科技部補助專題研究計畫成果報告
期末報告

反脆弱觀點下協同運輸的風險管理-以淘寶商城為研究個案

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中 文 摘 要 ： 隨著外在環境的不斷變化，風險管理的議題逐漸受到供應鏈研究學者的重視。近年來，供應鏈風險管理已經成為現今企業經營的重要課題，而風險本身具有非線性與不確定性的特點，無形中亦增加了管理者預測與管理供應鏈風險的困難。由於電子零售店與傳統零售店存在著交易行為與物流分開的特性，造成電子商務必須依賴強大的物流支援系統才得以順利運作其商業行為。隨著大陸淘寶商城的配送需求快速成長，因此風險管理將會是淘寶商城建構物流服務時的重要管理課題。另一方面，在供應鏈風險管理研究領域中，「反脆弱」是一個新興觀念，對於供應鏈相關領域而言，若能將反脆弱的觀念引進物流系統將有助於我們更瞭解物流系統的完整樣貌。本計畫將藉由模糊認知圖與敏感度模式等分析技術，以反脆弱的觀點逐年分階段建構研究個案物流機制的風險分析架構。藉由本計畫之研究調查工作，除了可建立評估研究個案之協同運輸管理的風險管理課題外，研究結果可進一步提供物流業者建構其供應鏈規劃模型與策略之參考。

中 文 關 鍵 詞 ： 反脆弱、協同運輸管理、電子商務、淘寶商城、模糊認知圖、敏感度模式

英 文 摘 要 ： The internet represents a growing and huge market and the development of e-commerce is an efficient business model which enables new relationship between consumers and suppliers. In order to send goods or products to customer fast and safely, strong support from efficient logistics system is necessary. The logistics process is complicated and has a lot of risks. For the past few years, the supply chain management has been widely studied in the academic as well as practical fields. However, there are fewer studies about the risk of collaborative transportation management for the Tmall. Risk management is regarded as the important issue in supply chain management, and the antifragile is the new concept of risk analysis. If managers understand the most antifragile parts in all business, they could take actions and know how to allocate resources to avoid risks happening. The objective of this study is to develop an evaluation model and discuss the risk of logistic delivery system via the Fuzzy Cognitive Map (FCM) and Sensitivity Model (SM). From the survey, we can establish an evaluation model to analyze and describe the antifragile, vulnerability and resilience of the delivery system using different kind of research methods. The results obtained in this study can be used to help the manager formulate strategies and reduce the risks proactively as well.

英 文 關 鍵 詞 ： Antifragile, Collaborative Transportation Management, E-Commerce, Tmall, Fuzzy Cognitive Maps, Sensitivity Model

Risk Management of Antifragile for Collaborative Transportation: A Case of Tmall

1. INTRODUCTION

The internet represents a growing and huge market and the development of e-commerce is an efficient business model which enables new relationship between consumers and suppliers. In order to send goods or products to customer fast and safely, strong support from efficient logistics system is necessary. In Taiwan, many e-tailers（retailers who sell goods via electronic transactions on the Internet）have formed close partnership with widespread convenience stores in the area of retailing delivery system originating from resolving delivery problems, so that consumers can order the goods on websites and pick up their ordered goods at the convenience store based on their scheduling preferences. In the logistics system of electronic commerce, the major difference between Taiwan and other countries is the retailing delivery (RD) system. In contrast to home delivery, people using retail delivery do not need to wait for their products at home, and thus have more flexibility to select the time and store that are most convenient. Up to date, the convenience stores in Taiwan have integrated the delivery service combine with the online store in Hong Kong to develop a new retail delivery model: "Multinational Retailing Delivery System". On the other hand, the e-commerce between Taiwan and Hong Kong will more closer and inseparable. Due to the advantage of the retailing delivery, the delivery mechanism will play an important role in the delivery system between Taiwan and Hong Kong.

Taiwan and Hong Kong has a high density of convenience stores. Also, most of stores in Taiwan and Hong Kong provide 24-hours service. According to this operation model, FamilyMart (Taiwan) and CircleK (Hong Kong) have already developed a multinational retailing delivery model. More and more famous e-commerce systems, such as KingStone, Books and SanMing, cooperate with convenience stores to provide multinational retail delivery service for their customers in Hong Kong. Customer can buy books through by the Taiwan's online bookstore service, and can pick up their books conveniently in Hong Kong's convenience store (CircleK).

Vulnerability is a new concept in supply chain risk management. In recent years, a growing number of studies in different fields have examined this issue, particularly because of the recent series of catastrophes and hazards that impacted global economy causing large losses. Supply chain risk management (SCRM) is no exception. Although a substantial number of studies in supply chain vulnerability have been performed to date, most of them employed qualitative analysis. In addition, relatively little research has been conducted on a specific system or company. The multinational retailing delivery model has had remarkable success but also is complicated and has a lot of risks. For the past few years, the supply chain management has been widely studied in the academic as well as practical fields. However, there are fewer studies about the risk of collaborative transportation management for the FamilyMart multinational delivery service. Risk management is regarded as the important issue in supply chain management, the objective of this study is to develop an evaluation model and discuss the risk of logistic delivery system via the Fuzzy Cognitive Map (FCM) and Sensitivity Model (SM). From the survey, we can establish an evaluation model to analyze and describe the vulnerability and resilience of the delivery system using different kind of research methods. The results obtained in this study can be used to help the manager formulate strategies and reduce the risks proactively as well.

2. LITERATURE REVIEW

The vulnerability concept was first applied in the natural sciences. Scholars of natural hazards explored the relationship between vulnerability and environmental change. Turner et al. (2003) believed that a complete vulnerability assessment must include three basic elements: exposure, sensitivity, and adaptive capacity. Exposure refers to the risk of experiencing catastrophic events, and adaptive capacity includes the ability to withstand shocks and continue operations and the ability to recover from attacks (Cutter, Boruff and Shirley, 2003; Kathleen and Micheal, 2007). Adger (2004) thus divided vulnerability into two attributes: biophysical vulnerability and social vulnerability. The former expresses the occurrence of weather-related events and the possibility of attacks; the field of exploration includes the degree of damage produced by weather, events, or hazards to the system. The focus of biophysical vulnerability lies in exploring the situations of human exposure to hazardous regions. The latter refers to people's inability to handle stress or changing social and economic factors.

Supply chain risk management is an important issue in today's business operations. However, non-linear and uncertain risks can potentially increase difficulties in managers' predictions and supply chain risk management. In recent years, along with the growing popularity of the Internet, the worldwide trading volume and frequency have gradually increased and led to the formation of the globalized supply chain concept.

Supply Chain disruption can have great impact on corporate financial performance, so it is widely accepted that supply chain risk management (SCRM) is necessary in today's businesses (Wagner & Neshat, 2009). Supply chain vulnerability is a conceptual framework of supply chain risk management. A supply chain is exposed not only to risks that come from the external environment but also risks caused by suboptimal interaction between organizations within the network. That is, while supply chain disruption is a situation that leads to the occurrence of risk, it is not the only determinant of the final result. However, the susceptibility of the supply chain to harm in this situation seems relevant. This leads to the concept of supply chain vulnerability. (Jüttner *et al*., 2003, Wagner & Bode, 2006).

In past decades, studies about supply chain vulnerability have been mounting rapidly because nature and man-made disasters have noticeably increased in number and intensity. Wagner and Neshat (2009) interpreted the relationship between supply chain disruption and supply chain vulnerability. According to them, supply chain vulnerability cannot be observed directly. There may be drivers or antecedents that lead to this concept. As the figure shows, supply chain vulnerability is generally considered to come from three directions, demand side, supply side, and supply chain structure (Wagner, Bode and Koziol, 2009; Wagner and Neshat, 2009). The first one includes random demands of customers (which is the main reason), the product and its characteristics, and the distribution and transportation operations required for serving the customer. The drivers of the supply side include the supplier portfolio and the supplier network. The last one is the disintegration of supply chains and the globalization of value-adding activities.

As shown in Table 1, Christopher and Peck (2004) define supply chain vulnerability as ‘‘an exposure to serious disturbance’’. Kathleen and Micheal (2007) describe vulnerability as “a susceptibility or predisposition to loss because of existing organizational or functional practices or conditions’’ in their study of the maritime supply chain. Wagner and Bode (2006) state that ‘‘supply chain vulnerability is a function of certain supply chain characteristics and the loss a firm incurs is a result of its supply chain vulnerability to a given supply chain disruption’’. Wagner and Bode (2009) further argue that supply chain characteristics are

antecedents of supply chain vulnerability and have impact on both the probability of occurrence as well as the severity of supply chain disruptions.

Table 1. Definitions of supply chain vulnerability

Author	Definition
Jüttner et. al(2003)	The propensity of risk sources and risk drivers to outweigh risk mitigating strategies, thus causing adverse supply chain consequences.
Christopher and Peck(2004)	An exposure to a serious disturbance.
Wagner and Bode (2006)	Supply chain vulnerability is a function of certain supply chain characteristics and the loss a firm incurs is a result of its supply chain's vulnerability to a given supply chain disruption.
Wagner, Bode and Koziol, 2009	Susceptibility or predisposition to loss because of existing organizational or functional practices or conditions.
Wagner and Bode (2009)	Supply chain characteristics are antecedents of supply chain vulnerability and have impact on both the probability of occurrence as well as the severity of supply chain disruptions.

Following from Svensson's (2001) broad analysis of supply chain vulnerability, we reviewed and classified the related research into holistic and atomistic categories. Svensson (2001, 2002) focuses on atomistic vulnerability. One demonstration of this is a conceptual framework of vulnerability found in the inbound and outbound logistics flows of an automotive assembler. The model he presented consisted of three principal components, source of disturbance, category of disturbance, and type of logistics flow. This study is based on a two-phase process that includes in-depth interviews and statistical techniques. It has been reported that the vulnerability in the inbound logistics the flows from sub-contractors, and the vulnerability in the outbound logistics that flows to customers, may be measured using five principal dimensions: service, level, deviation, consequence, and trend. This study found that focal firms have a higher level of vulnerability in their inbound flows than in outbound flows.

Another is the examination of companies' perceptions of corporate vulnerability in supply chains. This study was done using qualitative analysis to investigate the areas, the causes, and the contingency plans of vulnerability in upstream and downstream supply chains of the automotive industry. It was found that sub-contractors in this industry tend to be limited to myopic and vertical views of the aforesaid three examined elements of corporate vulnerability in upstream and downstream supply chains.

Tang (2006) believed that if an enterprise had no supply chain risk management method to take precautions against vulnerability, the competitive advantage will be lost. This research believes that the supply chain vulnerability cannot be directly observed but can be obtained by monitoring the driving factors of supply chain vulnerability. The root causes of supply chain vulnerability are divided into three kinds: supply side, demand side, and supply chain structure vulnerabilities. Demand side vulnerability mainly occurs in the downstream supply chain, including customers, product characteristics, external logistics, and customer service distribution and transportation.

Wagner and Neshat (2009) also studied a holistic supply chain in Germany. They developed an approach based on graph theory to quantify, and hence mitigate, supply chain vulnerability. Quantitative analysis of supply chain vulnerability aids managers in assessing the vulnerability of their supply chains and comparing the effectiveness of different risk mitigation strategies. They suggested that it is necessary to understand more about the dynamic nature of supply chain vulnerability over time and the consequences of this approach and up to future

research. In addition, they considered other methods that might suit the task. Overall vulnerability refers to the vulnerability of the whole supply chain system. Jüttner et al. (2003) thus defined supply chain vulnerability as "the creation of poor results in the supply chain when risk origins and risk-driven factors lean toward mostly risk mitigation strategies." We use Wagner and Bode's definition as reference. We define delivery vulnerability as: the properties of the delivery system construct the system's sensitivity. This sensitivity, and its loss due to risks to product delivery, comprises vulnerability.

3. METHODOLOGY

The Fuzzy cognitive maps (FCMs) combines the cognitive maps of psychology and the fuzzy relationship to explore the system association model. The structure uses the cognitive map concept to connect the positive and negative relationships between variables. The variable selection method is the expert questionnaire method. In relationship processing, the numerical interval method was used to define the relationship between two variables, and the matrix operations method uses the relationship of changes in fuzzy factors, and the changes in degree of influence.

