# 應用模糊認知圖探索第三方物流業者營運動態變化

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## 摘要

近來台灣的電子零售業者如雅虎購物中心、PayEasy 等已經逐漸和便利商店通路和第三方物流業者建構出讓消費者可以「在網路上購物，到便利商店取貨」一套商業服務模式(又名店配模式)。而這樣子的商業服務模式在台灣也漸漸蔚為風行。

在第三方物流業者與電子零售商合作的過程中，本研究發現電子零售商握有較多的籌碼，具有較大的議價能力，使得與其合作的第三方物流業者必須常常根據電子零售商的需求而做經營上的動態調控，在這樣雙方略顯不平等的合作之下，使得第三方物流業者經營上面臨一些挑戰。

因此，本研究運用模糊認知圖對第三方物流業者的經營動態變化做一探索性研究，並依此建構出符合該公司、產業情況的模糊認知圖，藉以觀察在某些關鍵參數的調控下，對整個系統認知圖所會產生的動態影響，並利於第三方物流業者往後經營之運用。以某第三方物流公司為例，本研究發現改善物流績效、與電子零售業者的關係與固定資產規模能夠帶給第三方物流業者顯著的正面效益，此外也能或多或少消抹一些電子零售業者所帶來的負面影響。除此之外，改善物流績效等背後的長(短)期效益也於研究中探討。

**關鍵字：**電子商務、電子零售、店配模式、第三方物流業者、模糊認知圖

# A Fuzzy Cognitive Map Modeling to Explore Operation Dynamics of Third-party Logistics Providers

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## Abstract

In Taiwan, e-tailers have formed partnership with third-party logistics providers *(3PLs)* and convenience stores so that the service of shopping on-line in an electronic store and picking up goods at a convenience store could be quite common and popular these days. This study observes that the e-tailers have more bargaining power at its disposal comparing to its counterparts in partnership：3PLs. Therefore, the initiative from how 3PLs operate their business should rest more on the dynamics of e-tailers, and inevitably, this could have detrimental effects on their own business operation. For that reason, the study applies the methodology “Fuzzy cognitive maps” to model and explore the operation dynamics for 3PLs. The system model that has been developed can be used to study the effects of any parameter change on the stability and growth of the remaining parameters. Different scenarios are implemented, observed, and appraised. The results show that the improvement of “Relationship with e-tailers”, “Logistics performance”, and “Unfitting size of fixed assets” could significantly facilitate 3PLs expanding the market shares, total profits and somewhat mitigating the problems 3PLs encounter. The effectiveness level behind the improvement is also addressed.

**Keywords**: e-commerce, e-retailing, third-party logistics providers *(3PLs)*, fuzzy cognitive maps (FCM)

# 誌謝

研究所的這兩年，對我來說是個充滿快樂與溫馨的時光。我要感謝身邊的親朋好友，讓我可以在煩惱時大吐苦水、在歡愉時放聲狂笑。我之所以能順利完成這篇論文、在書桌前撰寫這段誌謝，完全都要歸功於「你們」–讓我研究所生涯更趨完整的你們。

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現在是凌晨三點鐘，我的瞌睡蟲反常地沒來打擾我，我想這是因為我正透過研究所的通訊錄和照片來品嘗我和同學們的過去。這些過去就像讓我睡意全消的興奮劑，這些過去一點一滴侵蝕我在這時刻該有的睡意，我看到照片中大家開心的笑容，也勾起我和大家在一起的記憶。感謝各位同學帶給我的上進，我們曾一起念書考試、一起寫論文；感謝各位同學帶給我的墮落，我們曾一起出遊、一起玩通宵；感謝各位同學帶給我的苦辣，我們可能生過彼此悶氣、偷偷埋怨彼此；感謝各位同學帶給我的深刻回憶，我想有你們在，這些上進、墮落和苦辣都是烙印內心的深刻的回憶。

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林律友 謹記

己丑年仲夏

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# Chapter 1 Introduction

## 1.1. Research Background

Digital technology has invited tremendous changes to our society through intensive interaction with the Internet. It is the Internet that gives birth to e-commerce. In general, e-commerce implies the buying and selling of products or services over electronic systems such as the Internet and other computer networks. The definition could be referred to Grandon and Pearson (2004) ”the process of buying and selling products or services using electronic data transmission via the Internet and the www.”

Nowadays, e-commerce becomes an increasingly fast growing business and establishes a brand-new channel between sellers and buyers. Since the considerable growth of the e-commerce, electronic stores have emerged as a popular retail channel. Buyers can surf on the Internet browsing any information with few limitations while for sellers, the electronic stores stand for a new channel to contact buyers. The sellers who primarily use Internet as a medium for consumers to shop for the goods or service provided are named as e-tailers. This new kind of business is far away from the traditional ones.

In Taiwan, many e-tailers have formed close partnership with widespread convenience stores in the area of retailing delivery system resulted from delivery difficulty, so that consumers can order the goods on websites and pick up their goods at the convenience store based on their preferred scheduling. Nowadays, over 1,200,000 transactions have been completed via electronic commerce through the retail delivery model per month*（Feng and Huang, 2006）*. The integration of e-commerce and logistics system of convenience stores is called “***E-commerce retailing delivery（RD） model***.” It provides consumers with shopping on-line service in an electronic store and picking

up goods at a convenience store.

In the e-commerce RD model, third-party logistics providers perform in roles of bridging the service functions of e-tailers *（retailers who sell goods via electronic transactions on the Internet）* and convenience stores. Services such as warehousing, packaging and transportation services that are not crucial to e-tailers, no longer needed to be managed exclusively by e-tailers, are outsourced to third-party logistics providers *（Hereafter referred to as **3PLs**）*. Thus, 3PLs are important middlemen connecting the dots between e-tailers and logistics systems of convenience stores. The roles within e-commerce RD model are showed in Fig. 1. E-tailers are mainly responsible for maintaining the shopping platform, promoting and selling commodities to the consumers while 3PLs are in charge of preserving, packaging and transporting the commodities for the cooperative e-tailers. The examples of renowned, sizable e-tailers in Taiwan are PayEasy and Yahoo, and their partners are Choice Logistics, Kyyo Logistics, etc. Their function is also described in the Fig. 1.

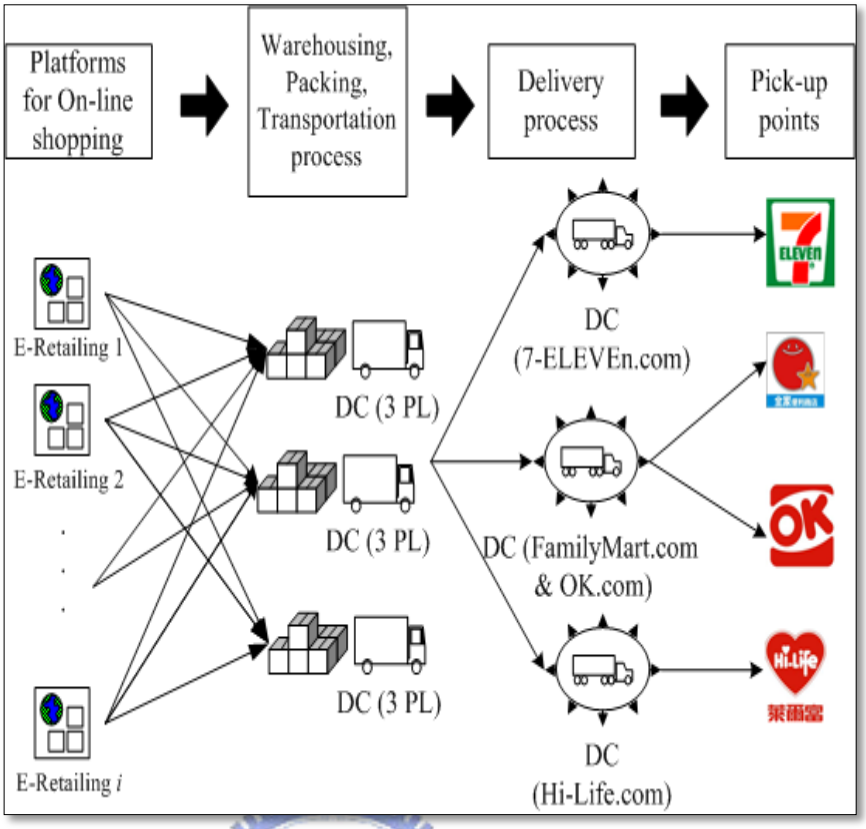


Fig. 1. The e-commerce retailing delivery model

More concretely, their cooperation mode is similar to the two departments in a company working together. One is e-tailers as a marketing department, and the other one is 3PLs as a logistics department. They've jointly built up the information system for transmitting the order data efficiently, and negotiated the transmission format and time to uphold the desired efficiency. Moreover, the interchange flows of information, goods, and cash between them are smooth and frequent without any hindrance. Like two departments in a company, they have meetings frequently for the purpose of communications and negotiations in pricing and services, performance reviews, and status as well as inventory check, etc. Hence, the close cooperation and relationship between the e-tailers and 3PLs are extremely effective as result.

Although with close relationship, the bargaining power is still unevenly tilted in e-tailers' favor. The strong e-tailers' bargaining power inevitably renders 3PLs some

undesirables. Hence, it is understandable that how the 3PLs operate their business may depend on not only their own *current statuses, threats from their competitors* but also, most importantly, *e-tailers' dynamic movements.* 3PLs need to respond to e-tailers and competitors' dynamic movement with dynamic counteractions. This would bring detrimental effects to 3PLs. Therefore, it's important for 3PLs within the e-commerce RD model to possess this insightful capability of understanding the *operation dynamics*.

## 1.2. Research Motivations

Because of the short development history and data collection difficulty, there have been very few studies about the dynamics of the roles within the e-commerce RD model. For this reason, it is worthwhile to *explore the critical concepts（or system variables, parameters）that lie in the operation dynamics of 3PLs, the strength of relationship among the concepts, and the possible amendments to the identified negative effects within the dynamic environment.*

Since the system of interest is dynamic, there are two well-known approaches to deal with the dynamic issues. One is "System Dynamics", and the other one is "Fuzzy Cognitive Maps."

**System dynamics** is an approach to understanding the behavior of complex systems over time. It deals with internal feedback loops and time delays that affect the behavior of the entire system. What makes using system dynamics different from other approaches to studying complex systems is the use of feedback loops, and stocks and flows. These elements help describe how even seemingly simple systems display baffling nonlinearity.

A **fuzzy cognitive map（FCM）** is a cognitive map within which the relations between the concepts can be used to compute the "strength of relationship" of these

elements. The theory behind the computation is fuzzy logic *（ Bart Kosko, 1986 ）*. Fuzzy cognitive maps are signed fuzzy digraphs. It helps demonstrate or simulate how experts deliberate upon a particular issue. In addition, it puts causal relationships in use and provides feedbacks.

