustments do not support Proposition 4. However, when manufacturers had decided to relocate their factories overseas, the transport services availability of each alternative site will be the evaluation criteria. Furthermore, when the factory applies the ‘postponement’ strategy, the Proposition is also supported.

Proposition 5: The transport cost will affect the firm’s supply chain adjustment.

From table 8, we found that the respondents’ supply chain adjustments affected the shipping time and mode choice, but transport cost was not a major consideration. Even the value of (transport costs/product sales prices) in the ‘maturity’ and ‘decline’ stages were higher than the value in the ‘introduction’ and ‘growth’ stages, the respondents in the stages of ‘maturity’ and ‘decline’ chose the faster but more expensive airfreight transport services. Therefore, this survey of IT firms does not support Proposition 5.

In addition, it recognizes that the response time in the supply chain is inversely proportional to the level of customer services, as shown in the upper part of figure 5. The lower part of the figure presents the relationship of transport speeds vs. response time with various distances ($Dist_1$, $Dist_2$, $Dist_3$) between the manufacturing factories and customer markets.

[Insert figure 5 about here.]

When a new product is first introduced to the market, the demand is low. Manufacturing and logistics operations stay on schedule. The response time to customers or retailers is not rushed. See Point A in figure 5, the response time t_1 will map the customer service level LOS_1 . The transport service provides speed v_1 delivers the products from manufacturer to the

customer/retailer ($Dist_1$) during period (t_1).

Moreover, as the PLC proceeds, firms adjust their supply chain in 'time', from 'speculation' strategies to 'postponement' strategy. In the meantime, the customer service requirements increased from Point A to C in the figure. In this case, the response time is shortened from t_1 to t_2 . If the distance $Dist_1$ remains unchanged, then a faster transport speed v_2 is needed.

No matter whether 'centralization' or 'diversification' is adopted in supply chain 'space' adjustments, the transport service has to increase its speed to v_3 due to the increased distance $Dist_2$ as long as the response time is unchanged. This is quite a common situation for firms seeking cost advantage input factors to relocate factories overseas. On the contrary, if the reason for factory relocation is to locate 'close to the customer market', then the distance between factory and customer/retailers is shorten from $Dist_1$ to $Dist_3$. For this case, to maintain the same response time t_2 , slower transport speed v_4 is satisfactory.

In general, the transport service requirements will change both when the supply chain adjusted in 'time' and 'space.' Especially, to resolve the incurred pressure caused by the response time, faster transport services are needed in order to deliver the products to the end customers and retailers on time.

The survey also finds that a lot of Taiwanese IT products are in the maturity stage of the life cycle. Many manufacturers conduct their business operations as 'original equipment manufacturer (OEM)'. In figure 5, the Taiwanese IT manufacturers mostly scatter around Point C. The firms always shorten the response time to enhance the level of customer services. In other words, faster transport services are applied to reach the above goals. 'Build to order (BTO)' is another most conventional business model for supply chain operation taken by the manufacturers. Therefore, Taiwanese IT firms have to improve their manufacturing technology as well as come up with fast and highly efficient logistics operations in order to meet the requirements of the global customers. This explains the phenomena of why Taiwanese firms, one after another, build up global logistics management systems.

5. Logistics operations of Taiwanese IT firms -- Acer's experiences

In order to explore the transport implications of the changes in supply chain adjustment, we utilized Acer's experience to describe a Taiwanese IT firm's globalized logistics development.

Because logistics strategies are dependent on a firm's supply chain operation, we divided Acer's logistics development into four stages in relation to changes in the supply chain. See figure 6 and 7. Before the late 1980s, during the first stage of Acer's logistics development, the company concentrated all its production activities at a single geographical location and served its world markets through traditional logistics network. At this stage, the main freight transport demand was from Taiwan to the market countries. Moreover, the value density -- the value of a product in relation to its weight and volume -- was low; as well as time was not considered to be a critical supply chain operation variable, leading to a large part of the finished products being transported by sea.

[Insert figure 6 about here.]