A cognitive map consists of nodes representing the most relevant concepts in an objective environment (Axelrod, 1976). Through adding plus (+) and minus (−) signs, it allows the identification for the type of relationship (Athanasios, Tsadiras and Konstantinos, 2003), positive or negative. Positive relationship means this concept has a positive impact on the other concept while negative relationship means the one has a negative impact on the other. Guided by these representations, a cognitive map can be expressed through a calculation of an adjacency matrix showing the sign of the relationship. However, one major limitation exists in cognitive maps, that is, the restriction of quantifying causal relationships among variables. In order to overcome the weakness, fuzzy numbers were incorporated to form a new technique that was named Fuzzy cognitive maps.

FCMs are essentially a modeling methodology rooted in a combination of fuzzy logic and neural networks. FCMs map the objective environment through concepts and causal relationship among concepts. Concepts and causal relationships among concepts are developed by the experts who operate, supervise, or know the environment well enough as well as how the concepts behave under different circumstances. Each concept could represent an entity, a variable, or so on due to the characteristic of the system. Causal relationships among concepts in that objective environment are developed through human experience and knowledge.

The graphical illustration of FCM is similar to the cognitive map. FCM also consists of nodes, signs but the additional element, directional and weighted arcs are incorporated into the map. Nodes in the graph stand for the concepts that describe the behaviors in the objective environment and they are connected by signed and weighted interconnections that represent the causal relationships among the concepts, as showed in Fig.1.

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

$$\mathrm{E} = \begin{matrix} w_{11} & \cdots & w_{1n} \\ \vdots & w_{ij} & \vdots \\ w_{n1} & \cdots & w_{nn} \end{matrix} \tag{1}$$

When an expert assigns a w_{ij} value, three issues must be kept in mind (Schneider *et al*., 1998). First, the w_{ij} indicates how strong a causal influence the *i* concept casts 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 causal relationship needs to be shown to establish if the *i* concept is a cause of j or vice-versa. However, to have a consensus among the experts with FCM is relatively difficult because every expert may have their own opinions, leading to the difficulty in explanation.

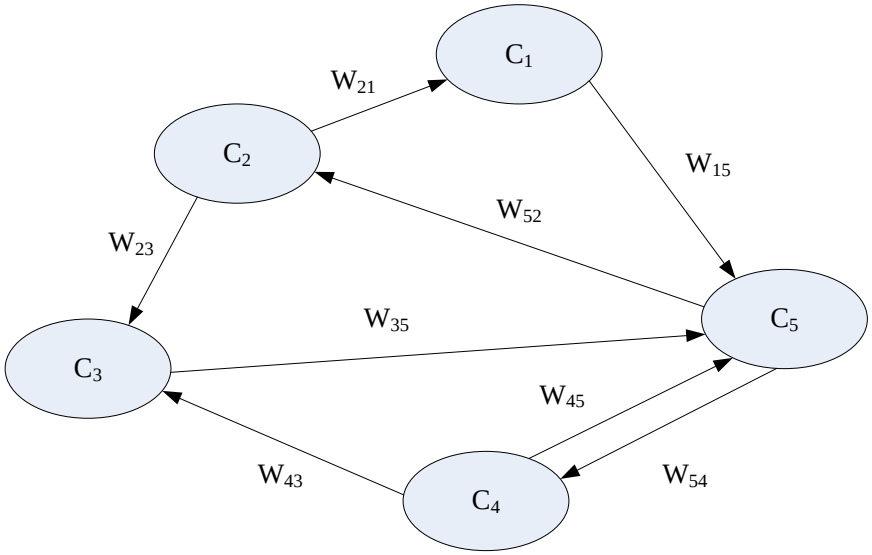

Figure 1. An example of a Fuzzy Cognitive Map with concepts and weighted causal relationship

Further in calculation, FCM uses a fuzzy value between -1 and 1. FCM can be represented

Once the adjacency matrix is available, a new value for each concept that is calculated according to the following equation could be acquired:

$$W_i\ (t_{n+1}) = W[\sum e_{ki}(t_n) W_k(t_n)] \tag{2}$$

Namely, $W_i(t_{n+1})$ is the value of concept W_i at step t_{n+1}, $W_k(t_n)$ is the value of concept W_k at step t_n, and $e_{ki}(t_n)$ is the strength of causal relationship from concept W_j to concept W_i and $S(x)$ is a bounded signal function that transforms the result of the multiplication in the interval [0,1]. $S(x)$ 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 the following Eq (3).

$$S(x) = \frac{1}{\left(1 + e^{-\alpha x}\right)} \tag{3}$$

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, 2002), political problems (Athanasios, Ilias, & Konstantinos, 2003), and critical success factors modeling for an IT project process (Luis, Rossitza, & Jose, 2007), but also to engineering such as behavioral analysis of electronic circuit (Styblinski & Meyer, 1998) and knowledge modeling for urban

design (Xirogiannis, Stefanou, & Glykas, 2004). Besides, FCM is also applied to strategic planning such as modeling political and strategic issues and situations (Andreou, Mateou and Zombanakis, 2005), and simulating the information systems of a strategic planning process. The area of decision-making, project management, and investment analysis is also applied, for example, relationship management in airline service (Kang, Lee and Choi, 2004).

4. DATA COLLECTION AND PROCESSING

4.1 Multinational Retailing Delivery System

In Taiwan there are a lot of convenience stores, which facilitates retail delivery (RD) service (shopping on-line and picking up orders at convenience stores). Retail delivery of e-commerce in Taiwan is more than ten years old, and the e-commerce RD model is mainly employed by providers. Providers have had to improve information flow both internally and externally, and integrate their logistics services into the retail delivery service provided by convenience stores. The procedure that combines e-tailing with the RD system is illustrated in Figure 2, the briefly RD process as the following:

1. On-line shopping: Major e-tailers in Taiwan provide RD services. Some decide the delivery mode of the goods (home delivery or retailing delivery), and the others provide consumers their choice of delivery mode.
2. Selection of pick-up point: When consumers choose a retail delivery system, the convenience stores will be shown on the website. Consumers then select a pick-up point on the e-map provided by the RD system.
3. Packing process: E-tailers transmit the information about goods ordered to their distribution center, and personnel there are responsible for packaging and transporting the goods ordered to the convenience store delivery centers.
4. Delivery process: The convenience store delivery center collects the orders and transports them to different convenience stores. It then sends the processed order information back to the e-tailers.
5. Pick-up goods: According to the information received from the delivery center, e-tailers will notify the consumers by e-mail or telephone about the pick-up. After that, consumers can pick up their goods. In general, consumers order goods on day D, and on day D+1 providers will start the packaging process. Consumers usually pick up their order at the selected convenience store in the afternoon on day D+2.

RD is for B2C business model, recently, the RD model develop different patterns, for example, the store-to-store retailing delivery is for C2C business model, seller (sender) and buyer (recipient) can use the store-to-store RD service for their logistics needs. The development of this logistics delivery model has provided a great deal of support to the C2C business model. Online stores can offer more delivery options for customers to choose from. Meanwhile, customers can make their own choices about which is the most convenient approach to getting their products.

In 2012, FamilyMart (Taiwan) and Circle K (Hong Kong) have integrate their information system and logistics system, provide a new RD model: multinational retailing delivery service. Based on the multinational RD service, online bookstore can provide their serve for their customer in Hong Kong, the Hong Kong's reader can choose books (or product) through the online bookstore in Taiwan, and pick up their books (or products) in Circle K (Hong Kong). Fig. 3 describe the basic concept of multinational retailing delivery service.

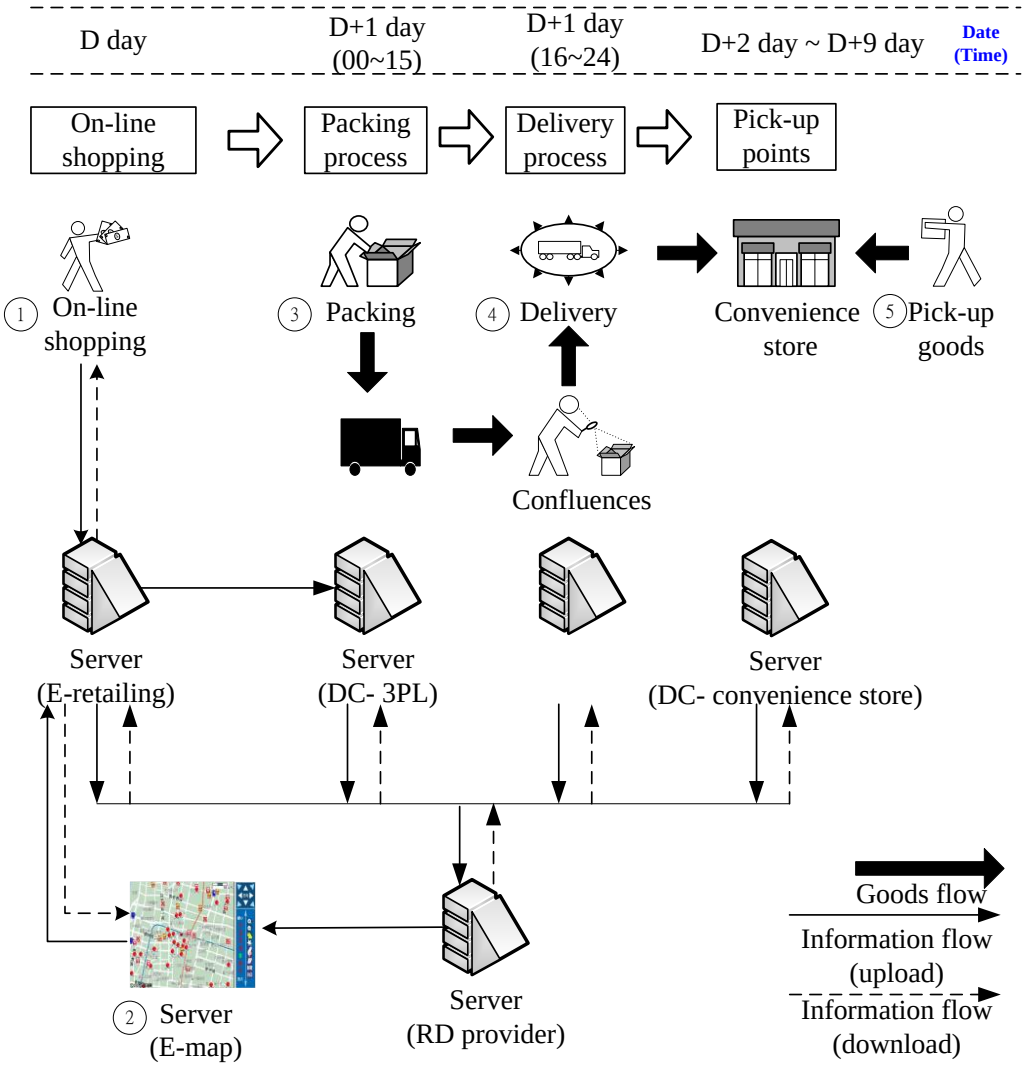

Figure 2. E-commerce RD model

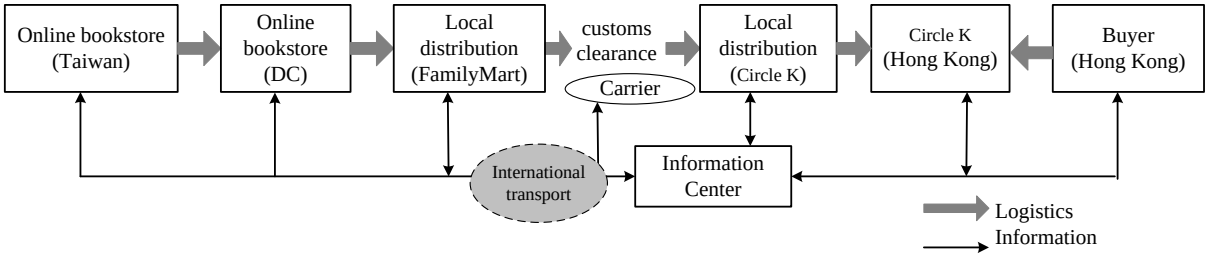

Figure 3. Basic concept of multinational retailing delivery service

4.2 The Proposed of FCM

The Fuzzy cognitive map combines the cognitive maps of psychology and the fuzzy relationship to explore the system association model. The structure uses the cognitive map concept to connect the positive and negative relationships between variables. The variable selection method is the expert questionnaire method. In relationship processing, the numerical interval method was used to define the relationship between two variables, and the matrix operations method uses the relationship of changes in fuzzy factors, and the changes in degree

of influence.