It is well-known that the methodology "System dynamics" is a solution to the dynamic environment. However, the study applies "FCM" instead of "System Dynamics". The supporting reasons are:

1. The concepts need to be constructed and confirmed by experts because there are few academically-proved concepts that describes the e-commerce RD system;
2. Experts are supposed to be top management of e-tailers and 3PLs. The questionnaire and survey will be as straightforward as possible.
3. The proposed map may contain both quantitative and qualitative concepts, and FCM can tackle such problem.
4. The strength of relationships , between the system concepts are too vague to be transformed or represented by an equation.

Because there is no much research on it, the study is more like an exploratory research. Hence, in order to get to know the issues of interested, it may be more appropriate to apply FCM because of its fewer limitations in application, and it may help smooth away the potential research obstacles.

## 1.3. Research Objectives

Based on the research background and motivations, the objectives of this study are:

(1). To set up a third-party logistics provider-based fuzzy cognitive map.

(2). To acquire insight on how in different scenarios the critical concepts influence the entire system.

Through fuzzy cognitive maps, casual links among concepts will be demonstrated. It specifies the causal relationship among concepts and depicts the causal links, then, helps 3PLs to implement the strategies in a global and systematic view.

## 1.4. Research Procedure

In Chapter 1, this study defines research background, motivations, and research objectives. The remaining of this research content is arranged as follows: Chapter 2 describes e-commerce background and reviews related literature on e-commerce RD model, and methodology applied. Chapter 3 shows how the methodology processes. In Chapter 4, the study will analyze the output generated by FCM. In Chapter 5, conclusions as well as recommendations for future research will be discussed.

Research procedure is portrayed in Fig. 2

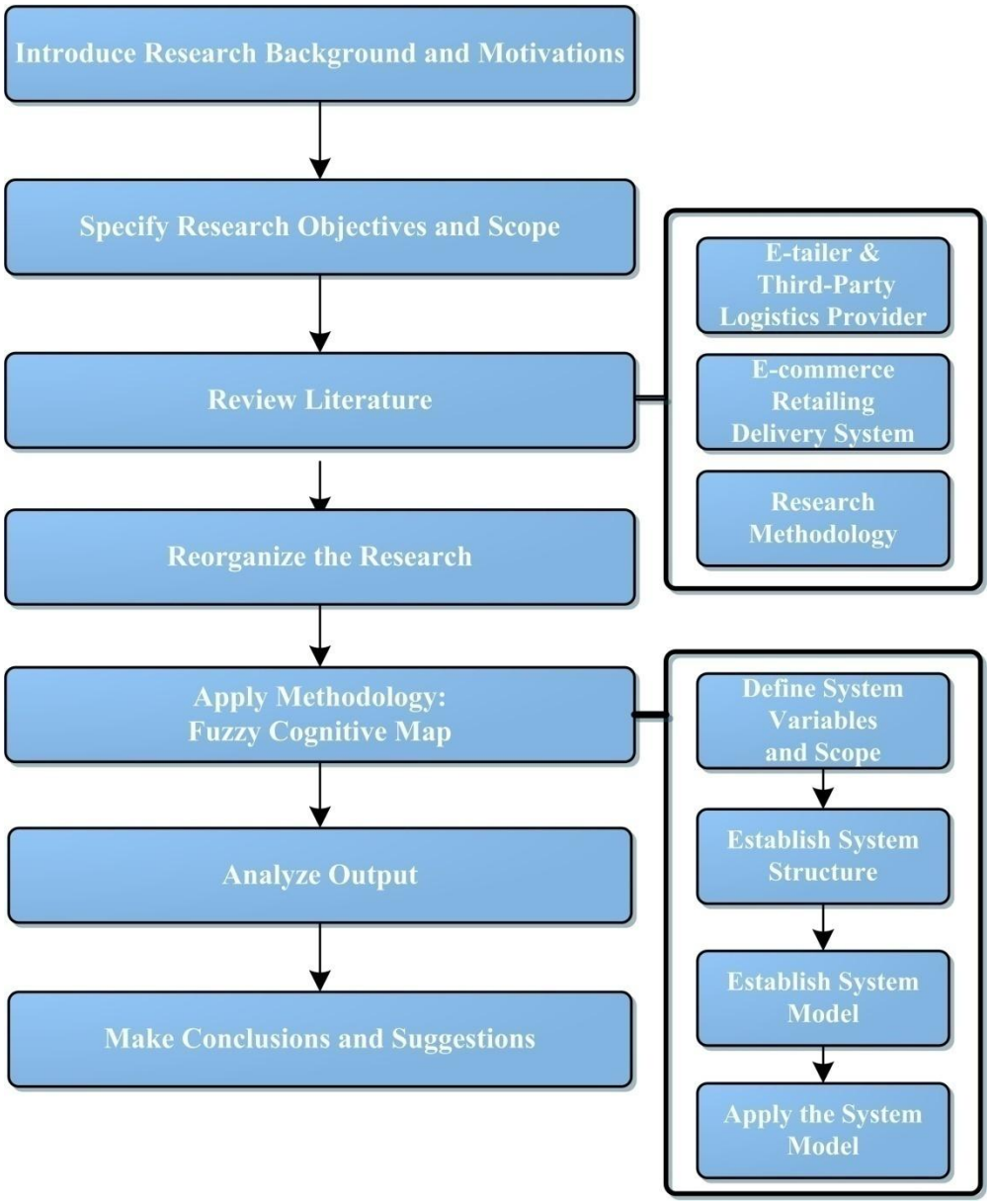


Fig. 2. Research procedure

# Chapter 2 Literature Review

## 2.1 An Overview of E-tailers in E-Commerce Environment

The retailers that do the activities of selling retail products or services on the Internet are now known as “e-tailers.” More specifically, an e-tailer is a retailer that sells retail goods or services directly to consumers online without operating storefront operations of any kind. Examples of e-tailers in Taiwan are Yahoo, and PayEasy.

Table 1. E-tailers and their logos

| ***E-tailers*** | ***Logos*** |
|---|---|
| Yahoo! |  |
| PayEasy |  |

In general E-tailers, are categorized into two types, “pure plays” as well as “bricks and clicks”. Compared to the traditional physical retail storefronts, consumers are allowed to get access to pure play as well as brick and click e-tailers via Internet, 24 hours a day, 7 days a week.

Pure play e-tailers use the Internet as its main channel of retailing. For instance, Dell and Amazon.com are two famous pure play e-tailers. They usually have higher chances to turn higher profit margins because of the fact that many expenses such as overhead expenses and labor costs can be greatly reduced, contributing to their lower product prices.

Meanwhile, brick and click e-tailers make use of both electronic stores and traditional physical storefronts to sell their goods or services. Compared with pure play e-tailers, there are more channels for brick and click e-tailers to promote and sell their services or goods at not only physical storefronts but also electronic stores.

However, for both pure play and brick and click e-tailers, there exist some problems to be solved. First, security is the frequently voiced concern. Examples of attacks on e-commerce companies such as Amazon.com and eBay, where the computers were overloaded with orders and operations were stopped, give top management much concern about e-commerce security. Also, the vulnerability of credit card numbers is needed to pay attention to. Second, it's hard to establish close relationships between e-tailers and consumers. Studies demonstrate that online shoppers distrust not only the e-tailers themselves *(e.g., Urban, Sultan, & Qualls, 2000)* and their payment systems *(e.g., Hoffman, Novak, & Peralta, 1999a)*, but also the very nature of the Internet and online shopping *(e.g., Hoffman, Novak, & Peralta, 1999b; Schoder & Yin, 2000)*. Thus, the improvement of security and customer-related relationship is a must for e-tailers.

## 2.2 An Overview of Third-party Logistics Providers

Lieb, Millen, and Wassenhove (1993) define 3PL（third-party logistics）as the use of external companies to perform logistics functions that have traditionally been performed within an organization. Also, 3PL providers are defined as a special middleman of logistics in channel who provides other enterprises with whole or part logistics business service, from delivering generic transportation service to design, execute and operate whole system of distribution and logistics in certain period by contract form（*Duo Zhang, 2000).*

In the past two decades, the rise of 3PL providers in the supply chain network has empowered the logistics market with new force. The reason why 3PL providers emerge is that companies compete in a number of businesses that are logistically distinct due to varied customer needs（*Fuller, O'Conor, and Rawlinson ,1993*）. Since 1990s, companies have increasingly outsourced logistics activities. About 60% of the Fortune 500 companies survey reports having at least one logistics provider contract（*Lieb and Randel,1996*）. Companies can achieve customer service improvement and cost reduction by outsourcing logistics services with such 3PLs *(Rabinovich et al., 1999).*

The advantages of 3PL providers help build a good developing environment for e-commerce. Internet-based collaboration applied in e-tailers and providers facilitates the integration of logistics flow, financial flow, information flow, workflow, and value-added flow. Providers can turn their e-tailers' logistics system into a professional and cost-effective one. They make dream come true the fast flow of goods among supply chains and shorten the time and distance needed from supply side to demand side.

With the gradual maturation of Internet and the continuous growth of e-commerce, 3PL providers could frequently ameliorate its logistics flow and enable their customers to have a quicker response and a better service quality. The partnered 3PLs with e-tailers in Tawain are showed in the below table 2.

Table 2. 3PLs in the e-commerce RD model

| ***3PLs*** | ***Logos*** |
|---|---|
| Kyyo Logistics |  |
| Choice Logistics |  |
| Connect Logistics |  |
| Dongtuo Logistics |  |

## 2.3 Introduction and Studies on E-commerce Retailing Delivery

In Taiwan, there are many convenience stores, which facilitate the retailing delivery (RD) service: “Shop on-line and pick up orders at convenience stores.” The retailing delivery services in Taiwan have made remarkable successes.

The history of retailing delivery of e-commerce in Taiwan is about eight years, and the e-commerce RD model is mainly operated by providers. The providers have had to improve the flow of information both internally and externally and integrate their logistics services into the retail delivery provided by convenience stores.

CVS.com (a joint venture by three families of convenience stores including Family.com, Hi-Life.com, and Okcvs.com) is an RD provider that began service at the beginning of 1999, while 7-11.com joined the market at the end of 2000. Because of the safe payment way and the quick delivery, RD services provided by convenience stores have played an important role in e-commerce logistics.

