國立交通大學

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碩士論文

應用模糊認知圖探討影響電子商務
24 小時到貨系統因素間關係

Using Fuzzy Cognitive Map for the Relationship Management in the 24-hour Delivery System for Online Shopping

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摘要

台灣在物流領域中，與其他國家較不同的營運方式，除了便利超商取貨之外，宅配到家的商業服務模式已蔚為風行。剛開始提供鞋子、衣服等商品；近年來，隨著線上購物模式的成熟發展，貨品的種類已延伸到日常生活用品。為了因應線上購買日常生活用品的需求，訂購的物品能不能在24小時內宅配到家，則成為值得探討的議題。有鑑於此，本研究希冀找出影響24小時到貨服務的重要因素，希望能提供給其他想發展24小時到貨服務的公司參考使用。回顧其他相關文獻得知，先前的研究在探討這類議題時，會使用最佳化模式或是分析網路程序法(ANP)來求解；本研究有別於其他研究的是找出影響24小時內到貨的重要因素，再透過敏感度模式（SM）及模糊認知圖（FCM）來做探索性分析，探討各個因素間相互影響的關係。研究結果顯示，24小時購物訂單數量、達到24小時配達能力以及具備穩定的庫存量是關鍵參數。

敏感度模式與模糊認知圖為兩種易於探討因素間關係的模式，能在短時間有效率的收集專家意見，將各領域專家的意見做結合，以表達出整個系統變數間的相互影響關係。藉由專家提出對關鍵因素的影響下，找出改善24小時購物服務的關鍵因素，以利於其他想發展24小時到貨服務業者往後經營之參考。

關鍵字：24 小時到貨，敏感度模式，模糊認知圖

USING FUZZY COGNITIVE MAP FOR THE RELATIONSHIP MANAGEMENT IN THE 24-HOUR DELIVERY SYSTEM FOR ONLINE SHOPPING

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ABSTRACT

In Taiwan, the shopping on-line service in an electronic store and picking up goods afterwards at home could be quite common and attractive these days, although the relationship between identified attributes may often be deemed contradicting to one another. Therefore, this study intends to focus on the approaches for improving 24-hour delivery performance by proposing appropriate Sensitivity Model (SM) and the Fuzzy Cognitive Map (FCM). According to the SM, we can see variables like “Order of 24-hour delivery service”, “Ability to achieve 24-hour delivery”, and “The resilience of safety stock” are critical to the system. Whereas, FCM is basically a cognitive map, within which, the relations between the elements (concepts) of a mental landscape can be employed to compute and estimate the impact strength for these elements.

In summary, SM and FCM can be adopted for systematic studies both as the instruction tool and the research tool as well. Then, the top management of PChome can have the option to exercise control for the concepts they are interested in and take into account the impact from simulation output. The findings from this study can be expected as references for future studies to improve the service for 24-hour delivery**.**

Keywords: 24-hour delivery, Sensitivity Model (SM), Fuzzy Cognitive Maps (FCM)

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研究所的這兩年，對我來說是人生的轉捩點。首先要感謝交通大學交通運輸研究所的老師們，給怡雯機會推甄錄取，也才有機會寫下這篇論文及誌謝。大學時常聽學長姐說：位於台北校區的北交研是快樂北交；是的，這裡的確是快樂北交，感謝馮正民老師、汪進財老師、黃台生老師、黃承傳老師、陳穆臻老師、邱裕鈞老師及許鉅秉老師提供一個溫馨的學習環境，讓怡雯在研究所能在充滿歡笑聲中學到很多知識，諸位恩師給予的提攜，怡雯感激不盡。

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怡雯

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Chapter 1 Introduction

1.1 Research Background

With the fast growth of broadband internet connection, shopping on-line has become a common way for those who want to pick up goods at home. With regard to the relationship between online searching and buying, research findings show that the searching online would positively affect online buying. Searching online also definitely influences the frequency of shopping trips online, which in turn, certainly influences the buying online. These findings suggest that, for some people, e-shopping could be a time-saving strategy, and leisure-oriented for others. Buyers can compare the goods via different websites, and then choose the best possible options offered at the website that they really want to buy. The shopping site will deliver goods to buyers' home in few days after the transaction is complete.

At the beginning, online shopping provides time-insensitive purchasing for the goods, such as 3C products, clothes, bags and so on. As it matures in recent years, the food items are also available; then these extended to the purchases for appliances, refrigerators, and even daily necessities, toilet paper. Since the on-line shopping market is more competitive than what would have been in a normal shopping environment, some suppliers may face the huge and tough losses. Therefore, constant improvement for the service quality remains to be the key factor for most sellers to survive in the business.

Recently one seller has found out that the top customer FAQ (Frequently Asked Questions) is: "When will I receive the goods?" The seller believes customers who are time-conscious would prefer the website offering 24-hour shipping for goods than others who can't. Therefore, the speed would also emerge as a prominent factor for sellers to compete with each other. In addition, the seller provides 24-hour shipping service, i.e. the customers can pick up ordered goods within 24 hours after the payment made. To achieve the 24-hour delivery goal, the seller has to concentrate on vendors' goods, comparing to the zero

inventory practice in the past. The challenge to switch from the original zero-inventory mode is the reason why vendor goods should be in the seller's warehouse for temporary storage. In order to convince the vendors, the seller needs to commit vendors go into the warehouse practice at any given time, and the seller has to agree to compensate if any goods were damaged. So there will be a huge investment upfront in building the warehouses in addition to precision daily inventory.

This study will focus on the 24-hour delivery shopping. The literature for on-line shopping will be reviewed, and the key factors of not accomplishing the 24-hour deliveries will be located via experts' in-depth interviews. The relationship between those factors will be discussed and probed through using FCM method. This study intends to streamline the resolutions for the problems identified so as to improve the service quality to realize the 24 hour delivery eventually.

1.2 Research Motivations

This study would attempt to supplement the findings from earlier studies. With increased usage of the World Wide Web (WWW), on-line shopping has become a new trading mode and widely preferred by consumers. Now, more and more operators launch new services for speeding up the delivery of this Taiwan's consumer business model. Customers can shop online without going out at all or waiting in a long time, instead, they can pick up the goods within 24 hours. It is similar to the studies discussed above that the focus is on side of logistics service. And this differs from previous studies. However, the idea of finding out the relationships between the concepts proposed can be used to compute the "strength of relationship" for these elements.

In recent years, there has been a dramatic proliferation of researches concerning on-line shopping. Shopping on-line has become a very common way for those who want to pick-up goods in convenience stores or at home within 24 hours. More recently, interest in comparative analysis has shifted towards in reflecting current developments with timesaving

consciousness which emphasizes picking up goods within 24 hours after the payment. Nonetheless, there exists a mechanism to compensate delay shipment experienced at the customer end. As for the customer, they trust the sellers and believe they can pick up their orders within agreed-upon 24 hours. If customers order goods, the goods will be received within 24 hours after payment, or customers can get the cash back as compensation for the un-kept promise. Thus to find out the key components for 24-hour shipment, this could be the motivation identified in this study, and the relationships between different components will also be discussed.

Fuzzy cognitive maps are signed fuzzy digraphs. FCM is a fuzzy cognitive map which the relations between the concepts can be used to compute the "strength of relationship" for these elements. It helps demonstrate or simulate how experts deliberate upon a particular issue. In addition, it puts causal relationships in use and provides functionalities of feedbacks.

Little literature has been published on the 24-hour delivery approach with FCM model, the study is more like an exploratory research. Hence, in order to get to know the issues which we are interested, it would be more appropriate to apply FCM because of its fewer limitations in application, and it may facilitate the removal of any potential research obstacles.

Because of the short history in development and difficulties experienced in data collection, there have been very few studies about the 24-hour delivery model. For this reason alone, it is worthwhile to explore the critical concepts (or system variables, parameters) imbedded in the 24-hour delivery model, the strength of relationships between concepts, and the feasible enhancements to the identified negative effects within the overall dynamic environment.

1.3 Research Objectives

This study is concerned with proposing a fuzzy cognitive map (FCM) driven approach for improving the performance for 24-hour delivery. A Fuzzy cognitive map can be used to compute the strength of impact for these elements, and the research issues are included as

follow:

- Issue1: To find out the relations between the important concepts for the achievement of 24-hour delivery.
- Issue2: Describe how we apply Sensitivity Model and Fuzzy Cognitive Maps in the simulation for the system relationship model.
- Issue3: Understand what inputs can be used to improve the service for 24-hour delivery.

1.4 Research Scope

The advantage of zero inventory and cost is considered as the most efficient business model for online shopping. However, customers' demands have been brushed aside and taken for granted. Until recently, PChome has had maintained its own warehouse. When consumers order goods in the morning and PChome will start their packaging process. The routine practice would be that consumers can pick up the ordered products in the afternoon of the same day.

Since this study is focusing on the service of shopping on-line and the purpose is to find out the crucial factors that will influence 24-hour delivery from technology manager's viewpoints. Therefore, the research scope of this study is highlighted in Figure 1.1

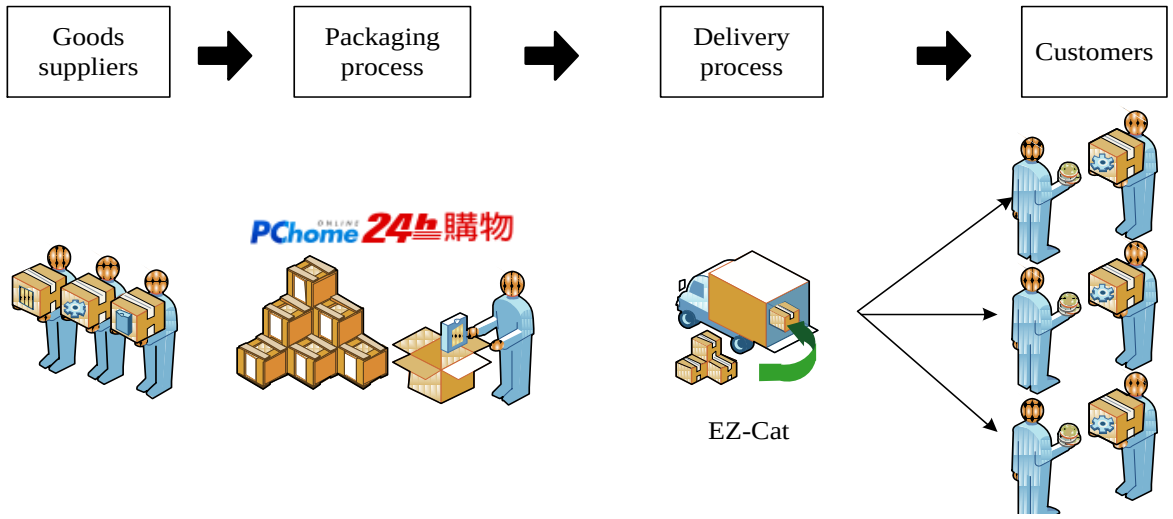

Figure 1.1 Research scope

1.5 Research Procedure

In Chapter 1, this study defines research background, motivations, and research objectives. The remaining of this research is arranged as follows: Chapter 2 describes the 24-hour delivery background and reviews related literature on 24-hour delivery, and methodology of Sensitivity Model and Fuzzy Cognitive Map. Chapter 3 shows the construction for concepts of 24-hour delivery. Chapter 4 shows how the methodology processes. In Chapter 5, the study will analyze the scenario output generated by FCM. In Chapter 6, conclusions as well as recommendations for future research will be discussed and proposed. Research procedure can be referenced and depicted in Figure 1.2.

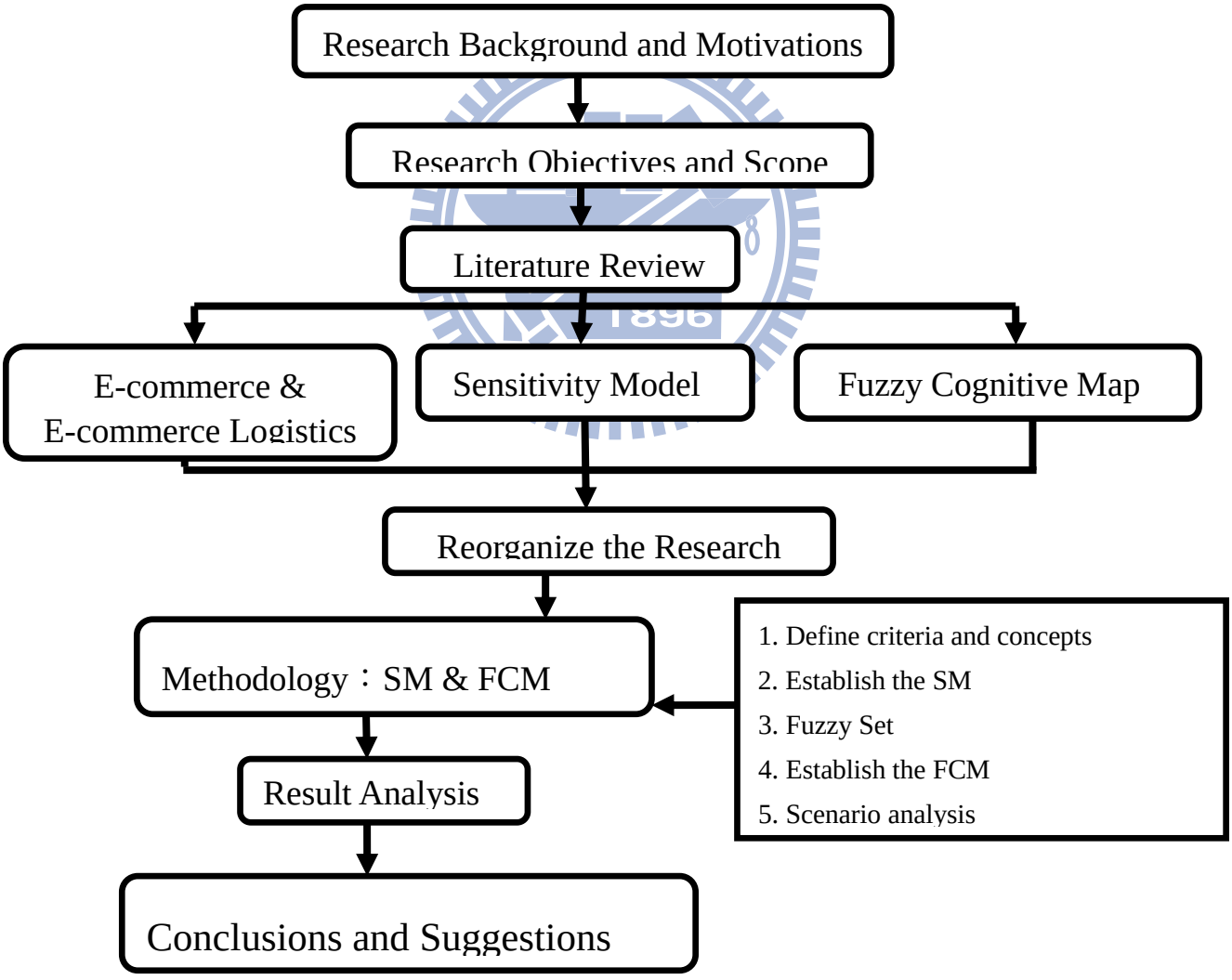

Figure 1.2 Research procedure

Chapter 2 Literature Review

2.1 E-commerce

Nowadays, the on-line shopping increasingly becomes a fast growing business and serves as a brand-new channel between sellers and buyers, i.e. e-commerce. Buyers can surf on the Internet, browsing any information with few restrictions; for sellers, the electronic stores stand for a new channel to reach to buyers. Urban residents shop online more often than suburban residents, because their inclinations are facilitated with faster Internet connectivity *(Farag, Sendy, Tim, Martin, & Jan 2007).*

