DOI: 10.20472/EFC.2016.005.015

CHUN WEI R. LIN
YunTech, Taiwan, R.O.C., Taiwan, R.O.C.

YUN-JIUAN MELODY PARNG
Tayeh University, Taiwan, R.O.C.

HONG-YI CHEN
Chaoyang University of Technology, Taiwan, R.O.C.

A FUZZY-NEURAL PERFORMANCE EVALUATION APPROACH OF SELECTING OUTSOURCE INTERNATIONAL LOGISTIC COMPANY

Abstract:

Owing to lack of confidence, the usage of domestic logistics services in the Asian region, e.g. Taiwanese companies, is comparatively lower than the use of international logistics companies. This paper develops an integrated fuzzy neural network performance evaluation model which is able to consider five key factors to evaluate their performance in the internationalization competence, namely, flexibility in organization structure, competitiveness in the global environment, versatility in service contents, sophistication in information technology application, and compliance in administrative regulations. The model successfully provides a transparent and systematic evaluation tool for industries to select appropriate logistic companies for international logistics services.

Keywords:

Performance Evalution, International Logistics, Outsourcing, Fuzzy Neural Network

JEL Classification: C00, C45, F23

Introduction

With the international trade amount increasing, the multinational Logistic center is becoming a very important factor to promote International In Logistic. Da-Wei Kuo's study in 2000, he shows that most of the manufactures deem Taiwanese logistic companies have low level international logistic service, so they prefer doing the international logistic parts by themselves to contract-out. Furthermore, Lin Hwang Ching (2001) thinks that the key factors of international logistic development are the change and upgrade of the industrial structure. However, logistic is the key point of the international market, so the internationalization of the Logistic Industry is to be of great urgency. With the increase in demand of international logistic and the rule survival of the fittest in the world, Taiwanese International Logistic Industry needs to open markets and establish their superiority to improve their competitiveness and the sustainable operation.

The World Competitiveness Report (WCR) evaluates the competition of a country using eight aspects: 1) Domestic economy macroeconomic; 2) Internationalization extent; 3) Government-extent; 4) Finance-performance; 5) Infrastructure-extent; 6) management-extent; 7) Science and technology-scientific; and 8) People-availability. Furthermore, many organizations will do the competition research in this epoch of the internationalization and globalization, such as World Competitiveness Report (WCR), World Economic Forum (WEF) and International Institute for Management Development (IMD). So this study evaluates models of International Logistic Industry in Taiwan.

Because Taiwanese logistic industry has low quality in international services (Da-Wei Kuo, 2000), this study will probe into the factors of the internationalization for logistic industry, then use Neuro-Fuzzy to establish the international logistic industry evaluation model. This study collects the dates of internationalization in logistic industry to analyze the factors of internationalization. Moreover, this study uses questionnaires to analyze the internationalization of the Taiwanese Logistic Company, and uses Neuro-Fuzzy to establish the International Evaluation Model. Because this study does not have enough data, this study uses Mega-Fuzzification to increase the test sample and to upgrade model performance.

This study is divided into four sections, the first chapter of this study and the research background, motivation and purpose; the second chapter of the method for the construction of models and performance assessment; in the third chapter and modeling analysis of samples; for statistical analysis in Chapter four and the final conclusion.

Methodology

Model Construction Method and Performance Evaluation:

The methodology adopted in this research include International Logistic Internationalization Factor, the neural-fuzzy ANFIS model, mega-fuzzification of small sample study, and performance evaluation. The detailed explanations are depicted as follows:

International Logistic Internationalization Factor*:*

The key factors of internationalization for logistics industry in Taiwan are included in five establishments in Pei-Ying Lin (2006) research. The five establishments which include 23 key factors are the structure of enterprise, the competitive environment of logistic, the contents of business, the information technology, and Policy.

Neuron-Fuzzy ANFIS model:

This study use Adaptive Network-Based Fuzzy Inference System (ANFIS) to build an evaluation model of international logistic industry. The ANFIS is proposed by Jang (1993), which applied Neuro-fuzzy learning. ANFIS can used the fuzzified input when need enhance the domain range for ANFIS can used non-enough data to training. The ANFIS have five layers of the network.

Mega-Fuzzification:

This study used the ANFIS of the Neuron-Fuzzy, and combine Mega-Fuzzification of the Li's (2005) to improve the accuracy. Mega-Fuzzification can help to fuzzily data, and can expand domain of the data, and it can adapt small data and non-enough data.