The procedure that combines e-tailing with RD system is illustrated below:

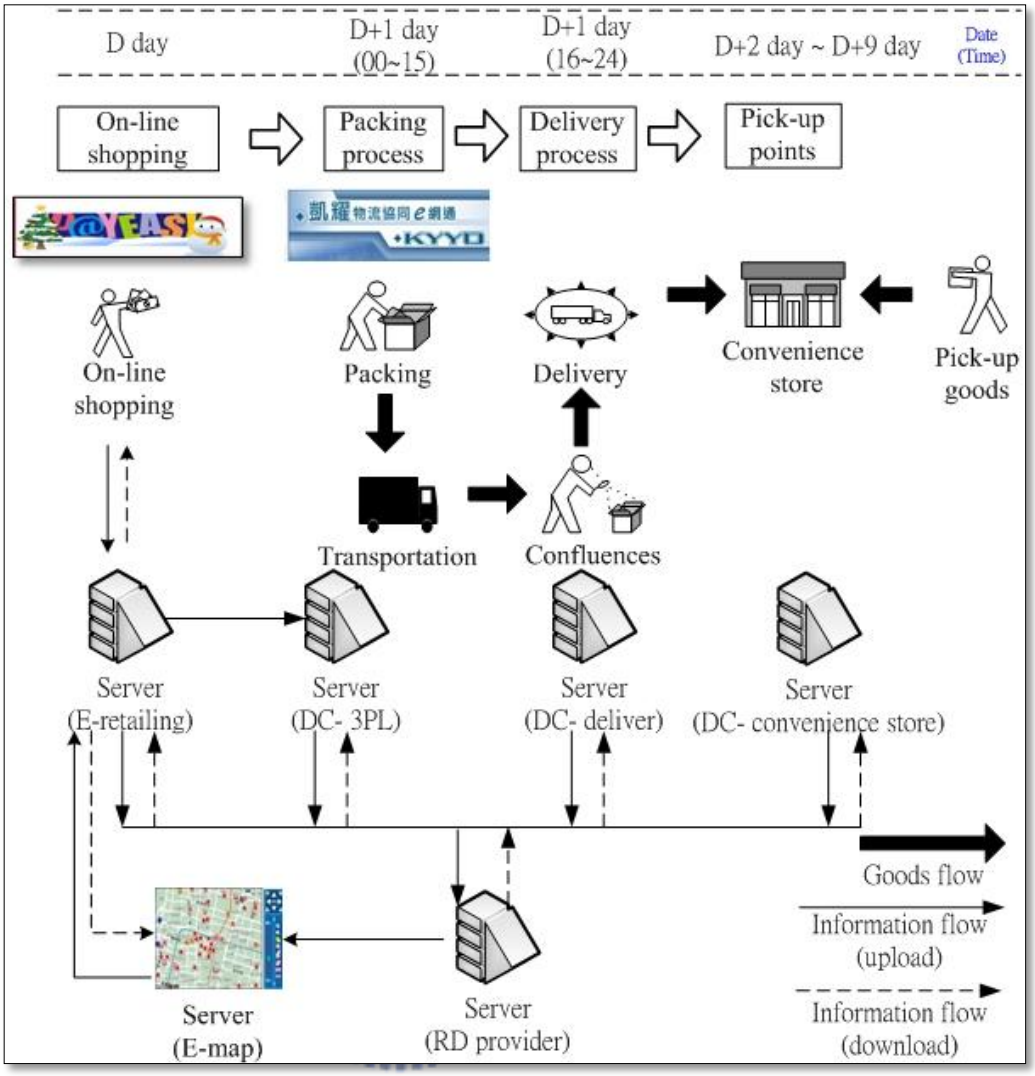


Fig. 3. Goods flow and information flow in the e-commerce retailing delivery model

1. **On-line shopping**

The major e-tailers in Taiwan have provided RD service. Some decide the delivery mode by goods (home delivery and retailing delivery), and the others provide consumers the choice of delivery mode.

**2. Selection of the pick-up points**

When consumers choose retailing delivery system, the convenience stores （7-11.com or CVS.com） will be shown on the website. Consumers could select the pick-up points on the e-map provided by RD system.

**3. Packing process**

The e-tailers transmit the information of goods ordered to providers, and providers are responsible for the packaging process and transporting the goods ordered to the delivery centre of convenience stores.

**4. Delivery process**

The delivery centre of convenience stores will collect the orders and transport them to different convenience stores, and then it will reply to e-tailers the processed order information.

**5. Pick-up goods**

According to the information replied from delivery centre, the e-tailers will notify the consumers by e-mail or phone calls about pick-up.

Generally speaking, consumers order goods on D day, and on the D+1 day providers will start their packaging process, and usually consumers can pick up the orders at the selected convenience store in the afternoon of the D+2 day.

Because the e-commerce retailing delivery service is very unique, there are few studies about it. However, there still are several researches focusing on the e-commerce RD model and its advanced exploration. The topic and the brief descriptions are as follow:

**i.** The Choice Behavior Analysis on the Pick-up Point for the E-commerce retailing Delivery（*CM Feng, YK Huang, 2005*）

The study is to examine what kind of improved services strategies can capture more market share and customer loyalty for the convenience stores.

**ii.** Modeling the Determinants of Logistics Service Quality on Retailing Delivery Service for Online Shopping（*CM Feng, YK Huang, 2007*）

This paper explores the structure of logistic for RD service for electronic commerce. This study examines the structure of the logistics service quality (LSQ) with the sample of 135 users of retailing delivery.

**iii.** A Catastrophe Model for Developing Loyalty Strategies: A Case Study on Choice Behavior of Pick-up Point for Online Shopping（*CM Feng, YK Huang, 2009*）

This study explores the relationships between the service quality and switching cost on choice behavior using a catastrophe model. It also applies general multivariate methodology for estimating catastrophe model II to actual market data to demonstrate the model's use in choice behavior. The analysis shows that, service quality and switching cost are the two major factors that influence choice behavior, and that a catastrophe phenomenon can occur with a high switching cost.

## 2.4 The development of FCM and its applications

Fuzzy cognitive maps （FCMs） are an extension of cognitive maps. A cognitive map demonstrates how humans deliberate upon a particular issue by analyzing, arranging the problems and graphically mapping interconnected concepts *(Eden & Ackermann, 2004).* Moreover, it specifies the causal relationship among concepts and depicts the causal links. The cognitive maps study the perceptions about the real world and the way they act to attain human desires.

Cognitive maps have been deemed as an useful tool in problem-solving *(Axelrod, 1976 and Eden and Ackermann, 2004)*, where a number of decision variables are casually interrelated*(Kim & Lee, 1998).* For that reason, cognitive maps enable decision-makers to analyze the potential casual relationships among concepts which can help reach more significant and meaningful solutions.

Also, a cognitive map is a model with construction rules portrayed by defining a hierarchical structure for a decisional process. It consists of nodes which represent the most relevant concepts in a decisional environment *(Axelrod, 1976).* Through adding plus (+) and minus (−) signs, it allows the identifying of the type of relationship *(Dikerson & Kosko, 1994),* positive or negative. Between two concepts, positive signs mean that one stimulates the other while negative signs represent an inhibition between two concepts. Guided by these rules, a cognitive map can be expressed through a calculation of an adjacency matrix showing the sign of the relationship. It should be noticed that if there's no relationship among concepts, the corresponding entry will be empty.

However, one major limitation exists in cognitive maps, that is, the restriction of quantifying relationships among variables. In order to overcome the weakness

embedded in the cognitive maps, fuzzy numbers were incorporated to form a new technique called Fuzzy cognitive maps（FCM）（*Kosko ,1986*）.

FCMs are a modeling methodology originated from a combination of fuzzy logic and neural networks, which describe the behavior of a system in terms of concepts and are developed by human experts who operate, supervise, or "know" the system and how they behave under different circumstances. Each concept represents an entity, a variable, or a characteristic of the system. Human experiences and knowledge are incorporated into a causal relationship between factors, characteristics, or components of the system.

The graphical illustration of FCM is a graph consisted of nodes, signs, directional and weighted arcs. Nodes of the graph stand for the concepts that are used to describe the behavior of the system and they are connected by signed and weighted interconnections representing the causal relationships existing between the concepts as showed in Fig.4.

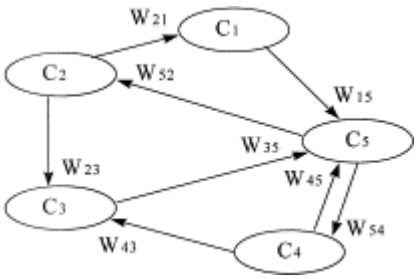


Fig. 4. An example of a Fuzzy Cognitive Map with concepts and weighted interconnections

Further in calculation, FCM can be represented as Fig.5. by a $n \times n$ adjacency matrix ($E$), while $n$ is the number of nodes. By values between [−1,1], each $e_{ij}$ means the relationship between the $i$ and $j$ concepts. Consequently, three types of relationships can be seen: (a) $e_{ij}>0$, indicating a positive relationship, (b) $e_{ij}<0$, indicating a negative relationship, and (c) $e_{ij}=0$, where no relationship exists.

$$E = \begin{pmatrix} e_{11} & \cdots & \cdots & \cdots & e_{1n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & e_{ij} & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ e_{n1} & \cdots & \cdots & \cdots & e_{nn} \end{pmatrix}$$

Fig. 5. An example of a n×n adjacency matrix

When an expert assigns a $e_{ij}$ value, three issues must be kept in mind *(Schneider et al., 1998)*. First, the $e_{ij}$ indicates how strong an influence the *i* concept is on *j*. Second, the strength of relationship precedes a fuzzy weight with a positive or negative sign, representing whether that relationship is direct or inverse, respectively. Last but not least, the causality relationship needs to be showed to establish if the *i* concept is a cause of *j* or vice-versa.

Behind the graphical representation of an FCM, there is a mathematical formulation. Fuzzy values of concepts arise from the transformation of the real values of the corresponding variables for each concept; and there are fuzzy values for the weights of the interconnections among concepts. Then, FCM is free to interact. At every step of interaction generates a new value for each concept that is calculated according to the following equation (equation.1.):

$$C_i(t_{n+1}) = S[\sum e_{ki}(t_n) C_k(t_n)] \qquad \textbf{Equation 1.}$$

Namely, $C_i(t_{n+1})$ is the value of concept $C_i$ at step $t_{n+1}$, $C_k(t_n)$ is the value of concept $C_k$ at step $t_n$, and $e_{ki}(t_n)$ is the weight of the interconnection from concept $C_j$ to concept $C_i$ and *S* is a bounded signal function that squashes the result of the multiplication in the interval [0,1].

FCM is comparatively easier to quantify, and then foretells state transitions through a simple matrix calculation. Due to the advantage, FCM has been applied to not only social science such as investment analysis problems *(Lee & Kim, 1997)*, political problems *(Athanasios, Ilias, & Konstantinos, 2003)*, and critical success factors modeling for an IT project process *(Luis, Rossitza, & Jose, 2007)*, but also to engineering such as behavioral analysis of electronic circuit *(Styblinski & Meyer, 1988)* and knowledge modeling for urban design *(Xirogiannis, Stefanou, & Glykas, 2004)*. Besides, FCM is also applied to Strategic planning such as modeling political and strategic issues and situations（*A.S. Andreou, N.H. Mateou and G.A. Zombanakis,2005*）, Simulating the information systems of a strategic planning process（*D. Kardaras and B. Karakostas,1999*）. Decision-making, project management, and investment analysis is also incorporated such as relationship management in airline service（*Kang, S. Lee and J. Choi,2004*）

## 2.5 Summary of Literature and Commentary

In the literature review, the current condition about e-commerce retailing delivery model is introduced. Thanks to the widespread convenience stores, they make e-commerce RD model very unique in the world. Also, how e-tailers and third-party logistics providers cooperate is discussed and explained further in Chapter 2. Third-party logistics providers are part of the e-commerce retailing delivery model and well functioned as a connector between e-tailers and convenience stores. Their relationship is quite close.