The development of information and communications technology (ICT) and e-business has profound influence on the competitiveness for a country, and the industries and businesses within it. In recent years, progress from ICT and e-business applications had played a very significant role in economic transformation in almost every country. Taiwan has been behind the establishment for well-developed IT infrastructure and more and more citizens and businesses embrace both the concept and practice for e-business *(2004 e-Business White Paper in Taiwan)*. Hence, consumers worldwide can shop online 24 hours a day, seven days a week, and 365 days a year *(Bellman, S., Lohse, G.L., & Johnson, E.J., 1999).*

According to Taiwan's e-business vision and goals, the future development of e-business in industrial and business fields will converge on the six focal points: i.e. "establishing high-efficiency supply chain management networks," "deploying logistics and marketing channel systems," "developing business models for knowledge-based services," "enhancing SMEs' e-business application capabilities," "establishing a sound e-business infrastructure," and" promoting the information technology services industry"*(2004 e-Business White Paper in Taiwan).*

Since the birth of shopping on-line via the Internet, e-commerce would be perfect for the buying and selling of products or services over electronic systems through the Internet and other computer networks. Now, reliable and timely delivery is one of the fundamental objectives for online shoppers. For this reason, the timely service for shopping on-line and picking up goods quickly would be paramount.

2.2 E-commerce Logistics

While studying online shopping behavior, we should bear in mind that logistics service is one of the fundamental objectives for serving online shoppers. Online shoppers place their orders at their office or home, anticipating quicker delivery than offline purchasing, and timely delivery would fit the bill *(Soopramanien and Robertson, 2007).*

It is essential that the Government promote the establishment of high-efficiency supply chain management networks, facilitating the communication and coordination between Taiwanese firms and their partners in industrial systems spanning across the Taiwan Strait or all over the world *(e-Business White Paper in Taiwan, 2004).*

Delivering goods to customers is a critical to any business. Therefore, when it comes to the organization of e-commerce transaction and physical distribution (PD), it is extremely important to distinguish between customer-related activities, such as order receiving, sales and marketing, and the processing and shipment for the ordered goods *(M. Hess 2002).*

Logistics can be as part of the service industry. The quality of logistics service performance is a key marketing component facilitating in the creation for customer satisfaction *(Mentzer, J. T., Flint, D. J., & Hult, G. T. M., 2001)*

Driven by the need for timely delivery system, competent information systems and low logistics operations cost due to economic scale, would be the precursors for logistics providers who have had to improve the flow of information both internally and externally, and integrate their logistics services in a comprehensive manner.

Since the advent of online shopping the service itself could not be successfully operated

without logistics support. Logistics service quality (LSQ) poses a significant impact on projected revenue and profitability. Empirical research results are shown in detail to confirm seven LSQ dimensions with Chinese characteristics, including qualities like timeliness, personal contact, order placement, order discrepancy handling, order status and conveniences. Hence, statistical analyses of the investigation were conducted to test the reliability and validity of the LSQ evaluation model *(FENG Yi-xiong, ZHENG Bing, &TAN Jian-rong, 2007)*

However, there is little research on the issues like 24-hour delivery for the online shopping environment.

2.3 The Development of SM and its Applications

The methodology derives from bio-cybernetics and incorporates feedback loops to check and balance the system performance with the analogy of symbiotic relationships between humans and the environment *(Vester, 1988)*. Sensitivity model is a semi-quantitative modeling tool based on system thinking and fuzzy logic, developed in the 1975 UNESCO program, Man and the Biosphere (MAB II). It has been used by major corporations such as IBM, Siemens, Daimler-Benz, Hoechst, as well as governmental agencies and academic institutes *(Chan & Huang 2009, Ulrich 2005).*

The fundamental ideas of SM, differing from other planning approaches, include system thinking, the use of fuzzy set theory, and simulation through semi-quantitative data (*Chan & Huang*, 2004).

Professor Vester elaborated on the basic structure of the sensitivity model and presented eight pertinent bio-cybernetic principles of good-system practice *(Vester, 1988).* Afterwards the variable set had to be checked against 18 essential criteria for any viable system, extracted from the main points listed here: People, economy, realm of space, human ecology, energy and waste, infrastructure, and laws and culture *(Vester, 2007).*

The sensitivity analysis according to Vester suggests a structured set of nine methodical

steps for a comprehensive construction and analysis of the models based on circular causal logic (see Figure 2.1 below). Sensitivity modeling enables four different, complementary approaches to understand a system under development. The very foundation is a system's description and a registration of a set of key variables. Once having established the premise, we can distinguish the four different purposes facilitating the understanding of the system under development (see Figure 2.1below):

1. Understand the system as a whole, e.g. explore the 'character' of each key variable: This view addresses the relative role of each variable from a systemic point of view.

2. Explain the cybernetics of a system, e.g. analyze interdependencies between key variables: This approach considers that how key variables relate and how they influence each other.

3. Simulate the system dynamics, e.g. understand disturbances within and to the system: This approach focus on changes to the system, e.g., once a new variable is introduced, another is eliminated or a wildcard appears.

4. Assess system cybernetics, e.g. examine the overall sustainability of the system: This approach asks how likely it is that the system will grow sustainably or is in threat of total extinction. This view is based on eight cybernetic rules formulated by Vester (Vester, 2007).

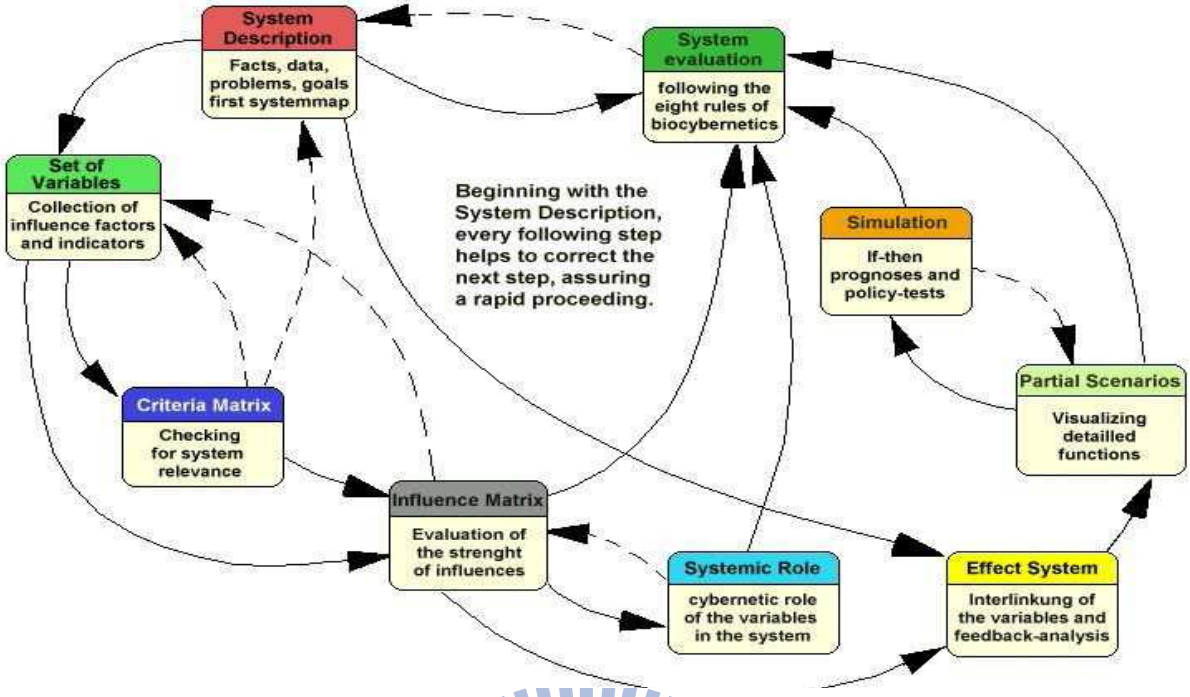

Figure 2.1 The recursive structure of sensitivity analysis (Vester, 2007)

The data required in the SM are prepared with the fuzzy logic approach. Fuzzy logic provides a new systematic way of thinking by which complex systems can be understood without detailed precision but nevertheless accurately with only a few ordinal parameters.

Sensitivity analysis according to Vester has been applied in such diverse areas as urban and regional planning. There are many references where the method has been successfully applied to different fields of research, regional and environmental planning and risk management.

2.4 The Development of FCM and its Applications

Cognitive maps (CM) have been deemed as a useful tool in problem-solving *(Axelrod, 1976 and Eden and Ackermann, 2004).* A CM demonstrates how humans deliberate upon a particular issue by analyzing, arranging the problems and graphically mapping interconnected concepts *(Eden & Ackermann, 2004).* For this reason, CMs enable decision-makers to analyze the potential casual relationships among concepts which can help reach more significant and meaningful solutions. Also, a CM 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, Peter P.Groumpos & Chrysostomos D.Stylios, 2000).* 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 and satisfy human desires. Example systems include Web-mining systems *(Lee, Kim, Chung, & Kwon, 2002).*

Through adding plus (+) and minus (−) signs, it allows the identifying of the type of relationship *(Dikerson & Kosko, 1993),* positive or negative. The concern of a CM is to see whether the state of one element is perceived to have an influence on the state of the other. Positive causal links (denoted as '+') should be regarded as excitatory relationships while negative causal links (denoted as '–') as inhibitory relationships between nodes .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 CMs, that is, the restriction of quantifying relations 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 map *(Bart Kosko, 1986).*

Fuzzy cognitive map (FCM) is a symbolic method for modeling and controlling a system which relies on expert experience and follows the principle of "decreasing precision with increasing intelligence". FCM is an extension of cognitive maps, and it is useful in modeling complex systems *(Peter P. & Chrysostomos, 2000).*

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. FCMs are fuzzy signed graphs with feedback. A FCM models a dynamic complex system as a collection of concepts and causal relations between concepts. 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. A simple illustrative picture of a FCM is depicted in Figure 2.2, for the five possible nodes-concepts

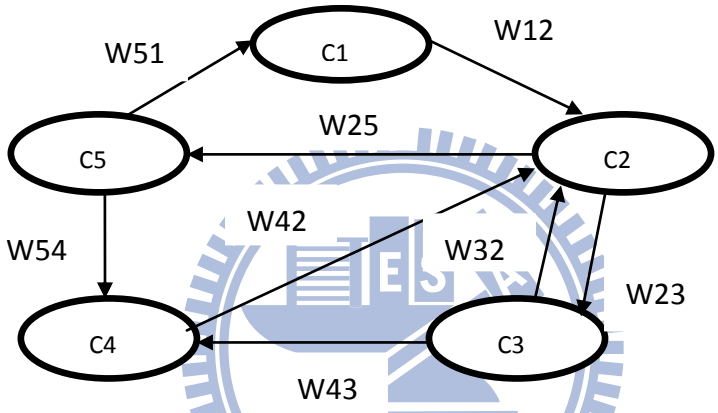

Figure 2.2 An example of a fuzzy cognitive map with concepts and weighted

They consist of nodes-concepts C_i and the interconnections w_{ij} between concept C_i and concept C_j. Further in calculation, FCM can be represented by an $n \times n$ adjacency matrix (w), while n is the number of nodes. By values between [−1, 1], each w_{ij} means the relationship between the i and j concepts. Consequently, three types of relationships can be seen: (a) $w_{ij} > 0$, indicating a positive relationship between concept C_i and C_j. Namely, an increase(decrease) in the value of C_i leads to an increase (decrease) in the value of C_j. (b) $w_{ij} < 0$, indicating a negative relationship between concept C_i and C_j. Namely, a decrease (increase) in the value of C_i leads to a decrease (increase) in the value of C_j. (c) $w_{ij} = 0$, where no relationship exists between concept C_i and C_j.

When an expert assigns a w_{ij} value, three issues must be kept in mind. First, the w_{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 shown to establish if the *i* concept is a cause of *j* or vice-versa (Rachung & Gwo-Hshiung, 2006).

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 (1):

$$C_i(t_{n+1}) = S\left(\sum_{k=1,k\neq i}^{n} w_{ki}(t_n) C_k(t_n)\right) \quad (1)$$

Namely, $C_i(t_{n+1})$ is the value of concept *Ci* at step t_{n+1}, $C_k(t_n)$ is the value of concept C_k at step t_n, and $w_{ki}(t_n)$ 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].

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, 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.

Besides, FCM is also applied to Strategic planning such as modeling political and strategic issues and situations *(Andreou A.S, Mateou N.H. and Zombanakis G.A., 2005).* Decision-making, project management, and investment analysis are also incorporated with it such as relationship management in airline service *(Kang, S. Lee and J. Choi, 2004).*

2.5 Summary of Literature and Commentary

The fundamental ideas of SM and FCM, which make them different from other planning approaches, include system thinking, and the use of fuzzy set theory. The Sensitivity model was by no means used for the first time in logistics, and here the use of SM is to make sure if all these problems are included.

The study applies the methodology “Fuzzy cognitive maps” to model and explore the operation for 24-hour delivery. The system model that has been developed can be used to study the effects of any parameter change on the stability and growth for the remaining parameters. It specifies the causal relationship among concepts and depicts the causal links, then, eventually facilitates PChome to implement the strategies in a global and systematic context.

