

## HOW THE PORT OPERATOR FACING PARTNERING WITH CONTAINER CARRIERS

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**Abstract:** Since “risk” is regarded as the core issue of fulfilling success in port partnership, we first define three types of partnering based on with/without resources involving, consider four risk factors and formulate two stages of risk processes, and then, develop a risk analysis model from the viewpoint of port operator (PO). This study acquires relative parameters through ways of questionnaires and in-depth interviews for Mote-Carlo simulation. It is concluded that the more market share a container carrier (CC) occupies the higher risk the PO involves in ‘resource-involving (RI)’ and ‘resources crossly-involving (RCI)’ partnerships; risk of PO also increases when partnering with multiple CC whose market proportion accumulate in ‘no resource-involving (NRI)’ partnership; on the contrary, the risk for PO decreases while cooperating with single CC in RCI partnership. The results will certainly be helpful for PO to evaluate the partnership risk with multiple CC and to develop marketing strategies.

**Keywords:** Partnership, Risk analysis, Mote-Carlo simulation, Analytic Hierarchy Process (AHP)

### 1. INTRODUCTION

In recent decades, various and more effective “buyer-seller” partnerships have been applied in accordance with the theories of supply chain management (SCM). Partnering has been improving the levels of service, increasing market share and decreasing the variances of demand and inventory (Lambert et al., 1996; Ryoo & Thanopoulou, 1999; Slack et al. 1996; Gudmundesson & Rhoades, 2001). Nowadays, levels of service, economy of scale and port location all have become core competencies for port container operators when facing fierce competition from a growing number of global players. (Chen, 1997). If the container port operators could meet the requirements of customer relationship management through SCM, i.e. via partnerships with the container carriers, they would thereby also gain improved performance and efficiency. In order to gain competitive advantage, the port operators not only provide import/export and transit cargo handling, engage in multiple-country consolidation, provide value-added warehousing and other integrated logistic services, but also apply an effective partnering strategy to integrate the resources of their vertical allies, especially the container carriers.

From the viewpoint of the port operator, there are many types of cooperative relationships with shipping carriers, such as conferences, strategic alliances, joint ventures, etc. (Ryoo & Thanopoulou, 1999; Slack et al., 2002; Soog & Panayides, 2002). However, what kind of partnering model between port operators and container carriers is most suitable? What key factors of such partnering can be identified? How much relative risk must the port operator assume in each type of partnership? What are the differences among different container carriers? Such issues will clearly affect the success of any of the possible partnership paradigms. Certainly, the amount of assumed risk is the core issue in the determination of an effective partnering strategy. But there has been little quantitative research to examine this specific topic. Therefore, this study aims to establish a risk analysis model, and to further examine the partnering risk between port operators and container carriers. .

For container port business, the container handling volume is highly dependent on frequency of callings. Cuganesan et al.(1999) emphasizes that not competition alone is a survival mechanism, cooperation also is a common and important survival strategy. In the ocean shipping context, an alliance is defined as a cooperative operational arrangement between two or more carriers that lies anywhere between a traditional arms-length relationship and an integrated strategic relationship that amounts to a virtual merger (Sheppard & Seidman, 2001). The formation of strategic alliances is defined as a voluntary inter-firm cooperative arrangement (Das & Teng, 2001). Ellram & Hendrick (1995) defined partnership as a continuous relationship between firms that contain mutual trust for a certain time period, sharing risk information and profit. The relationship is considered as a long-duration commitment between firms as well. Every partner shares information, risks and profits. Lambert et al. (1996) stated that a partnership is a tailored business relationship based on mutual trust, openness, shared risk and shared rewards that yields to a competitive advantage for which could be reached less by individual than by united. From the logistics view, a supply chain partnership is a relationship formed between two independent entities in supply channels to achieve specific objectives and benefits (Maloni & Benton, 1997).

Some studies pointed out that strategic alliances or partnering could be very unstable and has high failure percentage (Bruner & Spekman, 1998; Rhoades & Lush, 1997; Soog & Panayides, 2002). Midoro & Pitto (2000) found that the factors driving such cooperation are risk and investment sharing, economies of scales and a capability to increase service frequencies. No matter what partnership retains several inherent risks that could be potentially harmful to the participants (Maloni & Benton, 1997).

This paper is organized as follows: Section 2 reviews the partnering practices and theories developed in shipping and other industries. The analytical risk model for the port operator and shipping carriers is described in section 3. In section 4 we demonstrate a brief case study through simulation. Section 5 is dedicated to the discussion of the risk analysis model. Finally, section 6 summarizes the conclusions and recommendations.