The proposed fuzzy cognitive map is constructed according to the defined system scope and problems they encounter. In order to build up the fuzzy cognitive maps to acquire the insightful characteristics on the problems, the first step is to explore the concepts within fuzzy cognitive maps. From the in-depth interviews and literature review, this study constructed factors influencing the vulnerability of multinational stores and logistics service system and conducted a data collection through the expert questionnaire. This paper conduct a survey on practicing experts with relevant experience in managing multinational stores and logistics service system. The questionnaire survey design was set up through Taiwan FamilyMart's delivery service and Hong Kong CircleK's pickup services.

Fig. 4 explains the integrated supply chain management model of the case study. From Fig. 4, it can be known that the main members making up the multinational convenience stores and logistics service system can be divided into supermarkets, logistics, information, and multinational transportation businesses. According to the in-depth interviews and literature review, this study constructed 7 variables that influence the case study's logistic vulnerability: "Lack of integration and coordination （X_1）". "Frequencies of regular meetings （X_2）", "Bad performance of customs procedure （X_3）", "Stability of multinational logistics （X_4）", "Stability of information system （X_5）", "Performance of retailing delivery (Taiwan), （X_6）", "Performance of retailing delivery (Hong Kong), （X_7）" and "Vulnerability of multinational logistics （X_8）". Table 2 explains the definitions of the variables in the fuzzy recognition map.

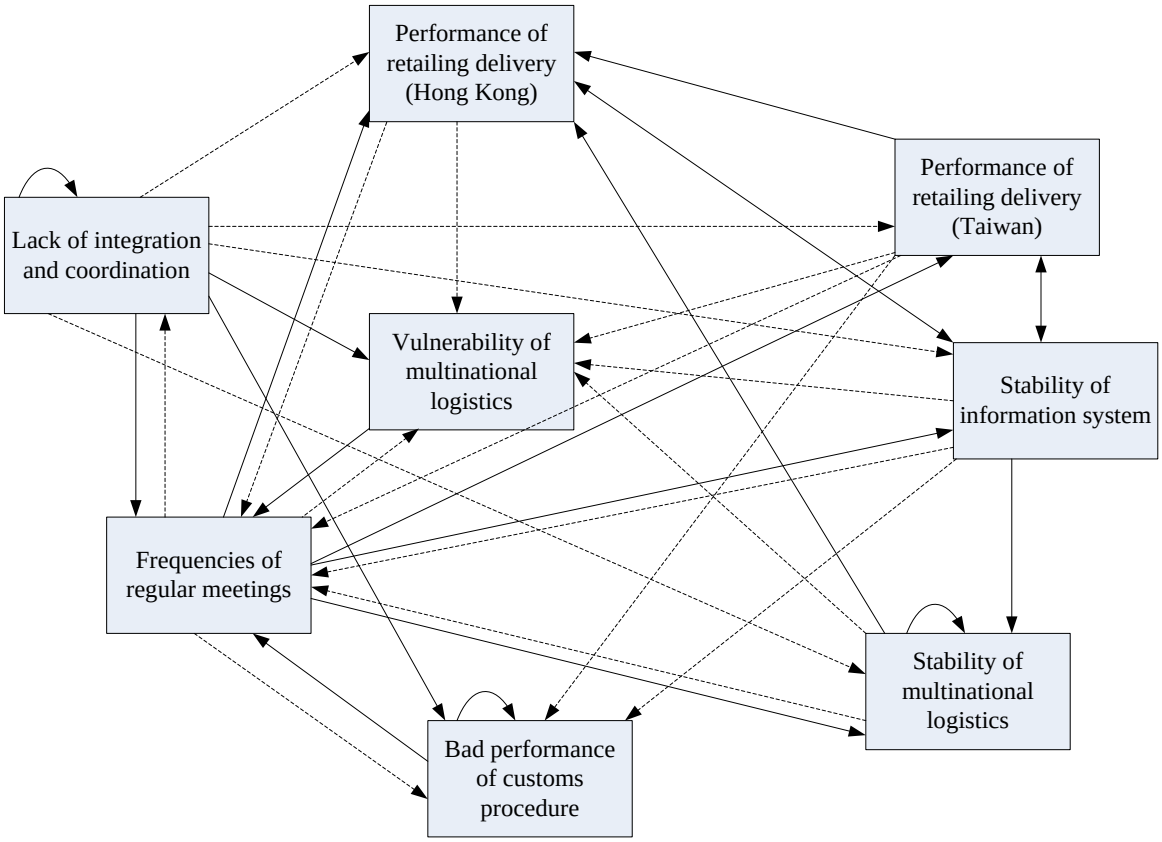

Figure 4. An example of a Fuzzy Cognitive Map with concepts and causal relationship

In the proposed FCM, directional arc represents the causal relationship. The dotted arcs will be activated if the value of concept state is above or below the threshold. For example, if the "Frequencies of regular meetings" is high enough, the "Stability of multinational logistics"

will then be perceived. As soon as the "Stability of multinational logistics" assets is activated, other related concepts will then be perceived （"Stability of multinational logistics" or "Performance of retailing delivery (Taiwan)", and "Performance of retailing delivery (Hong Kong)"）. Experts in this field will evaluate the concepts confirmation, the initial rating of concepts, and the strength of causal relationship.

Table 2. The definitions of the variables in the fuzzy recognition map

Variables	Definitions of Variables
Performance of retailing delivery (Taiwan)	The procedure includes storage of goods at the supermarket, pickup of goods by the delivery driver, transportation of goods to FamilyMart convenience store's logistics center, and transportation of goods to customs for clearance operations.
Bad performance of customs procedure	The procedure includes clearance operations after sending products to Taiwan customs, followed by maritime transportation to Hong Kong their shipping clearance operations.
Stability of multinational logistics	This variable refers to the following procedure: Goods are distributed through Taiwan Logistics Center to Hong Kong's CircleK Logistics Center, including the re-labels the products, conducts transfers of logistics data, and distributes.
Performance of retailing delivery (Hong Kong)	The process including categorizes and distributes the goods to the CircleK convenience store that consumers indicated. Consumers go to the Hong Kong CircleK convenience store to pick up the goods.
Stability of information system	After every completed logistical activity, each member in the multinational supply chain should return the status of the goods to let the supply chain member grasp the latest logistics data.

Table 2. The definitions of the variables in the fuzzy recognition map (con.)

Variables	Definitions of Variables
Frequencies of regular meetings	This variable refers to the development and coordination frequency of the daily mutual operations of multinational stores and distribution and logistics supply chain members. When operation bottlenecks or unexpected situations are encountered, communication, development, and coordination frequency will increase.
Lack of integration and coordination	When abnormalities occur in a sector of the multinational stores and distribution and logistics system, multinational stores and supply chain members have emergency response capabilities.
Vulnerability of multinational logistics	Refers to the vulnerability of the Taiwan FamilyMart delivery and Hong Kong CircleK pickup logistics system.

4.3 Sample Source and output

The directional arcs between the concepts in the Fig.4 represent the strength of causal relationship, which is solicited and gathered through the survey process. Every expert is asked to fill the values （e_{ij}） corresponding to the cells of the questionnaire. From the survey, 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 (4).

$$W(t) = \frac{1}{n}\sum_{i=1}^{n} W_i(t) \quad (4)$$

In Equation (5), $x_i(t)$ represents the status of period t in variable i; the values of x_i range between 0 and 1. The closer variable x_i is to 1, the better the status of variable x_i (or worse according to the variable's definition and differences). The variable w_{ji} is the weight value of variable j's influence on variable i; the values of w_{ji} will be less than 1, positively representing that variable j has a positive influence on variable i and negatively representing that variable j has a negative influences on variable i. The higher the value of w_{ji} is, the higher the degree of influence. In Equation (1), the status of period t+1 in variable X_i is determined by the status of all the variables at period t influencing variable X_i. The conversion function f makes sure every iteration of the fuzzy cognitive map converges to the variable range to the initial range set, and converts the value of $x_i(t)$ to a value between 0 and 1. This paper chose the logistical signal function as the conversion function. The common range setting of parameter λ is 0.2-5. The setting of λ is related to variable amounts in the fuzzy cognitive map and the complexity between variables. According to the characteristics setting in the fuzzy cognitive map, this study's λ value is set as 2.

$$x_i(t) = f \cdot \left(\sum_{\substack{j=1 \\ j\neq i}}^{n} x_j(t-1)w_{ji}\right), f = \frac{1}{1+e^{-\lambda x}} \quad (5)$$

For the questionnaire respondents, this paper chose ten supply chain members who were experts with managerial positions or higher. In the study's questionnaire format, these experts were invited to write the status of each variable, and the degree of influence each variable has on the other variables. According to the data collection and processing, the data gathered and operated is as in Table 3. For the questionnaire respondents, this paper chose ten supply chain members who were experts with managerial positions or higher. In the study's questionnaire format, these experts were invited to write the status of each variable, and the degree of influence each variable has on the other variables. According to the data collection and processing, the data gathered and operated is as in Table 3. The 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, the values range between 0 and 1. The closer they are to 1, the higher the degree of influence. Positive values represent that the influence is positive, and negative values represent that the influence is negative. The value interval of the status variable is 0-1. The closer the value of the status variable is to 0, the worse the system status is (or better depending on the definitions of the variables). When the value of the status variable is 1, this represents that the status of the variable is the better (or worse depending on the definitions of the variables).

Table 3. The input data

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	Stage
X_1	0.30	0.71	0.32	-0.33	-0.68	-0.70	-0.51	0.20	0.60
X_2	-0.57	0.00	-0.31	0.26	0.42	0.92	0.60	-0.33	0.50
X_3	0.00	0.81	0.60	0.00	0.00	0.00	0.00	0.13	0.30
X_4	0.00	-0.22	0.00	0.60	0.00	0.00	0.13	-0.19	0.70
X_5	0.00	-0.30	-0.42	0.47	0.00	0.55	0.33	-0.44	0.67
X_6	0.00	-0.15	-0.13	0.00	0.66	0.00	0.13	-0.33	0.75
X_7	0.00	-0.30	0.00	0.00	0.66	0.00	0.00	-0.31	0.65
X_8	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.43

Besides, not only the impact of strength but also the rating (or the initial state, S_0) of the concepts state is also asked. The acquired value is confined to the interval [-1, 1], showing the negative relationship, no relationship, or positive relationship, and revealing the strength of causal relationship to concepts in the corresponding column and row. Besides, not only the impact of strength but also the initial rating （initial state, W_0） of the concepts state is also inquired. The rating of concept state represents the assessment of current state. Its interval falls within [0, 1]. All the experts are consulted with their experience and knowledge evaluated on a numerical scale. In order to avoid illogical deviation and error, each value in the survey cell is rigorously checked to ensure that the value difference in each cell of every survey is within a reasonable range. The verification of whether the value conflicting with the prior experience is also implemented as result.

The output of proposed FCM is as Table 4 and Fig. 5 shows. After taking into account that the concepts incorporated need time to ferment in real world, each run is assumed to be one week. Each member of the multinational retailing delivery system, usually in the practice, needs about one week to respond to the changes. The interviewed experts expressed that when the multinational logistics system encountered external environment changes and needed to change, the time needed to prepare and change the results was about a week. A week's time includes (1) holding a meeting to determine the contents of operations that need to be repaired, (2) relevant unit making operation adjustments, and (3) announcing the changes to all units and starting to implement new operations. In addition, in a research on logistics operations, Wang et al. (2010) set each iteration of the Fuzzy cognitive map to a week as the managers implied. Therefore, in referring to the interviewed experts and the study's literature review of definitions, this paper set each iteration calculation to a week as the managers implied.