Chapter 3 The construction for concepts of 24-hour delivery

3.1 An Overview of 24-hour Delivery

In Taiwan, portal sites such as Yahoo.com and PChome.com currently provide 24-hour delivery services for on-line customers, and have made significant inroads thus far.

Online shopping, it starts from people ordering through the Internet and then the process is transferred to the supplier to ship goods that the customers just ordered. The advantage derived from zero-inventory and cost is considered the most prescient and efficient business model. However, customer demands have been carelessly brushed aside and taken for granted.

3.1.1 Introduction 24-hour Delivery of PChome

The service of 24-hour delivery is a rapid delivery approach adopted by PChome. In this 24-hour delivery scheme, PChome has its own warehouse to support this, but the logistics has been outsourced to EZ-Cat.

From major events and PR announcements from PChome, we can understand why PChome (2007) grand launch of first 24-hour delivery service in the world and the monthly sales of 24-hour delivery service have exceeded NTD 100 million in November.

Table 3.1 Major events and PR announcements of PChome

Date	Major events and PR announcements
Oct 31th,2007	PChome shopping 24-hour delivery service achieved the landmark sales of NTD 100 million in single month.
May 14th,2008	Cross-border synergy between B2C and C2C: "PChome shopping 24-hour delivery" is now at "Ruten Auction"
May 19th,2008	PChome 24hr Delivery expands the service to the island around.
Aug 13th,2008	PChome Online Shopping provided customers COD (Cash-On-Delivery) service in 24hr Delivery.

Source: http://event.pchome.com.tw/ipo/english/press_e1.html

The chairman Jan Hung Tze and CEO Arthur Lee said: “Due to rapid delivery and providing more choice of goods, 24-hour Delivery’s turnover keeps growing and becomes more and more popular. We will continue to expand this service in the coming year, providing more choices of goods, and we expect the revenues will growing strong as well”.

3.1.2 The Introduction for 24-hour Delivery Model

The procedure that integrates PChome with EZ-Cat system to sustain the 24-hour delivery is illustrated below:

1. On-line shopping

Consumers are shopping on-line via the Internet. The PChome online has a designated area for 24-hour delivery goods, and all the goods in this area can be picked up within 24 hours.

2. Packaging process

The PChome transmits the information and actions taken for goods ordered, packaging process and transporting the goods to the delivery center of PChome. In real practice, after consumers order the goods and the packaging process should only take about 30 minutes.

3. Delivery process

The delivery center of PChome will collect the orders and EZ-Cat will transport them to customers, and then it will reply to server of PChome with order processing information.

4. Pick-up goods

Consumers can see the processed delivery which will be available on the website. According to the information replied from delivery center, the EZ-Cat will notify the consumers by e-mail or phone call for pick-up.

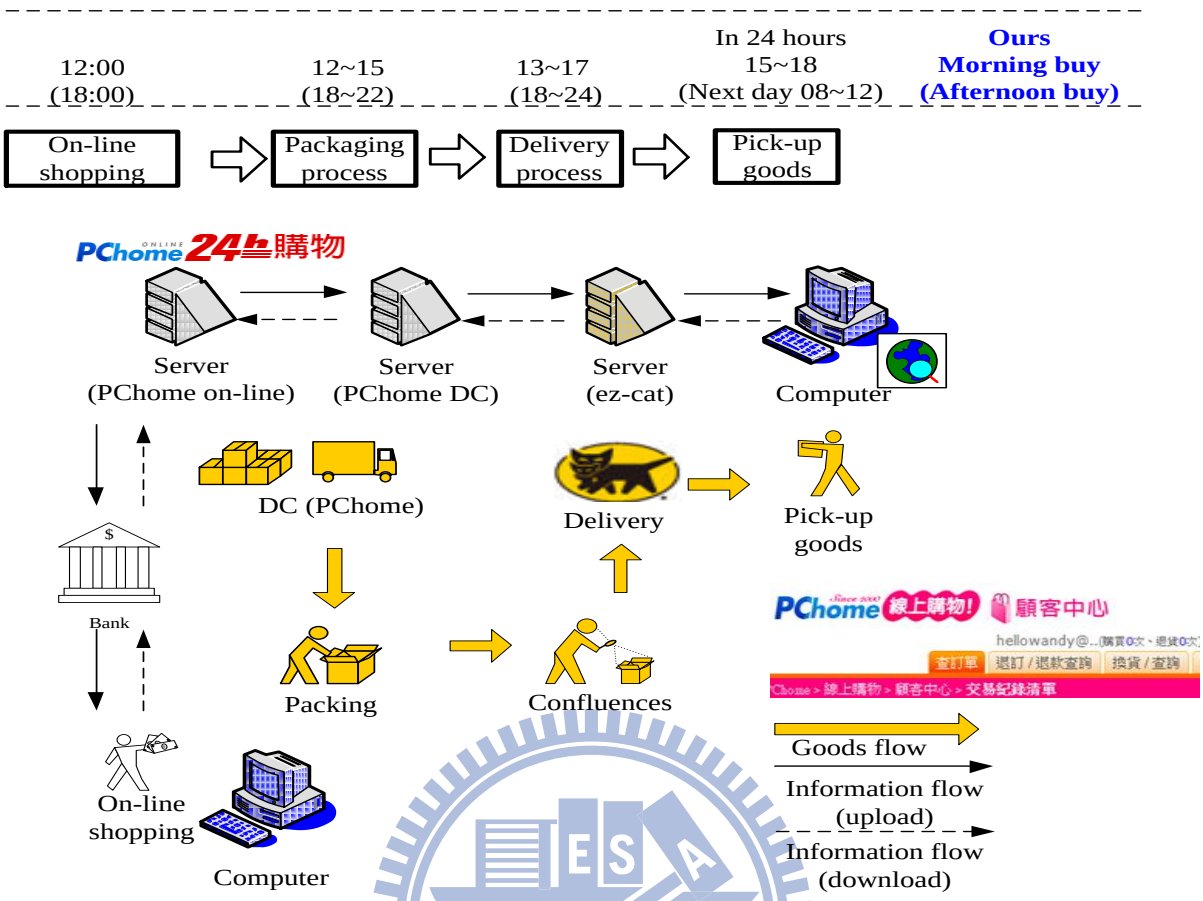

Figure 3.1 Goods flow and information flow in the24-hour delivery model

The information system of 24-hour delivery includes information accuracy, information flexibility, the speed of information, and information security. The most pertinent one would be the purchase order tracking information for customers.

As observed in Figure 3.2, Figure 3.3 and Figure 3.4, they illustrate the order tracking. Consumers can see the delivery processed via the website access.

Figure 3.2 Order tracking of goods flow (Order received)

Figure 3.2 shows a consumer shopping on-line via the Internet, and as the order condition has been certificated at today's 16: 27, the system informs the customer to receive the goods at16: 27 on next day.

Figure 3.3 Order tracking of goods flow (Packaging process)

Order tracking flow is represented in Figure 3.4. The delivery center of PChome processes the packaging for the order received until the EZ-Cat engages into delivery process. As shown in Figure 3.4, if for any reason, the customers return goods, they would be allowed to see the return list; we can then be sure that if the consumer places the order in the afternoon, and they should be able to pick up the goods in next morning.

Figure 3.4 Order tracking of goods flow (Pick-up goods)

3.2 Defining Criteria and Concepts

In order to construct the sensitivity model and fuzzy cognitive map to acquire the insightful characteristics from the identified problems, the first step is to explore the concepts within these two methods.

3.2.1 Defining Criteria

The construction of concepts is primarily based on: (1) Essentials of Service Marketing (Christopher Lovelock Jochen Wirtz Patricia Chew, 2009) (2) Field trips to PChome and in-depth interviews with experts according to the 24-hour delivery model. (3) The literature.

In the process for field trips and in-depth interviews, there are four categories within the criteria: purchasing category, logistics service category, image category, and information category; and criteria are identified as follow:

1. Purchasing Category

Service objective includes the promotion for customers to use online shopping interface by ordering the goods from Internet in addition to receiving the goods, thus, it is defined as the purchasing category.

(1) Web Interface

To evaluate whether the Web interface is easy to use or not would facilitate the smooth transition to real user-friendliness. Simple user interface can help customers in browsing, shopping, shopping trading, and order queries.

(2) Product Category

In order to meet customers' satisfaction, "Product Category" is always a major focal point for PChome. Based on customer demand for diverse types of goods used to evaluate the diversification of the system, then, PChome should have enough of the type and quantity to satisfy the customer.

(3) Maturity of 24-hour Delivery Model

The 24-hour delivery model that consumers order goods in the morning, and they will start their packaging process, and usually consumers can pick up the orders in the afternoon of

the same day. If the 24-hour distribution model becomes more mature, more customers would have faith on this shopping model.

2. Logistics Service Category

"Logistics service category" is defined as the outsourcing of logistics service to outside companies, and this also refers to the delivery of the process. As J. T. Mentzer et al. (2001) noted that logistics can be considered as a service industry. Therefore, logistics service category assumes an important role worthwhile for us to discuss.

One of the purposes of this study is that online retailers can use LSQ scale to understand the service expectations and perceptions of consumers better; as a result, subsequent improvements can be made for the LSQ. LSQ scale is brought into fully play when it is used periodically to track the LSQ trend, and also when it is used in conjunction with other forms of service quality measurement. An online retailer, for example, would learn a great deal about its LSQ and what needs to be done is to improve it by appropriately administering LSQ. The online shopping mall should have higher benchmarks so that the high quality for either online or offline will maintain the competitive edge in the online shopping market (FENG Yi-xiong et al., 2007).

The researches by Mentzer, Flint, and Hults' (2001) in logistics service quality can be summarized that the service quality perceptions are based on the dimensions of order placement and order receipt; and that rings true as a concept of procedure. Furthermore, the authors provided nine concepts to comprehensively evaluate the logistics service quality as result (Table 3.2).

Table 3.2 Definitions of the Nine Concepts about LSQ

Logistics Service Quality	Definitions
Personnel contact quality	The customer orientation of the supplier's logistics contact people. Customers care about whether customer service personnel are knowledgeable, empathize with their situation, and help them resolve their problems.
Order release quantities	Product availability. Customers should be the most satisfied when they are able to obtain the quantities they desire.
Information quality	Customers' perceptions of the information provided by the supplier regarding products from which customers may choose.
Ordering procedures	The efficiency and effectiveness of the procedures followed by the supplier.
Order Accuracy	How closely shipments match customers' orders upon arrival.
Order condition	The lack of damage to orders.
Order quality	How well products work, includes how well they conform to product specifications and customers' need.
Order discrepancy handling	How well firms address any discrepancies in orders after the orders arrive.
Timeliness	Whether orders arrive at the customer location when promised. The length of time between order placement and receipt.

Source: Mentzer, J. T., Flint, D. J., & Hult, G. T. M. (2001)

(4) Logistics Service Flexibility

The logistics provider offers a user-friendly of e-map mechanism for on-line shoppers. Customers maybe in an emergency and asked for early or postponed delivery, this situation clearly demands the flexibility from logistics service.

(5) Timeliness

Y.K. Huang and C.M. Feng explored the structure of logistic for RD service for electronic commerce. They conducted qualitative research to develop constructs for related items, such as timeliness and order condition designated to logistics service quality (LSQ) (C. M. Feng & Y. K. Huang, 2007). The time between placing requisition and receiving delivery is usually tight. Deliveries should arrive on the promised timeframe. Here is a case which uses whether on time or not as the means to evaluate the efficiency of this mode of distribution.

(6) Order Condition

The goods will be delivered to customers; prior delivery, customers are normally extremely concerned about the integrity of the goods received. Then the responsible party should ensure goods received from logistics provider are undamaged.

3. Image Category:

"Image category" is mainly related to psychological dimensions, which will have some impact on people's attitudes and behavior. These services include promoting, dealing with the lack of services, service attitude and so on.

(7) Promotion

Use the promotion activities to attain the short term sales objectives.

(8) Dealing with Timeliness

The promised goods need to be delivered within 24 hours. If the promise is broken, the company will give NT.100 coupons to customers as indemnification.

(9) Order Discrepancy Handling

It does not matter whether the order discrepancy handling is goods delivered to the "wrong place" or "wrong package", it definitely would affect the level of customer satisfaction. Then the order discrepancy handling will be instrumental to sustain the company positive image.

(10) Service Attitude

The delivery worker's service attitude is also important. Even the outsourcing to logistics companies, the service attitude would also indirectly affects the corporation's image.

4. Information Category:

Information is an intangible service, but it can still be converted into a permanent, tangible form.

(11) Information Flow Exchange

The logistics provider offers timely and accurate information on 24-hour delivery. The exchange includes ordering information flow, financial information, and delivery information flow.

(12) Inventory Fulfillment Notice

Inventory fulfillment notice is a list for goods held available in stock by PChome.

(13) The Stability for Information System

The information system includes the management for the flows of ordering information, financial information, and delivery information. The most important one would be the stability for information system for customers.

3.2.2 Defining Concepts of FCM

The construction of concepts is primarily based on: Modeling Operation Dynamics of Third-party Logistics Providers with Fuzzy Cognitive Maps (L.Y. Lin, Y.K. Huang and C.M Feng, 2009).

Several problems are identified as follow:

Table 3.3 The concepts in the FCM and their definitions

Concepts Descriptions	
Concepts	Definitions
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.
Logistics Performance	The speed and reliability of data transmission, warehousing, sorting, picking, packaging and transportation services.
Total Profit	The difference between revenue and total cost.
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.
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.
E-tailers' Balancing Order	In order not to overtly depend on certain provider, e-tailers usually give balancing order to other provider.
Turnover of Talents	Talents sometimes may be head-hunted and thus enhance competitors' competitiveness.
Confidentiality Disclosure	When talents are head-hunted, they may take the techniques, and/ or customer confidentiality along with their departures.
Avg. Logistics Cost Per Unit	The average cost per unit incurred from integration of information, transportation, inventory, warehousing, and packaging.
Utilization Rate	The ratio of realistic throughput/Max. Capacity.
Unfitting Size of Fixed Assets	Property, plant, and equipment may be insufficient because of large order, breakdown, etc.

Source: Modeling Operation Dynamics of Third-party Logistics Providers with Fuzzy Cognitive Maps (L.Y. Lin, Y.K. Huang and C.M Feng, 2009).

The identified problems and the causes behind them are evaluated accordingly. Complete concepts and reasoning could be referred to the following:

(A)Order of 24-hour Delivery Service

The order of 24-hour delivery service is strongly affected by the product category and the relationship with suppliers. Here, the ordering means that the market-share of all the competitors for the 24-hour delivery service.