## **2. DEVELOPING THE PARTNERSHIP RISK AND FRAMEWORK**

This study follows the previous definitions (Tsao & Feng, 2002; Lambert et al., 1996.) to classify three partnership types, four risk factors and two stages of life cycle. We defines three types of partnership depending on the resource allocation methodology utilized, i.e., the 'no resource-involving (NRI)' partnership, the 'resources-involving (RI)' partnership, and the 'resources crossly-involved (RCI)' partnership. In a typical 'no resource-involving' partnership, each partner holds independent ownership and control of its own resources. There are no additional resources exchanged under the cooperative agreements between the

partnered entities. Relationships such as incentive rate agreements and collaboration memoranda between port operators and container carriers are included in this type or paradigm. The RI partnership allows each partner's independent character to remain intact. But each partner provides some resource or resources, such as land, facilities, crews or capital, to their partners. There are some formal long-term contracts between or among the involved partners. In this paradigm, one party will partially control another party's resources. The B.O.T. (Build, Operate and Transfer) model is also a typical case for this type of partnership. The formation of a group organization, instead of individual firms, is the hallmark of the RCI partnership paradigm. Each party may hold stock and there may be an exchange of equity, and/or a joint company may be formed. All resources are pooled in the partnership through coordination of the individual partners.

The difference between a 'resources-involving' and 'no resource-involving' partnership is strictly the resource allocation methodology inherent to each. The 'resources crossly-involved' partnership usually has both a longer relationship duration and a more complicated ownership structure than the former two types.

Secondly, we review the past papers and conclude that the core risk factors are expressed by four concrete concepts: interdependence level (Beier & Stern, 1969; Frazier & May, 1983; Kumar & Steenkamp, 1995; Ruyter & Wetzel, 1999), objectives consensus (Morgan & Hunt, 1994; Lambert et al., 1996), information sharing (Anderson et al., 1990; Lambert et al., 1996; Lambert et al., 1999; Leverick & Cooper, 1998), and speculation behavior (Williamson, 1975; Moore, 1998).

Finally, this study concludes that the life cycle of partnership is fundamentally divided as 'construction phase' and 'maintain phase'. The detail of the two phases was described in previous paper (Tsao & Feng, 2002). During the phase of operation or commitment, if the market opportunity has elapsed, or dissatisfaction has emerged from one or more parties, the termination phase can be activated. Premature dissolution of the relationship is caused by risk factors; there is a discrete failure probability composed of various combinations of these risk factors. Only if both of the above two phases succeed can the partnership begin to flourish and expect a potential profit, otherwise, the partnership expenses will definitely occur as long as the partnership fails, no matter in what phase. This study uses conditional probability analysis to explain the operation of the partnership life cycle. Figure 1 shows the structure of partnership risk.

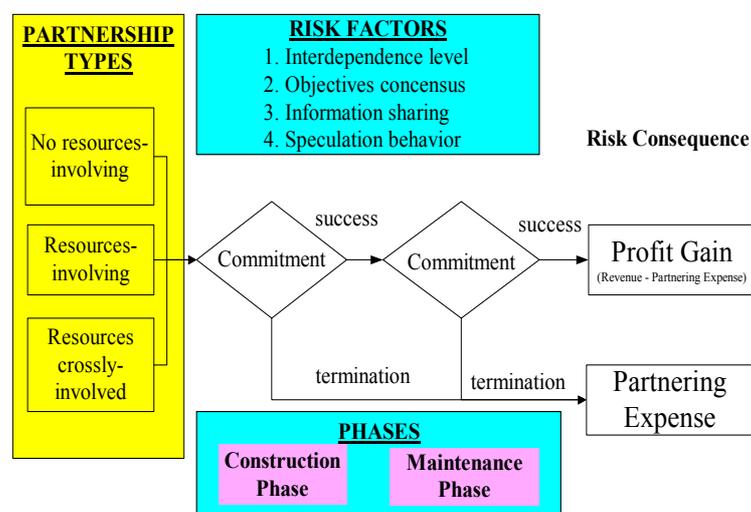


Figure 1. The Framework of Partnership Risk

### 3. THE PARTNERSHIP ANALYSIS MODEL FOR PORT OPERATOR AND CONTAINER CARRIERS

This study is based on the assumption that port operator and container carriers can cooperate by partnering to take advantage of their respective core competencies. For standardizing the variance of the difference gap between two partnership parties in the previous study [Tsao and Feng, 2003], this study defines partnership risk as the gap between subjective and objective expected profits divided by the standard deviation of the gap. Therefore, the partnership risk for each partnering types on the port operator's viewpoint is written as Equation (1):

$$RISK_k^l = \frac{GAP_k^l}{\sigma_k^l} \quad (1)$$

where

$k$  denotes partnership types,  $k = 1, 2, \dots, P$ ;  $l$  denotes container carrier,  $l = 1, \dots, M$ ;