Performance Evaluation:

This study used Mean Absolute Error (MAE), Mean Square Error (MSE), and Root Mean Square Error (RMSE) to Evaluation the Performance of the Neuro-Fuzzy model.

Research Results

Statistic Analysis:

Used Simple Additive Weight (SAW) to statistic number of every aspect, Table 1 is the Statistic Analysis. The Services type Coefficient of Variation (CV) is the biggest, it's mean the Services type have the big different in the industry of every firm.

Table 1. Statistic Analysis

	Mean	Variance
The structure of enterprise	0.0280	0.0001
The competitive environment of logistic	0.4894	0.0036
The contents of business	0.1424	0.0022
Information technology	0.0668	0.0002
Policy	0.1686	0.0014
Business Internationalization Number	0.8952	0.0134

Neuro-Fuzzy analysis:

This study used Neuro-Fuzzy to Evaluation the International number of Logistic industry, and used MAE, RMSE, and MSE to evaluation the performance, when the MAE, RMSE, and MSE smaller, it's mean model be better. In Table 2, the MAE, RMSE, and MSE in Neuro-Fuzzy is equal to zero, and used Mega-Fuzzification will be better.

Table 2: Performance Evaluation of Alternative Models

Neuro-Fuzzy	Training		
	MAE	RMSE	MSE
	3.2428e-009	5.1166e-009	2.6180e-017
	Testing		
	MAE	RMSE	MSE
	4.5951e-009	5.6430e-009	3.1844e-017
Mega-Fuzzification	Training		
	MAE	RMSE	MSE
	2.4241e-08	3.3484e-08	1.1212e-15

	Testing		
	MAE	RMSE	MSE
	3.0295e-08	3.4991e-08	1.2244e-15

Cronbach analysis:

Measure to the scale usually use Cronbach α to measure the internal consistency, If α of the higher, the internal consistency of consistency is also higher. In general, the good questionnaire the Cronbach α is bigger than 0.6. Table 3 shows the total Cronbach analysis, the structure of enterprise have two factors, the Cronbach α is 0.951, and 0.936 separately, and they all bigger then 0.6, demonstrate structure of enterprise scale is acceptable. The competitive environment of logistic have four factors, the Cronbach α is 0.618, 0.849, 0.922, and 0.889 separately, and they all bigger then 0.6, demonstrate structure of enterprise scale is acceptable. And the contents of business have two factors, the Cronbach α is 0.714, and 0.832 separately, they all bigger then 0.6 yet, demonstrate structure of enterprise scale is acceptable. Information technology have two factors, the Cronbach α is 0.701, and 0.897 separately, they all bigger then 0.6, demonstrate structure of enterprise scale is acceptable. Policy have three factors, the Cronbach α is 0.654, 0.883, and 0.882 separately, they all bigger then 0.6, demonstrate structure of enterprise scale is still acceptable.

Table 3. Total Cronbach Analysis

Aspects	Objects/Criteria	Cronbach α
The structure of enterprise	Management characteristics	0.951
	mobile with Supply chain	0.936
The competitive environment of logistic	Advantage of territory logistics	0.618
	Supply chain management of capabilities	0.849
	Infrastructure	0.922
	threat of foreign logistics	0.889
The contents of business	Customized services	0.714
	Efficiency and quality	0.832

Information technology	Supply chain real-time communication	0.701
	Operating information systems	0.897
Policy	Domestic political risk	0.654
	E-commerce regulations	0.883
	Environmental regulations	0.882

Construct validity Analysis:

When the questionnaire retrieve, willed be the construct validity analysis. The construct validity analysis is includes any validity strategies that focus on the content of the test. Factor analysis can help researchers to verify the validity, that's mean when explore the characteristics of the factors underlying the structure and form (Hawjeng Chiou, 2001). In this study, the first analysis for exploratory factor analysis, used principal component method to extraction the factor, the eigenvalue bigger than one to be the choose number of standard, the outcome in the Table 7

Table 4. Every Aspects Factors of Structural Property and Factor weight value

Aspects	Objects/Criteria	Normalized factor		Variance and Eigenvalue	
		Factors 1	Factors 2	Factors 1	Factors 2
Flexibility in organization structure	Management characteristics	0.594	—	78.780% (5.515)	—
		0.985	—		
		0.886	—		
		0.942	—		
		0.819	—		
		0.983	—		
		0.940	—		
	mobile with Supply chain	0.805	—	80.009% (4.000)	—
		0.905	—		