(B)Logistics Performance

"Logistics performance" is the core operation determining whether a logistics provider (EZ-Cat) could survive, including the speed and reliability of data transmission, picking, and transportation services. It's no doubt that this is a key evaluation criterion for 24-hour delivery.

(C)Relationship with Suppliers

"Relationship with suppler" is a critical factor that impacts whether how many of the suppliers would transfer the orders to 24-hour delivery of PChome. PChome needs to assist companies to establish long-term partnerships with suppliers.

(D)Product Category

In order to enable consumers to get a variety of goods more quickly, "PChome 24-hour area" has many types of items, even up to more than 190,000. To meet customers' satisfaction, "Product category" is always a concern for PChome.

(E) Ability to Achieve 24-hour Delivery

"Ability to achieve a 24-hour delivery" is also an objective of the company operation which is instrumental to whether PChome 24-hour delivery has enough ability to achieve 24-hour delivery service.

(F)Time Window Problem

Time window is a common form of time constraint extensively considered in the literature. It means a big vehicle departs from the warehouse, and then a set of small vehicles performs delivery to customers. During the operation, all of the vehicles must perform delivery during the time window allotted by both the warehouse and customers. Here, time

window problem means the time constraint can't work as expected.

(G)Information System

The information system of 24-hour delivery includes information accuracy, information flexibility, the speed of information, information security, and purchase order tracking information. The most important thing is the stability for information system for customers.

(H)Lack of Ability to Develop Information System

PChome is not a company in the business of software development, the information system of 24-hour delivery will cost more time and money. Therefore, capability of information systems development is a prominent factor whether the information system can work as expected or not.

(I)Resilience of Safety Stock

Keeping good relationship with the suppliers plays an important role on the amount of stock that PChome can store prior offering to the customers. What's more, the resilience of safety stock determines whether PChome can deliver the goods ordered by 24-hour delivery service on time or not.

(J)Stable Operation of Warehouse

Stable operation of warehouse is to evaluate the capability of PChome's self-built warehouse.

Chapter 4 Methodology

After defining concepts, then we can identify the relationship of 24-hour delivery and construct the appropriate system relationship model.

4.1 Data Collection Procedure

A questionnaire consisting of three sections was designed to collect information from these experts through in-depth survey. The subjects were asked to fill out a questionnaire eliciting information concerning the concepts' relationship for 24-hour delivery. There are seven survey findings to be collected, one is from professor in this field, and the other six are from 24-hour delivery management team of PChome.

4.2 The Research of Sensitivity Model (SM)

By following the defined concepts and criteria of SM, the instrument consists mainly in two parts. One is the criteria matrix, the other is impact matrix.

4.2.1 The Criteria Matrix of SM

The criteria matrix is applied to check the system comprehensiveness through the four categories of criteria, which are purchasing, logistics service, image, and information. Each category contains several sub-criteria with 13 items in total. Each of the concepts within system variables was evaluated by the planning team against the 13 items of sub-criteria, and the matrix was expected to fill out with 0, 0.5, or 1 indicating the status in not applicable, partially applicable or fully applicable respectively. Table 4.1 offers a SM criteria matrix of 24-hour delivery representing criteria matrix of a person.

Take the concept "Order of 24-hour delivery service" as an example; because it is highly related to both the criteria of "Web interface" and "Product category", then, both cells have to be filled out with 1. It also somewhat relates to "Logistics service flexibility" and "Order condition", therefore, it is required to fill out with 0.5.

Table 4.1 The Criteria Matrix of a person

Categories	Purchasing Category			Logistics Service Category				Image Category			Information Category		
Criteria / Concepts	Web Interface	Product Category	Maturity of 24-hour delivery model	Logistics Service Flexibility	Timeliness	Order Condition	Promotion	Dealing with Timeliness	Order Discrepancy Handling	Service Attitude	Information flow exchange	Inventory fulfillment notice	The stability for Information System
Order of 24-hour delivery service	1.0	1.0	0.5	0.5	0.5	0.5	1.0	0.5	0.5	1.0	0.5	0.5	1.0
Logistics Performance	0	0.5	0.5	1.0	1.0	0.5	0.5	1.0	0	0.5	1.0	0	0.5
Relationship with suppliers	0	0	0.5	0	0.5	0	1.0	0.5	0	0	0	0	0
Product Category	0	0	0.5	0.5	0.5	0	0.5	0	0	0	0	0	0
Ability to achieve 24-hour delivery	0	0.5	1.0	1.0	1.0	0	0	0.5	0.5	0	1.0	0.5	1.0
Time window problem	0	0.5	0.5	0.5	0.5	0	0.5	1.0	0.5	0	1.0	0	0.5
Information System	0.5	0	0.5	0.5	1.0	0.5	0	0.5	0.5	0	1.0	1.0	1.0
Lack of ability to develop information systems	0	0	0	0	0.5	0	0	0.5	0.5	0	1.0	1.0	1.0
Resilience of safety stock	0	0.5	0.5	1.0	1.0	0	0.5	0.5	0.5	0	1.0	1.0	0.5
Stable operation of warehouse	0.5	0.5	0.5	1.0	1.0	1.0	0.5	0.5	0.5	0	1.0	1.0	1.0
Sum (Score of sub-category)	2.0	3.5	5.0	6.0	7.5	2.5	4.5	5.5	3.5	1.5	7.5	5.0	6.5

Finally, the final scores are listed in the bottom row of the matrix. Table 4.2 shows the average value of SM criteria matrix in the scheme of 24-hour delivery.

Table 4.2 The criteria matrix value

Categories	Purchasing Category			Logistics Service Category			Image Category			Information Category		
Criteria / Concepts	Web Interface	Product Category	Maturity of 24-hour delivery model	Logistics Service Flexibility	Timeliness	Order Condition	Promotion	Dealing with Timeliness	Order Discrepancy Handling	Service Attitude	Information flow exchange	Inventory fulfillment notice	The stability for Information System
Order of 24-hour delivery service	0.8	1.0	0.1	0.8	0.9	0.7	0.9	0.6	0.5	0.9	0.6	0.6	0.9
Logistics Performance	0.0	0.6	0.9	0.7	1.0	0.9	0.1	1.0	0.8	0.9	0.9	0.0	0.7
Relationship with suppliers	0.0	0.7	0.6	0.0	0.6	0.5	1.0	0.5	0.6	0.6	0.0	0.0	0.0
Product Category	0.6	0.8	0.7	0.6	0.7	0.6	0.9	0.4	0.4	0.5	0.0	0.0	0.0
Ability to achieve 24-hour delivery	0.3	0.6	1.0	1.0	0.9	0.7	0.6	0.6	0.6	0.6	1.0	0.6	0.8
Time window problem	0.4	0.1	0.1	0.7	0.1	0.0	0.6	0.9	0.1	0.0	0.9	0.0	0.4
Information System	0.9	0.0	0.6	0.6	0.8	0.1	0.0	0.6	0.1	0.1	1.0	0.9	1.0
Lack of ability to develop information systems	0.7	0.0	0.0	0.0	0.6	0.0	0.0	0.4	0.4	0.2	0.9	0.9	0.9
Resilience of safety stock	0.0	0.9	0.7	0.8	0.9	0.0	0.7	0.1	0.1	0.6	0.8	0.8	0.1
Stable operation of warehouse	0.1	0.6	0.6	0.9	0.9	0.9	0.5	0.1	0.1	0.0	0.1	0.7	0.1
Sum (Score of sub-category)	3.8	5.2	5.3	6.0	7.3	4.5	5.3	5.1	3.6	4.3	6.2	4.6	5.0

In Table 4.2, the one with higher score within the logistics service category is "Timeliness" (7.3) and the higher scored one in information category is "Information flow exchange" (6.2). This means that these two criteria are important factors in system development. It can be seen in Table 4.2 that the criterion "Timeliness" has the highest score (7.3) over "Logistics service flexibility" (6.0) and "Order condition" (4.5) in the logistics service category, which tells us that material entities such as order of 24-hour delivery service, logistics performance and resilience of safety stock are the major components of 24-hour

delivery system. In addition to these internal characteristics of the system, the high scores within the last three criteria of the category of information (6.2, 4.6 and 5.0) remind us that it's important to take the information factors, and we should take into the account of the information factors within the process of policy formulation as well.

4.2.2 The Impact Matrix of SM

After compiling the impact matrix, this would lead to an output table of systemic characteristics and a graphic display of the relations among the concepts. This step is based on a pair-wise comparison, in which, each concept and criteria are arranged in an impact matrix as shown in Table 4.3.

In the sensitivity model, the effect can be classified as of no significance, low significance, medium significance and high significance, and expressed as 0, 1, 2, and 3 respectively. Each cell in the impact matrix aims to examine the direct influence of the vertical variable (column variable) on the horizontal variable (row variable).

The values in the last two columns and rows of the impact matrix (Table 4.3) provide us with needed information to identify the role for each variable in the system. This study used AS and PS to represent a one-directional effect. When sum up the numbers of one row to the right, we get the active sum (AS) of the corresponding variable. It represents how strongly any concept affects on the other concepts of the system. We also add the numbers in a column and get the passive sum (PS) of a variable, showing the extent to which the concept is affected by other concepts.

Table 4.3 The impact matrix

	A	B	C	D	E	F	G	H	I	J	AS	P
A	0.00	1.71	2.43	0.00	0.00	0.00	2.71	0.00	1.43	2.00	10.29	86.69
B	0.00	0.00	1.57	1.29	0.00	2.57	0.14	0.00	0.00	0.00	5.57	34.22
C	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.71	3.71	45.63
D	2.43	0.00	1.86	0.00	1.00	0.00	0.43	0.00	2.00	2.00	9.71	30.53
E	1.43	3.00	1.57	0.00	0.00	2.71	0.00	1.14	0.00	0.00	9.86	50.69
F	1.14	1.43	1.43	0.00	1.14	0.00	0.86	1.43	0.00	1.29	59.76	8.82
G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.14	0.71	3.57
H	0.00	0.00	0.00	0.00	0.00	0.00	0.86	0.00	0.29	0.00	1.14	2.94
I	1.43	0.00	1.86	1.43	1.29	0.86	0.00	0.00	0.00	1.71	8.57	51.43
J	0.00	0.00	1.57	0.43	1.71	0.71	0.00	0.00	0.00	0.00	4.43	31.63
PS	8.43	6.14	12.29	3.14	5.14	6.86	5.00	2.57	6.00	7.14		
Q*100	122.0	90.7	30.2	309.1	191.7	127.1	14.3	44.4	142.9	62.0		

If a concept has a relatively high AS, like “Order of 24-hour delivery service” (10.29), any change in that concept would have significantly impact on the system. In contrast, if the AS of a concept is a small number, this concept has to change dramatically before it produces a significant effect on the other concepts of the system. Such as (G) information system (0.71), the result shows a striking effect of information system on the system; it includes information accuracy, information flexibility, the speed of information, and information security. The most important one would be the stability for information system for customers. A high PS such as relationship with suppliers (concept C = 12.29) means that as soon as something happens within the system, this concept will be affected significantly. On the other hand, a small PS means that within the system, a lot of phenomena can happen without changing this concept, e.g. lack of information systems development capabilities (concept H=2.57). It may be due to PChome company is not a computer design company; more emphasis are put on how to sell the goods quickly, so less resource spent on the development of information systems.

AS and PS might explain the relationship between active and passive directional effects. There are two other indices that are useful in describing the role of a concept in a system, i.e.

P and Q. P, the product of AS and PS, represents the concept plays a primary role. Q, the quotient of AS over PS, is for describing the distinct role of a concept. A variable with a high quotient value (Q) and a high product value (P), such as order of 24-hour delivery service (A) means that it is an important concept in the system. With the aid of P and Q, we can interpret the role of the concept of the system more synthetically. This provides us with the first strategic indications by expressing the four indices (AS, PS, P, Q) in a conceptual context. By their location within this grid, the fields depict the roles of the concepts.

Figure 4.1 illustrates what happens in that model, each of the concepts is located along the four indices AS, PS, P, and Q, which creates a field of tension between active, critical, reactive, and buffering. We can find out one concept above the 45° line is meant that the concept strongly affects on the other concepts, in contrast, one concept under the 45° line is meant that the concept is affected by other concepts.

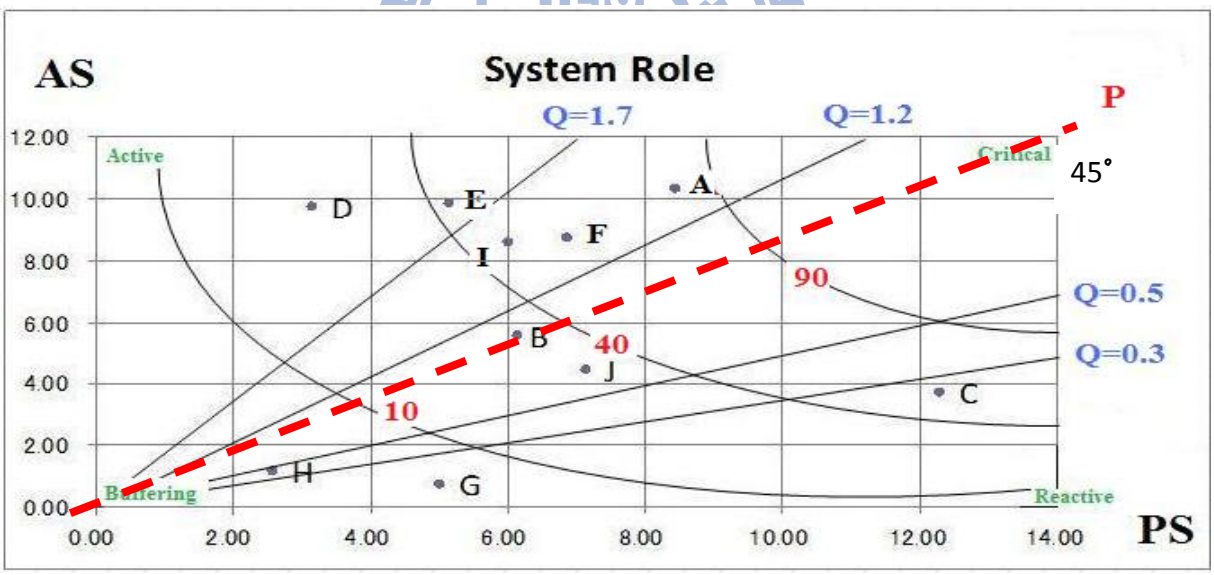

Figure 4.1 System roles of the variables

According to the above rules, all the concepts of the system are plotted in Figure 4.1 We can see that order of 24-hour delivery service (A), and time window problem (F) are the critical concepts in 24-hour delivery system, which means these concepts are the major driving force behind system development.