$\sigma_k^l$  denotes standard deviation of the gap;

$GAP_k^l$  denotes gap between the subjective and objective expected revenue (cost saving) of decision maker for partnership type  $k$ , partnering with container carrier  $l$ . For one container carrier case, Equation (1) can be expressed as:

$$GAP_k = PP_k - ER_k \quad (2)$$

where

$PP_k$  denotes expected subjective revenue (cost saving) for partnership type  $k$ ;

$ER_k$  denotes expected objective revenue (cost saving) for partnership type  $k$ .

The difference between the earning and loss of partnership is expressed in Equation (3).

$$ER_k = G_k - L_k \quad (3)$$

where

$ER_k$  denotes expected value of partnership earning for partnership type  $k$ . It is defined as the difference between the expected consequence resulting from a successful partnering ( $G_k$ ) and the expected consequence resulting from a terminated partnering ( $L_k$ ) for partnership type  $k$ .

In Equation (3),  $G_k$  indicates the expected consequence resulting from a successful partnering. It is measured as the product of the probabilities of success through two partnering phases ( $1 - p_{ik}$ ) and the consequence of success ( $q_{ik}$ ), as indicated in Equation (4). On the contrary,  $L_k$  indicates the expected consequence resulting from a terminated partnering. It is measured as the sum of the product of the probabilities of termination ( $p_{ik}$ ) and the consequence of partnering termination ( $q'_{ik}$ ) for each of two phases, as shown in Equation (5):

$$G_k = \prod_{i=1}^2 (1 - p_{ik}) \times q_{ik} \quad (4)$$

$$L_k = p_{1k} \times q'_{1k} + (1 - p_{1k}) \times p_{2k} \times q'_{2k} \quad (5)$$

where

$i$  denotes phase of partnering (construction phase:  $i = 1$  and maintenance phase:  $i = 2$ );  
 $q_{ik}$  denotes consequence of partnering success for partnership type  $k$ ;  
 $q'_{ik}$  denotes consequence of termination for partnership type  $k$  in partnering phase  $i$ ;  
 $p_{ik}$  denotes probability of partnering success for partnership type  $k$  in partnering phase  $i$ .

There are some assumptions in the risk analysis model. First, consequence of partnering success only occurs in all successful phases. The conditional probability of the success partnering is defined as  $(1 - p_{1k})q'_{1k} + (1 - p_{1k})(1 - p_{2k})q'_{2k}$ . Second, there is no gain only partnership success in construction phase, that is,  $q'_{1k} = 0$ . Finally, there is only gain when partnership success in maintenance phase, that is  $q'_{2k} = q'_k$ .

As illustrated, the termination probability is determined by the core risk factor of lack of commitment that is associated with four identified risk factors. Accordingly, the termination probability is measured as the sum of product of the weight of importance ( $w_{ijk}$ ) and the probability of occurrence of the risk factor ( $\delta_{ijk}$ ), as shown in Equation (6):

$$p_{ik} = \sum_{j=1}^n (w_{ijk} \times \delta_{ijk}) \tag{6}$$

where

$w_{ijk}$  denotes weight of importance of risk factor  $j$  for partnership type  $k$  in partnering phase  $i$ ;  $\delta_{ijk}$  denotes probability of occurrence of risk factor  $j$  for partnership type  $k$  in partnering phase  $i$ .

$w_{ijk}$  in Equation (6) is obtained by using Analytic Hierarchy Process (AHP) through pairwise comparison of risk factors. The nominal scale is used to achieve a concise pair-wise comparison evaluation. In accordance with AHP techniques, we derive the comparison matrix of AHP through three steps (Al-Harbi, 2000; Huser & Tadikamalla, 1996; Saaty, 1980). First, we establish one comparison matrix of weight of importance of risk factor  $j$ ,  $w_j$ , given a partnership type  $k$  and phase  $i$ . Next, we derive relative weights for the various risk factors in each matrix. The relative weights are computed as the components of the normalized eigenvector associated with the largest eigenvalue of their comparison matrix. Finally, we compute and check the consistency ratio (CR).

As for partnering consequences, they are divided into two categories: the consequences of partnering termination and those of success. As defined, the consequences of termination are the sum of relation cost and termination costs, as shown in Equation (7). They differ by both partnership type and termination phase.

$$q'_{ik} = \sum_{r=1}^i c_{rk} + c_{tk} \tag{7}$$

where

$c_{rk}$  denotes relation cost for partnership type  $k$  in partnering phase  $r$ , (construction phase:  $r = 1$  and maintenance phase:  $r = 2$ );  
 $c_{tk}$  denotes termination cost for partnership type  $k$ .