After the relative literature of e-commerce RD model is reviewed, it is noted that there seems to be no study on the operation dynamics of e-tailers and third-party logistics providers. Since it is crucial for 3PLs to comprehend the operation dynamics, the study on the dynamics of two roles with fuzzy cognitive maps can possibly be contributive.

Fuzzy cognitive maps can demonstrate how humans deliberate upon a particular issue, specify the causal relationship among concepts, and moreover, depict the causal links. For this reason, fuzzy cognitive maps enable decision-makers to analyze the potential causal relationships among concepts and how the concepts influence the system. It can help attain more meaningful solutions to the real-world problem.

# Chapter 3 Construction of FCM

## 3.1. Defining Concepts

As previously mentioned, this study highlights the two roles, e-tailers and 3PLs in e-commerce retailing delivery model, and discusses the 3PLs' operation dynamics. What of interest in the research is to explore the critical concepts that lie in the operation dynamics of 3PLs in the e-commerce RD system, the strength of relationship among concepts, and to acquire insight on how in different scenarios the critical concepts influence the entire system.

Though their cooperation is tight and relationship between them is very close as previous section 2.3. states, e-tailers and 3PLs are two different business entities in essence. They still bargain, negotiate, and even compete with each other under the table. To stay competitive, as one party starts changing his decisions, adjusting his strategies, etc, the other two parties will soon respond to his changes or adjustments. The interactions between the two parties are, in fact, dynamic, and which implies 3PLs' operation should also be dynamic. Therefore, the methodology "Fuzzy cognitive maps" is applied to explore the system dynamics, and to attain the research objectives.

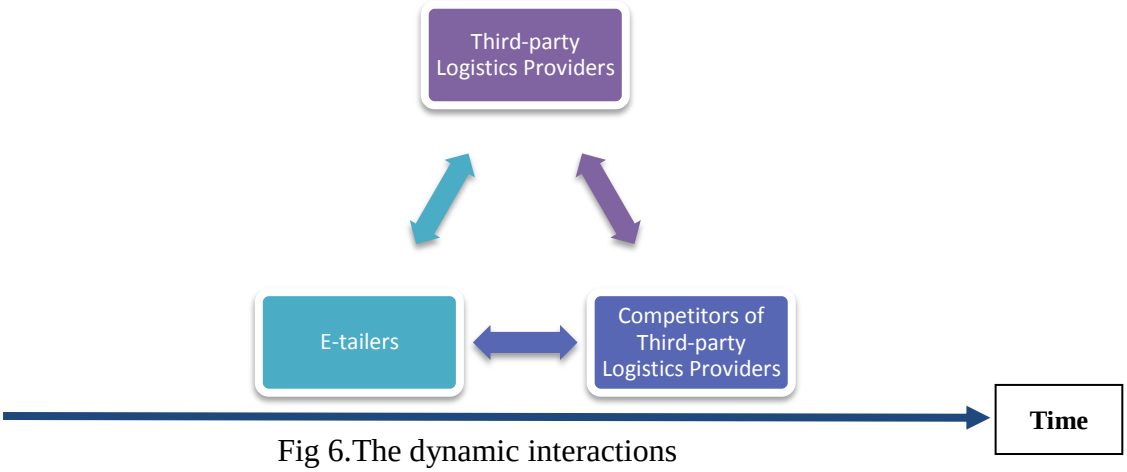


Fig 6.The dynamic interactions

In order to build up the fuzzy cognitive maps to acquire9 insight on the critical concepts and problems, the initiative step is to define the concepts within fuzzy cognitive maps.

The construction of concepts is primarily based on:（1）**Field trips** to selected providers, and **In-depth interviews with experts** within the e-commerce RD model, and （3）the **Literature**.

### 3.1.1. Field trips and in-depth interviews with experts

The visited 3PLs and experts are *Kyyo Logistics*, *Connects Logistics* and their respective ***top managers*** of logistic department. The partners of Kyyo Logistics are the most two remarkable e-tailers in Taiwan: *Yahoo!* and *PayEasy*. In the process of in-depth interviews with Kyyo Logistics, several problems are identified *(table 3)*, and are incorporated into the FCM. This study will introduce the Kyyo Logistics in the later section 3.2.

### 3.1.2. Literature

It is observed that 3PLs are stuck in a buyer market, which means e-tailers are more powerful when cooperating with 3PLs. Meanwhile, the literature on the e-commerce RD model is few, so that the literature reviewed slightly tends to focus on the selection of 3PLs because that sort of literature depicts what customers expect 3PLs to be. Among the literature on the selection of 3PLs, *Selection of logistics service provider: An analytical network process（ANP）approach（Sanjay Jharkharia, Ravi Shankar, 2007）* is the main reference for constructing the concepts. That research collects and rearranges the selection criteria of 3PLs from the previous literature and to a certain it reveals how the customers expect 3PLs to be*（table. 5）*.

## 3.2. Case Company Introduction

Kyyo Logistics, now located in Hsin-Tien, Taiwan, was established in December 1993. During Kyyo's early stage, its core business was warehousing and packaging. Through providing mail-order companies and banks with excellent services, Kyyo successfully transformed itself into the logistic center for various customers.

With the rise of consumer awareness, the retailing business became increasingly complex. Kyyo Logistics then went a step further and provided the service of contacting delivery companies on behalf of the customers. With more and more accumulation in customer requests, and the stringent demand for efficiency and effectiveness, Kyyo Logistics again gradually transformed from its original role of logistic center to the center of goods flow, information flow and cash flow for the retailers.

Though functioning as the center, Kyyo Logistics has no fleet of its won. Also, it promises that it won't treat transportation business service within its core competitiveness. Because of that unique characteristic and promise, it helps customers with its objective views to choose the most suitable and reliable delivery companies（e.g. President Transnet and HCT transportation）. With various kinds of existing delivery alternatives, especially the participation of logistics system of 7-11.com and CVS.com in the e-commerce retailing delivery model, Kyyo Logistics creates a lot of business opportunities to e-tailers. Now, the celebrated e-tailers such as PayEasy are all customers of Kyyo Logistics.

Although competent in business, Kyyo Logistics is still positioned itself in a buyer market. E-tailers exploit their powers to increase their benefits, and somewhat inadvertently suppress the Kyyo's growth. Due to this tricky situation, Kyyo Logistics inevitably faces some problems. *First*, to retain the bargaining power, e-tailers will

transfer the order from the original partners, Kyyo Logistics, to other third-party logistics providers. This incurs Kyyo Logistics with a great loss because the quantity of orders transferred is large. *Second*, because e-tailers control the cost strictly, Kyyo's gross profit is very low, and its utilization rate is high, which means the profit gained from e-tailers is not much, nor enough. Besides, high utilization rate drives e-tailers to transfer more orders to other third-party logistics providers. It has Kyyo hesitate to purchase more fixed assets, hire more employees, etc. Finally, Kyyo's competitors grow increasingly. Its competitors are benefited a lot from transferred orders. Moreover, e-tailers had forced Kyyo Logistics by having its competitors maturing at an early stage, led to Kyyo's competitors evolving and growing much faster and stronger.

Kyyo Logistics is no doubt very competitive compared to the other third-party logistics providers. However, it is still necessary for it to overcome some difficulties, especially the interactions with its e-tailers. Hence, several scenarios are proposed in Chapter 4 to help clear the treacherous and vicious cycle. The table 3 shows the threats Kyyo Logistics face and their respective descriptions.

Table 3. Threats of Kyyo Logistics

| Threats | Descriptions |
|---|---|
| **Competitor Growth** | No matter what sorts of industries, they are destined to fight against competitors, so are the 3PLs. But in the e-commerce RD model, e-tailers' power is so big and unchallenged as to compel 3PLs to facilitate the maturity of other 3PLs. |
| **E-tailer balances the** | To keep from overtly dependent on certain 3PLs, the e-tailers transfer the orders to other 3PLs to reinforce their bargaining power. |

| | |
|---|---|
| **order** | Moreover, high *utilization rate* of 3PLs may lead to order transfer because e-tailers would like to spread the risk through diversification. They may keep in mind whether 3PLs's fixed assets could function well at all the time. |
| **Ownership Status** | *Turnover of talents*, along with *confidentiality disclosure of customer* base is the major difficulty that 3PLs must face. Moreover, the mixture of high *utilization rate* and *low gross profit* together would pose as hardship to 3PLs, too, making 3PLs think twice over whether or not to invest more in fixed assets. |

After the field trips to selected 3PLs, in-depth interviews with experts, and literature reviewed, concepts are constructed. How the concepts are identified is depicts in the following.

**Concepts Identification and Construction**

Here describes how the concepts are constructed.

After in-depth interview with experts, the identified problems are found. They are, shown in the table 3, competitor growth, e-tailers' balancing order, and ownership status. All three identified problems have their corresponding causes behind.

In order to depict the causality in the map, the identified problems are transformed into new several concepts. For example, "Competitor competitiveness" is always a concern for Kyyo Logistics no matter the competitor competitiveness grows or not. "E-tailers' balancing order" is also a great impact factor influencing Kyyo Logistics' market share. "Turnover of talents" and "Confidentiality disclosure" are two its own problems. Besides, the "Gross profit" is transformed to "Total profit" and take "Avg. logistics cost per unit" into consideration because "Total profit" is a more general term

that could be more easily understood and explained while “Avg. logistics cost per unit” is an impact factor for the total/gross profit since the service price per unit cannot be controlled fully by Kyyo. High “Utilization rate” is originally good for Kyyo. However, it becomes a reason for e-tailers to transfer the orders to Kyyo’s competitors. Moreover, e-tailers have asked 3PLs to invest in the “Fixed assets” to decrease the utilization rate.

Once the identified problems are transformed more delicately in the map, there are still some general operation-related concepts could be added in the map. They are “Relationship with e-tailers”, “Market share”, and “Logistics performance’. “Relationship with e-tailers” is quite a critical element that will influence the order volume, and the balancing order. “Market share” is an indicator telling Kyyo’s operation competitiveness. “Logistics performance” somewhat represents the e-tailers and consumers’ satisfaction level. As the result, there are 11 concepts constructed as showed in the table 4.