		0.949	—		
		0.926	—		
		0.880	—		

Aspects	Objects/Criteria	Normalized factor		Variance and Eigenvalue	
		Factors 1	Factors 2	Factors 1	Factors 2
Competitiveness in the global environment	Advantage of territory logistics	0.213	0.796	42.885% (2.144)	27.608% (1.380)
		0.183	0.651		
		0.814	-0.329		
		0.884	-0.322		
		0.789	0.334		
	Supply chain management of capabilities	0.855	—	77.488% (2.325)	—
		0.839	—		
		0.944	—		
	Infrastructure	0.966	—	93.234% (1.865)	—
		0.966	—		
	Threat of foreign logistics	0.955	—	91.251% (1.825)	—
		0.955	—		

Aspects	Objects/Criteria	Normalized factor		Variance and Eigenvalue	
		Factors 1	Factors 2	Factors 1	Factors 2
Versatility in service	Customized	0.822	—	77.778%	—

contents	services	0.822	—	(1.556)	
	Efficiency and quality	0.772	-0.266	50.204% (4.016)	20.014% (1.601)
		0.533	0.788		
		0.591	0.452		
		0.889	-0.028		
		0.738	-0.502		
		0.734	-0.562		
		0.650	0.337		
		0.700	0.152		

Aspects	Objects/Criteria	Normalized factor		Variance and Eigenvalue	
		Factors 1	Factors 2	Factors 1	Factors 2
Sophistication in information technology application	Supply chain real-time communication	0.886	—	78.550% (1.571)	—
		0.886	—		
	Operating information systems	0.966	—	86.766% (2.603)	—
		0.911	—		
		0.917	—		
Compliance in administrative regulations	Domestic political risk	0.845	—	65.695% (1.971)	—
		0.796	—		
		0.790	—		
	E-commerce regulations	0.956	—	91.341% (1.827)	—
		0.956	—		

	Environmental regulations	0.956	–	91.341%	–
		0.956	–	(1.827)	

Neuron-Fuzzy ANFIS model:

Layer 1: $O_{1,i}=\mu_{A_i}(x), \quad for \quad i=1,2$ (1)

$O_{1,i}=\mu_{B_{i-2}}(y), \quad for \quad i=3,4$ (2)

Layer 2: $O_{2,i}=w_i=\mu_{A_i}(x)\cdot\mu_{B_i}(y), \quad i=1,2$ (3)

Layer 3: $O_{3,i}=\overline{w}_i=\frac{w_i}{w_1+w_2}, \quad i=1,2$ (4)

Layer 4: $O_{4,i}=\overline{w}_i f_i=\overline{w}_i(p_i x+q_i y+r_i), \quad i=1,2$ (5)

Layer 5: $O_{5,i}=\sum_t \overline{w}_i f_i=\frac{\sum_i w_i f_i}{\sum_i w_i}$ (6)

Mega-Fuzzification:

a= (min-1/N_U ×core)/(1-1/N_U) (7)

b= (Max-1/NL ×core)/(1-1/NL) (8)

for 1<NU <∞and 1<N_L <∞. *a= min/5* (9)

b=Max×5 (10)

Performance Evaluation:

Mean Absolute Error (MAE): $MAE=\frac{1}{n}\sum_{i=1}^{n}|T_i-O_i|$ (11)

Mean Square Error (MSE): $MSE=\frac{1}{n}\sum_{i=1}^{n}[T_i-O_i]^2$ (12)

Root Mean Square Error (RMSE): $RMSE=\sqrt{\frac{1}{n}\sum_{i=1}^{n}[T_i-O_i]^2}$ (13)

Recommendations:

This study in the future, recommendations can try increase the study scope, in this study just focus on capital more than 100 million companies, if increase the study scope can increase the sample size, then Reliability and Validity will promote. And most companies in Taiwan, so if increase the capital less than 100 million companies will closer to the actual situation of industries.

Discussions

Samples analysis:

The logistics industry include Domestic transport, International Transport, Regional distribution, Import and export agents, Import and export declarations, The flow of processing, and Warehousing custody. This study research on the storage, transport, and logistics farm, total number is 3,808 in the in Ministry of Economic Affairs, R.O.C. database. And the farm focus on the capital more than 100 million companies, total sample is 75, have 13 companies return the questionnaire, and available sample is 11.