Since the 1990s, the second stage of Acer's logistics development, Acer adjusted its supply chain as factories were relocated to Mainland China and Southeast Asian countries to utilize cheaper and cost comparative factors. Materials, semi-finished products, components and finished products were transported to the geographically dispersed manufacturing factories. In this stage, the output of a primary manufacturing factory in one country may simply be the input for a sub-assembly factory of Acer located in another country. The semi-finished products may be transported back to Taiwan for final assembly, then re-export to foreign

markets. The increment of transport demand of semi-finished products ΔQ_1 , as illustrated in figure 7, was generated along with the process of supply chain operation.

[Insert figure 7 about here.]

In the third stage, each of Acer's offshore manufacturing factories performed an independent operation in the supply chain and ships output to a final assembly factory in Taiwan. After final assembly, the finished products were exported to the markets. Because the offshore factory was operated independently, the increment of transportation demand (ΔQ_2) was fully reflected in the freight flow from Mainland China and Southeast Asian countries to Taiwan.

But in recent years, the ability to respond to customers' requirements in ever-shortening time-frames has become critical, has lead Acer to further adjust their supply chain operation. All of the outputs from each offshore factory are shipped directly to the final assembly factories in locations near the marketplace. This is the fourth stage of Acer's logistics development, the physical flow of components and semi-finished products are not transported to Taiwan, freight flow between the offshore factory to the marketplace has increased and the freight flow to and from Taiwan has decreased ($-\Delta Q_3$). In the decision of modal choice, because the response time of IT industry operation has become shorter, air transport services demand is increasing and sea transport demand is decreasing.

Because all of the movements of materials, semi-finished products, components and finished-products determine the freight transport demand, the various stages of logistics development mentioned above will create different freight transport demands in terms of trip generation and distribution. In Acer's experience, the freight transport demand to and from Taiwan will indeed fluctuate according to the firm's international division of labor as well as the various supply chain adjustment strategies.

6. Conclusions and recommendations

Many traditional freight transport researches that implied the assumption of firms' manufacturing activities are concentrated at a single location cannot well-describe the supply chain operations of today's globalized manufacturing firms. Moreover, since the industries globalized and transport demand is a derived demand, the understanding of firms' supply chain adjustment will be the basic information of transport demand analysis. This paper compared supply chain adjustment practises at forty-five IT firms in Taiwan and investigated five Propositions.

As to Proposition 1, the survey indicates that Taiwanese IT firms are indeed involved in international collaboration. Firms actually diversify and adjust their manufacturing activities in their supply chains with respect to space factors. There are also quite a few manufacturers who have established offshore factories for cheaper, cost advantage production input factors. Since this study used only the respondents' main reason as the analytic basis for offshore relocation, some information may be missing as a result of problem simplification. However, the main purpose of this proposition in this study was to find the reasons for supply chain "space" adjustment, the simplified analysis still provides material to achieve the goal of the research.

Proposition 2A and 2B are supported. The firms apply different supply chain adjustments to the products according to their PLC. Basically the supply chain adjustments in 'space' do appear according to the stages of the PLC. The adjustments in space migrate from domestic 'centralization' to 'diversification' at various sites. As to the adjustments in 'time', there are four basic types, which correspond to the various stages of the PLC. Regarding the PLC, we are aware that it is a more or less subjective judgement for respondents to identify at what

stage of the life cycle their products are positioned. However, this study concentrates on clarifying if the decisions directed at the supply chain adjustment were related to the various PLC stages. From the results of the survey, we found that the analysis allows for exploration of the firms' decision-making information to clarify the propositions.

Proposition 3 for supply chain adjustments that affect freight transport origin/destination and modal choice is supported. The supply chain adjustments in 'space' will actually affect the transport demand between origin and destination. In the meantime, if the postponement strategy is adopted, faster transport services will be needed.

Proposition 4 contains two layers. Not until the firms decide to undergo the adjustments in 'space,' does this proposition find support. However, once the firms decide on foreign investment, the international freight transport service availability becomes one of the considering factors for factory offshore relocation. Additionally, when firms apply 'postponement' strategies, this proposition is also supported.

Finally, this study found that the transport cost was not a major consideration for the respondents' supply chain adjustments.

In general, this study discovered that the concepts of centralization/diversification in 'space' and postponement/speculation in 'time' do exist in the supply chain adjustments of the IT manufacturing industry. The adjustment strategies of global supply chain will affect a firm's modal choice, and that the space diversification will affect the trip generation and distribution. How to establish the quantitative model for supply chain adjustment and freight transport demand would be an interesting focus for future research.