On the other hand, the consequences of partnering success are measured by the partnering

revenues ( $rev_k$ ) subtracted by the relation costs of two phases ( $c_{ik}$ ), as indicated in Equation (8) and (9):

$$q_k = rev_k - \sum_{i=1}^2 c_{ik} \tag{8}$$

$$rev_k = orev_k + crev_k \tag{9}$$

where

$rev_k$  denotes partnering revenue resulting from partnering for partnership type  $k$  ;

$orev_k$  denotes operating revenue resulting from operation for partnership type  $k$  ;

$crev_k$  denotes capital return resulting from capital investment for partnership type  $k$  ; it only incurs when  $k=3$ .

As for operating revenue ( $orev_k$ ), it is measured as the product of negotiated service charge ( $pri_k$ ) and additional transportation demand ( $vol_k$ ), as shown in Equation (10). In addition, the capital return ( $crev_k$ ) of partnership is measured as the product of capital amount ( $\Phi_k$ ) and the expected profitable rate ( $\Psi_k - 1$ ), as indicated in Equation (11):

$$orev_k = pri_k \times vol_k \tag{10}$$

$$crev_k = \Phi_k \times (\Psi_k - 1) \tag{11}$$

where

$pri_k$  denotes negotiated service charge by partnership type  $k$  ;

$vol_k$  denotes additional transportation demand incurred by partnership type  $k$  ;

$\Phi_k$  denotes capital amount spent for partnership type  $k$  , it only occurs when  $k=3$ ;

$\Psi_k$  denotes expected return rate from capital investment for partnership type  $k$ , it only occurs when  $k=3$ .

While substituting Equations (9), (10), and (11) into Equation (8), the expression of the consequences of partnering success is rewritten as Equation (12).

$$q_k = pri_k \times vol_k + [\Phi_k \times (\Psi_k - 1)] - \sum_{i=1}^2 c_{ik} \tag{12}$$

The additional demand volume is measured as overall market volume ( $m$ ) multiplied by the difference of market share ( $\lambda_k$ ), as indicated in Equation (13):

$$vol_k = m \times (\lambda_k - \lambda_0) \tag{13}$$

where

$m$  denotes the overall market demand volume;

$\lambda_k$  : the market share resulting from partnership type  $k$  ;

$\lambda_0$  denotes the original market share.

This study assumes the risk is addable and mutual exclusive. It can be written as a general form of Equation (14).

$$RISK^P = \sum_l \sum_k RISK_k^l + \omega \tag{14}$$

where

$RISK^P$  denotes partnership risk of port operator;

$\omega$  denotes noise of partnership. The noise is varied by the situations of partnership between container carriers and port operator. For example, if A partnership is not related to B partnership for same port operator, then  $\omega = 0$ . If there is negative relationship between A and B partnership, then  $\omega < 0$ ; otherwise,  $\omega > 0$ .

The number of combination between M container carriers and port operator partnership can be illustrated as Equation (15).

$$C_2^M = \frac{M!}{2!(M-2)!} \quad (15)$$

Finally, the operation procedure of partnership risk analysis model is shown as follows.

- **Identify the partnership parties:** one by one or one by multiple?
- **Design questionnaires:** For different party and purposes, the evaluator designs various questionnaires to collect parameters, weights and termination probabilities.
- **Interview:** This study suggests in-deep interviews with container carriers and port operator before evaluation. Using the questionnaire for a checklist, intention of decision makers will be obtained. Specially, the decision maker's subjective expected revenue (cost saving) for partnership  $PP_k$  could be obtained after our scenario setting.
- **Calculate risk factors:** This study use the AHP technique to calculate the weights of risk factors.
- **Set parameters range:** This study sets the lower, middle and upper values of triangle probability function by the data collected procedure from interviewing and questionnaire.
- **Monte Carlo simulation:** We use the software of @RISK to simulate presetting scenarios and to calculate risk values and sensitivity analysis after setting random number generator, no. of iterations, probability distribution function type, mean and variance.
- **Interpret the simulation results:** The real situations can be illustrated by the figures of simulation results. Furthermore, we can find out the partnership risk and control the risk by the analysis results.