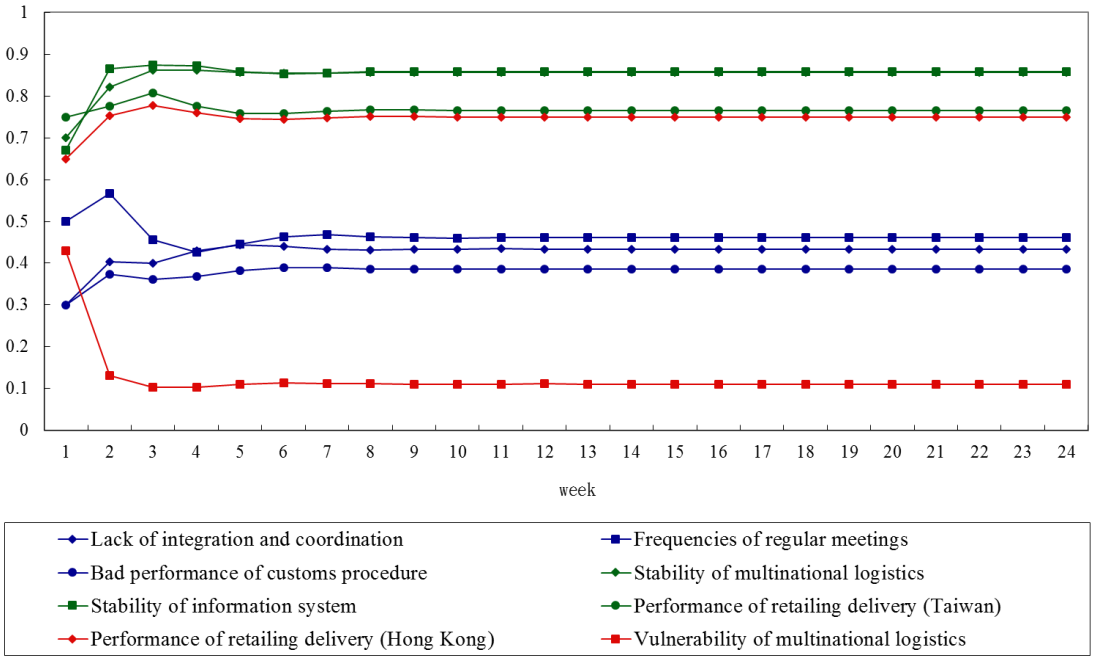

Figure 5. Result of FCM

The results reflected in Figure 5 indicate that:

(1) Frequencies of regular meetings was increased at the first run, and then decrease during 10-20 weeks, after 20 workdays it gradually increases, then drop back down a bit about 40 weeks after. This would more likely explain that bad performance of customs procedure was not stabilized at the beginning. After 40 weeks the bad performance of customs procedure was

closes to 0.38 representing that, frequencies of regular meetings will have almost no changes in the long run.

(2) Bad performance of customs procedure and lack of integration and coordination. After 20 weeks, they will slowly increase and finally closes to 0.46 and 0.38.

(3) "Performance of retailing delivery (Taiwan)", "Performance of retailing delivery (Hong Kong)", "Stability of information system" and "Stability of multinational logistics" are all increased, then miner decrease and finally stably close to 0.76, 0.74, 0.85 and 0.85.

(4) Vulnerability of multinational logistics decreased until 3 runs, and dropped to 0.11 after 30 weeks.

Table 4. Final State for each variable of FCM

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
State (S_0)	0.60	0.50	0.30	0.70	0.67	0.75	0.65	0.43
State (S_{24})	0.43	0.46	0.39	0.86	0.86	0.77	0.75	0.11

Fig. 4 shows the FCM, the variable including "Lack of integration and coordination (X_1) ". "Frequencies of regular meetings (X_2) ", "Bad performance of customs procedure (X_3) ", "Stability of multinational logistics (X_4) ", "Stability of information system (X_5) ", "Performance of retailing delivery (Taiwan), (X_6) ", "Performance of retailing delivery (Hong Kong), (X_7) " and "Vulnerability of multinational logistics (X_8) ".

4.4 Sensitivity Model Analysis

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 2004, 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). 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.

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 Table5. 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 5) provide us with needed information to identify the role for each variable in the system.

Then, this paper explored the Fuzzy cognitive map through the sensitivity model. The variables act as key influencing factors. In the influence weight matrix, AS is the Active Sum, which represents the sum of variables that influence other variables. The greater the AS value of variables is, the greater the degree to which a variable influences other variables. PS is the Passive Sum, which represents the degree to which a variable receives the influence of other

variables. The variable Q is the ratio of AS/PS. The greater the Q value is, it more difficult it is for the variable to influence other variables and to receive the influence of other variables. According to AS and PS, sensitivity can be obtained in the Fuzzy cognitive map. The further the variable is from the original point, the more that the size of the Q value can represent the area size of the variable in Fig. 6.

Table 5. The impact matrix

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	AS	Q
X_1	1	3	2	2	3	3	2	1	17	5.7
X_2	2	0	2	1	2	3	2	2	14	1.1
X_3	0	3	2	0	0	0	0	1	6	0.7
X_4	0	1	0	2	0	0	1	1	5	0.7
X_5	0	1	2	2	0	2	2	2	11	1.0
X_6	0	1	1	0	3	0	1	2	8	1.0
X_7	0	1	0	0	3	0	0	2	6	0.8
X_8	0	3	0	0	0	0	0	0	3	0.3
PS	3	13	9	7	11	8	8	11	-	-

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 effects 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. If a concept has a relatively high AS, like “Lack of integration and coordination” (17), 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 Stability of multinational logistics (2). A high PS such as relationship with suppliers 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.

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 “Performance of retailing delivery (Taiwan)” 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 6 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 line is meant that the concept strongly effects on the other concepts, in contrast, one concept under the line is meant that the concept is affected by other concepts. According to the above rules, all the concepts of the system are plotted in Figure 6. We can see that “Lack of integration and coordination”, “Frequencies of regular meetings”, and “Stability of multinational logistic” are the critical concepts in multinational retailing delivery system, which means these concepts are the major driving force behind system development.

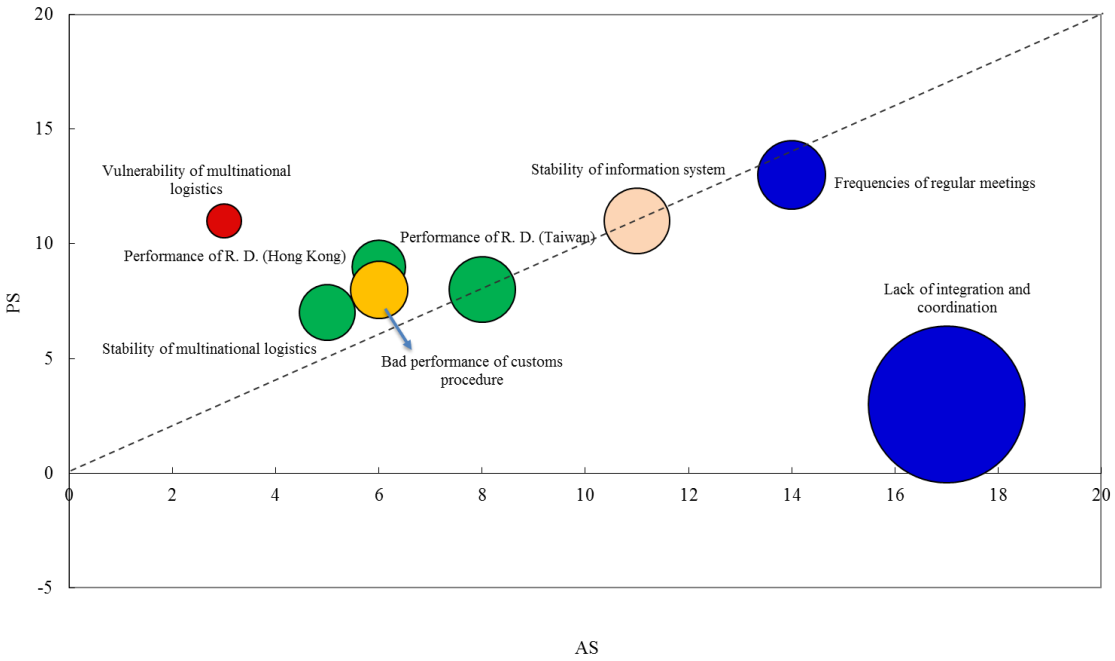

Figure 6. System roles of the variables

5. CONCLUSSION AND SUGGESTIONS

Along with the external environment's continual changes, the topic of risk management has extended to receiving the focus of supply chain research scholars. This paper analyzes the extremely complex procedure of the operations of the multinational stores and distribution logistics mechanism. The procedure has many uncertain factors that lead to operational risks. Therefore, how to decrease the vulnerability of the system itself and increase the system's recovery ability has become an important topic for supply chain risk management. In the future, all industry supply chain systems will face many challenges. Along with the development of related technologies in logistics and distribution, the derived logistics service patterns are also becoming increasingly diverse. The logistics industry cannot avoid encountering more cross-industry competition. In facing these external environment changes, each industry's supply chain management personnel must develop the industry's supply chain risk identification and evaluation indicators.

Because of great development in electronic commerce, online shopping has become more and more popular. Many marketing experts believe that websites are the most important retail channel. Online trade is not only business to customer (B2C, company proved the service for the customer), but also customer to customer (C2C, customer provide service to another customer). That is, people can buy or sell their own property through e-commerce systems like e-auctions. The E-retailing is obviously becoming a noticeable market. However, as the market grows and matures, "delivery service failure" becomes one of the challenges for E-tailers. With the increase of e-transaction volume between Taiwan and China (Hong Kong) and based on the Economic Cooperation Framework Agreement, the retailing delivery provider in Taiwan upgrade the service and become a transnational retailing delivery service mechanism. To better understand the vulnerability of transnational delivery system, we use FCM and SM to analyze the vulnerability of our case. In this study, we first describe the basic concept of multinational retailing delivery system, second, we also developed a FCM model to analysis the vulnerability

of research case. The variable of the FCM including “Lack of integration and coordination”. “Frequencies of regular meetings”, “Bad performance of customs procedure”, “Stability of multinational logistics”, “Stability of information system”, “Performance of retailing delivery (Taiwan)”, “Performance of retailing delivery (Hong Kong)” and “Vulnerability of multinational logistics”. Finally, according sensitivity model analysis, we shows that the “Lack of integration and coordination”, “Frequencies of regular meetings”, and “Stability of multinational logistic” are the critical concepts in multinational retailing delivery system, which means these concepts are the major driving force behind system development.

The results obtained in this study can be used to improve the delivery service quality for delivery providers and evaluate the delivery quality management strategies. Based on the research process and results as shown previously, there are still some work can be performed to enhance the research quality. Some of the key research opportunities and recommendations for further research, for example, the relationship among the variable of the FCM maybe exit nonlinear or chaotic behavior, it is an interesting research topic for future researcher. Besides, there are several different model of multinational retailing delivery system, in our cast (“Taiwan-Hong Kong”) model belong the B2C business model, future researcher can consider the case of Taobao (“Taiwan-China”), it belong the C2C business model. Taobao's growth rate is quite fast, and C2C model is more complex than B2C model, the case of Taobao will be a very important case.

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Risk Management of Antifragile for Collaborative Transportation: A Case of Tmall

1. INTRODUCTION

The internet represents a growing and huge market and the development of e-commerce is an efficient business model which enables new relationship between consumers and suppliers. In order to send goods or products to customer fast and safely, strong support from efficient logistics system is necessary. In Taiwan, many e-tailers（retailers who sell goods via electronic transactions on the Internet）have formed close partnership with widespread convenience stores in the area of retailing delivery system originating from resolving delivery problems, so that consumers can order the goods on websites and pick up their ordered goods at the convenience store based on their scheduling preferences. In the logistics system of electronic commerce, the major difference between Taiwan and other countries is the retailing delivery (RD) system. In contrast to home delivery, people using retail delivery do not need to wait for their products at home, and thus have more flexibility to select the time and store that are most convenient. Up to date, the convenience stores in Taiwan have integrated the delivery service combine with the online store in Hong Kong to develop a new retail delivery model: "Multinational Retailing Delivery System". On the other hand, the e-commerce between Taiwan and Hong Kong will more closer and inseparable. Due to the advantage of the retailing delivery, the delivery mechanism will play an important role in the delivery system between Taiwan and Hong Kong.