The 'OEM' and 'BTO' business models are popular among many Taiwanese IT manufacturers. Most of the products manufactured under these models have entered into the maturity life cycles. Firms not only have to lower the manufacturing costs, but also have to enhance the transport efficiency to satisfy the level of service. Any product steps in the maturity or decline stages will more rely on faster transport services when the manufacturing locations diversify. If the 'postponement' strategy is applied, the turnaround time gets shorter once the order is received. Fast transport services will be necessary to meet the supply chain operations. In terms of the influences that the supply chain adjustments have on the transport demand, the diversification in 'space' will lower the total quantity in freight transport in the host country. The postponement strategy will increase the demand for faster transport services.

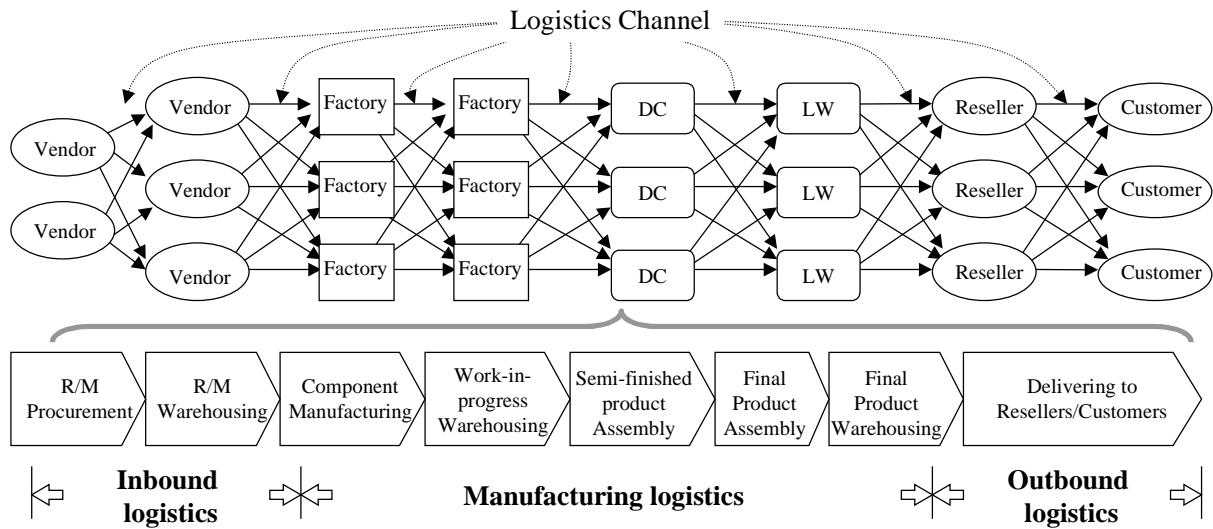
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Notes: DC=Distribution Center, LW=Local Warehouse, R/M=Raw Materials

