Available online at www.sciencedirect.com
ScienceDirect
Expert Systems with Applications 35 (2008) 1998–2016
Expert Systems with Applications
www.elsevier.com/locate/eswa

Leveraging the supply chain flexibility of third party logistics – Hybrid knowledge-based system approach

K.L. Choy [a,*], Harry K.H. Chow [a,1], K.H. Tan [b,2], Chi-Kin Chan [c,3], Esmond C.M. Mok [d,4], Q. Wang [a,5]

[a] Department of Industrial and Systems Engineering, Hong Kong Polytechnic University, Hung Hom, Hong Kong
[b] Nottingham University Business School, Jubilee Campus, Nottingham NG8 1GL, United Kingdom
[c] Department of Applied Mathematics, Hong Kong Polytechnic University, Hung Hom, Hong Kong
[d] Department of Land Surveying & Geo-Informatics, Hong Kong Polytechnic University, Hung Hom, Hong Kong

Abstract

Nowadays, intensified globalization and consequent competitive pressures have reemphasized the importance of third party logistics (3PL) in managing logistics processes as well as customer and supplier relationships within the supply chain management (SCM). However, 3PL providers and their upstream and downstream parties within the whole chain have usually interacted as disconnected entities in the logistics performance management process. Despite the increased interest in using and improving logistics information systems, the number of researchers investigating the design and implementation of this process in close detail is still very small. This paper proposes an intelligent performance measurement system (K-LPMS) for measuring the performance of 3PL providers and their upstream and downstream supply chain partners. With the help of K-LPMS, 3PL providers are capable to fulfil different customer's supply chain service requirement through accessing the capability of each SC partners and reconfigure SC network. This paper describes the structure of K-LPMS and its features. The results of testing and applying the tool in companies are presented. This paper concludes by discussing the implications of this research for managers, and identifying directions for future research.

Keywords: Supply chain flexibility; Supply chain management; 3PL; Knowledge-based system; Operations management

1. Introduction

With the globalization of businesses and the consequent competitive pressures, there has been an increasing dependence on the ability of companies to deliver customer-adapted products, all over the world, quickly and on time (Sohail & Sohal, 2003). The pressures for quick response and customer orientation have driven many companies to concentrate their energies on core competences that are critical to survival. Instead of being stuck in the high cost and unsatisfactory result of managing logistics operation by themselves, many companies choose to outsource some or all of their logistics activities to specialist firms. Therefore, a third party logistics (3PL) business is emerging and developing rapidly to fulfil the demands for advanced logistics services, in such fields as, transportation, warehousing, freight consolidation and distribution, product marking, labeling and packaging, inventory management, cross docking, product returns, order management, and logistics information systems (Rabinovich, Windle, Dresner, & Corsi, 1999).

* Corresponding author. Tel.: +852 27666597; fax: +852 23625267.
E-mail addresses: mfklchoy@inet.polyu.edu.hk (K.L. Choy), 04900171r@polyu.edu.hk (H.K.H. Chow), kim.tan@nottingham.ac.hk (K.H. Tan), machanck@polyu.edu.hk (C.-K. Chan), lsemok@polyu.edu.hk (E.C.M. Mok), tracy.wang@inet.polyu.edu.hk (Q. Wang).
[1] Tel.: +852 27666597; fax: +852 23625267.
[2] Tel.: +44 115 8467749; fax: +44 115 8466341.
[3] Tel.: +852 26777928; fax: +852 23629045.
[4] Tel.: +852 27665953; fax: +852 23302994.
[5] Tel.: +852 34003247; fax: +852 23625267.