Taiwan and Hong Kong has a high density of convenience stores. Also, most of stores in Taiwan and Hong Kong provide 24-hours service. According to this operation model, FamilyMart (Taiwan) and CircleK (Hong Kong) have already developed a multinational retailing delivery model. More and more famous e-commerce systems, such as KingStone, Books and SanMing, cooperate with convenience stores to provide multinational retail delivery service for their customers in Hong Kong. Customer can buy books through by the Taiwan's online bookstore service, and can pick up their books conveniently in Hong Kong's convenience store (CircleK).

Vulnerability is a new concept in supply chain risk management. In recent years, a growing number of studies in different fields have examined this issue, particularly because of the recent series of catastrophes and hazards that impacted global economy causing large losses. Supply chain risk management (SCRM) is no exception. Although a substantial number of studies in supply chain vulnerability have been performed to date, most of them employed qualitative analysis. In addition, relatively little research has been conducted on a specific system or company. The multinational retailing delivery model has had remarkable success but also is complicated and has a lot of risks. For the past few years, the supply chain management has been widely studied in the academic as well as practical fields. However, there are fewer studies about the risk of collaborative transportation management for the FamilyMart multinational delivery service. Risk management is regarded as the important issue in supply chain management, the objective of this study is to develop an evaluation model and discuss the risk of logistic delivery system via the Fuzzy Cognitive Map (FCM) and Sensitivity Model (SM). From the survey, we can establish an evaluation model to analyze and describe the vulnerability and resilience of the delivery system using different kind of research methods. The results obtained in this study can be used to help the manager formulate strategies and reduce the risks proactively as well.

2. LITERATURE REVIEW

The vulnerability concept was first applied in the natural sciences. Scholars of natural hazards explored the relationship between vulnerability and environmental change. Turner et al. (2003) believed that a complete vulnerability assessment must include three basic elements: exposure, sensitivity, and adaptive capacity. Exposure refers to the risk of experiencing catastrophic events, and adaptive capacity includes the ability to withstand shocks and continue operations and the ability to recover from attacks (Cutter, Boruff and Shirley, 2003; Kathleen and Micheal, 2007). Adger (2004) thus divided vulnerability into two attributes: biophysical vulnerability and social vulnerability. The former expresses the occurrence of weather-related events and the possibility of attacks; the field of exploration includes the degree of damage produced by weather, events, or hazards to the system. The focus of biophysical vulnerability lies in exploring the situations of human exposure to hazardous regions. The latter refers to people's inability to handle stress or changing social and economic factors.

Supply chain risk management is an important issue in today's business operations. However, non-linear and uncertain risks can potentially increase difficulties in managers' predictions and supply chain risk management. In recent years, along with the growing popularity of the Internet, the worldwide trading volume and frequency have gradually increased and led to the formation of the globalized supply chain concept.

Supply Chain disruption can have great impact on corporate financial performance, so it is widely accepted that supply chain risk management (SCRM) is necessary in today's businesses (Wagner & Neshat, 2009). Supply chain vulnerability is a conceptual framework of supply chain risk management. A supply chain is exposed not only to risks that come from the external environment but also risks caused by suboptimal interaction between organizations within the network. That is, while supply chain disruption is a situation that leads to the occurrence of risk, it is not the only determinant of the final result. However, the susceptibility of the supply chain to harm in this situation seems relevant. This leads to the concept of supply chain vulnerability. (Jüttner *et al*., 2003, Wagner & Bode, 2006).

In past decades, studies about supply chain vulnerability have been mounting rapidly because nature and man-made disasters have noticeably increased in number and intensity. Wagner and Neshat (2009) interpreted the relationship between supply chain disruption and supply chain vulnerability. According to them, supply chain vulnerability cannot be observed directly. There may be drivers or antecedents that lead to this concept. As the figure shows, supply chain vulnerability is generally considered to come from three directions, demand side, supply side, and supply chain structure (Wagner, Bode and Koziol, 2009; Wagner and Neshat, 2009). The first one includes random demands of customers (which is the main reason), the product and its characteristics, and the distribution and transportation operations required for serving the customer. The drivers of the supply side include the supplier portfolio and the supplier network. The last one is the disintegration of supply chains and the globalization of value-adding activities.

As shown in Table 1, Christopher and Peck (2004) define supply chain vulnerability as ‘‘an exposure to serious disturbance’’. Kathleen and Micheal (2007) describe vulnerability as “a susceptibility or predisposition to loss because of existing organizational or functional practices or conditions’’ in their study of the maritime supply chain. Wagner and Bode (2006) state that ‘‘supply chain vulnerability is a function of certain supply chain characteristics and the loss a firm incurs is a result of its supply chain vulnerability to a given supply chain disruption’’. Wagner and Bode (2009) further argue that supply chain characteristics are

antecedents of supply chain vulnerability and have impact on both the probability of occurrence as well as the severity of supply chain disruptions.

Table 1. Definitions of supply chain vulnerability

Author	Definition
Jüttner et. al(2003)	The propensity of risk sources and risk drivers to outweigh risk mitigating strategies, thus causing adverse supply chain consequences.
Christopher and Peck(2004)	An exposure to a serious disturbance.
Wagner and Bode (2006)	Supply chain vulnerability is a function of certain supply chain characteristics and the loss a firm incurs is a result of its supply chain's vulnerability to a given supply chain disruption.
Wagner, Bode and Koziol, 2009	Susceptibility or predisposition to loss because of existing organizational or functional practices or conditions.
Wagner and Bode (2009)	Supply chain characteristics are antecedents of supply chain vulnerability and have impact on both the probability of occurrence as well as the severity of supply chain disruptions.

Following from Svensson's (2001) broad analysis of supply chain vulnerability, we reviewed and classified the related research into holistic and atomistic categories. Svensson (2001, 2002) focuses on atomistic vulnerability. One demonstration of this is a conceptual framework of vulnerability found in the inbound and outbound logistics flows of an automotive assembler. The model he presented consisted of three principal components, source of disturbance, category of disturbance, and type of logistics flow. This study is based on a two-phase process that includes in-depth interviews and statistical techniques. It has been reported that the vulnerability in the inbound logistics the flows from sub-contractors, and the vulnerability in the outbound logistics that flows to customers, may be measured using five principal dimensions: service, level, deviation, consequence, and trend. This study found that focal firms have a higher level of vulnerability in their inbound flows than in outbound flows.

Another is the examination of companies' perceptions of corporate vulnerability in supply chains. This study was done using qualitative analysis to investigate the areas, the causes, and the contingency plans of vulnerability in upstream and downstream supply chains of the automotive industry. It was found that sub-contractors in this industry tend to be limited to myopic and vertical views of the aforesaid three examined elements of corporate vulnerability in upstream and downstream supply chains.

Tang (2006) believed that if an enterprise had no supply chain risk management method to take precautions against vulnerability, the competitive advantage will be lost. This research believes that the supply chain vulnerability cannot be directly observed but can be obtained by monitoring the driving factors of supply chain vulnerability. The root causes of supply chain vulnerability are divided into three kinds: supply side, demand side, and supply chain structure vulnerabilities. Demand side vulnerability mainly occurs in the downstream supply chain, including customers, product characteristics, external logistics, and customer service distribution and transportation.

Wagner and Neshat (2009) also studied a holistic supply chain in Germany. They developed an approach based on graph theory to quantify, and hence mitigate, supply chain vulnerability. Quantitative analysis of supply chain vulnerability aids managers in assessing the vulnerability of their supply chains and comparing the effectiveness of different risk mitigation strategies. They suggested that it is necessary to understand more about the dynamic nature of supply chain vulnerability over time and the consequences of this approach and up to future

research. In addition, they considered other methods that might suit the task. Overall vulnerability refers to the vulnerability of the whole supply chain system. Jüttner et al. (2003) thus defined supply chain vulnerability as "the creation of poor results in the supply chain when risk origins and risk-driven factors lean toward mostly risk mitigation strategies." We use Wagner and Bode's definition as reference. We define delivery vulnerability as: the properties of the delivery system construct the system's sensitivity. This sensitivity, and its loss due to risks to product delivery, comprises vulnerability.

3. METHODOLOGY

The Fuzzy cognitive maps (FCMs) combines the cognitive maps of psychology and the fuzzy relationship to explore the system association model. The structure uses the cognitive map concept to connect the positive and negative relationships between variables. The variable selection method is the expert questionnaire method. In relationship processing, the numerical interval method was used to define the relationship between two variables, and the matrix operations method uses the relationship of changes in fuzzy factors, and the changes in degree of influence.

A cognitive map consists of nodes representing the most relevant concepts in an objective environment (Axelrod, 1976). Through adding plus (+) and minus (−) signs, it allows the identification for the type of relationship (Athanasios, Tsadiras and Konstantinos, 2003), positive or negative. Positive relationship means this concept has a positive impact on the other concept while negative relationship means the one has a negative impact on the other. Guided by these representations, a cognitive map can be expressed through a calculation of an adjacency matrix showing the sign of the relationship. However, one major limitation exists in cognitive maps, that is, the restriction of quantifying causal relationships among variables. In order to overcome the weakness, fuzzy numbers were incorporated to form a new technique that was named Fuzzy cognitive maps.

FCMs are essentially a modeling methodology rooted in a combination of fuzzy logic and neural networks. FCMs map the objective environment through concepts and causal relationship among concepts. Concepts and causal relationships among concepts are developed by the experts who operate, supervise, or know the environment well enough as well as how the concepts behave under different circumstances. Each concept could represent an entity, a variable, or so on due to the characteristic of the system. Causal relationships among concepts in that objective environment are developed through human experience and knowledge.

The graphical illustration of FCM is similar to the cognitive map. FCM also consists of nodes, signs but the additional element, directional and weighted arcs are incorporated into the map. Nodes in the graph stand for the concepts that describe the behaviors in the objective environment and they are connected by signed and weighted interconnections that represent the causal relationships among the concepts, as showed in Fig.1.

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

$$\mathrm{E} = \begin{matrix} w_{11} & \cdots & w_{1n} \\ \vdots & w_{ij} & \vdots \\ w_{n1} & \cdots & w_{nn} \end{matrix} \tag{1}$$

When an expert assigns a w_{ij} value, three issues must be kept in mind (Schneider *et al*., 1998). First, the w_{ij} indicates how strong a causal influence the *i* concept casts 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 causal relationship needs to be shown to establish if the *i* concept is a cause of j or vice-versa. However, to have a consensus among the experts with FCM is relatively difficult because every expert may have their own opinions, leading to the difficulty in explanation.

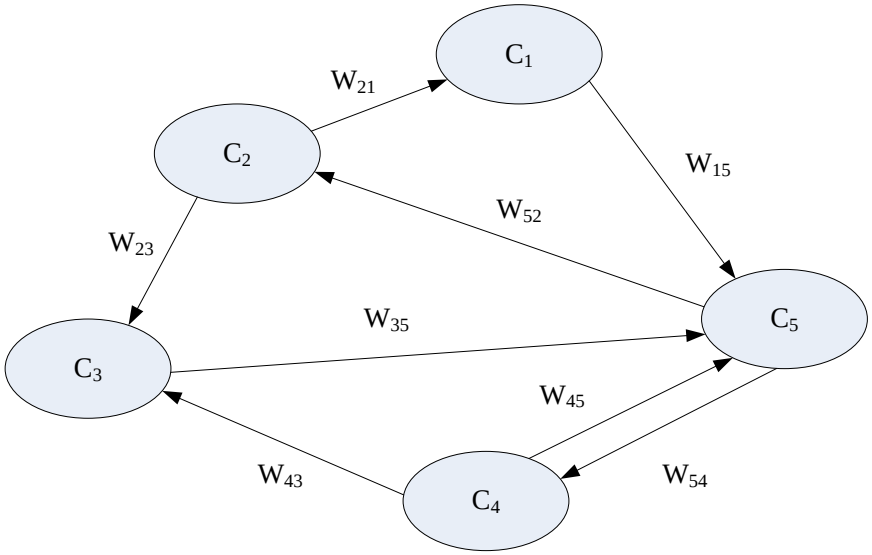

Figure 1. An example of a Fuzzy Cognitive Map with concepts and weighted causal relationship

Further in calculation, FCM uses a fuzzy value between -1 and 1. FCM can be represented

Once the adjacency matrix is available, a new value for each concept that is calculated according to the following equation could be acquired:

$$W_i\ (t_{n+1}) = W[\sum e_{ki}(t_n) W_k(t_n)] \tag{2}$$

Namely, $W_i(t_{n+1})$ is the value of concept W_i at step t_{n+1}, $W_k(t_n)$ is the value of concept W_k at step t_n, and $e_{ki}(t_n)$ is the strength of causal relationship from concept W_j to concept W_i and $S(x)$ is a bounded signal function that transforms the result of the multiplication in the interval [0,1]. $S(x)$ 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 the following Eq (3).

$$S(x) = \frac{1}{\left(1 + e^{-\alpha x}\right)} \tag{3}$$

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, 2002), political problems (Athanasios, Ilias, & Konstantinos, 2003), and critical success factors modeling for an IT project process (Luis, Rossitza, & Jose, 2007), but also to engineering such as behavioral analysis of electronic circuit (Styblinski & Meyer, 1998) and knowledge modeling for urban

design (Xirogiannis, Stefanou, & Glykas, 2004). Besides, FCM is also applied to strategic planning such as modeling political and strategic issues and situations (Andreou, Mateou and Zombanakis, 2005), and simulating the information systems of a strategic planning process. The area of decision-making, project management, and investment analysis is also applied, for example, relationship management in airline service (Kang, Lee and Choi, 2004).