Figure 1 Supply Chain of Manufacturing Industry

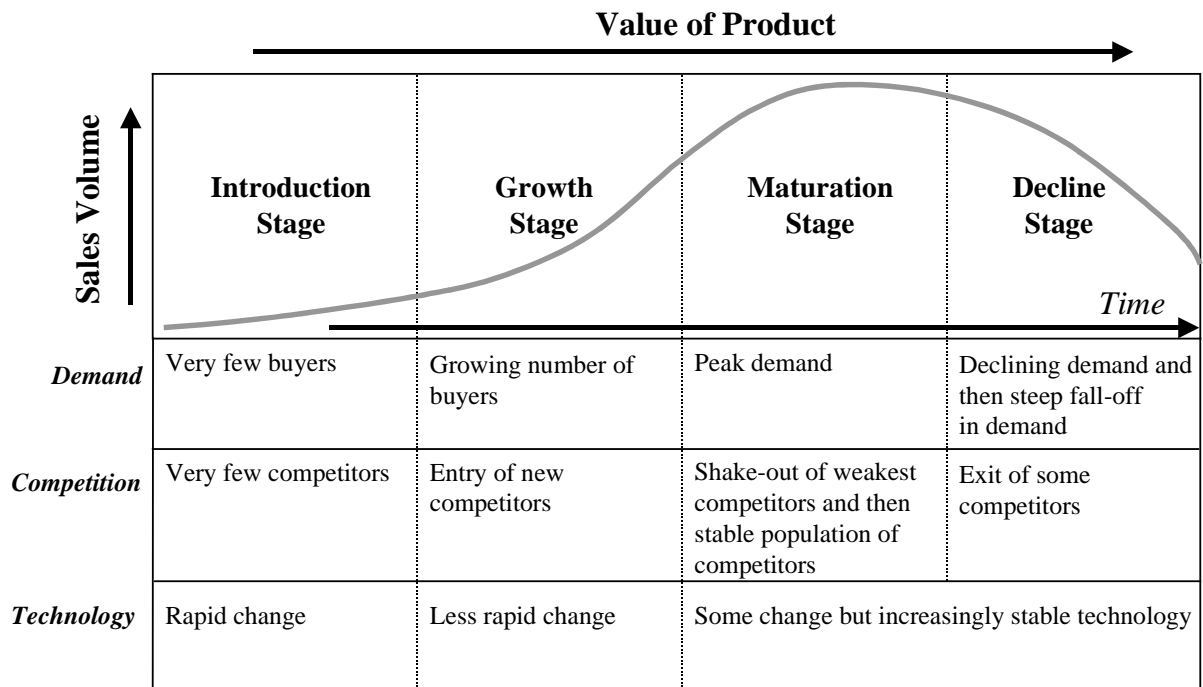


Figure 2 Profile of product life cycle.

Source: (Dicken, 1992).

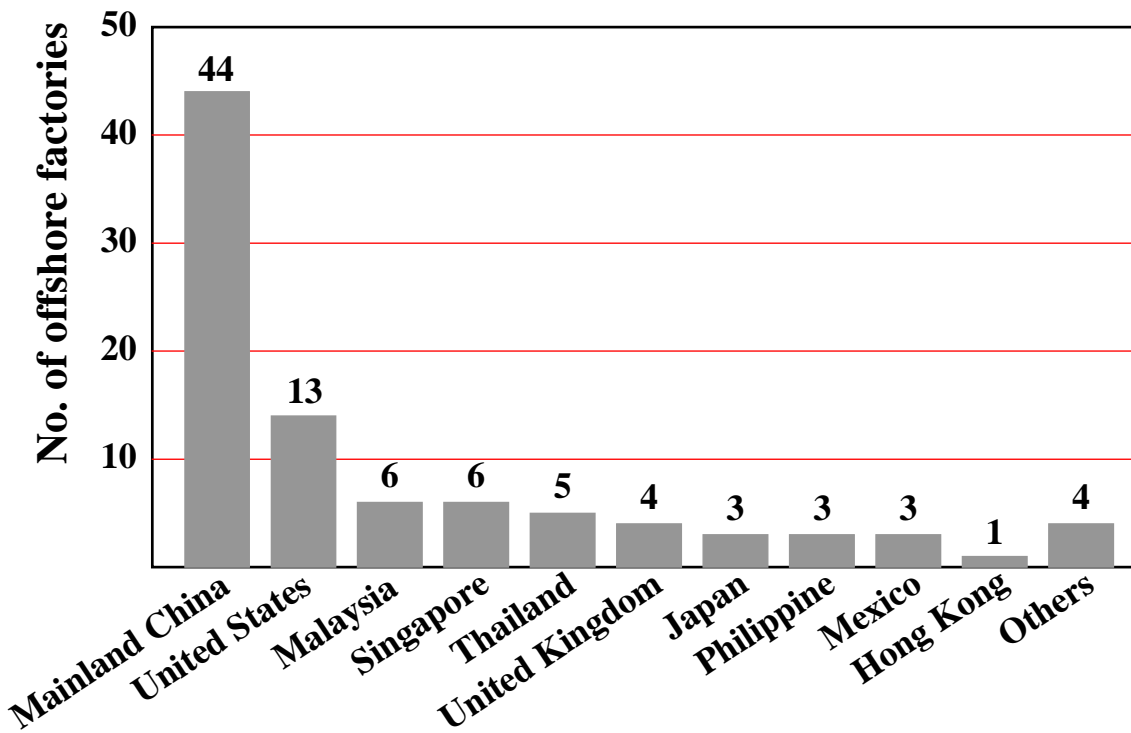


Figure 3 The distribution of surveyed IT firms' foreign investment.