Internationalization logistics industry factors:

This study factors follow the key factors of internationalization for logistics industry in Taiwan by Pei-Ying Lin (2006), the chapter introduce and description the five aspects and 23 factors in this study, as summarized in Table 5.

This study absorb about the logistic factors to find the questionnaire of evaluation model. The questionnaire used Likert scale, and half-open-questionnaire, it's absorb aspects of Pei-Ying Lin (2006) and Ching Hsiung Huang (2000), then used Simple Additive Weight (SAW) to do the International Logistic Industry Evaluation standard, SAW used linear combination. It will do the Normalization, and then summed with the weight, the answer is the Logistic company International level in this study.

Table 5. Weight in Evaluation Model of International Logistic Factor

Evaluation Model of International Logistic Factor						
	Factor of Layer 2 (Aspects)		Factor of Layer 3 (Objects/Criteria)		Layer Connection	Sorting
International Logistic (Goal)	Flexibility in organization structure	0.08	Funds size	0.16	0.0128	18
			Way of organizing international	0.14	0.0112	20
			Management characteristics	0.13	0.0104	21
			Standard implementation	0.04	0.0032	23
			International human	0.30	0.0240	12
			Mobile with Supply chain	0.23	0.0184	14
	Competitiveness in the global environment	0.50	Threat of foreign logistics	0.55	0.2750	1
			Advantage of territory logistics	0.09	0.0450	6
			Supply chain management of capabilities	0.28	0.1400	2
			Infrastructure	0.08	0.0400	9

Evaluation Model of International Logistic Factor						
	Factor of Layer 2 (Aspects)		Factor of Layer 3 (Objects/Criteria)		Layer Connection	Sorting
International Logistic (Goal)	Versatility in service contents	0.09	Services type	0.04	0.0036	22
			Customized services	0.49	0.0441	7
			Efficiency and quality	0.87	0.0783	5
			Integrated services	0.17	0.0153	17

	Sophistication in information technology application	0.07	Supply chain real-time communication	0.35	0.0245	11
			Operating information systems	0.27	0.0189	13
			Integrated Information Management System	0.19	0.0133	16
			The EDI Standard	0.18	0.0126	19

Evaluation Model of International Logistic Factor						
	Factor of Layer 2 (Aspects)		Factor of Layer 3 (Objects/Criteria)		Layer Connection	Sorting
International Logistic (Goal)	Compliance in administrative regulations	0.26	Domestic political risk	0.06	0.0156	15
			Logistics development policy and law	0.37	0.0962	3
			International trade law	0.31	0.0806	4
			E-commerce regulations	0.16	0.0416	8
			Environmental regulations	0.10	0.0260	10

The structure of enterprise:

The funds size: The funds size is the farm funds relatively for the industry, namely farm funds divide by industry funds. Follow the Turnover tax statistics data in the Financial and taxation information center in Ministry of Finance, the average capital was 137,370 millions in the Logistic industry. And the capitals among 5 million to 10 millions have 1,993 firms, have 52.33%. And more than 10 millions have 96 firms, have 2.5%.

Way of organizing international: Due to the rapidly changing environment, face higher business strategy uncertainty and environmental uncertainty, so business must constantly change the strategy follow the environment. In order to increase the business competitiveness and profit, business usually used entry strategies was Exporting, Licensing, Franchising, Joint ventures, and Wholly owned subsidiaries。 Ministry of Economic Affairs, R.O.C. have ten class for Logistic industry Internationalization: Introduction of Foreign capital, Introduction of Foreign Management, Introduction of Foreign Human, Set up Abroad Offices, Set up Abroad Company, Cooperation with Domestic Industry, Cooperation with Abroad Industry,

Acquisition with Abroad Industry, Investment with Abroad Industry, Cooperation with non-Logistic Industries.

Management characteristics: The high management team responsible for strategic planning, implementation and decisions. And the high management background and company culture have high influential with the company. This study used the Huang, Ching Hsiung (2000) study, and follows the human resources to build up the questionnaire in this study.

Standard implementation: Enterprises to obtain internationally recognized certification standard will help businesses get the recognition outside. Standards easy to see like ISO, SLA, STC, and etc. The Table 6 is the most standard integration by Hong Kong Trade Development Council (2006). The standards which Aviation industry has AS9100, Logistic/ Security industry have TAPA FSR, and C-TPAT, and common standards include ISO series, WEEE/RoHS, and etc.