## 4. CASE STUDY

### 4.1 Parameter Setting

The parameters of simulation in Table 1, including relation cost, termination cost, capital return rate and additional transportation demand, are gained from interviewing high-level managers in eight top-20 container carriers in the port of Keelung in Taiwan and five chiefs of Keelung Harbor Bureau (KLHB). Based on the surveyed maximum, median and minimum values of variables, we construct the triangle probabilities distribution for each variable in order to describe the uncertainty situation as input data for the risk analysis model. Furthermore, we assume some scenarios, as outlined below.

- **Port annual container handling volume:** 2,100,000TEU. It is used to illustrate the market volume in the port. Within the study period, the size of market is unchanged.
- **Basic port tariff:** NTD 2,400/TEU. It assumes that the port charge is a flat structure.
- **Discounted port tariff:** According to the type of partnership, the port operator offers

container carriers 3%, 10% and 20% discounts to attract ship calling and container handling. It also provides for some differences for the market and value sharing between each partnering.

- **Noise of partnership:** This study assumes there is no relationship between different partnerships,  $\omega = 0$ .

Table 1. Parameters of Port Operator Partnering with Container Carrier with Different Market Share

Unit: NTD\$10K,  $K=10^3$

Market Share	Item	NRI	RI	RCI
5%	$PP_k$	20	500	3,000
	$c_{1k}$	Tri(0, 100,300)	Tri(3K,6K, 10K)	Tri(15K, 25K, 40K)
	$c_{2k}$	0	0	Tri(600, 1500,3000)
	$c_{ik}$	Tri(-300,-100, 0)	Tri(120, 160, 200)	Tri(2K, 2.5K, 3K)
	$\sigma_k$		0	Tri(0.94, 1.03, 1.06)
	$vol_k$	Tri(-0.05, 0.1, 0.15)	Tri(-0.1, 0.1, 0.18)	Tri(-0.2, 0.2, 0.4)
10%	$PP_k$	20	600	7000
	$c_{1k}$	Tri(0,200,500)	Tri(3K, 6K, 10K)	Tri(15K, 25K, 40K)
	$c_{2k}$	0	0	Tri(800, 3K,5K)
	$c_{ik}$	Tri(-500, -200, 0)	Tri(120, 160, 200)	Tri(2K, 2.5K, 3K)
	$\sigma_k$			Tri(0.94, 1.03, 1.06)
	$vol_k$	Tri(-0.05, 0.1, 0.15)	Tri(-0.1, 0.1, 0.18)	Tri(-0.2, 0.2, 0.4)
15%	$PP_k$	20	750	9000
	$c_{1k}$	Tri(0,400,2000)	Tri(3K, 6K, 10K)	Tri(15K, 25K, 40K)
	$c_{2k}$	0	0	Tri(1K, 6K, 9K)
	$c_{ik}$	Tri(-2K, 400, 0)	Tri(120, 160, 200)	Tri(2K, 2.5K, 3K)
	$\sigma_k$			Tri(0.94, 1.03, 1.06)
	$PP_k$	20	750	9000

**Note:** Tri (a,b,c) denotes the lower, middle and upper value of triangle function.

#### 4.2 Weight of Risk Factors

Moreover, the termination probabilities and weights of risk factors for partnering, which were collected from the selected eight companies and five chiefs of KLHB, are provided in this study. All of them are experts in their marine and port business. They were inquired through questionnaires and in-depth interviews. The termination probabilities are the weighted average of all experts' value. The relative weight values are calculated using AHP technique through pairwise comparison acquired from questionnaires. The weights of risk factor, such as: interdependence level, objectives consensus, information sharing and speculation behavior, in two different phases are shown in Table 2. All the consistency ratios meet the consistency requirement ( $CR \leq 0.1$ ) of AHP.

### 4.3 Result of Simulation

The quantitative model is designated to be a stochastic process and is measured through Monte Carlo simulations using the computer software program @RISK 4.5. The 1,000 iterations of simulation are ran the risks of different partnering scenarios.

Table 2. Weights of Risk Factors in Construction and Maintenance Phase

Phase	Container Carrier		Port Operator	
	Construction	Maintain	Construction	Maintain
Interdependence	0.143	0.383	0.431	0.108
Objectives consensus	0.290	0.168	0.181	0.624
Information sharing	0.511	0.328	0.267	0.197
Speculation behavior	0.055	0.120	0.121	0.017
Consistency ratio	0.04	0.08	0.1	0.07

Table 3. Gap between the Subjective and Objective Expected Revenue for Partnership  
Unit: NTD10K