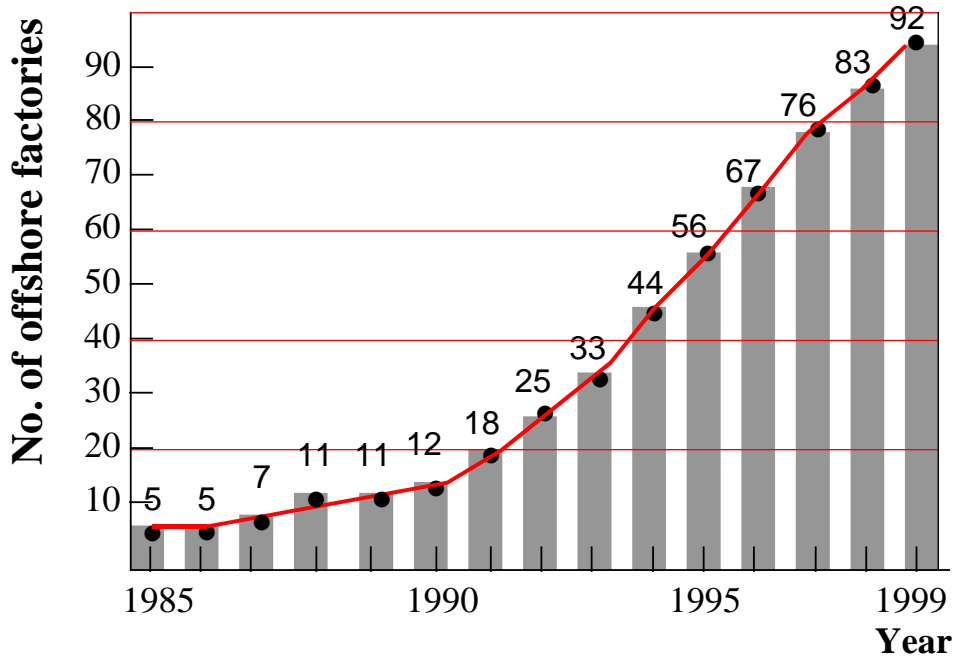


Figure 4 The trend of foreign investment.