Table 4. The concepts in the FCM and their respective definitions

| ***Concepts Descriptions*** | |
|---|---|
| **Concepts** | **Definitions** |
| *A.* Market Share | The percentage or proportion of a 3PL's order volume (in a market) divided by the total order volumes in e-commerce retailing delivery market. |
| *B.* Logistics Performance | The speed and reliability of data transmission, warehousing, sorting, picking, packaging and transportation services. |
| *C.* Total Profit | The difference between revenue and total cost. |
| *D.* Relationship with e-tailers. | A relatively long-term association between two or more entities. Sales representatives may involve in, for example, price, order volume, etc through their friendship with e-tailers. |
| *E.* Competitors’ competitiveness | The competitors’ power in the e-commerce RD system. It can be depicted as an overall image of competitor ability, performance and relationship |

| | |
|---|---|
| | with cooperated e-tailers. |
| *F.* E-tailers' Balancing Order | In order not to over depend on certain provider, e-tailers usually give balancing order to other provider to |
| *G.* Turnover of Talents | Talents sometimes may be head-hunted and thus enhance competitors' competitiveness. |
| *H.* Confidentiality Disclosure | When talents are head-hunted, they may bring the techniques, and/ or customer confidentiality with them. |
| *I.* Avg. Logistics Cost Per Unit | The average cost per unit incurred from integration of information, transportation, inventory, warehousing, and packaging. |
| *J.* Utilization Rate | The ratio of realistic throughput/Max. Capacity. |
| *K.* Unfitting Size and Quality of Fixed Assets | Property, plant, and equipment may be insufficient because of large order, breakdown, etc. |

Table 5. Summary of literature on the criteria for the selection of a provider

| ***Selection criteria*** | ***Relevance in logistics outsourcing*** |
|---|---|
| Compatibility with the users (CPT) | It refers to the ability of the user and the provider and their support systems to work together in close coordination to achieve some common objectives. It may be classified in terms of the attributes of business process, cultural fit, technology capability, characteristics of other service providers of the user, etc. |
| Cost of service (CST) | It refers to the total cost of logistics outsourcing, which should be minimum. |
| Quality of service (QLT) | Quality of the provider includes many aspects such as on-time delivery, accuracy of order fulfillment, frequency and cost of loss and damage, promptness in attending customers' complaints, commitment to continuous improvement, etc. |
| Reputation of the company (RPT) | The reputation of a provider refers to the opinion of the people about how good they are in satisfying the needs of the customer. The reputation of a provider plays a major role in its selection. This is more relevant in the initial screening of the providers. |
| Long-term relationships | Long-term relationships, which include shared risks and rewards, ensure cooperation between the user and the provider. It also helps |

| | |
|---|---|
| (LTR) | in controlling the opportunistic behavior of providers. |
| Performance measurement (PM) | Provision of periodic evaluation of the performance of the provider enables the two parties to identify the gaps in service. On-time shipments, inventory accuracy, shipping errors, reduction in cash-to-cash cycle, logistics cost reduction, and reduction in customers' complaints may be used as the most important performance measures in logistics outsourcing. |
| Willingness to use logistics manpower (WIL) | The willingness of the provider to retain some of the user's logistics employees, who would otherwise become unemployed after the outsourcing contract, avoids any chance of sabotage. It also improves the goodwill between the user and the provider. |
| Flexibility in billing and payment (FBP) | Flexibility in billing and payment conditions increases goodwill between the user and the provider. |
| Quality of management (QM) | Able management of the provider may not only provide good service to the user but may also foster a long-term relationship between the user and the provider |
| Information sharing and mutual trust (INF) | Mutual trust-based information sharing between the user and the provider is necessary not only for the continuance of the agreement but also for the continuous improvement of the service. |
| Operational performance (OP) | A good operational performance of the provider is reflected by measures such as delivery performance, performance-monitoring capability, statistical data reporting to the user, fault diagnosis capability, detailed accounting information, system security, responsiveness, confidentiality of sensitive data, etc. |
| Information technology (IT) capability | The advanced IT capabilities of a provider help in reducing uncertainties and inventory level. In some cases, the providers may allow the users to take advantage of their advanced IT capabilities. In such cases, the user companies need not invest in advanced IT capabilities just for the sake of tracking of goods and raw materials. |
| Size and quality of fixed assets (FA) | It helps in good operational performance. Availability of quality assets (such as air-conditioned warehouses and vehicles), which suit the needs of the user, is a plus point for the provider. |
| Experience | Prior experience of the provider in the product line of user is the |

| | |
|---|---|
| in similar products (ESP) | added advantage to the user. |
| Delivery performance (DP) | Two dimensions of DP, namely “speed” and “reliability”, are important for the satisfaction of the user. |
| Employee satisfaction level (ESL) | It is important as the presence of dissatisfied employees at the provider's end may lead to strike, lockouts, sabotage, and other such unwanted activities, which may adversely affect the logistics operations. |
| Financial performance (FP) | A sound financial performance of the provider ensures continuity of service and regular upgrading of the equipments and services, which are used in logistics operations. |
| Market share (MS) | The market share of the provider reflects its financial performance, customer satisfaction, and reputation. |
| Geographical spread (GS) and range of services provided (RS) | Wide geographic spread and range of services offered by the provider are desirable as these create enhanced access to market and many more avenues to the user. Large GS and RS offered by the provider may also enable the user to save some money on distribution and marketing of the product. |
| Risk management (RM) | It is the capability of the provider to address any unforeseen problem. It is needed to ensure the continuity of the services. |
| Surge capacity of provider (SC) | It becomes important if (due to sudden rise in demand of product) there is a rise in the logistics needs of the user. |
| Clause for arbitration and escape (CAR) | In the long run the possibility of a dispute between the user and the provider cannot be denied. Therefore, provision of a CAR, which is acceptable to both the parties, is necessary. |
| Flexibility in operations and delivery (FOD) | Flexibility in operations and delivery may enable the user to give customized service to its customers, particularly in special or non-routine requests. |

## 3.3. The Research Framework

The proposed fuzzy cognitive map（Fig.7） is constructed according to the defined system scope and problems they encounter. Identified negative effects are incorporated into the map.

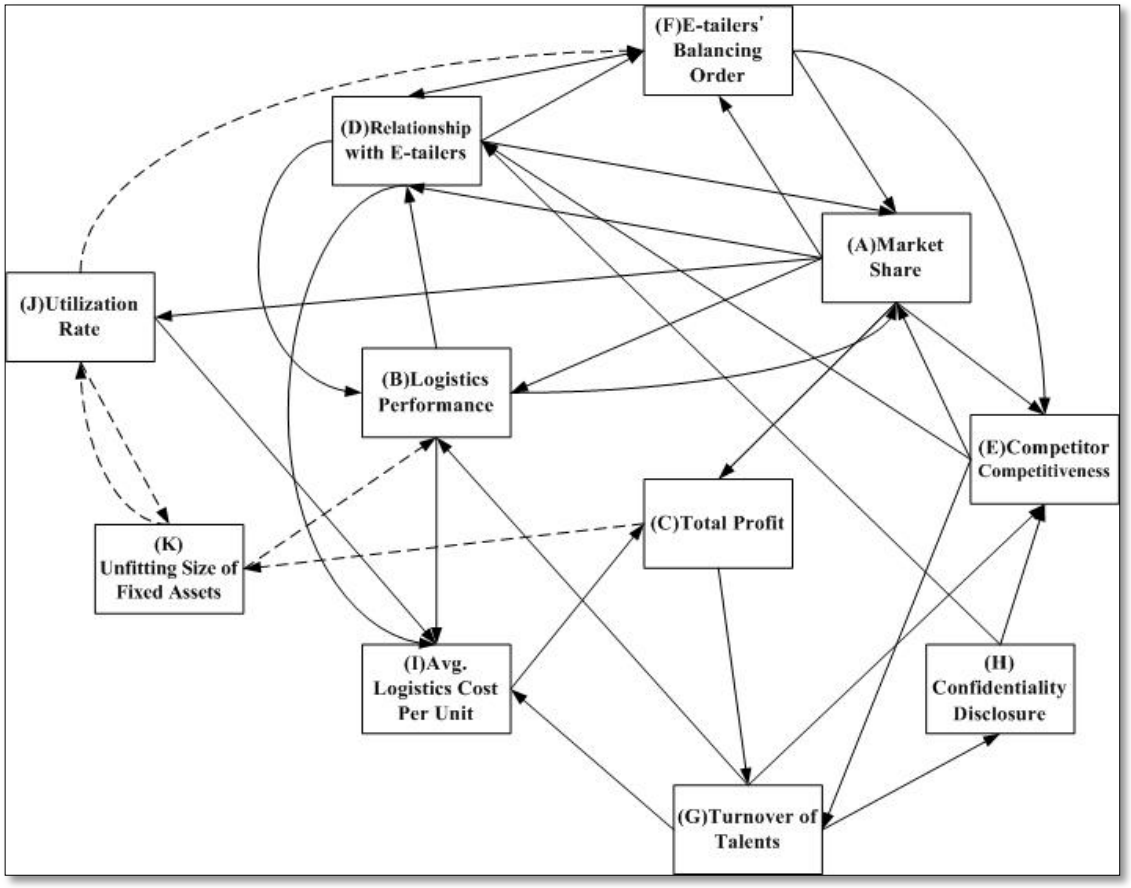


Fig. 7.The proposed FCM

In the proposed FCM, directional arc represents the causal link. The dotted arcs will be activated if the value of concept state is above or below the threshold. For example, if the utilization rate is high enough, the problem of unfitting size of fixed assets will then be perceived. As soon as the problem of unfitting size of fixed assets is activated, other related concepts will then be perceived（shown by the dotted arcs from or to the concept of unfitting size of fixed assets）. Every directional and weighted arcs means that concept i has an strength of relationship on concept j. For instance, the

market share will affect logistics performance and relationship with e-tailers and so on. Whether the existence and strength of relationship of each directional and weighted arcs will be determined by the experts.

## 3.4. Input

The **directional arcs** between the concepts in the Fig.8 represent the strength of relationship, which will be asked and gathered through the survey. Every expert will be asked to fill the values( $e_{ij}$ )in the cells*( table 6. )*. The value of $e_{ij}$ asked will be confined to the interval [-1, 1], showing the negative impact, no impact, and positive impact, and telling the strength of relationship of concepts in the column on those in the row. For example, the impact value of concept A on E is 0.75, which represents the concept A has the impact on the concept E, the strength of relationship is 0.75.

Moreover, not only the strength of relationship but also the **concept ratings**（or we say, the initial state, $C_0$, shown on the bottom of the table 6.）are asked. The concept ratings represent the assessment of current concept. The rating interval is within [0,1].

## 3.5. Data Collection and Processing

### 3.5.1. Sample Source and Size

The data is collected through the expert survey. Experts are from top management of e-tailers- Yahoo, PayEasy and 3PLs- Kyyo Logistics. The two e-tailers account for about 80% market share in the e-commerce RD market. Kyyo Logistics is their main partners. The experts of e-tailers are responsible for the assessment of initial state, that is concept ratings, and the experts of Kyyo logistics are responsible for the adjacency matrix.

Since the FCM needs to be completed through expert knowledge, it's weighty to

have the leading experts write down the value of each cell to ensure the credibility. The number of surveys is somehow less important. After the data collection process, 6 surveys are acquired.