0957-4174/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.eswa.2007.08.084

Many executives in the leading companies believe that the key advantage of an efficient supply chain (SC) is that competitiveness and profitability can increase, if internal key activities and business process are linked and managed across multiple firms (Serve, Yen, Wang, & Lin, 2002). Such an objective can only be achieved by an independent organization which interacts with all the partners in the whole chain. In the current environment of dynamic, changing customer preferences, and disruptive technological shifts, the network of SC is frequently restructured to respond such environmental changes. Thus, SC is a dynamic network that is being reconfigured continuously in terms of integrating new partners and re-organizing the networking of current operations in order to achieve the creation of value. In this current SC operations environment, 3PL has taken on the major responsibility of supporting the flexibility of customers' SC networks. 3PL does not solely concentrate on their own internal operations, but closely cooperates with their customer's SC partners such as manufacturers, suppliers and subcontracted logistics service providers (LSP), within the chain. Nevertheless, the frequent reconfiguration of customer's SC network has created a new challenge for 3PL in the context of performance management. During the reconfiguration of the SC network, 3PL needs to change or redesign existing logistics operations modes including the selection of new sub-contracted LSPs. Hence, a new set of performance measures to suit the new SC network scenario and for selecting appropriate sub-contracted LSPs is needed. On the other hand, due to indirect contact with suppliers, customers increasingly rely on 3PL to manage the whole logistics flow and the performance of multiple suppliers since their performance is directly affecting the efficiency of the SC. This illustrates the importance of performance measurement (PM) for 3PL and shows its impact on SC flexibility. This impact comes about because 3PL relies on performance measuring information to allocate resources and to manage the SC partners within the chain. Usually, decisions regarding this are made by senior logistics mangers relying on their experience, know-how and knowledge. Human decision making is based on personal preferences, choices and personal satisfaction and hence contains an element of bias. In order to improve the quality of decision making, this paper proposes a knowledge-based logistics performance measurement system (K-LPMS) to support logistics managers with the provision of the most satisfactory results during the selection of sub-contracted LSP and the formulation of performance indicators during the configuration of the SC network.

The proposed K-LPMS is a hybrid integration of knowledge processing modules: case-based reasoning (CBR) for retrieving past cases where performance indicators have been set; and a mathematical algorithm for calculating the capability value of sub-contracted LSPs and customers' suppliers. This capability value is information for 3PLs which is useful for reconfiguring the SC operations. The salient features of the system are its ability to: (a) enable logistics managers to visualise the complex measurement of relationships in the SC network; (b) allow logistics managers to measure and manage relationships between sub-contracted LSPs; (c) examine the impact of flexibility on values within the reconfigured SC network; and (d) allow information to be passed, assessed and quantified, so that knowledge gained from the measurement could be used to improve performance. In the following sections, literature on 3PL and PM approaches are reviewed. Then, the development of the knowledge-based system is explained. The results obtained from its application are then described. After that, the implications of this research to industrialists and academics are discussed.

2. Review of related studies

2.1. Supply chain flexibility (SCF)

Today, many large global enterprises such as Wal-Mart, Toyota and Dell have exploited their supply chain management skills as important competitive weapons (Hult, Ketchen, & Slater, 2004). Supply chain management (SCM) is a holistic approach to the effective management of the interface between all the organizations involved, entailing the integration of both upstream and downstream processes (Christopher & Juttner, 2000; Harland, Lamming, & Cousins, 1999). It appears to treat all organizations within the value chain as a unified "virtual business entity". Hence, SCM focuses on how organizations utilize their partner's processes, technology, and capability to enhance competitive advantages (Farley, 1997). When all organizations in the value chain 'integrate' and act together, performance is enhanced through the cooperation and coordination of films. In recent years, severe SC disruptions have created a new appreciation of supply chain flexibility (SCF). In the face of disruption, the SC process needs to be dynamically reconfigured so that different SC players remain in sync (Gosain, Malhotra, & Elsawy, 2004). The following cases are examples of failure of SC operations to lack of flexibility:

Case 1: Ford Motor Company had to close five plants in North America due to part shortages (Mello, 2001).

Case 2: A decrease in quarterly earnings in 1996 of $900 million for General Motors was due to an 18-day labour strike at a brake supplier factory that idled workers at 26 assembly plants.

Case 3: Boeing's $2.6 billion loss in 1997 was due to the failure of two key suppliers to deliver critical parts on time.

Case 4: During 2000, Sony's console shipment in US was 50% less than planned due to a shortage of PlayStation2 graphic chips.

Case 5: Ericsson's loss of three market-share points against Nokia in 2000, and being forced to exit the handset market was due to disruption in the