4.3 The Research of Fuzzy Cognitive Map (FCM)

Fuzzy cognitive map (FCM) is a matrix computing process, expressing the variables change, and the data can be efficiently collected by questionnaire design in a short time. The experts' opinions in various fields will be associated and integrated into set of methods in order to express the entire system. According to the defined concepts about 24-hour delivery in the past, the FCM Model is constructed; it is decided by each concept, with each other concept, it will be connected according to the sign of each interconnection.

4.3.1 Data Consistency Verification

From the perspective of logic, a consistent theory is one that does not contain a contradiction. In order to avoid illogical deviation, the verification of whether the value conflicted with prior experience is executed. Each value in the cells of survey is checked to ensure that the value in each cell of every survey is within a reasonable interval. The arc represents the relations between each item of the questionnaire, and their corresponding weights will be determined by the experts afterward.

Table 4.4 The data consistency verification

	A	B	C	D	E	F	G	H	I	J	Status
Professor	0.95	0.96	0.83	0.93	0.94	0.91	0.88	0.97	0.95	0.95	0.98
Management 1	0.89	0.91	0.97	0.96	0.85	0.92	0.93	0.73	0.95	0.96	0.96
Management 2	0.97	0.97	0.83	0.93	0.92	0.87	0.88	0.73	0.93	0.96	0.88
Management 3	0.88	0.81	0.12	0.78	0.76	0.91	0.69	0.59	0.71	0.50	0.98
Management 4	0.90	0.95	0.83	0.88	0.86	0.75	0.31	0.70	0.93	0.84	0.80
Management 5	0.88	0.96	0.12	0.90	0.91	0.67	0.88	0.54	0.82	0.90	0.92
Management 6	0.94	0.93	0.83	0.99	0.84	0.80	0.88	0.97	0.98	0.96	0.98

First, the current status of each expert was given high degree of consistency assessment value. Next, each expert's data consistency verification is reflected in Table 4.4[1]. According

[1] $\{\chi^2 < \chi^2_{0.05}(54) \cong 34.76\}$ It was found to be statistically significant at 0.05.

to test of homogeneity overall, the results have been very positive, and Table 4.4 reflected that the data had high degree of consistency with A, B, D, E, F, I; thus, all of the measures were strongly positively correlated.

4.3.2 Fuzzy Logic

We present the use of fuzzy logic as a post-processing method to improve the result in correlation applications. It helps demonstrate or simulate how experts deliberate upon a particular issue. In addition, it puts causal relationships in use and provides feedbacks.

According to Dubois and Prade (1980), a fuzzy number Ã is a fuzzy subset of a real number, and its membership function is μÃ (*x*) :R→[0,1], where *x* represents the criteria, and is described by enshrined with the following characteristics:

(1) μÃ (*x*) is a continuous mapping from *R* to the closed interval [0,1].

(2) μÃ (*x*) is a convex fuzzy subset.

(3) μÃ (*x*)is the normalization of a fuzzy subset, which means that there exists a number X_0 such that$\mu\tilde{A}(X_0)=1$. It can be called fuzzy number if all the conditions above are satisfied.

The triangular fuzzy number$\mu\tilde{A}(x) = (L,M,U)$ can be defined as equation(2) and Figure 4.2.

$$\mu\bar{A}(x)=\begin{cases}(x-L)/(M-L) & L \geq M \geq L \\ (U-x)/(U-M) & M \leq x \leq U \\ 0 & \text{otherwise}\end{cases} \qquad (2)$$

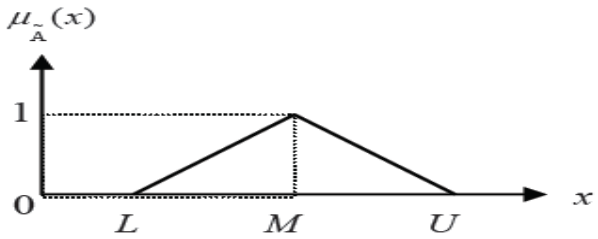

Figure 4.2 Membership function of triangular fuzzy number

Then, weights for connection are determined by experts; the experts describe the influence of one concept to another, using a linguistic variable, like strong influence, medium

influence, and little influence, which is then transformed in numerical value.

According to the extension principle of triangular fuzzy numbers, the arithmetic operations of two triangular fuzzy numbers $\tilde{A}=(a_1,a_2,a_3)$ and $\tilde{B}=(b_1,b_2,b_3)$ can be expressed as follows:

(1) Addition of two fuzzy numbers

$$(a_1,a_2,a_3)\oplus(b_1,b_2,b_3)=(a_1+b_1,a_2+b_2,a_3+b_3)$$

(2) Subtraction of two fuzzy numbers

$$(a_1,a_2,a_3)\Theta(b_1,b_2,b_3)=(a_1-b_1,a_2-b_2,a_3-b_3)$$

(3) Multiplication of two fuzzy numbers

$$(a_1,a_2,a_3)\otimes(b_1,b_2,b_3)\cong(a_1b_1,a_2b_2,a_3b_3)$$

(4) Multiplication of any real number k and a fuzzy number

$$k\cdot(a_1,a_2,a_3)=(ka_1,ka_2,ka_3)$$

(5) Division of two fuzzy numbers

$$(a_1,a_2,a_3)\Delta(b_1,b_2,b_3)\cong(a_1/b_3,a_2/b_2,a_3+b_1)\text{ where }b_1\neq0,b_2\neq0,b_3\neq0$$

The concept of linguistic variable plays a major role in many applications of fuzzy set theory. It is very difficult for conventional quantification to express reasonably for those situations that are overtly complex or hard to define in the evaluating process for real FCM problems. Thus the notion of a linguistic variable is necessary in such situations. First, the results of the data must be added together in some predetermined ways. The most typical fuzzy set membership function has the graph of a triangle. According to the extension principle of triangular fuzzy numbers in Table 4.5, the arithmetic operations of fuzzy number are as follows:

Table 4.5 The linguistic variable triangular fuzzy number

Linguistic variable	The triangular fuzzy number
Strong influence	(0.87 , 0.92 , 1.00)
Medium influence	(0.53 , 0.66 , 0.87)
Little influence	(0.23 , 0.28 , 0.53)
No influence	(0.00 , 0.00 , 0.23)

These will have a number of rules that transform a number of variables into a fuzzy result, that is, the result is described in terms of membership in fuzzy sets. The triangular fuzzy number is according to the equation (3).

$$\tilde{W}_k = (a_k, b_k, c_k), k = 1,2....n$$

$$\text{and} \quad a_k = \text{Min}\{a_{lk}\}, b_k = \frac{1}{m}\sum_{l=1}^{m} b_{lk}, c = \text{Max}\{c_{lk}\} \tag{3}$$

Defuzzification interprets the membership degrees of the fuzzy sets into a specific decision or real value. The defuzzification method for fuzzy numbers will be utilized to obtain comparably crisp value. A common and useful defuzzification technique in fuzzy control is certainly the center of area, also called center of gravity method as depicted in equation (4).

$$W_k = \frac{a_k + b_k + c_k}{3} \tag{4}$$

The W_k coordinate of the centered is the defuzzified value. The linguistic variable defuzzified value is according to the equation (4).

Table 4.6 The defuzzified value of linguistic variable.

Linguistic variable	The defuzzified value
Strong influence	0.93
Medium influence	0.69
Little influence	0.35
No influence	0.08

After compiling fuzzy sets into the linguistic variable defuzzified values, as shown in Table 4.6, we use these values to place into fuzzy cognitive map. The defuzzified value show

the positive impact with strong influence (+0.93), medium influence (+0.69) little influence (+0.35); no impact with no influence; negative impact with strong influence (-0.35), medium influence (-0.69) little influence (-0.93).

4.3.3 The Input Data of FCM

From the survey, after compiling fuzzy sets into the linguistic variable defuzzified value, as shown in Table 4.6, we can establish an evaluation model for management strategies via FCM. Each concept has a value, ranging between [-1, 1] and the values of concepts correspond to the real situation what experts would expect to occur. The final adjacency matrix is then given by a normalized sum according to the equation (5).

$$W = \frac{1}{n}\sum_{i=1}^{n} W_i \qquad (5)$$

According to the data collection and processing, the data gathered and operated is as in Table 4.7. Thus, the following weight matrix for the FCM could be produced: Showing the negative impact, no impact, or positive impact, and revealing the strength of impact to concepts in the column on those in the row. Besides, not only the impact of strength but also the rating (or the initial state, C_0) of the concepts state is also asked. Accordingly, we compile fuzzy sets into the linguistic variable with defuzzified value, as shown in Table 4.6; we get the rating of concept state, we place it at the bottom of the Table 4.7. This represents the assessment of current state and its interval is within [0, 1]. [2]

[2] The table filled in "( )"means negative number.

Table 4.7 The input data

	A	B	C	D	E	F	G	H	I	J
A	0.00	0.58	0.65	0.00	0.00	0.00	0.73	0.00	(0.48)	0.59
B	0.00	0.00	0.00	0.50	0.00	(0.83)	0.00	0.00	0.00	0.00
C	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00
D	0.69	0.00	0.00	0.00	(0.33)	0.00	0.15	0.00	0.60	0.58
E	0.27	0.00	0.48	0.00	0.00	0.73	0.00	(0.30)	0.00	0.00
F	0.00	(0.46)	0.00	0.00	(0.40)	0.00	0.25	0.39	0.00	0.35
G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.05
H	(0.20)	0.00	0.00	0.00	0.00	0.00	0.28	0.00	(0.10)	0.00
I	(0.48)	0.00	0.00	0.00	0.38	0.10	0.00	0.00	0.00	0.53
J	(0.30)	0.00	(0.30)	(0.20)	0.49	(0.25)	0.00	0.00	0.00	0.00
Current state	0.89	0.89	0.67	0.71	0.83	0.60	0.77	0.51	0.46	0.66

For every directional and arced weight, it means that the concept i has the strength of relationship on concept j. Other than this, it should note that order of 24-hour delivery service (A), logistics performance (B), and ability to achieve 24-hour delivery (E) are the three critical elements with considerable influences over the entire fuzzy cognitive map.

4.3.4 The Framework of FCM

In order to deal with the problem of dependence and feedback among concepts, we first depict the FCM as shown in Figure 4.3 to illustrate the situation from the relationship of 24-hour delivery, and the weights between concepts are shown with different color arrows. The black arrow means that concept has positive effect on other concept; in contrast, the red arrow means that concept has negative effect as opposed to other concept.

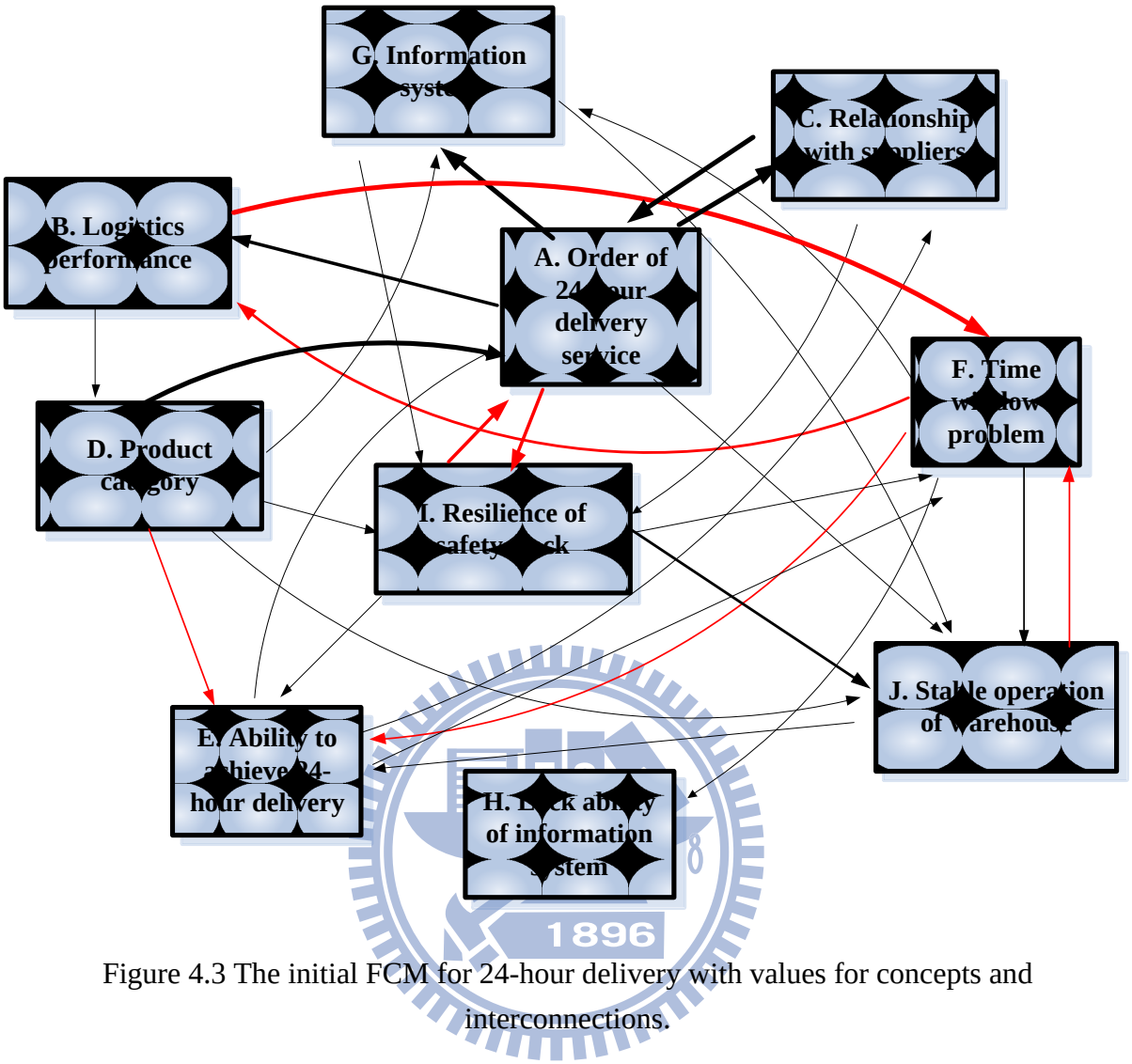

Figure 4.3 The initial FCM for 24-hour delivery with values for concepts and interconnections.

To summarize the salient features of the values, several findings should be noted:

(1) Concept A has striking effects on concept B, C, G and J. The order of 24-hour delivery service is strongly affected by the logistics performance and the relationship with suppliers.