Table 6. International Certification and standards

Industry standards:		Common standards:	
Aviation	AS9100	Corporate Social Responsibility	SRA, SA 8000, Code of Conduct
Automobile	TS16949, QS9000, VDA6.1	Health and Safety	OHSAS 18001, F&IU
Food	ISO22000, HACCP, SQF, BRC, EuropGap, GMP	Environmental protection	ISO 14001, IECQ HSPM QC 080000, Green Product Management System (WEEE/RoHS)
IT	ISO27001, ISO17799, BS7799, ISO20000, BS15000	Quality	ISO 9001, Audit Scoring, QM 9004, 5-S, ISO 10002, Lean Six Sigma, Balanced Scorecard
Forestry	FSC Quarlifor		
Logistics/Security	TAPA FSR, C-TPAT		
Medical Professions	ISO13485		
Telecommunications	TL9000		
Service	Qualicert		

International human: when the company has important decision about overseas investment, then they internationalization decision team and manager, when they have high international experience the decision will be precision. So, when they have high international human, it's mean they have higher international competitive ability. The International human used how many doctorate degree and master degree to do the international human number in this study.

Mobile with Supply chain: when the supply chain operating costs too high, global resources will move to the low cost region, then the supply chain will mobile. So the logistic industries can mobile follow with his Supply chain, and change the company structure and other resource allocation.

The competitive environment of logistic:

Threat of foreign logistics: Threat of substitutes is by Porter in Five Forces Model with industrial competitiveness analysis. About this, when the companies do the international transport they needed to understand the competition level of the overseas markets, then expand the breadth and depth.

Advantage of territory logistics: The competitive advantages at the global logistics market in Taiwan include: Taiwan have many high technological equipment can shorten many time and improve management of tally; Taiwan Human quality is higher in Asian, so can supply the high quality with International Logistic.

Supply chain management of capabilities: mean companies have global resources with the regional strategic procurement decision, and can meet regional demand for customer service, and to adapt regional demand of this market then will quick response.

Infrastructure: enhance the efficiency of the logistics industry in addition to upgradable management style and how many domestic environment infrastructures do them have. The infrastructures include road network, transit facilities, parking facilities, and loading and unloading cargo space. Because any company have different service of they focus, so what infrastructure does they needed have different, so in this study we ask does the Government give enough infrastructure does they needed.

The contents of business:

Services type: Diversification of Customer needs and Customer needed more transport type, so the contents of business needed diversification to satisfy every different demand patterns. Ministry of Economic Affairs (2004) sum of the logistic ten types: Warehousing custody, Import and export agents, flow of processing, Express, Consulting, Support Information System, Domestic transport, Regional distribution, International Transport, Collecting money, and Custom Broker.

Customized services: Due to the increasing diversification of consumer demand, the consumers have much different demand, so the logistic companies need supplied any personalized and flexible services. In this study, combined with Ching Hsiung Huang (2000) for marketing management side, and have two questions above.

Efficiency and quality: The efficiency and quality of the logistic is important in internationalization. Time and accurate delivery are first key point in International Logistic.

Integrated services: Company can integrate all of the services like one stop shopping to the customer. If the logistic farms can integration or coalition services, then they will increase the service of the other customer needed.

Information technology:

Supply chain real-time communication: International Logistic needs and safe and high speed information communication, real-time communication can reduce unnecessary errors and improve the accuracy of logistics operations. In this part discuss the Logistic firms can swimmingly communications with Upstream and downstream firms.

Operating information systems: International Logistic usually concern many different Strategic Business Unit (SBU), they usually distributed in many different countries, so a good operating information systems can help the firm to finish the customer demand.

Integrated Information Management System: Ministry of Economic Affairs (2004) class Integrated Information Management System include Distribution Planning System, Automated Storage System, Order Picking System, Site Monitoring System, Cargo Tracking System, Automated logistics processing systems, Dynamic Query System Container, Warehouse Management System, and Inventory reconciliation system.

The EDI Standard: Electronic Data Interchange (EDI), the standard is an information system for external standardization. It’s standardized the word of the logistic activity, and will reduce the order double key in and reduce the error probability. So does the firm for data transmission used the EDI is an important factors.