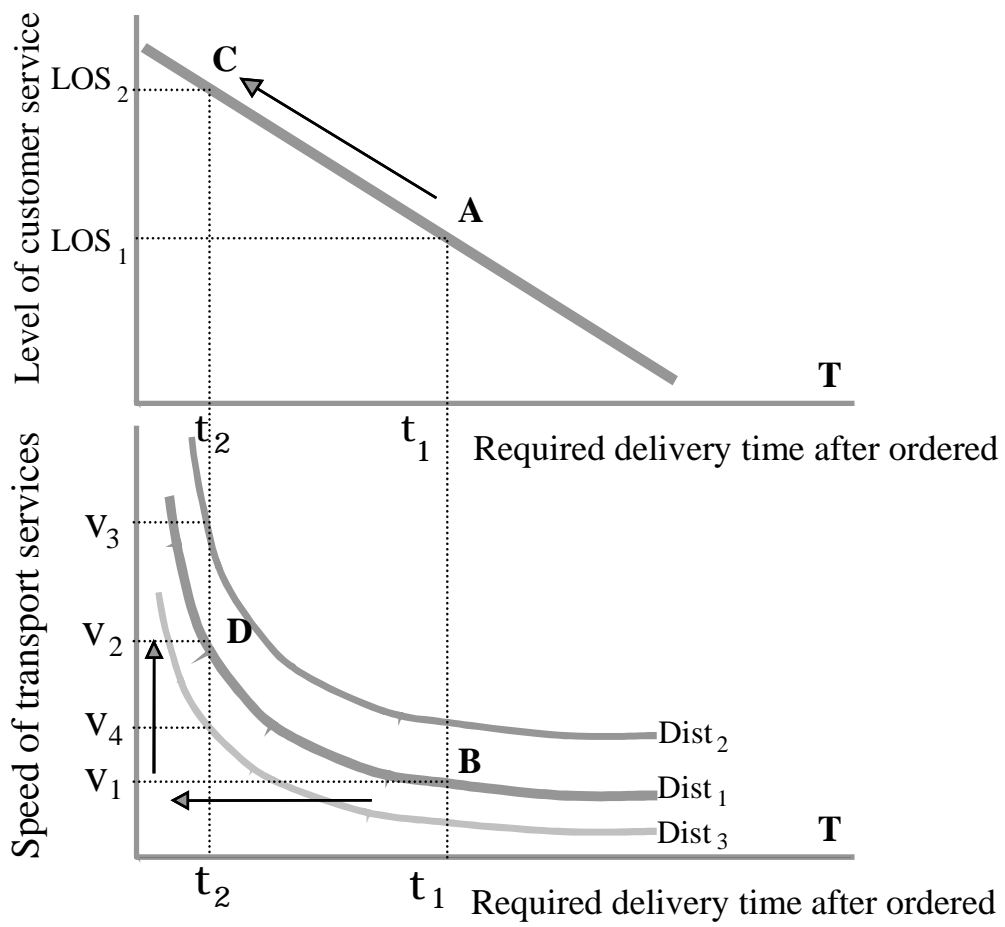


Figure 5 The relationships among response time, transport speed and level of service.

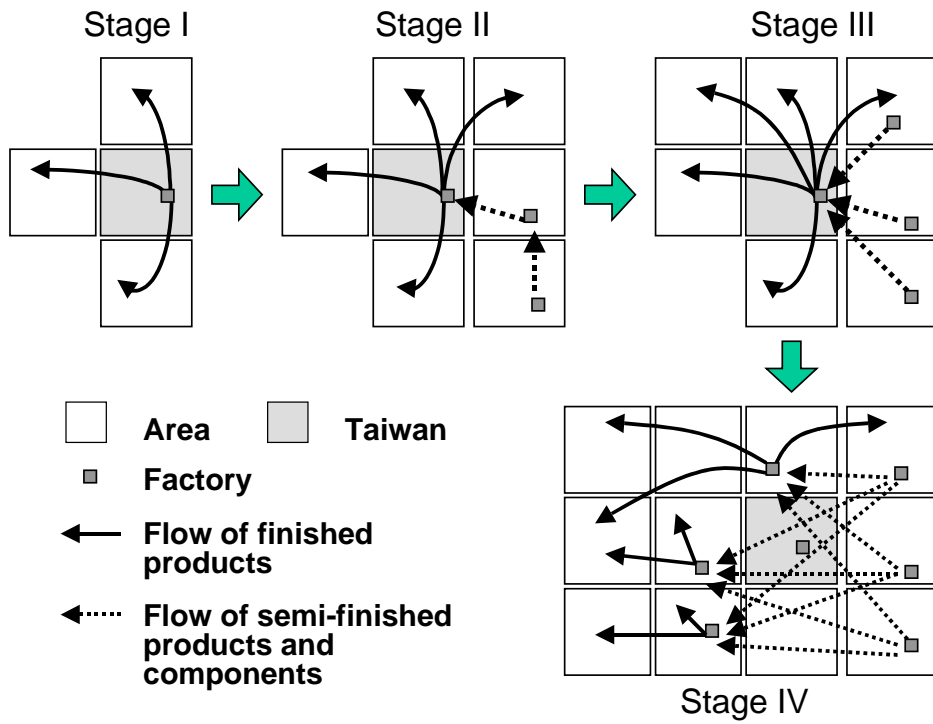


Figure 6 Acer's global logistics development.