4. DATA COLLECTION AND PROCESSING

4.1 Multinational Retailing Delivery System

In Taiwan there are a lot of convenience stores, which facilitates retail delivery (RD) service (shopping on-line and picking up orders at convenience stores). Retail delivery of e-commerce in Taiwan is more than ten years old, and the e-commerce RD model is mainly employed by providers. Providers have had to improve information flow both internally and externally, and integrate their logistics services into the retail delivery service provided by convenience stores. The procedure that combines e-tailing with the RD system is illustrated in Figure 2, the briefly RD process as the following:

1. On-line shopping: Major e-tailers in Taiwan provide RD services. Some decide the delivery mode of the goods (home delivery or retailing delivery), and the others provide consumers their choice of delivery mode.
2. Selection of pick-up point: When consumers choose a retail delivery system, the convenience stores will be shown on the website. Consumers then select a pick-up point on the e-map provided by the RD system.
3. Packing process: E-tailers transmit the information about goods ordered to their distribution center, and personnel there are responsible for packaging and transporting the goods ordered to the convenience store delivery centers.
4. Delivery process: The convenience store delivery center collects the orders and transports them to different convenience stores. It then sends the processed order information back to the e-tailers.
5. Pick-up goods: According to the information received from the delivery center, e-tailers will notify the consumers by e-mail or telephone about the pick-up. After that, consumers can pick up their goods. In general, consumers order goods on day D, and on day D+1 providers will start the packaging process. Consumers usually pick up their order at the selected convenience store in the afternoon on day D+2.

RD is for B2C business model, recently, the RD model develop different patterns, for example, the store-to-store retailing delivery is for C2C business model, seller (sender) and buyer (recipient) can use the store-to-store RD service for their logistics needs. The development of this logistics delivery model has provided a great deal of support to the C2C business model. Online stores can offer more delivery options for customers to choose from. Meanwhile, customers can make their own choices about which is the most convenient approach to getting their products.

In 2012, FamilyMart (Taiwan) and Circle K (Hong Kong) have integrate their information system and logistics system, provide a new RD model: multinational retailing delivery service. Based on the multinational RD service, online bookstore can provide their serve for their customer in Hong Kong, the Hong Kong's reader can choose books (or product) through the online bookstore in Taiwan, and pick up their books (or products) in Circle K (Hong Kong). Fig. 3 describe the basic concept of multinational retailing delivery service.

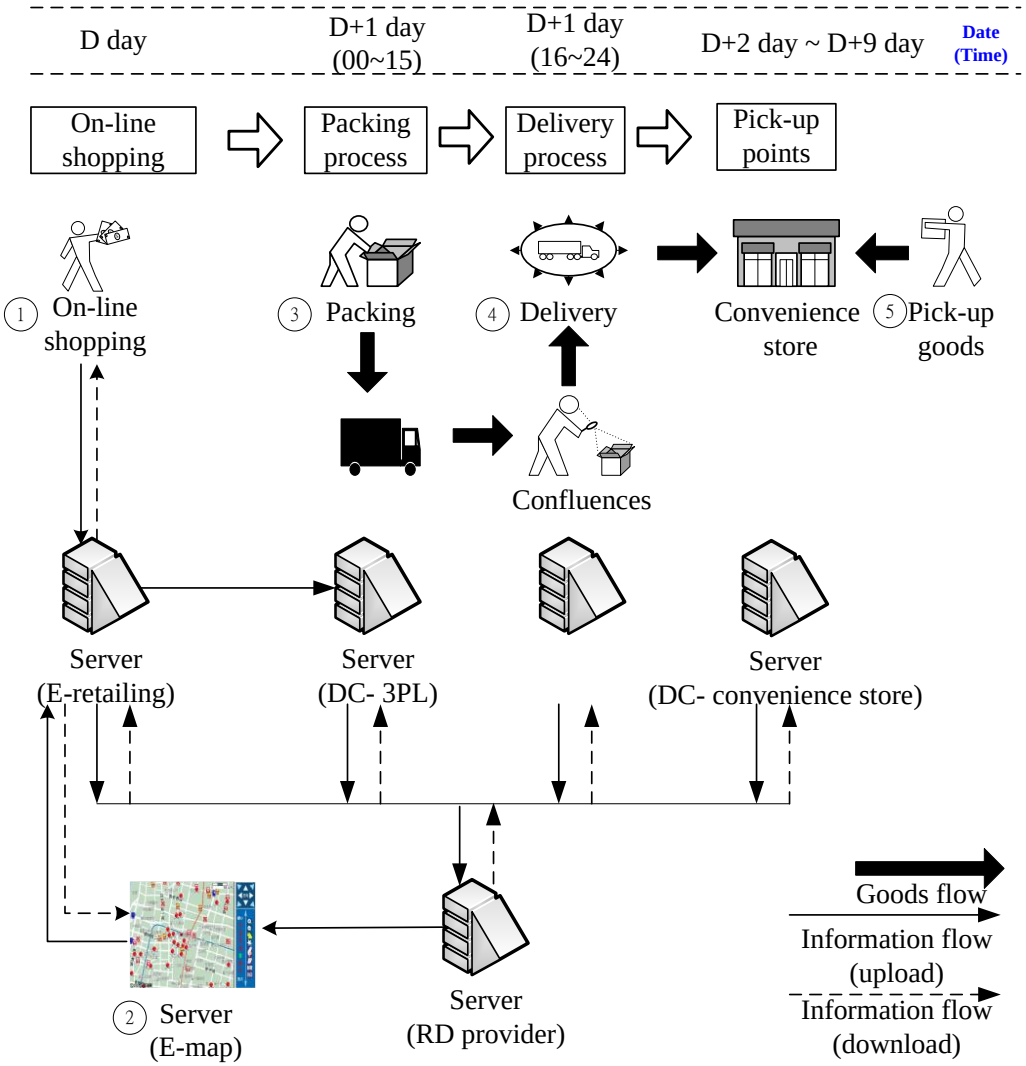

Figure 2. E-commerce RD model

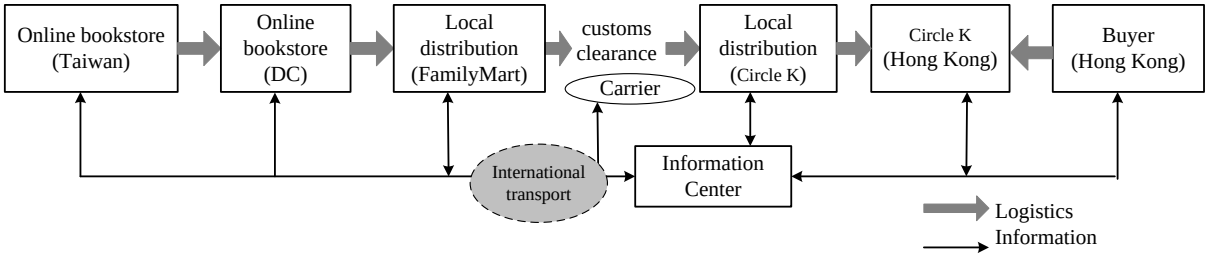

Figure 3. Basic concept of multinational retailing delivery service

4.2 The Proposed of FCM

The Fuzzy cognitive map combines the cognitive maps of psychology and the fuzzy relationship to explore the system association model. The structure uses the cognitive map concept to connect the positive and negative relationships between variables. The variable selection method is the expert questionnaire method. In relationship processing, the numerical interval method was used to define the relationship between two variables, and the matrix operations method uses the relationship of changes in fuzzy factors, and the changes in degree

of influence.

The proposed fuzzy cognitive map is constructed according to the defined system scope and problems they encounter. In order to build up the fuzzy cognitive maps to acquire the insightful characteristics on the problems, the first step is to explore the concepts within fuzzy cognitive maps. From the in-depth interviews and literature review, this study constructed factors influencing the vulnerability of multinational stores and logistics service system and conducted a data collection through the expert questionnaire. This paper conduct a survey on practicing experts with relevant experience in managing multinational stores and logistics service system. The questionnaire survey design was set up through Taiwan FamilyMart's delivery service and Hong Kong CircleK's pickup services.

Fig. 4 explains the integrated supply chain management model of the case study. From Fig. 4, it can be known that the main members making up the multinational convenience stores and logistics service system can be divided into supermarkets, logistics, information, and multinational transportation businesses. According to the in-depth interviews and literature review, this study constructed 7 variables that influence the case study's logistic vulnerability: "Lack of integration and coordination （X_1）". "Frequencies of regular meetings （X_2）", "Bad performance of customs procedure （X_3）", "Stability of multinational logistics （X_4）", "Stability of information system （X_5）", "Performance of retailing delivery (Taiwan), （X_6）", "Performance of retailing delivery (Hong Kong), （X_7）" and "Vulnerability of multinational logistics （X_8）". Table 2 explains the definitions of the variables in the fuzzy recognition map.

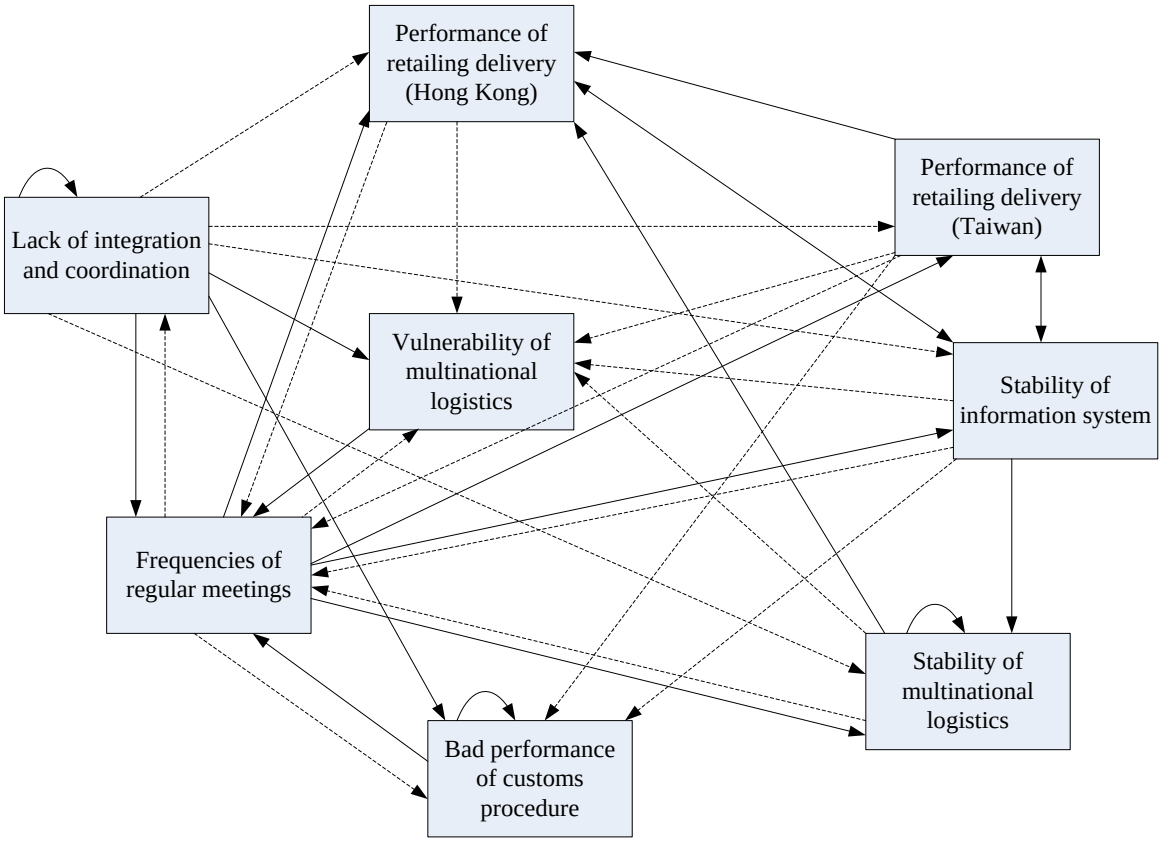

Figure 4. An example of a Fuzzy Cognitive Map with concepts and causal relationship

In the proposed FCM, directional arc represents the causal relationship. The dotted arcs will be activated if the value of concept state is above or below the threshold. For example, if the "Frequencies of regular meetings" is high enough, the "Stability of multinational logistics"

will then be perceived. As soon as the "Stability of multinational logistics" assets is activated, other related concepts will then be perceived （"Stability of multinational logistics" or "Performance of retailing delivery (Taiwan)", and "Performance of retailing delivery (Hong Kong)"）. Experts in this field will evaluate the concepts confirmation, the initial rating of concepts, and the strength of causal relationship.