Items	Market share 5%			Market share 10%			Market share 15%		
	NRI	RI	RCI	NRI	RI	RCI	NRI	RI	RCI
Minimum	-84.33	-2,282.93	-1,483.13	-130.09	-2,781.23	-3,155.54	-380.12	-3,472.93	-5,908.15
Mean	-36.08	-1,783.92	420.18	-45.66	-2,051.00	-709.42	-145.47	-2,527.35	-1,664.03
Maximum	6.39	-1,166.51	2,369.29	32.19	-1,422.58	1,591.50	51.10	-1,587.79	2,256.51
Std. Dev.	15.92	223.82	643.08	28.01	258.28	817.78	91.99	381.94	1,379.53

From the port operator (PO) viewpoint, the gap between the subjective and objective expected revenue (cost saving) of decision maker for partnership type and partnering with different scale container carrier (CC) are showed as Table 3. It is found that PO partnering with 5% market share CC in NRI is closer to the expectation than 10% and 15% shares. RI partnership having involved more resources in port area than NRI, it is harder for CCs to shift or cut down their container volume. For PO offers favor bidding conditions, it is lower partnership risk for PO whatever partnering with CC having any market share scale.

Comparing different CC scale in same partnership type, we find that PO NRI partnering with 15% market share CC has a higher standard deviation than with 5% and 10% one. In RI partnership situation, the different scale of CCs has obvious revenue tiers. On the contrary, there are minimum gap values of different scale concentrated at 0 in the RCI partnerships.

The result of sensitivity analysis shows that 'relation cost' is the most sensitive variable in all types of partnerships and scales. The reason for this could be that both PO and CC are deeply concerned the relation cost between their partnerships. In fact, from the resources involving viewpoint, PO is weaker than CC in bargain power. If PO cannot recover his costs from partnership, PO will not achieving his expected revenue. Second, the 'additional volume' is a more sensitive variable both in NRI + 5% market share CC and RCI + 15% cases. The reason of the polarization is the lack of the contributions from 5% market share CC's additional volume in NRI and as well as for the contribution of 15% market share CC's additional volume in RCI. Furthermore, 'capital return rate' is sensitive in RCI with 5% and 10%. Finally, the 'termination cost' becomes a burden in low market share partnership.

The partnership risks in different types and partners are calculated and showed in Table 5. First, PO has less risk when NRI and RI partnering with any scale of CC. It is shown as the risk values among different scale of CC partnering with PO in Table 5. But PO partnering with market share 5% CC is more risky than with market share 10% and 15% of CC. The more market share of CC has in the RCI partnership, the more revenue and container volume will the PO gain.

Table 4. Sensitivity Analysis Results

Parameters	Market Share 5%			Market Share 10%			Market Share 15%		
	NRI	RI	RCI	NRI	RI	RCI	NRI	RI	RCI
Relation	-0.777	-0.981	0.623	-0.746	-0.926	-0.677	-0.942	-0.939	-0.825
Cost	(-0.794)	(-0.977)	(0.603)	(-0.711)	(-0.938)	(-0.660)	(-0.942)	(-0.937)	(-0.828)
Additional	0.599			0.692		0.458			0.414
Volume	(0.607)			(0.646)		(0.458)			(0.387)
Termination			-0.522						
Cost			(-0.482)						
Capital			0.474			0.457			
Return rate			(0.446)			(0.456)			

Note: () denotes correlation coefficient.

Table 5. Relative Risk Values among Different Scale of CC Partnering with PO

Market share of CC		NRI	RI	RCI
5%	Minimum	-5.30	-10.20	-2.31
	Mean	-2.27	-7.97	0.65
	Maximum	0.40	-5.21	3.68
10%	Minimum	-4.64	-10.77	-3.86
	Mean	-1.63	-7.94	-0.87
	Maximum	1.15	-5.51	1.95
15%	Minimum	-4.13	-9.09	-4.28
	Mean	-1.58	-6.62	-1.21
	Maximum	0.56	-4.16	1.64

This study expands the model from one container carrier to multiple container carriers. The partnership risk in NRI, RI and RCI are shown in Table 6. We use fuzzy theory to analyze the results of simulation. The tendency figures use total market share as x axle and relative risk value as the y axle. We can find from Figure 5 to Figure 7 that the higher total market share (market share combination) of CC takes, the more relative risk value of PO with two CC partners in NRI partnership marks. But the increasing rate of relative risk will decay when the total market share increase. It shows in Figure 5 that PO partnering with multiple container carriers will take less risk than single one in same market share level.

On the other side, the more total market share the PO has, the more relative risk tendency of RI partnership the PO take. It shows in Figure 6 that PO partnering with multiple container carriers will take more risk than single one in same market share level. Furthermore, the risk of two CC partners in RI, same scale combination (10%+10%) is less than different scale combination (5%+15%).