(2) Concept B impacts D and has negative effect on F. If logistics performance is good, the product category should increase, but that also means the time window doesn't need to be any better.

(3) Concept C influences A and I in a striking manner. Relationship with suppliers is a critical factor that impacts whether how many the suppliers would transfer the orders to

24-hour delivery of PChome.

(4) Concept D affects A, I and J noticeably. The more product category, the better it can meet customers' satisfaction, and contribute to more future orderings.

(5) Concept I has a striking effect on J. If referring to real estate, warehousing size, quality, due to some factors (such as damage, trafficking), etc. then the fixed assets are insufficient.

4.3.5 The Processing of FCM

All the experts are consulted with their experience and knowledge, and ultimately evaluated on an appropriate numerical scale. At each simulation step of the FCM, the value of concepts is calculated according to equation (1). Where $C_i(t_{n+1})$ 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 $w_{ki}(t_n)$ is the weight of the interconnection from concept C_k to concept C_i.

$$C_i(t_{n+1}) = S\left(\sum_{k=1,k\neq i}^{n} w_{ki}(t_n) C_k(t_n)\right) \quad (1)$$

$S(x)$ is a threshold function that squashes the result of the multiplication in the interval [0, 1]. The logistic signal function has been used to transform to an S-shaped curve as Figure 4.4.

$$S(x) = \frac{1}{(1+e^{-\alpha x})} \quad (7)$$

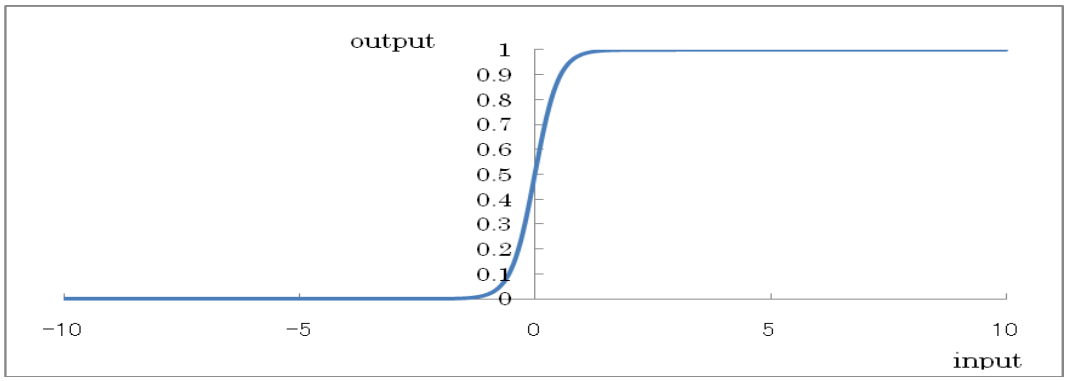

Figure 4.4 The logistic signal function

In general, as observed in Figure 4.4, the input is the setting in the interval [-10, 10] and also sets the constant α for 4. Then, after calculating the logistic signal function, we can get

the value in the interval [0, 1].

From Equation 1, k doesn't equal to i, it means that concept evaluates from the standpoint of self-interest. In order to clarify, whether the self-evaluation for the concept is good or not, we conducted tests basing on equation (8). Where β_j represents the weight of other concepts, and (1-β_j) represents how they evaluate themselves. The result indicated that the more you evaluate on just the concept, the pace in system improvement will be more slowly.

$$C_j(t_{n+1}) = \beta_j * S\left(\sum_{k=1,k\neq j}^{n} w_{kj}(t_n)C_k(t_n)\right) + (1-\beta_j)C_j \qquad (8)$$

Figure 4.5 illustrates the concept consider about themselves for $(1-\beta_j)$ equal to 0.5. It indicates that the system was not stability at the beginning; such a partial explanation for this may lie in the fact that the product category (D) is not stable. To increase the order of 24-hour delivery (A) and improve the ability to achieve 24-hour delivery (E), we need about 10~25 workdays to adjust. After 30 workdays, we find that the Ability to achieve 24-hour delivery is steady at 0.88 in the long run.

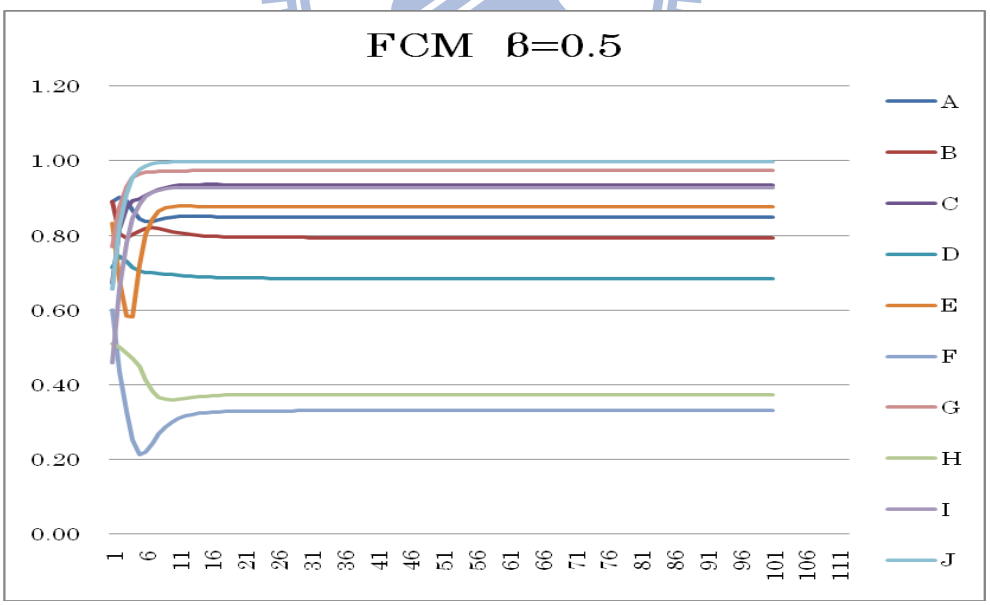

Figure 4.5 The output of FCM (β=0.5)

Figure 4.6 illustrates the concept consider about themselves for $(1-\beta_j)$ equal to 0.95. Compare to Figure 4.5, we find out the system needs 36 runs to achieve the goal. The result indicated that the more you consider on each factor independently, the system will be slower

to improve. Considering the overall promotion significantly accelerates the improve process.

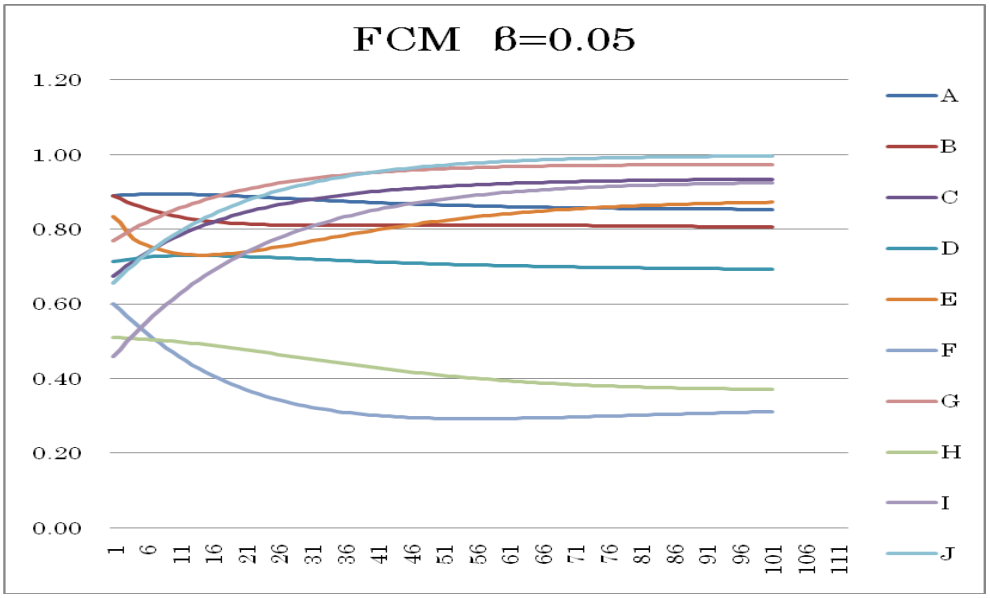

Figure 4.6 The output of FCM (β=0.05)

4.3.6 The Output of FCM (β=1)

After the data collection and processing through equation (1), the original output from the proposed FCM is as follow and depicted in Table 4.8.

Table 4.8 The runs of calculation and their respective value

Run	A	B	C	D	E	F	G	H	I	J
0	0.89	0.89	0.67	0.71	0.83	0.60	0.77	0.51	0.46	0.66
1	0.91	0.72	0.96	0.78	0.53	0.27	0.99	0.49	0.86	1.00
2	0.84	0.83	0.90	0.65	0.63	0.18	0.98	0.45	0.93	1.00
3	0.77	0.83	0.90	0.70	0.69	0.17	0.97	0.39	0.92	1.00
4	0.82	0.81	0.89	0.70	0.90	0.20	0.96	0.37	0.93	1.00
5	0.84	0.82	0.93	0.69	0.90	0.33	0.97	0.32	0.93	1.00
6	0.86	0.79	0.94	0.70	0.87	0.32	0.97	0.37	0.93	1.00
7	0.85	0.80	0.94	0.68	0.88	0.33	0.97	0.37	0.93	1.00
8	0.85	0.80	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
9	0.85	0.80	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
10	0.85	0.80	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
11	0.85	0.79	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
12	0.85	0.79	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
13	0.85	0.79	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
14	0.85	0.79	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
15	0.85	0.79	0.94	0.68	0.88	0.33	0.97	0.37	0.93	1.00

It has to be stressed that the study observes the rule that, if there is no sudden accident to the case company, it will survive as time goes on. The concepts C, G, I, and J run after 3 runs and their results observed are close to the range [0.93, 1]. It shows that relationship with suppliers (C), resilience of safety stock (I), and stable operation of warehouse (J) experience almost no changes in the long run. To summarize the salient features of the analysis, several findings should be of interest. Figure 4.7 illustrates what has been transpired in that model.

We could observe that the value of each concept will vibrate when the vibration is stable[3]. In addition, it is important to emphasize that the incorporated concepts need to take time to adapt to real world in the scheme of research design. Each run is assumed to be 5 workdays; means that PChome needs about 5 workdays to respond and address all the necessary condition changes.

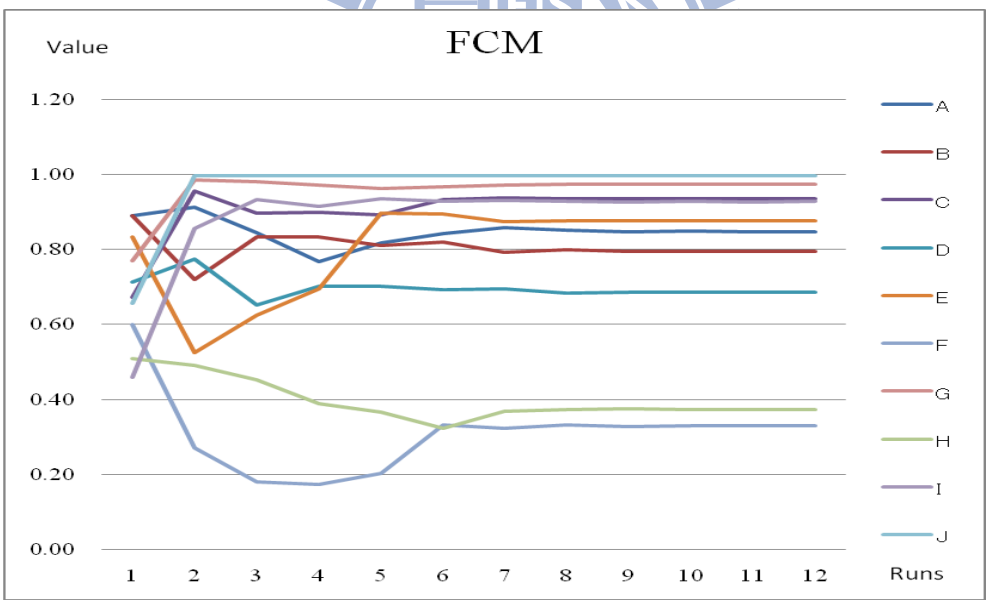

Figure 4.7 The output of proposed FCM

The first step is test, to explain that system had no stability at the first 10 workdays. Such a partial explanation for this may point to the fact that the product category is not stable. The

[3] The results of the $\left| \mathbf{E}_{t+1} - \mathbf{E}_{t} \right| = \mathbf{0.001}$ means the value is stable.

second step is adjustment, to increase the order of 24-hour delivery and improve the ability to achieve 24-hour delivery, we need about 10~25 workdays to adjust and adapt. Finally step is when 30 days after the system stabilizes; we should be able to witness that the ability to achieve 24-hour delivery is steady at 0.88 in the long run.

The results reflected in Figure 4.7 indicate that:

(1) Logistics performance (concept B) was decreased at the first run, and after 5 workdays it gradually increases, then drop back down a bit about 25 workdays after. This would more likely explain that logistics performance was not stabilized at the beginning. After 30 workdays the logistics performance was closes to 0.79 representing that, logistics performance will have almost no changes in the long run.

(2) Product category (concept D) increased at the first and decreased at the second runs. A partial explanation for this may lie in the fact that the product category is not stable. Then it gradually increases, and after 15 workdays the product category is at a steady within the range of [0.68, 0.69].

(3)Ability to achieve 24-hour delivery (concept E) at the first run decreased, followed by an immediate sharp increase between 5 to 20 workdays. Then the ability of achieving 24-hour delivery gradually declines for a duration of 25 to 30 workdays. We can conclude that PChome Company's major goal is to increase the order of 24-hour delivery and improve the ability to achieve 24-hour delivery. It is glad to see that the ability to achieve 24-hour delivery is steady at 0.88 in a longer term.

(4)Lack of ability to develop information system (concept H) decreased until 6 runs, and dropped to a range [0.32, 0.37] after 25 workdays. It may be due to PChome company is not a computer design company, so they may take a long time to resolve this deficiency and improve it. One possible solution is considering outsourcing to other information industry, but

PChome Company insists of having faith in their information systems.

(5)Time window problem (concept F) closes to 0.20 until 5 runs, and also represents time window problem experiencing slight increases from 25 to 30 workdays. The time window problem is stabilized to relatively low about 0.33 after 30 workdays.