Table 2. The definitions of the variables in the fuzzy recognition map

Variables	Definitions of Variables
Performance of retailing delivery (Taiwan)	The procedure includes storage of goods at the supermarket, pickup of goods by the delivery driver, transportation of goods to FamilyMart convenience store's logistics center, and transportation of goods to customs for clearance operations.
Bad performance of customs procedure	The procedure includes clearance operations after sending products to Taiwan customs, followed by maritime transportation to Hong Kong their shipping clearance operations.
Stability of multinational logistics	This variable refers to the following procedure: Goods are distributed through Taiwan Logistics Center to Hong Kong's CircleK Logistics Center, including the re-labels the products, conducts transfers of logistics data, and distributes.
Performance of retailing delivery (Hong Kong)	The process including categorizes and distributes the goods to the CircleK convenience store that consumers indicated. Consumers go to the Hong Kong CircleK convenience store to pick up the goods.
Stability of information system	After every completed logistical activity, each member in the multinational supply chain should return the status of the goods to let the supply chain member grasp the latest logistics data.

Table 2. The definitions of the variables in the fuzzy recognition map (con.)

Variables	Definitions of Variables
Frequencies of regular meetings	This variable refers to the development and coordination frequency of the daily mutual operations of multinational stores and distribution and logistics supply chain members. When operation bottlenecks or unexpected situations are encountered, communication, development, and coordination frequency will increase.
Lack of integration and coordination	When abnormalities occur in a sector of the multinational stores and distribution and logistics system, multinational stores and supply chain members have emergency response capabilities.
Vulnerability of multinational logistics	Refers to the vulnerability of the Taiwan FamilyMart delivery and Hong Kong CircleK pickup logistics system.

4.3 Sample Source and output

The directional arcs between the concepts in the Fig.4 represent the strength of causal relationship, which is solicited and gathered through the survey process. Every expert is asked to fill the values （e_{ij}） corresponding to the cells of the questionnaire. From the survey, 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 (4).

$$W(t) = \frac{1}{n}\sum_{i=1}^{n} W_i(t) \quad (4)$$

In Equation (5), $x_i(t)$ represents the status of period t in variable i; the values of x_i range between 0 and 1. The closer variable x_i is to 1, the better the status of variable x_i (or worse according to the variable's definition and differences). The variable w_{ji} is the weight value of variable j's influence on variable i; the values of w_{ji} will be less than 1, positively representing that variable j has a positive influence on variable i and negatively representing that variable j has a negative influences on variable i. The higher the value of w_{ji} is, the higher the degree of influence. In Equation (1), the status of period t+1 in variable X_i is determined by the status of all the variables at period t influencing variable X_i. The conversion function f makes sure every iteration of the fuzzy cognitive map converges to the variable range to the initial range set, and converts the value of $x_i(t)$ to a value between 0 and 1. This paper chose the logistical signal function as the conversion function. The common range setting of parameter λ is 0.2-5. The setting of λ is related to variable amounts in the fuzzy cognitive map and the complexity between variables. According to the characteristics setting in the fuzzy cognitive map, this study's λ value is set as 2.

$$x_i(t) = f \cdot \left(\sum_{\substack{j=1 \\ j\neq i}}^{n} x_j(t-1)w_{ji}\right), f = \frac{1}{1+e^{-\lambda x}} \quad (5)$$

For the questionnaire respondents, this paper chose ten supply chain members who were experts with managerial positions or higher. In the study's questionnaire format, these experts were invited to write the status of each variable, and the degree of influence each variable has on the other variables. According to the data collection and processing, the data gathered and operated is as in Table 3. For the questionnaire respondents, this paper chose ten supply chain members who were experts with managerial positions or higher. In the study's questionnaire format, these experts were invited to write the status of each variable, and the degree of influence each variable has on the other variables. According to the data collection and processing, the data gathered and operated is as in Table 3. The 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, the values range between 0 and 1. The closer they are to 1, the higher the degree of influence. Positive values represent that the influence is positive, and negative values represent that the influence is negative. The value interval of the status variable is 0-1. The closer the value of the status variable is to 0, the worse the system status is (or better depending on the definitions of the variables). When the value of the status variable is 1, this represents that the status of the variable is the better (or worse depending on the definitions of the variables).

Table 3. The input data

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	Stage
X_1	0.30	0.71	0.32	-0.33	-0.68	-0.70	-0.51	0.20	0.60
X_2	-0.57	0.00	-0.31	0.26	0.42	0.92	0.60	-0.33	0.50
X_3	0.00	0.81	0.60	0.00	0.00	0.00	0.00	0.13	0.30
X_4	0.00	-0.22	0.00	0.60	0.00	0.00	0.13	-0.19	0.70
X_5	0.00	-0.30	-0.42	0.47	0.00	0.55	0.33	-0.44	0.67
X_6	0.00	-0.15	-0.13	0.00	0.66	0.00	0.13	-0.33	0.75
X_7	0.00	-0.30	0.00	0.00	0.66	0.00	0.00	-0.31	0.65
X_8	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.43

Besides, not only the impact of strength but also the rating (or the initial state, S_0) of the concepts state is also asked. The acquired value is confined to the interval [-1, 1], showing the negative relationship, no relationship, or positive relationship, and revealing the strength of causal relationship to concepts in the corresponding column and row. Besides, not only the impact of strength but also the initial rating （initial state, W_0） of the concepts state is also inquired. The rating of concept state represents the assessment of current state. Its interval falls within [0, 1]. All the experts are consulted with their experience and knowledge evaluated on a numerical scale. In order to avoid illogical deviation and error, each value in the survey cell is rigorously checked to ensure that the value difference in each cell of every survey is within a reasonable range. The verification of whether the value conflicting with the prior experience is also implemented as result.

The output of proposed FCM is as Table 4 and Fig. 5 shows. After taking into account that the concepts incorporated need time to ferment in real world, each run is assumed to be one week. Each member of the multinational retailing delivery system, usually in the practice, needs about one week to respond to the changes. The interviewed experts expressed that when the multinational logistics system encountered external environment changes and needed to change, the time needed to prepare and change the results was about a week. A week's time includes (1) holding a meeting to determine the contents of operations that need to be repaired, (2) relevant unit making operation adjustments, and (3) announcing the changes to all units and starting to implement new operations. In addition, in a research on logistics operations, Wang et al. (2010) set each iteration of the Fuzzy cognitive map to a week as the managers implied. Therefore, in referring to the interviewed experts and the study's literature review of definitions, this paper set each iteration calculation to a week as the managers implied.

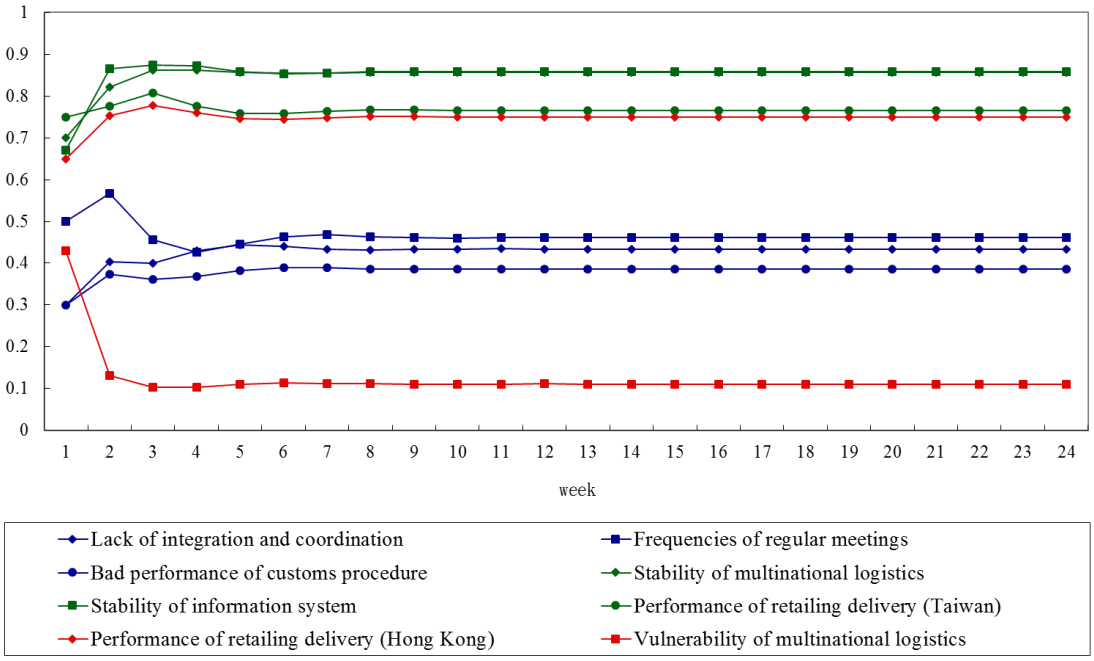

Figure 5. Result of FCM

The results reflected in Figure 5 indicate that:

(1) Frequencies of regular meetings was increased at the first run, and then decrease during 10-20 weeks, after 20 workdays it gradually increases, then drop back down a bit about 40 weeks after. This would more likely explain that bad performance of customs procedure was not stabilized at the beginning. After 40 weeks the bad performance of customs procedure was

closes to 0.38 representing that, frequencies of regular meetings will have almost no changes in the long run.

(2) Bad performance of customs procedure and lack of integration and coordination. After 20 weeks, they will slowly increase and finally closes to 0.46 and 0.38.

(3) "Performance of retailing delivery (Taiwan)", "Performance of retailing delivery (Hong Kong)", "Stability of information system" and "Stability of multinational logistics" are all increased, then miner decrease and finally stably close to 0.76, 0.74, 0.85 and 0.85.

(4) Vulnerability of multinational logistics decreased until 3 runs, and dropped to 0.11 after 30 weeks.

Table 4. Final State for each variable of FCM

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
State (S_0)	0.60	0.50	0.30	0.70	0.67	0.75	0.65	0.43
State (S_{24})	0.43	0.46	0.39	0.86	0.86	0.77	0.75	0.11

Fig. 4 shows the FCM, the variable including "Lack of integration and coordination (X_1) ". "Frequencies of regular meetings (X_2) ", "Bad performance of customs procedure (X_3) ", "Stability of multinational logistics (X_4) ", "Stability of information system (X_5) ", "Performance of retailing delivery (Taiwan), (X_6) ", "Performance of retailing delivery (Hong Kong), (X_7) " and "Vulnerability of multinational logistics (X_8) ".

4.4 Sensitivity Model Analysis

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 2004, 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). 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.

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 Table5. 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 5) provide us with needed information to identify the role for each variable in the system.