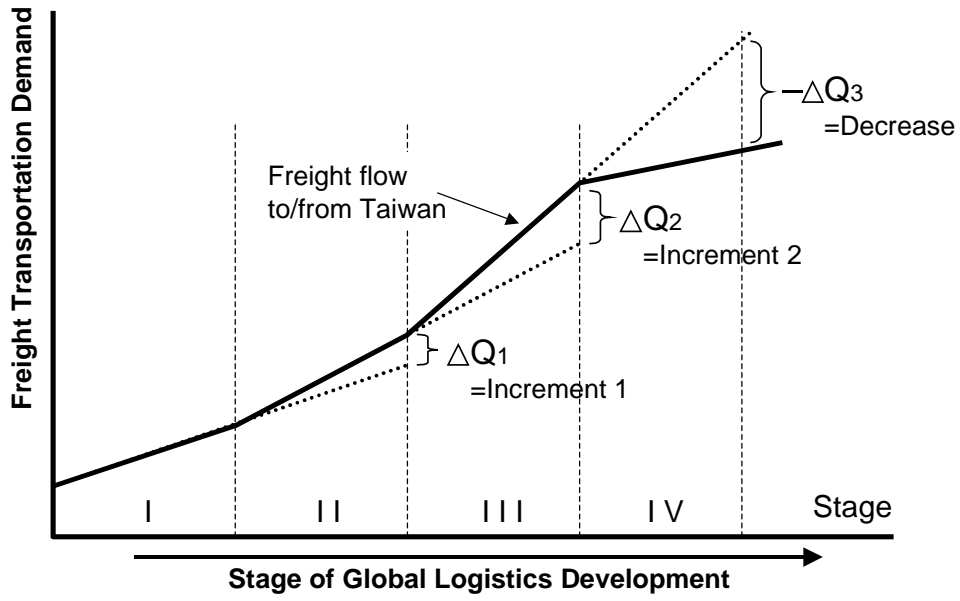


Figure 7 Acer's logistics development and freight transport demand to and from Taiwan.

Table 1 The manufacturing product structures (by production values)

Unit: %

Year	Information technology	Chemical	Metal	Consuming Industrial	Total
1989	17.9	29.4	24.4	28.3	100.0
1990	18.6	29.0	25.0	27.4	100.0
1991	19.0	28.4	25.7	26.8	100.0
1992	19.2	28.2	26.8	25.8	100.0
1993	20.3	28.2	27.0	24.5	100.0
1994	21.7	28.6	26.5	23.2	100.0
1995	24.1	28.4	26.1	21.4	100.0
1996	25.2	29.1	25.3	20.4	100.0
1997	27.6	28.1	25.7	18.7	100.0
1998	30.3	27.3	24.9	17.5	100.0

Source: Directorate-General of Budget, Accounting and Statistics, 2000.

Table 2 Positions of Surveyed Respondents

Title of the Position	No. of Respondents		Responsibility for logistics operation			
		%	Yes	%	No	%
Top Management	1	2 %	0	0 %	1	2 %
Senior Management	4	9 %	3	7 %	1	2 %
Department Managers	25	55 %	20	44 %	5	11 %
Supervisors & Engineers	12	27 %	12	27 %	0	0 %
Others	3	7 %	0	0 %	3	7 %
Total	45	100 %	35	78 %	10	22 %

Source: The survey in this study.

Table 3 Questionnaire Survey Response Profile

Annual Sales (million USD)	No. of Respondents	(%)
Less than 500 million	31	69 %
\$501 million – 1 billion	7	16 %
\$1 – 1.5 billion	5	11 %
\$1.5 – 2.0 billion	1	2 %
Greater than \$2 billion	1	2 %
Total	45	100.00

Source: The survey in this study.

Table 4 Reasons for Offshore Relocation

Reasons	No. of respondents	%
Cheaper labor cost	41	45 %
Proximity of customer markets	22	24 %
Lower land cost	15	16 %
Easier to access new technologies	6	7 %
Skilled labor availability	3	3 %
Lower tax/tariff	3	3 %
Other	2	2 %
Total	92	100 %

Note: Only the most major reason is considered for each offshore factory.

Source: The survey in this study.