If the orders for 24-hour delivery service remain high, relationship with suppliers will be good, and the lack of ability to develop information system will decrease. Thanks to the decreased time window problem, the ability to achieve 24-hour delivery will stay at the desired high level.

Chapter 5 Scenario Analysis

5.1 Scenario Introduction

In Taiwan, portal sites provide consumers with shopping on-line service in an electronic store and picking up goods within 24 hours. Based on the research background and motivations, the results revealed that order of 24-hour delivery service (A), logistics performance (B), relationship with suppliers (C), product category (D), ability to achieve 24-hour delivery (E), time window problem (F), information system (G), lack of ability to develop information system (H), the resilience of safety stock (I), and stable operation of warehouse (J) can be used to construct the system relationship model.

5.1.1 Scenario 1 - Order of 24-hour delivery increase

PChome Company's major goal is to increase the order of 24-hour delivery and improve the ability to achieve 24-hour delivery. As mentioned above, we get the rating of concept state we put it at the bottom of the Table 4.6, it represents the current state and it means the order of 24-hour delivery is good (A=0.89) now. Although we all think of the goal is to increase order of 24-hour delivery and improve the ability to achieve 24-hour delivery, a number of intervention conditions have also been considered. Such us holiday order, typhoon order and so on. Hence, it is assumed that order of 24-hour delivery service increase suddenly. Therefore, the research set the initial state value of order of 24-hour delivery service (concept A) at 1.0, to observe the differences between the original output and the adjusted ones.

After setting the initial state value of order of 24-hour delivery service (concept A) to 1.0, the original input of proposed FCM is as follows Table 5.1[4].

[4] The table filled in "( )"means negative number.

Table 5.1 The input data

	A	B	C	D	E	F	G	H	I	J
A	0.00	0.58	0.65	0.00	0.00	0.00	0.73	0.00	(0.48)	0.59
B	0.00	0.00	0.00	0.50	0.00	(0.83)	0.00	0.00	0.00	0.00
C	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00
D	0.69	0.00	0.00	0.00	(0.33)	0.00	0.15	0.00	0.60	0.58
E	0.27	0.00	0.48	0.00	0.00	0.73	0.00	(0.30)	0.00	0.00
F	0.00	(0.46)	0.00	0.00	(0.40)	0.00	0.25	0.39	0.00	0.35
G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.05
H	(0.20)	0.00	0.00	0.00	0.00	0.00	0.28	0.00	(0.10)	0.00
I	(0.48)	0.00	0.00	0.00	0.38	0.10	0.00	0.00	0.00	0.53
J	(0.30)	0.00	(0.30)	(0.20)	0.49	(0.25)	0.00	0.00	0.00	0.00
Current state	1.00	0.89	0.67	0.71	0.83	0.60	0.77	0.51	0.46	0.66

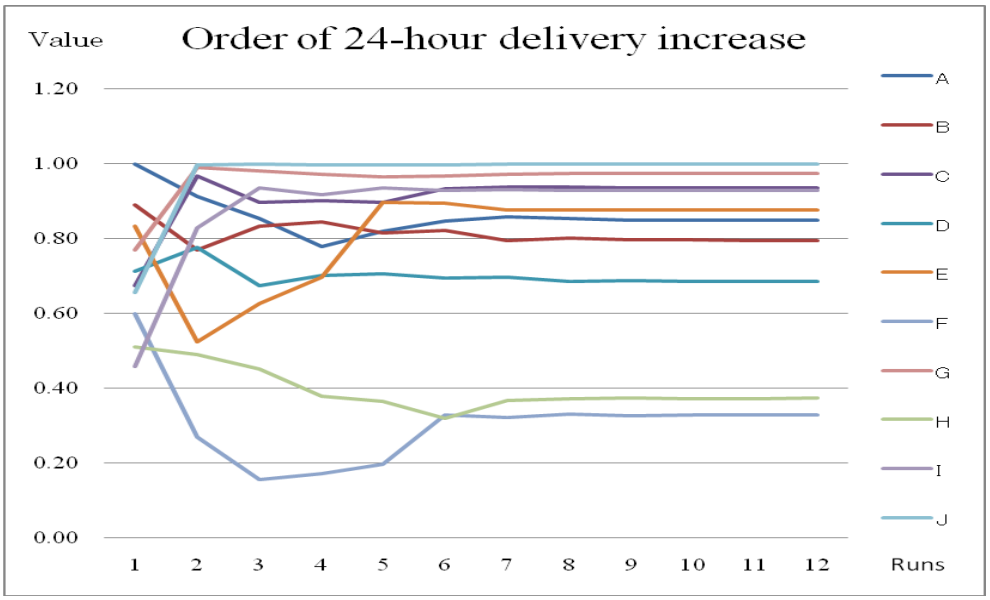

Figure 5.1 The output of scenario 1

The results reflected in Figure 5.1 indicate that:

(1) Findings of this study points to the fact that, if there are no sudden and drastic changes within the parameters and variables from the case company, all the findings so far would hold true. The concepts C, G, I, and J run after 3 runs close to the range [0.93, 1].

(2) Logistics performance (concept B), ability to achieve 24-hour delivery (concept E) and time window problem (concept F) rapidly decreased at the first run.

(3) Lack of ability to develop information system (concept H) did not decrease until the 6^{th} run, and dropped to a range [0.37, 0.38] after 35 workdays.

Its orders from 24-hour delivery service will remain high, relationship with suppliers will still be good, and the lack of ability to develop information system will increase. Thanks to the decreased incidents of time window problem, the ability to achieve 24-hour delivery will stay at high level.

5.1.2 Scenario 2 - Sudden Dip of Time Window Problem

Time window is a common form of time constraint extensively evaluated in the literature. The results reflected in Figure 4.4 indicate that time window problem gradually declines. The balance value is closes to 0.33, and represents time window problem will drop a little bit about 25 workdays later. Although suppliers (or customers) always request us send the good in some time interval what they wanted, a number of conditions have also been considered. The dipping of time window problem is possibly due to the weakness of the request of suppliers (or customers). Hence, we assumed that PChome Company's time window problem precipitates to the lowest point suddenly, and we respond by changing the output data for 0 on the runs of 7 to see the differences between the original output and the adjusted ones. The input of proposed FCM is as follows Table 5.2.

Table 5.2 The output data of scenario 2

Run	A	B	C	D	E	F	G	H	I	J
0	0.89	0.89	0.67	0.71	0.83	0.60	0.77	0.51	0.46	0.66
1	0.91	0.72	0.96	0.78	0.53	0.27	0.99	0.49	0.86	1.00
2	0.84	0.83	0.90	0.65	0.63	0.18	0.98	0.45	0.93	1.00
3	0.77	0.83	0.90	0.70	0.69	0.17	0.97	0.39	0.92	1.00
4	0.82	0.81	0.89	0.70	0.90	0.20	0.96	0.37	0.93	1.00
5	0.84	0.82	0.93	0.69	0.90	0.33	0.97	0.32	0.93	1.00
6	0.86	0.79	0.94	0.70	0.87	0.32	0.97	0.37	0.93	1.00
7	0.85	0.80	0.94	0.68	0.88	0.33	0.97	0.37	0.93	1.00
8	0.85	0.80	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
9	0.85	0.80	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
10	0.85	0.80	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
11	0.85	0.79	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
12	0.85	0.79	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
13	0.85	0.79	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
14	0.85	0.79	0.94	0.69	0.88	0.33	0.97	0.37	0.93	1.00
15	0.85	0.79	0.94	0.68	0.88	0.33	0.97	0.37	0.93	1.00

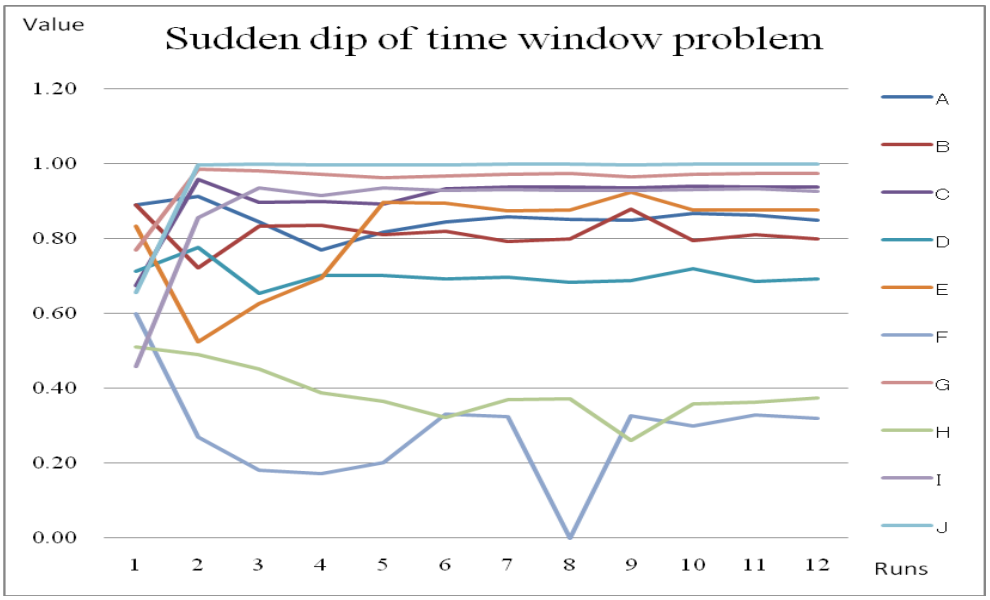

Figure 5.2 The output of scenario 2

The results reflected in Figure 5.2 indicate that:

(1) It has to be stressed that the study observes if there is only one sudden and unpredictable incident to the case company, it is assumed that PChome Company's time window problem falls straight to the lowest point on the run 7. The concepts C, G, I, and J run after 3 runs close to the range [0.93, 1].

(2) Logistics performance (concept B), ability to achieve 24-hour delivery (concept E) and time window problem (concept F) decreased at the first run. The sudden incident has led to the highest point of logistics performance and ability to achieve 24-hour delivery.

(3) Lack of ability to develop information system (concept H) increased until 6 runs, and the sudden incident has led to an abrupt dip on run 8.

Thanks to the decreasing in time window problem, the ability to achieve 24-hour delivery will remain at high level.

5.2 Scenario analysis

5.2.1 Scenario 1 analysis

Figure 5.3 illustrates the value difference between the adjusted scenario and the original scenario according to the scenario runs. Each run is assumed to last 5 workdays after the consultation with experts.

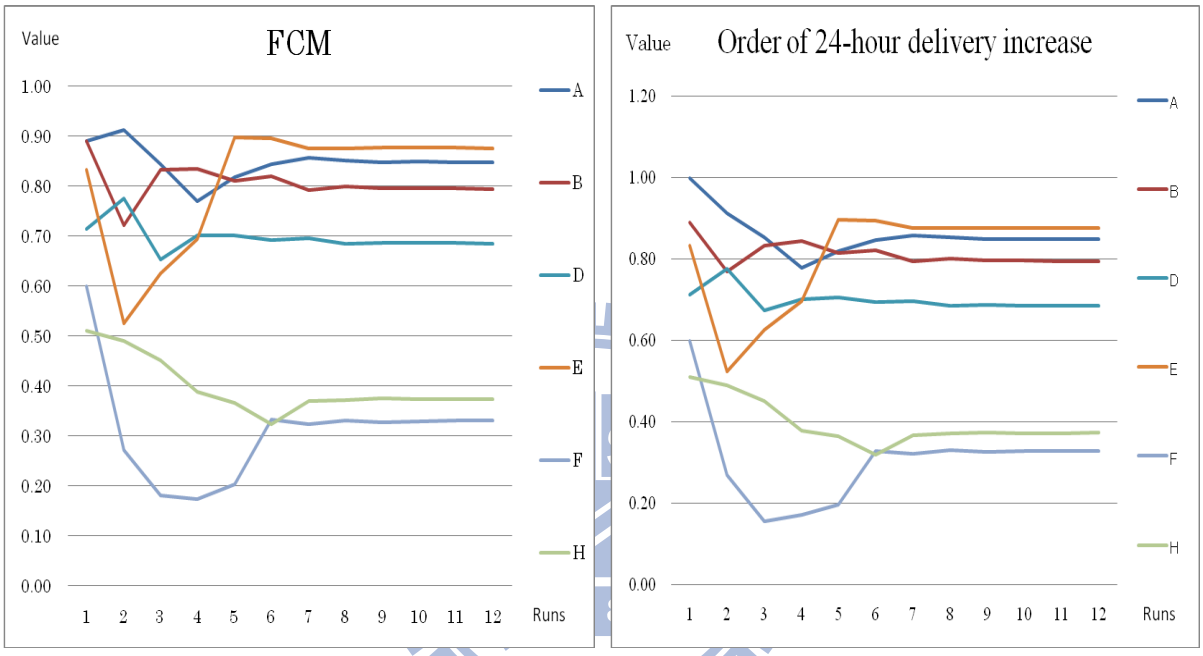

Figure 5.3 The output of the original FCM and adjusted scenario 1

(1) Order of 24-hour delivery service (concept A) decreased sharply about 20 workdays.

(2) Logistics performance (concept B) decreased at the first run about 5 workdays. Compared with the original scenario, when the order of 24-hour delivery became steady, the logistics performance became steady, too.

(3) Product category (concept D) increased at the first run, and the product category declined to 0.65 between 5 to 15 workdays. Compared with the original scenario that represents the order of 24-hour delivery increase will reduce product category. After 20 workdays the product category is steady at 0.68.

(4) Ability to achieve 24-hour delivery (concept E), the output of adjusted scenario can be equated with the original scenario, that is to say the system can help PChome to achieve 24-hour delivery.

(5) Time window problem (concept F) closes to 0.20 until 4 runs, and also represents time window problem slight increases from 25 to 30 workdays. Compared with the original scenario, it is something different from 5 to 10 workdays that represents the order of 24-hour delivery increase will trigger more time window problem. The time window problem is also steady at low status about 0.33 after 30 workdays.