### 3.5.2. Data Consistency Verification

In order to avoid illogical deviation and errors, the verification of whether the value ($e_{ij}$) conflicted with prior experience is executed. Moreover, each value in the cells of survey ($e_{ij}$) is checked to ensure that the value in each cell of every survey is within a reasonable interval. That interval is set as 0.33. If the value difference between maximum and minimum given by experts is above 0.33, the discussion and negotiation with experts about the $e_{ij}$ will be necessary work. Until the deviation is within the anticipative interval and without confronting prior experience, the values of all cells ($e_{ij}$) will be applied.

### 3.5.3. Data Processing

All the experts are consulted with their experience evaluated on a numerical scale. Let $S_i$ be the weighting of expert $i$ and $w_i$ the adjacency matrix of the FCM defined by that expert. The final adjacency matrix is then given by a normalized sum according to the following equation:

$$W = \frac{\sum_{i=1}^{N} S_i W_i}{\sum_{i=1}^{N} S_j} \qquad \text{Equation 2.}$$

The study assumes that the weighting of every expert is the same. The complete survey is as follows:

Table 6. The survey format

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A. Market Share | 0.00 | (0.07) | 0.63 | 0.43 | (0.47) | 0.42 | 0.00 | 0.00 | 0.00 | 0.68 | 0.00 |
| B. Logistics Performance | 0.56 | 0.00 | 0.00 | 0.75 | 0.00 | 0.00 | 0.00 | 0.00 | (0.30) | 0.00 | 0.00 |
| C. Total Profit | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (0.48) | 0.00 | 0.00 | 0.00 | (0.63) |
| D. Relationship with E-tailers | 0.59 | 0.58 | 0.00 | 0.00 | 0.00 | (0.46) | 0.00 | 0.00 | (0.10) | 0.00 | 0.00 |
| E. Competitor Competitiveness | (0.60) | 0.00 | 0.00 | (0.50) | 0.00 | 0.00 | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 |
| F. E-tailers' Balancing Order | (0.41) | 0.00 | 0.00 | (0.20) | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| G. Turnover of Talents | 0.00 | (0.25) | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 | 0.75 | 0.32 | 0.00 | 0.00 |
| H. Confidentiality Disclosure | 0.00 | 0.00 | 0.00 | (0.10) | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| I. Avg. Logistics Cost Per Unit | 0.00 | 0.00 | (0.70) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| J. Utilization Rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (0.30) | 0.00 | 0.00 | (0.30) | 0.00 | 0.35 |
| K. Unfitting Size of Fixed Assets | 0.00 | (0.20) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (0.75) | 0.00 |
| Rating | 0.81 | 0.81 | 0.63 | 0.88 | 0.60 | 0.53 | 0.53 | 0.30 | 0.60 | 0.80 | 0.30 |

## Findings:

### The Concept Ratings from the E-tailers

At the bottom of the table 6 shows the concept raiting from the e-tailers. It shows how the e-tailers perceive the concept of Kyyo Logistics. We could observe that the concepts which are rated as high performance are "Market share", "Logistics performance", "Total profit", "Relationship with e-tailers", "Utilization rate" ,and "Unfitting size of fixed assets". However, the total profit seems to be a little bit lower. It means the e-tailers also know that Kyyo Logistics earns little although its market share is quite large. As to the concepts such as "Competitor competitiveness", "E-tailers' balancing order", "Turnover of talents", "Average logistics cost per unit", and so on are

rated as poor performance in e-tailers'views. More controllable concepts with poor performance such as "Turnover of talents" and "Avg. logistics cost per unit" probably be mitigated by improving work environment, reengineering packaging process, and so on.

**The Strength of Relationship**

The strength of relationship is showed in the above cells. The values in the brackets stand for the negative impact of concept in the column on those in the row while the other values show no or positive impact. The absolute value above 0.50 is underlined. It is noted that:

1st. Market share have striking effects on six concepts such as C, and J, which means a dominating concept.

2nd. Logistics performance impacts concept A and D eminently.

3rd. Relationship with e-tailers influence concept A and B markedly.

4th. Competitor Competitiveness affects concept A and D noticeably.

Therefore, the survey implies that the concepts A, B, D, and E have decisive effect on the entire system. After the sensitivity test, the above findings are proved to be true. Besides, the threshold value is gathered through expert survey showed in the following table 7.

Table 7. The concepts with threshold and their impacts

| **Impact of Concept i on j** | **J-K** | **J-F** | **K-J** | **K-B** | **C-K** |
|---|---|---|---|---|---|
| Threshold Value | 0.875 | 0.75 | 0.30 | 0.30 | 0.40 |

As soon as the adjacency matrix is operated, the $C_i$ $(t_{n+1})$ could be manipulated as the following equation.

$$C_i(t_{n+1}) = S[\sum e_{ki}(t_n) C_k(t_n)] \qquad \text{Equation 3.}$$

$C_i(t_{n+1})$ is the value of concept $C_i$ at step $t_{n+1}$, $C_k(t_n)$ is the value of concept $C_k$ at step $t_n$, and $e_{ki}(t_n)$ is the weight of the interconnection from concept $C_j$ to concept $C_i$ and $S(x)$ is a bounded signal function that squashes the result of the multiplication in the interval [0,1].

## 3.6. Output

After the data collection and processing, the original output of proposed FCM is as follows.

Table 8. The runs of calculation and their respective concepts value

| *Run* | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* | *J* | *K* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 0.81 | 0.81 | 0.63 | 0.88 | 0.60 | 0.53 | 0.53 | 0.30 | 0.60 | 0.80 | 0.30 |
| **1** | 0.83 | 0.74 | 0.59 | 0.89 | 0.47 | 0.44 | 0.35 | 0.83 | 0.17 | 0.79 | 0.50 |
| **2** | 0.87 | 0.75 | 0.84 | 0.88 | 0.47 | 0.89 | 0.34 | 0.74 | 0.15 | 0.91 | 0.18 |
| **3** | 0.76 | 0.81 | 0.86 | 0.86 | 0.61 | 0.68 | 0.24 | 0.73 | 0.13 | 0.86 | 0.75 |
| **4** | 0.78 | 0.72 | 0.83 | 0.84 | 0.56 | 0.64 | 0.26 | 0.67 | 0.11 | 0.89 | 0.10 |
| **5** | 0.77 | 0.81 | 0.84 | 0.83 | 0.53 | 0.66 | 0.26 | 0.68 | 0.13 | 0.86 | 0.74 |
| **6** | 0.81 | 0.70 | 0.83 | 0.87 | 0.55 | 0.65 | 0.25 | 0.69 | 0.12 | 0.89 | 0.11 |
| **7** | 0.78 | 0.82 | 0.85 | 0.83 | 0.52 | 0.66 | 0.26 | 0.68 | 0.13 | 0.87 | 0.74 |
| **8** | 0.81 | 0.70 | 0.83 | 0.88 | 0.54 | 0.65 | 0.25 | 0.68 | 0.12 | 0.89 | 0.11 |
| **9** | 0.78 | 0.83 | 0.85 | 0.84 | 0.52 | 0.66 | 0.25 | 0.68 | 0.12 | 0.87 | 0.74 |
| **10** | 0.82 | 0.71 | 0.84 | 0.88 | 0.54 | 0.66 | 0.24 | 0.68 | 0.11 | 0.89 | 0.11 |
| **11** | 0.78 | 0.83 | 0.85 | 0.84 | 0.52 | 0.66 | 0.25 | 0.68 | 0.12 | 0.87 | 0.75 |
| **12** | 0.82 | 0.71 | 0.84 | 0.88 | 0.54 | 0.66 | 0.24 | 0.68 | 0.11 | 0.89 | 0.10 |
| **13** | 0.79 | 0.83 | 0.85 | 0.84 | 0.52 | 0.66 | 0.25 | 0.67 | 0.12 | 0.87 | 0.75 |
| **14** | 0.82 | 0.71 | 0.84 | 0.88 | 0.54 | 0.66 | 0.24 | 0.68 | 0.11 | 0.89 | 0.10 |
| **15** | 0.79 | 0.83 | 0.85 | 0.84 | 0.52 | 0.66 | 0.25 | 0.67 | 0.12 | 0.87 | 0.75 |
| **16** | 0.82 | 0.71 | 0.84 | 0.88 | 0.54 | 0.66 | 0.24 | 0.68 | 0.11 | 0.89 | 0.10 |
| **17** | 0.79 | 0.83 | 0.85 | 0.84 | 0.52 | 0.66 | 0.25 | 0.67 | 0.12 | 0.87 | 0.75 |
| **18** | 0.82 | 0.71 | 0.84 | 0.88 | 0.54 | 0.66 | 0.24 | 0.68 | 0.11 | 0.89 | 0.10 |
| **19** | 0.79 | 0.83 | 0.85 | 0.84 | 0.52 | 0.66 | 0.25 | 0.67 | 0.12 | 0.87 | 0.75 |
| **20** | 0.82 | 0.71 | 0.84 | 0.88 | 0.54 | 0.66 | 0.24 | 0.68 | 0.11 | 0.89 | 0.10 |

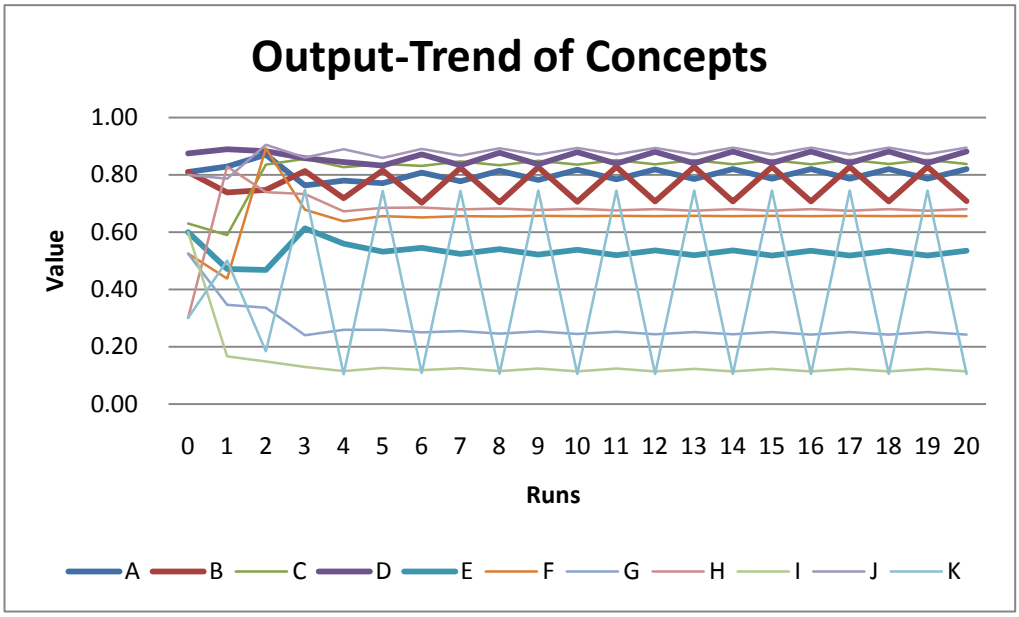


Fig. 8. The output of proposed FCM

After taking into account that the concepts incorporated need time to ferment in real world, each run is assumed to be 10 workdays, or 14 days instead. Kyyo Logistics, usually in the practice, needs about 5 to 10 workdays to respond to the changes. Moreover, the concepts- "Relationship with e-tailers", "Logistics performance", "Market shares", and "Competitor Competitiveness" are the critical elements mentioned before with considerable influences over the entire fuzzy cognitive map, accordingly, the following analyses will center and converge on these concepts. The study has noted that

(1). Value of concept A (*Market share*) keeps vibrating within the range [0.79, 0.82]. It shows there is no fierce change the market share as the time goes by.