Then, this paper explored the Fuzzy cognitive map through the sensitivity model. The variables act as key influencing factors. In the influence weight matrix, AS is the Active Sum, which represents the sum of variables that influence other variables. The greater the AS value of variables is, the greater the degree to which a variable influences other variables. PS is the Passive Sum, which represents the degree to which a variable receives the influence of other

variables. The variable Q is the ratio of AS/PS. The greater the Q value is, it more difficult it is for the variable to influence other variables and to receive the influence of other variables. According to AS and PS, sensitivity can be obtained in the Fuzzy cognitive map. The further the variable is from the original point, the more that the size of the Q value can represent the area size of the variable in Fig. 6.

Table 5. The impact matrix

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	AS	Q
X_1	1	3	2	2	3	3	2	1	17	5.7
X_2	2	0	2	1	2	3	2	2	14	1.1
X_3	0	3	2	0	0	0	0	1	6	0.7
X_4	0	1	0	2	0	0	1	1	5	0.7
X_5	0	1	2	2	0	2	2	2	11	1.0
X_6	0	1	1	0	3	0	1	2	8	1.0
X_7	0	1	0	0	3	0	0	2	6	0.8
X_8	0	3	0	0	0	0	0	0	3	0.3
PS	3	13	9	7	11	8	8	11	-	-

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 effects 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. If a concept has a relatively high AS, like “Lack of integration and coordination” (17), 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 Stability of multinational logistics (2). A high PS such as relationship with suppliers 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.

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 “Performance of retailing delivery (Taiwan)” 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 6 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 line is meant that the concept strongly effects on the other concepts, in contrast, one concept under the line is meant that the concept is affected by other concepts. According to the above rules, all the concepts of the system are plotted in Figure 6. We can see that “Lack of integration and coordination”, “Frequencies of regular meetings”, and “Stability of multinational logistic” are the critical concepts in multinational retailing delivery system, which means these concepts are the major driving force behind system development.

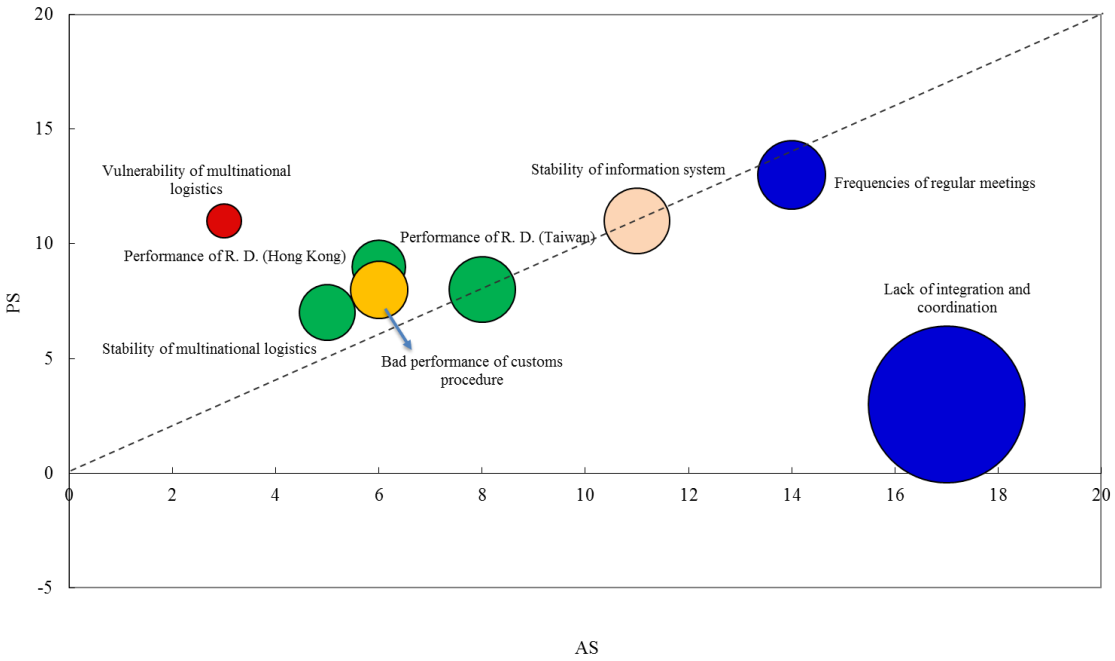

Figure 6. System roles of the variables

5. CONCLUSSION AND SUGGESTIONS

Along with the external environment's continual changes, the topic of risk management has extended to receiving the focus of supply chain research scholars. This paper analyzes the extremely complex procedure of the operations of the multinational stores and distribution logistics mechanism. The procedure has many uncertain factors that lead to operational risks. Therefore, how to decrease the vulnerability of the system itself and increase the system's recovery ability has become an important topic for supply chain risk management. In the future, all industry supply chain systems will face many challenges. Along with the development of related technologies in logistics and distribution, the derived logistics service patterns are also becoming increasingly diverse. The logistics industry cannot avoid encountering more cross-industry competition. In facing these external environment changes, each industry's supply chain management personnel must develop the industry's supply chain risk identification and evaluation indicators.

Because of great development in electronic commerce, online shopping has become more and more popular. Many marketing experts believe that websites are the most important retail channel. Online trade is not only business to customer (B2C, company proved the service for the customer), but also customer to customer (C2C, customer provide service to another customer). That is, people can buy or sell their own property through e-commerce systems like e-auctions. The E-retailing is obviously becoming a noticeable market. However, as the market grows and matures, "delivery service failure" becomes one of the challenges for E-tailers. With the increase of e-transaction volume between Taiwan and China (Hong Kong) and based on the Economic Cooperation Framework Agreement, the retailing delivery provider in Taiwan upgrade the service and become a transnational retailing delivery service mechanism. To better understand the vulnerability of transnational delivery system, we use FCM and SM to analyze the vulnerability of our case. In this study, we first describe the basic concept of multinational retailing delivery system, second, we also developed a FCM model to analysis the vulnerability

of research case. The variable of the FCM including “Lack of integration and coordination”. “Frequencies of regular meetings”, “Bad performance of customs procedure”, “Stability of multinational logistics”, “Stability of information system”, “Performance of retailing delivery (Taiwan)”, “Performance of retailing delivery (Hong Kong)” and “Vulnerability of multinational logistics”. Finally, according sensitivity model analysis, we shows that the “Lack of integration and coordination”, “Frequencies of regular meetings”, and “Stability of multinational logistic” are the critical concepts in multinational retailing delivery system, which means these concepts are the major driving force behind system development.

The results obtained in this study can be used to improve the delivery service quality for delivery providers and evaluate the delivery quality management strategies. Based on the research process and results as shown previously, there are still some work can be performed to enhance the research quality. Some of the key research opportunities and recommendations for further research, for example, the relationship among the variable of the FCM maybe exit nonlinear or chaotic behavior, it is an interesting research topic for future researcher. Besides, there are several different model of multinational retailing delivery system, in our cast (“Taiwan-Hong Kong”) model belong the B2C business model, future researcher can consider the case of Taobao (“Taiwan-China”), it belong the C2C business model. Taobao's growth rate is quite fast, and C2C model is more complex than B2C model, the case of Taobao will be a very important case.

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科技部補助計畫衍生研發成果推廣資料表

日期:2016/10/26

科技部補助計畫	計畫名稱: 反脆弱觀點下協同運輸的風險管理-以淘寶商城為研究個案
	計畫主持人: 黃昱凱
	計畫編號: 104-2410-H-343-011- 學門領域: 交通運輸

無研發成果推廣資料

104年度專題研究計畫成果彙整表

計畫主持人：黃昱凱	**計畫編號：**104-2410-H-343-011-
計畫名稱：反脆弱觀點下協同運輸的風險管理-以淘寶商城為研究個案	

成果項目					量化	單位	質化 （說明：各成果項目請附佐證資料或細項說明，如期刊名稱、年份、卷期、起訖頁數、證號...等）
國內	學術性論文	期刊論文			2	篇	Y. K. Huang* and C. M Feng (2016), Analysis of Vulnerability in Multinational Retailing Delivery Service System: A Case Study of FamilyMart and Circle K, Asian Transport Studies, Vol. 4, No. 3, pp. 178-193.（國科會計畫編號MOST 104-2410-H-343-011 -） Y. K. Huang (2015), The Evaluation of Logistics Service Quality on Store-to-Store Delivery: A Case of Online Used Books Store, Journal of International Logistics and Trade, (Accept).（KCI）（國科會計畫編號MOST 104-2410-H-343-011 -）
		研討會論文			1		Y. K. Huang* and C. M Feng (2015), Analysis of Vulnerability in Multinational Retailing Delivery Service System: A Case Study of FamilyMart and Circle K, EASTS Conference 2015.（菲律賓宿霧）（本篇文章獲得EASTS2015年度 最佳論文獎）.
		專書			0	本	
		專書論文			0	章	
		技術報告			0	篇	
		其他			0	篇	
	智慧財產權及成果	專利權	發明專利	申請中	0	件	
				已獲得	0		
			新型/設計專利		0		
		商標權			0		
		營業秘密			0		
		積體電路電路布局權			0		
		著作權			0		
		品種權			0		
		其他			0		
	技術移轉	件數			0	件	
		收入			0	千元	

國外	學術性論文	期刊論文			0	篇	
		研討會論文			0		
		專書			0	本	
		專書論文			0	章	
		技術報告			0	篇	
		其他			0	篇	
	智慧財產權及成果	專利權	發明專利	申請中	0	件	
				已獲得	0		
			新型/設計專利		0		
		商標權			0		
		營業秘密			0		
		積體電路電路布局權			0		
		著作權			0		
		品種權			0		
		其他			0		
	技術移轉	件數			0	件	
		收入			0	千元	
參與計畫人力	本國籍	大專生			0	人次	
		碩士生			0		
		博士生			0		
		博士後研究員			0		
		專任助理			0		
	非本國籍	大專生			0		
		碩士生			0		
		博士生			0		
		博士後研究員			0		
		專任助理			0		
其他成果 （無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。）							

科技部補助專題研究計畫成果自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現（簡要敘述成果是否具有政策應用參考價值及具影響公共利益之重大發現）或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估
   ■達成目標
   □未達成目標（請說明，以100字為限）
   　□實驗失敗
   　□因故實驗中斷
   　□其他原因
   說明：

2. 研究成果在學術期刊發表或申請專利等情形（請於其他欄註明專利及技轉之證號、合約、申請及洽談等詳細資訊）
   論文：■已發表　□未發表之文稿　□撰寫中　□無
   專利：□已獲得　□申請中　■無
   技轉：□已技轉　□洽談中　■無
   其他：（以200字為限）
   本計畫的研究成果發表在東亞運輸研討會(2015EASTS)，並獲得該年度最佳論文獎，部分研究成果已經發表在Asian Transport Studies，另外部分成果也預計在Journal of International Logistics and Trade以及Eurasian Journal of Business and Management發表（均已接受）。

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性，以500字為限）
   隨著物流配送相關技術的發展，其所衍生的物流服務型態也將日益多元，物流產業不可避免的會遇到越來越多的異業競爭。展望未來，台灣各種產業的供應鏈體系都將面臨許多的挑戰，如食品產業所面臨的原物料安全風險、製造產業在美商蘋果公司的要求下，勢必也需要符合越來越嚴格的綠色供應鏈要求，進而面臨技術風險與財務風險、電子商務產業在兩岸電子商務交易日趨頻繁，加深電子商務供應鏈產業的深度與廣度，從而增加供應鏈斷鏈的風險。本研究之成果可供運輸產業進行配送需求分析、電子商務物流需求與選擇行為分析等研究領域參考，同時，由於研究對象係以台商在大陸淘寶商城所建構的物流系統以及阿里巴巴集團所建構的菜鳥物流網為研究主體，針對淘寶商城物流架構進行物流與供應鏈斷鏈之風險評估，所構建的分析模型亦可提供業界針對不同物流配送需求的電子零售店發展相關物流服務規劃時之參考依據。此外，研究結果可供運輸業者研擬營運策略藉此提供更符合市場需求的服務，同時，亦可作為政府部門研擬有關企業E化相關經建計畫之參考，俾使經建計畫不至偏離廠商實際需求。

4. 主要發現

本研究具有政策應用參考價值：□否 ■是，建議提供機關交通部運輸研究所

（勾選「是」者，請列舉建議可提供施政參考之業務主管機關）

本研究具影響公共利益之重大發現：■否 □是

說明：（以150字為限）

在本研究中發現，組織溝通協調的機制將會是影響協同運輸風險管理的重要因子。