以複雜適應系統理論與資訊科技觀點研究供應鏈的演化現象

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摘　　要

在供應鏈管理的研究中，有很多的理論觀點可以用來探討供應鏈的演化，而其中，複雜適應系統理論是最適合，也是最近常被用來研究供應鏈演化的理論，故本研究想引用複雜適應系統理論觀點，來理解供應鏈網絡的演化現象。以複雜適應系統理論觀點來研究供應鏈演化的過程，發現資訊科技可以催化、形成供應鏈的演化，促成供應鏈成員之間的互動與決策改變，並產生新的結構關係。實際上，促進供應鏈網絡演化的動力，由外緣與內因交互作用所組成，而資訊科技的介入，可視為關鍵性的外部因素。當供應鏈網絡的整體績效改善，則表示供應鏈已成功地演化。

從複雜適應系統理論與資訊科技觀點來研究供應鏈網路的演化現象，本文提出了四個理論性命題。命題一假設供應鏈網絡的演化力量由外緣與內因交互作用產生；演化的流程視為這些力量重複出現的結果；假設這個演化可提升網絡成員的績效，表示已演化成功。命題二主張資訊科技的介入，可視為外緣，將增加供應鏈網絡中的交易數量；然而，命題三假設資訊科技的引用，將使交易價格及其波動性降低，定價更加透明化，且具有長期均衡的現象。最後，命題四主張資訊科技的介入，將使作業效率提升，浪費性損失降低。

本文以台灣切花供應鏈為研究的個案，來實證供應鏈網絡演化的理論性命題。以

宏觀研究的觀點，基於縱斷面的個案分析方法，評估供應鏈的演化現象，將整個演化的流程劃分為三個階段，即供應商驅動（階段一）、零售商驅動（階段二）與電子系統驅動（階段三）等階段，以便探討促成供應鏈網絡演化的相關因素。在每一個演化的階段中，我們可以觀察到不同成員的形態與行為。這些宏觀研究的初級資料，可以從深度訪談與內部文件資料取得。

接著本文以微觀研究的觀點來證明供應鏈網絡演化的成果，檢驗不同演化階段績效的改變，來印證資訊科技的效力。這些微觀研究的時間序列資料，可從「批發資訊分享熱線」資訊系統來蒐集，進而證明本文的理論性命題二、三與四。

根據本文實證的結果，從階段一演化至階段二，資訊科技的介入可視為外部因素，促使荷蘭式拍賣機制的建立，催促台灣切花供應鏈網絡的成員、決策路徑與其相互關聯產生演化性的改變，例如：四家拍賣市場成立、拍賣作業與交易的整合等。供應鏈演化的成果為切花市場的快速成長，以上的分析結果支持本文的命題一與二。從階段二演化至階段三，資訊科技驅動「批發資訊分享熱線」系統的建置，催化台灣切花供應鏈網絡的改變，例如：資訊的整合、供應商編號的彙整、需求管理與調撥作業的協調等。演化的成果為價格透明化與穩定性、減少浪費性損失等，以上分析結果可支持本文的理論性命題一、三與四。

在整個供應鏈的演化過程中，管理者應該以達到整體供應鏈網絡最佳化為管理重點，並作為最適決策的依據。一方面，能快速回應環境的改變，修正網絡內的目標與策略來因應這個改變；另一方面，最適資訊科技的引入，可以幫助供應鏈的演化，進而提升網絡成員的績效。

關鍵詞：供應鏈管理、複雜適應系統、供應鏈演化、資訊科技、績效

An Analysis of Evolutionary Phenomena of Supply Chain Networks from the Perspective of Complex Adaptive Systems and Information Technology

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ABSTRACT

A ‘supply chain network’ (SCN) can be seen as falling within the confines of ‘complex adaptive systems’ (CAS) theory, in which the observable patterns, or forces, that exist are essentially attributable to the interplay between the SCN and its environment; in the present study, we set out to investigate the evolution of SCNs within a dynamic environment. The forces facilitating the evolution of supply chains comprise of the interactions between external conditions and internal factors, with the adoption of information technology (IT) within an SCN representing a critical external condition. Ultimately, the evolution of a supply chain can only be successfully achieved if there is continuing significant improvement in the overall performance of the SCN.

Four propositions are developed in this study from a perspective of CAS and IT. Proposition 1 posits that the evolutionary forces of an SCN comprise of the interactions between external conditions and internal factors, with the evolutionary process being seen as a repetitive sequence of these forces, and evolution only being successful if it brings about an increase in the degree of ‘fit’ (hereafter, ‘fitness’) for network agents. Proposition

2 argues that the adoption of IT, as an external condition, will lead to a rise in transaction quantity, whilst Proposition 3 posits that with the adoption of IT, there will be a reduction in both prices and price volatility, along with greater visibility of pricing and long-run pricing equilibrium. Finally, Proposition 4 argues that with the adoption of IT there will be an increase in operational efficiency and a corresponding reduction in wastage losses.

This study incorporates a case study involving the cut-flower supply chains in Taiwan; our investigation of the cut-flower industry is undertaken as the means of critically examining our propositions on the evolution of SCNs. Our case study investigation essentially examines the evolutionary phenomena from a macro-study perspective based upon a longitudinal approach, with the evolutionary process being divided into the three stages of 'supplier-driven', 'retailer-driven' and 'e-system-driven' evolution in order to explore the forces facilitating such evolution. Within each evolutionary stage, we can observe the patterns and behavior of the various agents within the supply chain. The primary data for our macro-study perspective are obtained from in-depth interviews and in-house documents.

We then go on to confirm the evolutionary outcomes from a micro-study perspective examining the changes in performances between the 'supplier-driven' stage (Stage 1) and the 'retailer-driven' stage (Stage 2), and between the 'retailer-driven' stage and the 'e-system-driven' stage (Stage 3), through our empirical analyses of the effectiveness of IT. Time-series data, collected from the 'Wholesale Information Sharing Hotline' (WISH) system are adopted to support our propositions in this study.

Our results reveal that between Stages 1 and 2, IT intervention, as an external condition, led to the introduction of the Dutch auction mechanism triggering changes in agents, decision rules and connectivity, such as the foundation of four auction houses and the integration of operations and transactions. The evolutionary outcome was soaring

growth in the cut-flower market, as posited in Propositions 1 and 2. Between Stages 2 and 3, with IT driving the establishment of the WISH system, the changes amongst the various agents included the integration of information and coding systems, and the coordination of operations through demand management and transshipment systems. The evolutionary outcomes were price visibility and stability and a reduction in wastage losses, thereby providing support for Propositions 1, 3 and 4.

During the overall process of supply chain evolution, the idea of managing the whole SCN to achieve global optimization provides an engaging vision and a certain requirement for appropriate decision-making by managers. On the one hand, managers need to be able to respond rapidly to the changing environments and adapt to such changes by modifying the objectives and strategies within the SCN. On the other hand, the adoption of appropriate IT can assist in the achievement of supply chain evolution to further increase the 'fitness' of the agents.

Keywords: Supply chain management; Complex adaptive systems; Supply chain evolution; Information technology; Performance.

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