(2). Value of concept B (*Logistics performance*) vibrates within the range [0.71, 0.83], and somewhat represents logistics performance will drop a little bit about 40 workdays later.

(3). Value of concept D (Relationship with e-tailers) vibrates at first and has almost no changes in the long run.

(4). Value of concept E (Competitor competitiveness) drops to a range [0.52, 0.54] after 80 workdays.

To conclude, the study observes that if there is no sudden accident to the case company, it will survive as time flows. Its market share will remain high, relationship with e-tailers will still be good, and the competitor competitiveness will decrease. However, the logistics performance drops a little. Thanks to the decreased competitor competitiveness, the market share will stay at the high level.

# Chapter 4 Scenario Analysis

Every business entity's major goal is to increase the market share and total profits accrued, inclusive of Kyyo Logistics. Besides, e-tailers recently encourage Kyyo Logistics to purchase more fixed assets such as plants, and equipment but Kyyo Logistics wonder whether the capital input will do benefits to itself. Hence, it is assumed that Kyyo's goal this year is to increase market share, total profit, and then mitigate and regain the control for the problems, especially the fixed assets-related problem they face. Therefore, the research improves initial state value of three concepts (logistics performance, relationship with e-tailers and unfitting size of fixed assets) to see the difference between the original output and the adjusted ones. Moreover, competitor competitiveness is also included to acquire potential insights from the difference. All the strategies are believed to be able to reach the goals and mitigate the problem occurrences.

## 4.1. Scenario 1: Logistics performance improves 20%

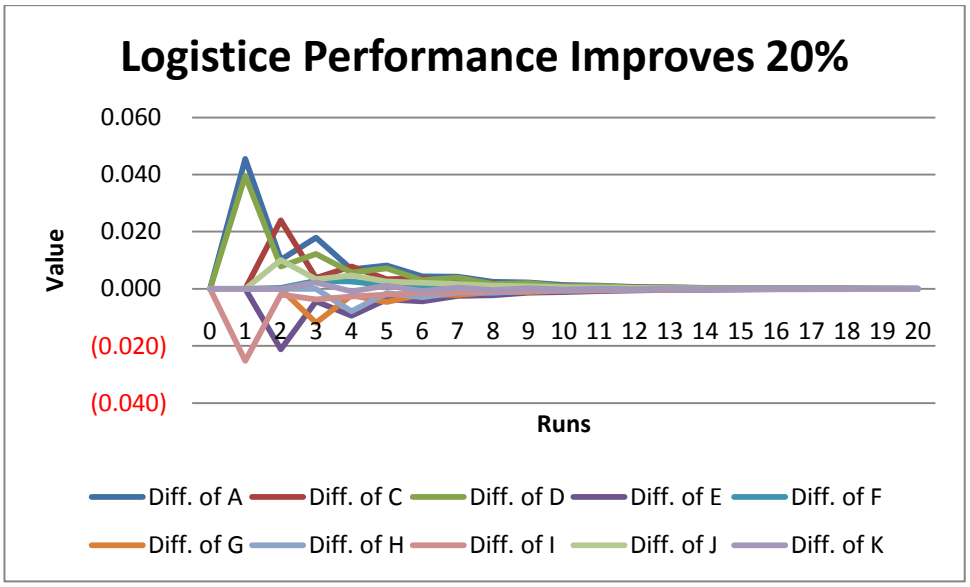


Fig. 9.The difference between the scenario with and without positive changes in the initial value of Concept B

Once the value of logistics performance increases 20%, the following changes would be noticed:

1. The market share and total profit also increase for about 140 and 120 workdays each.

2. The movement of utilization follows market share accordingly.

3. The increase of e-tailers' balancing order starts after the 20$^{th}$ workdays and ends after 90$^{th}$ workdays. The e-tailers' balancing order would last a period of time.

4. The lack of fixed assets also occurs on the 30$^{th}$ workdays and ends on the 70$^{th}$ workdays.

5. The statuses of competitor competitiveness, turnover of talents, and confidentiality disclosure are comparatively diminishing at initial and be the same with the original output in the long run.

## 4.2. Scenario 2: The relationship with e-tailers improves 20%

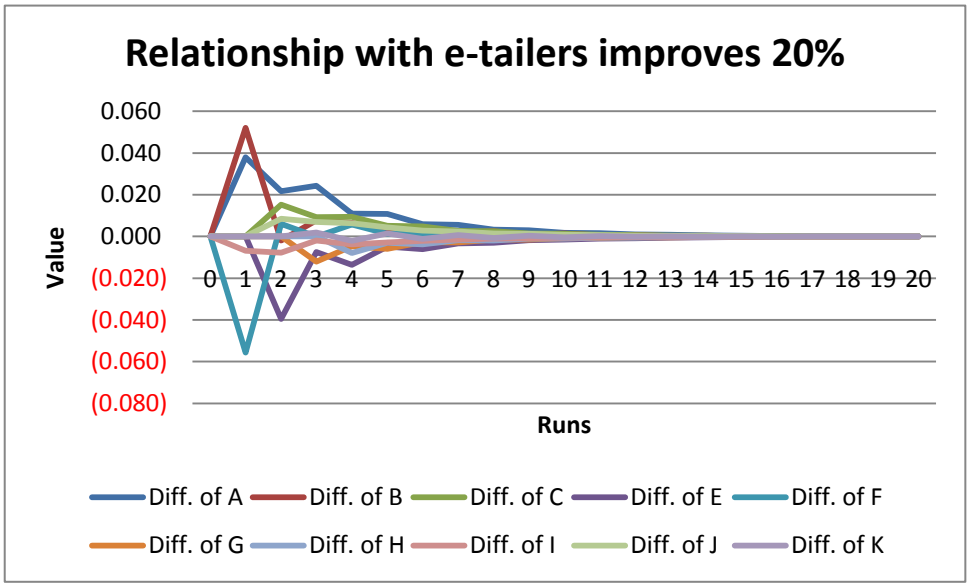


Fig. 10. The difference between the scenario with and without positive changes in the initial value of concept D

It is observed from the above figure that when the relationship with e-tailers positively increases 20%,

(1). The market share and total profit also increase for 140 workdays and 120 workdays each.

(2). The problem of lacking fixed assets arises accordingly with the increased market share.

(3). Utilization rate increases in accordance.

(4). Value of some concepts such as competitor competitiveness and confidentiality disclosure goes down on the beginning workdays.

(5). E-tailers' balancing order drops tremendously on the 10$^{th}$ workdays, and then greatly ascends because of the increasing market share.

## 4.3. Scenario 3: Unfitting Size of Fixed Assets improves 20%

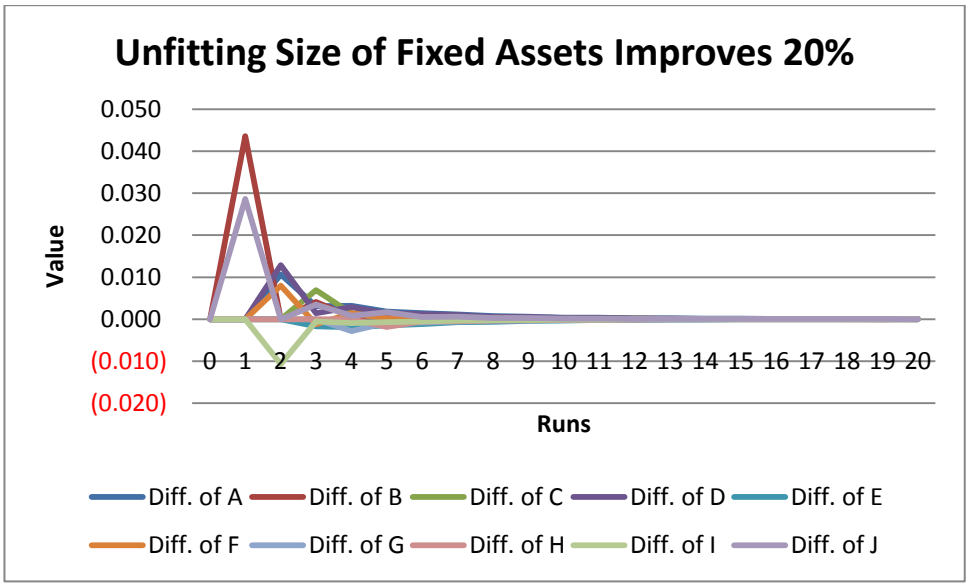


Fig. 11. The difference between the scenario with and without positive changes in the initial value of concept K

If the value of unfitting size of fixed assets improves 20%, the following changes would be noticed:

(1). The market share increases for 90 workdays.

(2). Total profit increases for 70 workdays.

(3). The increase of e-tailers' balancing order starts after the 20$^{th}$ workdays and ends after 50$^{th}$ workdays. The e-tailers' balancing order would last about 30 days.

(4). Other negative concepts are diminishing at first and step by step the value of concepts are the same with the original output.

## 4.4. Scenario 4: Sudden Increase to the Competitor Competitiveness 20%

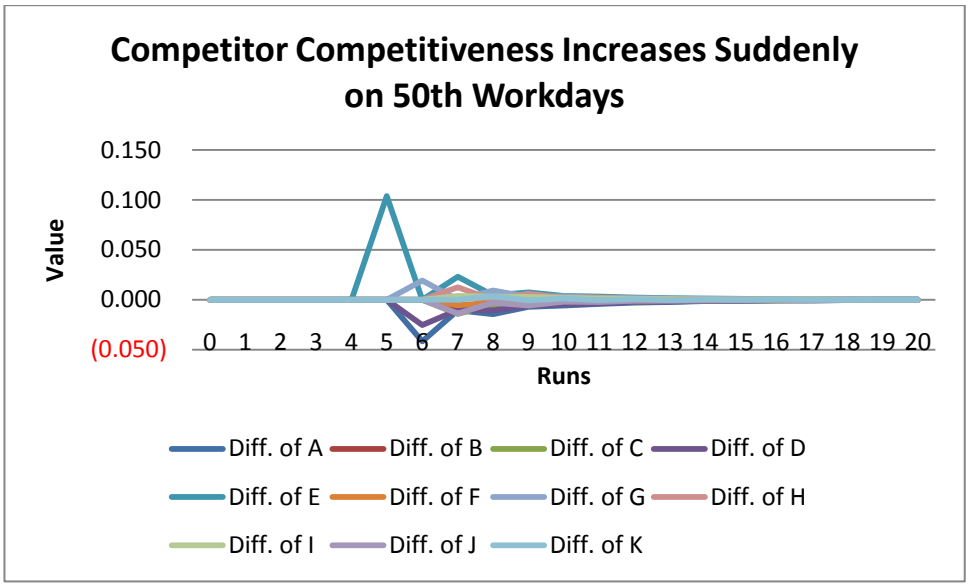


Fig. 12. The difference between the scenario with and without sudden positive changes in the 5th run value of concept E

It is the simulation output that the competitors promptly improve their competitiveness by, for example, service innovation, etc. Some observations are notified.