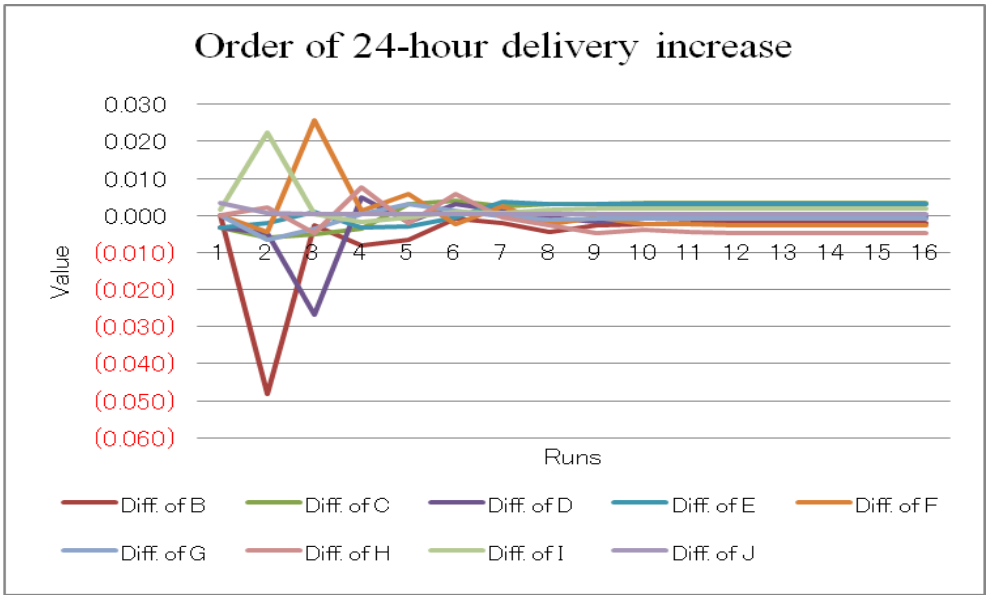

Figure 5.4 The difference between the scenario 1 changes

The following changes should be noted: The logistics performance (concept B) and product category (concept D) decrease for about 10 and 15 workdays each. The increase of relationship with suppliers (concept C) starts after the 10th workday and ends after 15th workday. The statuses of the resilience of safety stock, time window problem, and lack of ability to develop information systems are comparatively diminishing at initial stage and stay the same with the original output in a longer term.

5.2.2 Scenario 2 Analysis

Figure 5.5 illustrates the value difference between the adjusted scenario 2 and the original FCM according to the runs from scenarios. Each run is assumed to be 5 workdays after the consultation with experts.

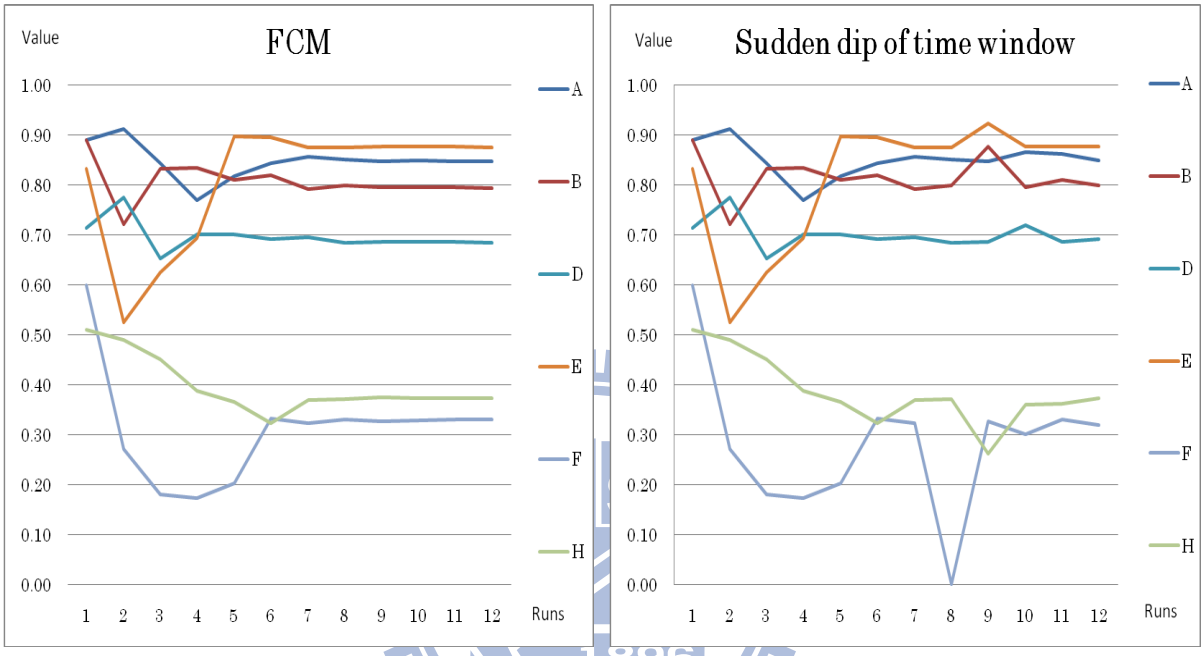

Figure 5.5 The output of the original FCM and adjusted scenario 2

(1) Order of 24-hour delivery service (concept A): The curve adjusted scenario 2 is similar to original curve.

(2) Logistics performance (concept B): Compared with the original scenario, the sudden incident has led to the highest point of logistics performance after 5 workdays.

(3) Product category (concept D): Compared with the original scenario, the sudden incident has led to the highest point of product category after 10 workdays, and after 15 workdays the product category is steady at 0.69.

(4) Ability to achieve 24-hour delivery (concept E): The sudden incident has led to the highest point of ability to achieve 24-hour delivery after 5 workdays. Without this, the output

of adjusted scenario can be equated with the original scenario, that is to say the system can help PChome to achieve 24-hour delivery.

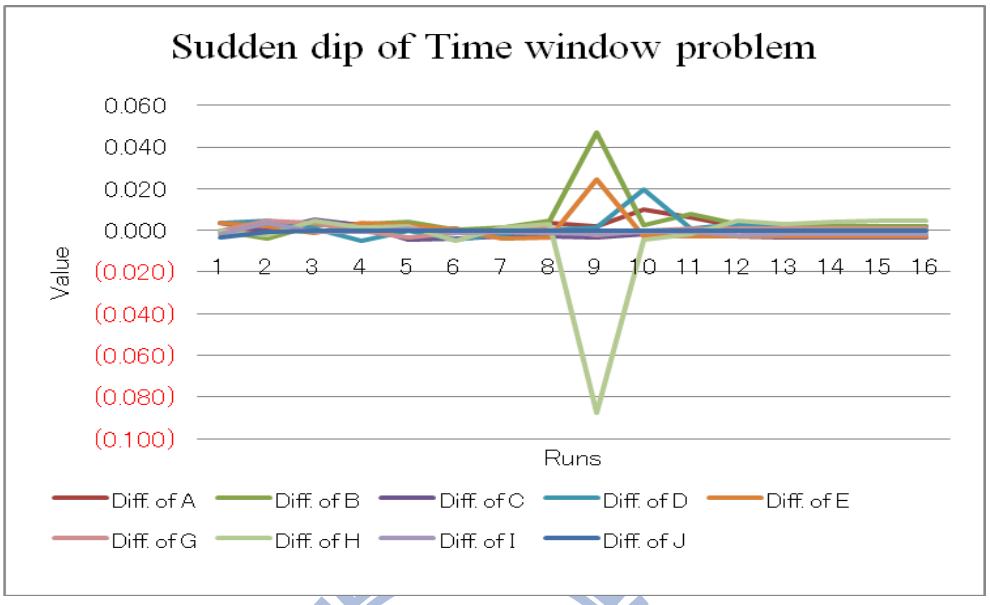

Figure 5.6 The difference between the scenario 2 changes

The following changes would be noticed: Order of 24-hour delivery service (concept A) is similar to that of the original curve. An interesting finding is that has led to the highest point of order of 24-hour delivery service (concept A) after 5 workdays. The logistics performance (concept B), and ability to achieve 24-hour delivery (concept E) also increase for about 5 workdays each. This sudden incident has led to the highest point of product category (concept D) after 10 workdays. The statuses of the resilience of safety stock (concept I), the relationship with suppliers (concept C), information system (concept G) and lack of ability to develop information systems (concept H) are comparatively diminishing at the initial and be the same with the original output in the long run.

Chapter 6 Conclusions and Suggestions

6.1. Conclusions

In Taiwan, the service of shopping on-line in an electronic store and picking up goods at home could be quite common and popular these days. Based on the research background and motivations, the research issues tend to point out the relationships to the 24-hour delivery, and they are as follow:

Issue 1:

Through the literature reviews and in-depth interviews as well as discussions with experts, this research constructs 10 important concepts and 13 criteria for the achievement of 24-hour delivery service. Then, proceed to construct the system relationship model. The reported in this paper have demonstrated that these two systems can be practically implemented, and hope to applicative to the other company. In conclusion, SM and FCM could be used for systematic studies both as an instruction tool and research tool.

Issue 2:

From SM, we find out that order of 24-hour delivery service (A) and time window problem (F) are major components of 24-hour delivery system; that material entities are order of 24-hour delivery service (A), logistics performance (B) and resilience of safety stock (I). The high scores within the last three criteria of the category of information remind us that information flow exchange is also taking into the account of the external factors during the process of policy formulation. Lack of ability to develop information system (H) for PChome company, the more likely explanation may be due to PChome company is not a computer design company; the possible solution is considering outsourcing to other information industry.

Issue 3:

The findings of FCM lead to a number of implications. The order of 24-hour delivery

service is strongly affected by the relationship with suppliers. Relationship with suppliers is a critical factor that impacts whether how many the suppliers would transfer the orders to 24-hour delivery of PChome. Keeping good relationship with the suppliers plays an important role for PChome can offer to meet customers' satisfaction. The result revealed that the ability to achieve 24-hour delivery is steady at 0.88 in the long run. It is recommended that the approach outlined in this study be replicated in other e-shopping or third party companies.

6.2. Suggestions

The SM and FCM were chosen as the design methodologies is because they can be easily interpreted, since they clearly show the relationships between the different concepts and, at the same time, it is relatively easy and flexible to add or remove concepts, whenever necessary. Another problem that often arises in data gathering has to do with the fact that are often based on a survey, that is, the data are gathered through questionnaires, interviews, and so forth. In reality, there are several functions could be used to transform the value of the data. A questionnaire is under development, which will be sent to expert specialists along with the description of the current 24-hour delivery model for future improvement of the model.

The assumption that the simulation is setting to be 5 workdays per run is a controversial one under practical consideration during this research; this means that PChome needs about 5 workdays to respond to the changes in the research design, which limits our interpretations. In the meantime, the simulation could be more complicated to discuss and explore even more issues. We set $\beta = 1$ represents the weight don't affected by other concepts. In the future, maybe we can set every concept for different weight. We are hopeful that future research will be designed with much more sophistications allowing the ability to differentiate different point of view.

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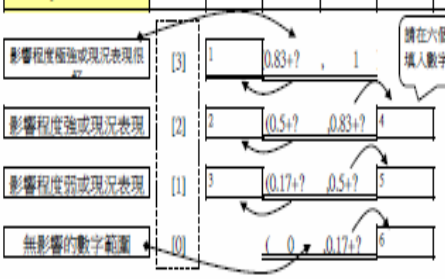
Appendix

請以「1、0.5、0」填寫兩變數之間的關連性，若同意下表的數字則不用修改，若需要修改請在方格中填上「1(關係很強)、0.5（關係中等）、0（無關）」

網站留易對訂單數量的影響為"1"	Purchasing Category			Logistics Service Category			Image Category				Information Category		
	Web Interface	Product Category	Maturity of 24-hour delivery model	Logistics Service Flexibility	Timeliness	Order Condition	Promotion	Dealing with Timeliness	Order Discrepancy Handling	Service Attitude	Information flow eXchange	Inventory fulfillment notice	Instability Information System
A. Order of 24-hour delivery service	1.0	1.0		0.5	0.5	0.5	1.0	0.5	0.5	0.5	0.5	0.5	0.5
B. Logistics Performance		0.5	1.0	0.5	1.0	0.5		1.0	1.0	0.5	1.0		0.5
C. Relationship with suppliers		1.0	0.5		0.5	0.5	1.0	1.0	1.0	1.0			
D. Product Category	0.5	1.0	1.0	0.5	0.5	0.5	1.0	0.5	0.5	0.5			
E. Ability to achieve 24-hour delivery	0.5	0.5	1.0	1.0	1.0	1.0	0.5	0.5	0.5	1.0	1.0	0.5	1.0
F. Time window	1.0			0.5			0.5	1.0			1.0		0.5
G. Information System	1.0		0.5	0.5	1.0			0.5		0.0	1.0	1.0	1.0
H. Lack of ability to develop information systems	1.0				0.5			0.5	0.5	0.5	1.0	1.0	1.0
I. The resilience of safety stock		0.5	1.0	1.0	1.0		1.0			1.0	1.0	1.0	
J. Stable operation of warehouse		0.5	1.0	1.0	1.0	1.0	0.5					1.0	



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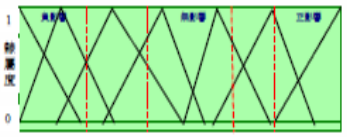

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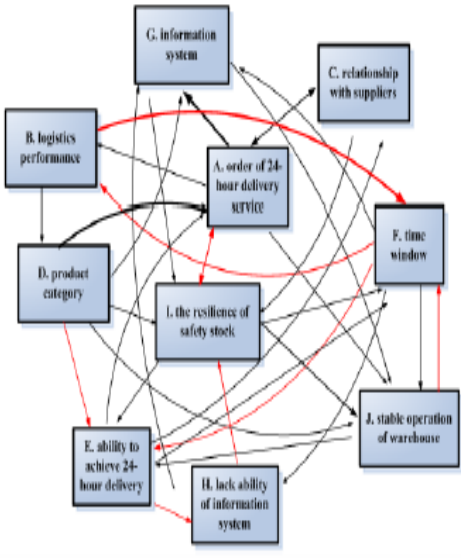
狀態評估（Rating）										
	A. Order of 24-hour delivery service	B. Logistics Performance	C. Relationship with suppliers	D. Product Category	E. Ability to achieve 24-hour delivery	F. Time window	G. Information System	H. Lack of ability to develop information systems	I. The resilience of safety stock	J. Stable operation of warehouse
A. Order of 24-hour delivery	0	1	3				3		1	2
B. Logistics Performance		0	1	(1)		3				
C. Relationship with suppliers	2		0						1	
D. Product Category	2		2	0	0		0		1	2
E. Ability to achieve 24-hour	(1)	3	1		0	3		2		
F. Time window problem	(1)	0	1		(1)	0	1	2		2
G. Information System					0		0		0	0
H. Lack of ability to develop information systems							(1)	0	0	
I. The resilience of safety stock	(1)		1	(1)	1	(1)			0	1
J. Stable operation of warehouse			1		2	(1)				0



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