Table 6. Relative Risk Values of 1 PO Partnership with 2 CC for Different Types

		Container Carrier (CC) I								
Type of partnership		NRI			RI			RCI		
	CC II	5%	10%	15%	5%	10%	15%	5%	15%	15%
5%	Minimum	-5.30	-20.40	-4.61	-39.15	-37.48	-20.97	-19.29	-4.88	-4.30
	Mean	-2.27	-15.94	1.31	-29.15	-27.82	-15.91	-14.59	-1.86	-1.68
	Maximum	0.40	-10.42	7.37	-19.03	-17.68	-10.72	-9.37	0.88	0.53
10%	Minimum	-4.88	-20.97	-39.15	-43.07	-38.05	-21.54	-19.86	-4.64	-4.25
	Mean	-1.86	-15.91	-29.15	-31.76	-27.79	-15.88	-14.56	-1.63	-1.59
	Maximum	0.88	-10.72	-19.03	-22.03	-17.98	-11.02	-9.67	1.15	0.69
15%	Minimum	-4.30	-19.29	-37.48	-41.40	-36.37	-19.86	-18.19	-4.25	-4.13
	Mean	-1.68	-14.59	-27.82	-30.44	-26.47	-14.56	-13.23	-1.59	-1.58
	Maximum	0.53	-20.40	-17.68	-20.68	-16.63	-20.97	-19.29	0.69	0.56

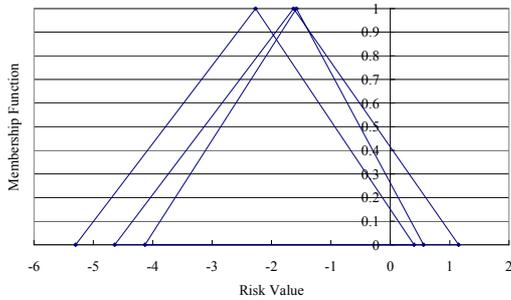


Figure 2. Risk of PO in NRI Partnership

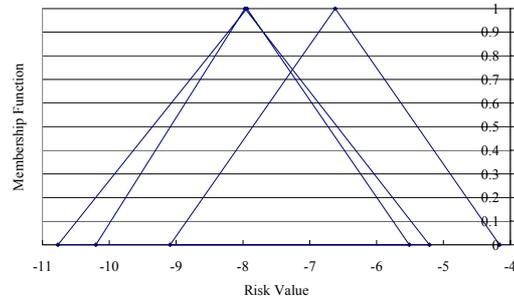


Figure 3. Risk of PO in RI Partnership

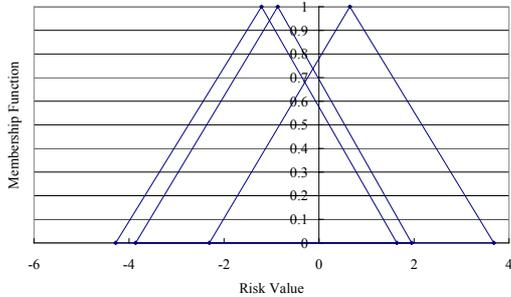


Figure 4. Risk of PO in RCI Partnership

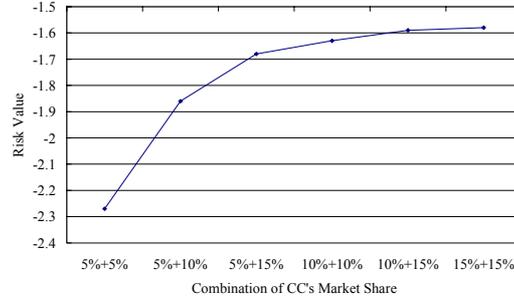


Figure 5. Average Risk Trend of PO Partnering with Two CC in NRI

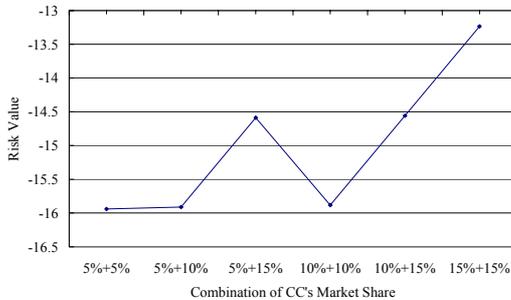


Figure 6. Average Risk Trend of PO Partnering with Two CC in RI

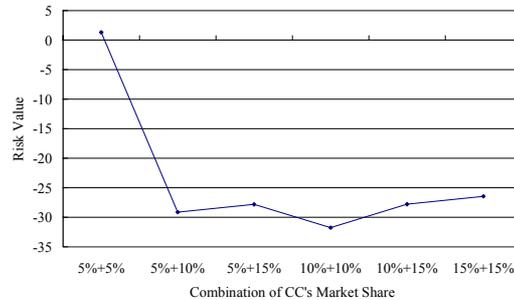


Figure 7. Average Risk Trend of PO Partnering with Two CC in RCI

Clearly, the more total market share RCI partnership owns, the less relative risk tendency it takes. It shows in Figure 7 that PO partnering with multiple container carriers will take more risk than single one in same market share level. We explain the fact that it is hard to handle the RCI partnership when the number of partner increases.