(1). The market share and the relationship with e-tailers soon drop.

(2). The turnover of talents and confidentiality disclosure increase after the competitor competitiveness ascends.

(3). Once the competitor competitiveness increases 20%, it may take130 workdays for the Kyyo Logistics to catch up with them.

## 4.5. Commentary on the Scenario Analysis

There are some scenarios analyses are proposed from section 4.1. to section 4.4.

(1). The 20% improvement of logistics performance.

(2). The 20% improvement of relationship with e-tailers.

(3). The 20% improvement of unfitting size of fixed assets.

(4). The 20% improvement of competitor competitiveness at the pointed time.

**The 20% Improvement**

From the previous three analyses, the study observes that "Same for the 20% improvement, the effects differ." The 20% improvement of logistics performance and relationship with e-tailers seems to be better than the 20% improvement of unfitting size of fixed assets. The table 9 shows how three scenarios bring long-term or short-term changes, and the influence level to the concepts. Table 10 tells the what signs stand for.

Table 9. The overview to three scenarios effects

| | | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sce. 1** | Short-Term Influence | ++ | | + | ++ | - | 0 | 0 | 0 | - | + | 0 |
| | Continuity | ++++ | | +++ | ++++ | --- | + | --- | -- | --- | +++ | +/- |
| **Sce. 2** | Short-Term Influence | ++ | +++ | + | | -- | --- | 0 | 0 | - | + | 0 |
| | Continuity | ++++ | ++++ | +++ | | ---- | +++ | --- | -- | --- | +++ | ++/-- |
| **Sce. 3** | Short-Term Influence | + | ++ | 0 | + | 0 | + | 0 | 0 | - | - | |
| | Continuity | ++ | ++ | ++ | ++ | -- | + | - | - | - | -- | |

Table 10. The corresponding meaning of signs

| | Descriptions | Signs |
|---|---|---|
| **Short-term（within 3 runs）Influence** | Diff.=0 | 0 |
| | Diff. >0 | +/- |
| | Diff. ≥0.3 | ++/-- |
| | Diff. ≥0.5 | +++/--- |
| **Continuity** | ≥ 3 runs | +/- |
| | ≥ 6 runs | ++/-- |
| | ≥ 9 runs | +++/--- |
| | ≥ 12 runs | ++++/---- |

According to the above table 9, if we would like to decrease the effects of balancing order, the better way is to improve relationship with e-tailers. However, the simulation also tells that if the relationship does improve, the effect will last for just such a period of time. What if the top management would like to depress the competitor competitiveness, the better method is also to improve relationship with e-tailers, not logistics performance or fixed assets, according to the changes noticed.

Moreover, the sudden 20% improvement competitor competitiveness is also simulated. It is observed that once the sudden enhancement happens to the competitor competitiveness, for example, new service or new infrastructure, Kyyo Logistics need to take about 130 workdays to regain its market share. Therefore, it is recommended for Kyyo Logistics to surpass their competitors at least 130 workdays or 182 days to deal with the sudden changes.

In sum, top management of Kyyo Logistics could apply the proposed fuzzy cognitive map to simulate different scenarios to quickly explore the possible changes

# Chapter 5 Conclusions and Suggestions

## 5.1. Conclusions

E-tailing has been a popular business in recent years, and it becomes more conspicuous than before especially after the financial crisis. However, how to deliver the goods to the consumers is a big issue to the e-tailers. Thanks to the widespread convenience stores in Taiwan and the well-functioned third-party logistics providers, e-tailers can successfully find out a way to have consumers' orders delivered. That is, e-tailers provide consumers with the service of shopping on-line in an electronic store and picking up goods at a convenience store. It is the third-party logistics providers that put the finishing touch on the e-commerce retailing delivery.

In this study, the proposed FCM concerning the operation dynamics of the third-party logistics providers within the e-commerce retailing delivery model is constructed and explored. Through the many field trips to the selected companies of third-party logistics providers, in-depth interviews as well as discussions with experts, and literature reviews, this research constructs 11 concepts and strength of relationships among them. The influential concepts such as market share, logistics performance, and relationship with e-tailers are explored and found.

The output of FCM has shown reasonable trends and effects in relation to the scenarios studied. What interests us the most is the connections among and in between market share, logistics performance, relationship with e-tailers, and competitor competiveness because they cast more impacts on the entire concepts interwoven within the map.

It has been noticed that the model predicts an ascending market share and total profit if the relationship with e-tailers and logistics performance are significantly

improved. It is also interesting to note that as the relationship with e-tailers and logistics performance are significantly improved, the negative concepts like competitor competitiveness are more or less mitigated, and which means the improvement of logistics performance as well as relationship with e-tailers could help Kyyo Logistics get through the obstacles, and ultimately become more competitive. As expected, the utilization rate and the problem of lacking fixed assets are outstanding in accordance when the relationship with e-tailers and the logistics performance are increased. As to the e-tailers' balancing order, it does occur when the market share is increased, and which is a risk diversification mechanism for e-tailers. Besides, the sudden enhancement of competitor competitiveness is simulated. The simulation foretells if the competitor competitiveness improves 20%, the Kyyo Logistics will regain its market share after 130 workdays. It's a concrete period of time for Kyyo Logistics to prepare itself well in case of sudden accidents happen. Last but not least, there is something more could be discussed behind the 20% improvement. The one who would like to apply the simulation output should rethink the cost-effectiveness.

In conclusion, the proposed FCM could be used for systematic studies both as an instruction tool and research tool. Before making strategic simulations, top management of logistics business could control the concepts they are interested in and take into account the simulation output.

## 5.2. Suggestions

### 5.2.1. Concepts and Strength of Relationship

It should also be pointed out and emphasized that this is a model with much unintended vagueness, and can be more credible if more authoritative opinions from experts are incorporated. Concepts are comparatively few to well describe the system. strength of relationships are also vague, not specific.

### 5.2.2. Data Processing and Data Consistency Verification

It may be appropriate to apply the idea of “Fuzzy Set” into data processing procedure. It may provide a different perspective into the study.

Besides, the data consistency verification applied in the study is not conscientious enough because the acceptable interval is set as 0.33, and which is not academically approved to be suitable. It may be somewhat debatable.

### 5.2.3. Selection of the Bounded Signal Function

In reality, there are several functions could be used to transform the value. The study applies the most used function. There may be other functions that could better portray the trend of concepts.

### 5.2.4. Simulations

The simulation per run is set to be 10 workdays because of the practical considerations. However, it is still arguable that not all the concepts could be activated within 10 workdays. In the meantime, the simulation could be more complicated to discuss more issues.

Although the constructed fuzzy cognitive map exist some unintended drawbacks,

however, it is a useful tool for quick and comprehensive explorations, for better understanding of the dynamics involved, and for building a basis of more complicated scenarios.

But further explorations are still needed to verify its credibility and to fine-tune the various concepts and operation processes involved.

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# Appendix

您好：

這是「**應用模糊認知圖協助提昇第三方物流業者營運績效**」之系統關聯模式問卷調查表，其目的在於探討某些關鍵因素的改善對第三方物流業者營運動態所帶來的影響。本問卷調查僅供學術研究使用，敬請撥冗詳細填答，您的專業經驗與答覆，對本學術研究會有莫大的幫助，感謝您的支持與協助。

國立交通大學交通運輸研究所

請於下表填入變數之間的影響數值，如兩變數為正相關，請填入小數點兩位內且介於（**0~1**）之間的數值，負相關則請填入小數點兩位內的數值（**-1~0**），如填表者認為兩變數無影響關係，請直接填寫數值**0**即可。

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A. 市佔率 | 0.00 | | | | | | | | | | |
| B. 物流績效 | | 0.00 | | | | | | | | | |
| C. 總利潤 | | | 0.00 | | | | | | | | |
| D. 和電子零售業者之關係 | | | | 0.00 | | | | | | | |
| E. 競爭者競爭強度 | | | | | 0.00 | | | | | | |
| F. 電子零售業者平衡訂單決策 | | | | | | 0.00 | | | | | |
| G. 人才業內流動 | | | | | | | 0.00 | | | | |
| H. 內部資料轉移 | | | | | | | | 0.00 | | | |
| I. 平均每單位物流成本 | | | | | | | | | 0.00 | | |
| J. 產能利用率 | | | | | | | | | | 0.00 | |
| K. 固定資產規模與品質不足 | | | | | | | | | | | 0.00 |
| 狀態評估（Rating） | | | | | | | | | | | |

請在Rating部份，填入您認為能代表該公司目前狀況的數值，數值範圍請介於0~1之間。舉例說明：K. 固定資產規模與品質不足 若Rating為1，即代表固定資產規模與品質極為不足；A. 市佔率 若Rating為1，即代表該公司的市佔率極為龐大。

下頁為問卷要素說明。

| *關鍵因素說明* | |
|---|---|
| **關鍵因素** | **說明** |
| **A. 市佔率** | 在店配市場中，所處理的貨品量所佔有的比率。 |
| **B. 物流績效** | 資料傳輸、倉儲、理貨、揀貨、包裝和配送等之速度與可靠度(能在電子零售業者要求的貨品狀態下、時間內完成任務)。 |
| **C. 總利潤** | 總營收扣除總成本之差額，可自由運用於人事留任或資遣、購置或維修固定資產等處，以補不足。 |
| **D. 與電子零售業者之關係** | 人際關係在台灣貿易中是很重要的一環。業務代表通常會透過彼此間的交情，來影響下單量、價格和資訊交換狀況等。 |
| **E. 競爭者競爭強度** | 競爭者在店配市場的影響力，通常是競爭者能力、績效和與電子零售商的關係的整體概念來表達。 |
| **F. 電子零售業者平衡訂單決策** | 為避免過度仰賴某第三方物流業者，電子零售商通常會適度轉單給其他家第三方物流業者。 |
| **G. 人才業內流動** | 優秀人才有時會被競爭者挖角，進而加強競爭者的競爭力。 |
| **H. 內部資料轉移** | 人才被挖角時，通常也會帶著原有公司的文化、技術和顧客資料過去。 |
| **I. 平均每單位物流成本** | 平均處理每單位商品所需之(資訊、倉儲管理、包裝和運輸所衍生的)成本。 |
| **J. 產能利用率** | 廠商實際總產出佔總產能的比率。 |
| **K. 固定資產規模與品質不足** | 指地產、倉庫和機械設備的規模、品質因某種因素（如損壞、販賣）等而不足。 |

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