Table 5 The interrelationship analysis on the location selections, investment reasons and product characteristics for offshore factories

Reasons	Unit: factory										
	Mainland China	Thailand	Philippines	Malaysia	Singapore	Mexico	UK	Japan	USA	Hong Kong	Others
Cheaper labor cost	29	4	3	5	---	---	---	---	---	---	---
Lower land cost	13	2	---	---	---	---	---	---	---	---	---
Lower tax/tariff	2	---	---	1	---	---	---	---	---	---	---
Easier to access new technologies	---	---	---	---	1	---	---	2	3	---	---
Skilled labor availability	---	---	---	---	1	---	1	---	1	---	---
Proximity of customer markets	---	---	---	---	4	3	3	1	7	1	3
Others	---	---	---	---	---	---	---	---	2	---	---
Total	44	6	3	6	6	3	4	3	13	1	3
Unit: No. of offshore factories											
Introduction	0	0	0	0	1	0	0	1	1	0	1
Growth	1	0	0	0	4	0	2	2	10	1	2
Maturity	21	3	1	2	1	2	2	0	2	0	1
Decline	22	3	2	4	0	1	0	0	0	0	0

Source: The survey in this study.

Table 6 Analysis on product life cycle stage and supply chain adjustments in ‘space’.

Unit: No. of products

Stage of product life cycle	Introduction	Growth	Maturity	Decline	Total
No. of products	2	19	35	9	65
<i>Made fully in Taiwan</i>	1	15	9	2	27
(%)	50%	79%	26%	22%	---
<i>Partial or fully made in offshore factories</i>	1	4	26	7	38
(%)	50%	21%	74%	78%	---

Source: The survey of this study

Table 7 Analysis on product development and supply chain adjustment strategies in ‘time’

Unit: No. of products

Stage of product life cycle	Introduction	Growth	Maturity	Decline	Total
No. of products	2	19	35	9	65
Manufacturing Strategy					
Speculation	2	12	25	2	---
No action	0	6	8	1	---
Postponement	0	1	2	6	---
Logistics Strategy					
Speculation	2	7	4	0	---
No action	0	9	5	2	---
Postponement	0	3	26	7	---
<i>Made fully in Taiwan</i>	1	15	9	2	28
Manufacturing Strategy					
Speculation	1	9	7	1	---
No action	0	5	1	0	---
Postponement	0	1	1	1	---
Logistics Strategy					
Speculation	1	4	1	0	---
No action	0	8	1	0	---
Postponement	0	3	7	2	---
<i>Partial or fully made in offshore factories</i>	1	4	26	7	37
Manufacturing Strategy					
Speculation	1	3	18	1	---
No action	0	1	7	1	---
Postponement	0	0	1	5	---
Logistics Strategy					
Speculation	1	3	3	0	---
No action	0	1	3	2	---
Postponement	0	0	19	5	---

Source: The survey of this study.

Table 8 Statistics on transport service demand vs. product development

Stage of product life cycle	MS	LS	Location of Factory	No. of samples (product)	Required Delivery time after ordered	Final assembly time after ordered	Average transport time	Mode Choice		No. of products in each group of transport cost/sales price*				
					(day)	(day)	(day)	Air %	Sea %	I	II	III	IV	V
Introduction	S	S	Taiwan	1	8.5	1.0	7.5	100.0%	0.0%	1	0	0	0	0
			Offshore	1	8.2	1.0	7.2	0.0%	100.0%	1	0	0	0	0
Growth	S	S	Taiwan	15	6.9	1.2	5.7	80.0%	20.0%	8	5	2	0	0
			Offshore	4	7.5	1.6	5.9	75.0%	25.0%	3	0	1	0	0
Maturation	S	P	Taiwan	9	4.9	1.3	3.6	89.9%	11.1%	2	3	2	1	1
			Offshore	26	5.1	1.6	3.5	96.2%	3.8%	4	4	8	8	2
Decline	P	P	Taiwan	2	5.3	3.7	1.6	100.0%	0.0%	0	0	1	0	1
			Offshore	7	5.4	3.6	1.8	100.0%	0.0%	0	0	1	4	2

Notes: MS = Manufacturing strategy, LS = Logistics strategy, S = Speculation, P = Postponement.

* I: Unit transport cost / product sale price ≤ 0.01 ; II: $0.01 < \text{Unit transport cost} / \text{product sale price} \leq 0.05$; III: $0.05 < \text{Unit transport cost} / \text{product sale price} \leq 0.10$; IV: $0.10 < \text{Unit transport cost} / \text{product sale price} \leq 0.15$; V: $0.15 < \text{Unit transport cost} / \text{product sale price}$.

Source: The survey in this study.