Policy:

Domestic political risk: Any International Logistics Company in Taiwan may be subject to the country policy and Foreign affairs from the Government, and this uncertainty risk is domestic political risk. This domestic political risk will influence the firm, may be a chance, or may be an obstacle for a business.

Logistics Development Policy and law: Government will consider the profit of the country as a whole will development of relevant policies; the policies may be barrier

the internationalization. So what does the policy will help or barrier for the company is the key point in this factor.

International trade law: when do the international business activities, the companies need follow the countries trade law, and the international trade law is ensure every country are equal. The laws of important in International trade are: World Trade Organization (WTO), Organization for Economic Co-operation and Development (OECD), Asia-Pacific Economic Cooperation (APEC), and Group of eight (G8), so the company needed understand and follow this law.

E-commerce regulations: E-commerce regulations are wanted to establish a safe and reliable network environment for business-to-business trading. So the integrity of regulations is very important, and it's needed the Government to harmony with the industry.

Environmental regulations: Recently, the concepts of environmental protection are promotion, and the environmental regulations enacted must important, and these regulations will influence the services content. But every company are characteristics, so they have different influence effect with theirs internationalization.

Model construction:

The study used Neuro-Fuzzy to establish the evaluation model, it was five inputs with five different establish and one output. The input includes the structure of enterprise, the competitive environment of logistic, the contents of business, information technology and policy, and output is the international level of the logistic company. The number of the structure of enterprise is F(B); Competitive environment of logistic is F(E); The contents of business is F(S); Information technology is F(T); Policy is F(P). The variable of PNeuro-Fuzzy is the evaluation number by the Neuro-Fuzzy:

$$P_{Neuro-Fuzzy} = F(B,E,S,T,P) \tag{11}$$

There are five input variable in this study, every variable will class at high, low, and medium, so the fuzzy rule have 3×3×3×3×3 equal 243 rules. The training samples were random by population, and 80% to training, 20% to testing, and have 13 data in Neuro-Fuzzy, and 50 data in Mega-Fuzzification. This study used MATLAB to run the model, and the total number of 1000 training. The Table 7 is the Neuro-Fuzzy and Mega-Fuzzification parameter defines.

Table 7. Neuro-Fuzzy parameter definition

	Neuro-Fuzzy	Mega-Fuzzification
Input node	5	5
Output node	1	1
Rules	243	243
Sample	11	50
Training sample	80% of population	80% of population
Testing sample	20% form other population	20% form other population
Number of training	1,000	1,000

CONCLUSIONS

This study used the key factors of globalization to establish the evaluation questionnaire by Pei-Ying Lin (2006), then used Neuro-Fuzzy establish the model to Evaluation the International Logistic level for Taiwan logistic company.

The International Evaluation model establishes by Neuro-Fuzzy, then used MAE, RMSE, and MSE to evaluation the model performance. The performances in Neuro-Fuzzy have MAE, MRSE, and MSE have number 3.2428e-009, 5.1166e-009, and 2.6180e-017 separately. And the Mega-Fuzzification model has 3.0295e-08, 3.4991e-08, and 1.2244e-15 separately. The Neuro-Fuzzy model can evaluate how internationalization does the firm have, and when the information is not enough, the other firms can used this model to find the logistic company internationalization number

REFERENCES

Huang, Ching Hsiung (2000), *A study on the key factors of the industrial competitiveness: Take the steel wire and rope industries of Taiwanese district as the example*, Master thesis, Chang Jung Christian University.

Lia, Der-Chiang, Wu, Chih-Sen, Tsai, Tung-I, Chang, Fengming M. (2005), Using mega-Fuzzification and data trend estimation in small data set learning for early FMS scheduling knowledge, *Computers & Operations Research*, pp. 1857-1869

Kuo, Da-Wei (2000), *International Logistics Development Strategy for Logistics Industry in Taiwan*, Master thesis, National Kaohsiung First University Science and Technology.

Jang, J.-S. R. (1993), *ANFIS: Adaptive- Network-Based Fuzzy Inference Systems*, IEEE Transactions on System.

Jang, J.-S. R., Sun, C.-T., & Mizutani, E. (1997), *Neuro-fuzzy and soft computing: a computational approach to learning and machine intelligence*, New Jersey: Prentice Hall.

Lin, Hwang Ching (2001), *A study on logistics development trend form logistics professionals perspective*, Master thesis, Soochow University.