## 5. DISCUSSION

This risk analysis model focuses on port operators' benefits and reflects its measurements of correlative risk factors in terms of business operation surplus, which is further commuted into monetary value only. In contrast to the appraisals of figures in this model, which merely evaluates on the basis of monetary units, we find a structure of partnership in terms of non-monetary factors to obtain values of relative risks can be an effective alternative for decision-makers to be informed about risk differentiations. Obviously, a more complete analysis of the construction of a partnership should not just emphasize the port operators' interests, but should also take into consideration the allies' concerns for balance, as this happens to be a prime prerequisite factor in deciding the duration and cooperation of the relationship. Therefore, this study suggests that a complete and balanced partner relationship framework should contain equal risk evaluations based on model simulation for both sides. Whenever conflicts between two sides emerge, it is worthwhile either to adopt conventional multi-objectives theories to generate an optimum solution, or to employ game theory to describe a mutual decision-making process.

The probability of success and termination of partnership could be derived from this model through in-depth interviews of container shipping decision-makers as to what factors of partnership could exert influence on diverting decisions of cooperation, that is, by analyzing ways of comprehension how interdependence level, objectives consensus, information sharing and speculation behaviors contribute to the possibilities of deterioration or break-up of relations, and evaluating risk conditions for the duration of partnership between container shipping lines and port operator. For further applications, we could control the variances of subjective factors by well questionnaire design. It must be unique questionnaire for different case studies.

Because it is hard to calibrate the parameters of specific uncertain factors in the model, we denote the uncertain characteristics by the likelihood among minimum, middle and maximum value of triangular probability function. Finally, we use Monte Carlo simulation to generate expected revenue. However, the actual distribution status of parameters and their reciprocal relations leave more fields to be explored. All of partnership network scenarios result in various combinations by which to increase the complexity of this model and its operation. In other words, the inherent limitations of this risk simulation model constitute another 'risk' assessment issue.

The additional transportation demands incurred are associated with two service attributes provided, i.e. service charge and travel time (Cullinane & Toy, 2000). In theory, the lower fares the service charge, or the shorter the travel time takes, the greater the additional demand volumes demand, and vice versa. For purposes of condensing and simplifying the operational procedures of the simulation, we put aside Tsai *et al* (2002)'s disaggregate demand Logit model, which includes extra transportation volume as one of the considering parameters, owing to high frequencies of freightage fluctuation and flexible marketing strategy on which

fares, services and volumes can not be fully controlled. Hence, we use a triangular probability function to fix the uncertainty of transportation volumes and assume market scales are stable all the time. Nevertheless, whenever this model is reinforced to grasp factors beyond the previously-mentioned ones adopted here, (interdependence level, objectives consensus, information sharing, and speculation behavior), it is certainly time for making use of Logit model's conception of disaggregate demand so as to extend and fortify our model.

## 6. CONCLUSION REMARKS

This study explore the partnership building between port operator and multiple container carriers in container business. The partnership risk is a core issue of partnership and defined as the gap between subjective and objective expected profits divided by the standard deviation of the gap. The framework of the risk analysis model consists of three types of partnering, considers four risk factors and formulates two stages of risk process, and then develops a risk analysis model from the viewpoint of one port operator.

This study concludes interdependence level, objectives consensus, information sharing and speculation behavior as the key risk factors. This study also follows the life cycle of partnering through two phases, which are construction and maintain phases. Facing the three types of partnership depending on resources spent, i.e. 'no resource-involving', 'resources-involving' and 'resources crossly-involving' partnership, the questionnaires for in-depth interviewing is designed in this study and further simulates the Keelung port case to verify the practicability.

By means of the risk analysis simulations, it is found that the container carrier with more market share may take more risk in RI and RCI partnering with port operator. The risk will be increased with decreasing rate when port operator partnering with multiple container carriers. On the contrary, the risk for port operator to corporate with single container carrier in RCI partnership will be decreased. The results of this study could help a port operator to evaluate the partnership risk with multiple container carriers and to develop the relationship marketing strategies.

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