Journal of the Eastern Asia Society for Transportation Studies, Vol. 6, pp. 3386 - 3400, 2005

RISK MANAGAMENT OF INTERNATIONAL TRANSPORTATION OF INTEGRATED CIRCUIT PRODUCTS

Ya-Ling Yang
Ph. D. Candidate
Graduate School of Management
National Kaoshiung First University of Science and Technology
Instructor
Department of Aviation & Maritime Transportation Management
Chang Jung Christian University
396 Chang Jung Rd., Sec.1, Kway Jen, Tainan 711, Taiwan.
Fax: +886-6-2785056
E-mail: yly@mail.cju.edu.tw

Wen-Hwa Shyu
Associate Professor
Department of Aviation & Maritime Transportation Management
Chang Jung Christian University
396 Chang Jung Rd., Sec.1, Kway Jen, Tainan 711, Taiwan.
Fax: +886-6-2785056
E-mail: shyu@mail.cju.edu.tw

Chao-Hsin Lin
Assistant Professor
Department of Risk Management and Insurance
National Kaohsiung First University of Science and Technology
2, Juoyue Rd., Nantz District, Kaohsiung 811, Taiwan.
Fax: +886-7-6011020
E-mail: llinchao@ccms.nkfust.edu.tw

Shuo-Fen Hsu
Associate Professor
Department of Risk Management and Insurance
National Kaohsiung First University of Science and Technology
2, Juoyue Rd., Nantz District, Kaohsiung 811, Taiwan.
Fax: +886-7-6011020
E-mail: shuofen@ccms.nkfust.edu.tw

Abstract: Integrated circuit **(**IC) products are small-volume, lightweight, and high-unit-price. The loss could be very high if the cargo had not arrived destination safely. We apply risk management techniques to analyze international transportation risks. The data of claim cases of year 2000 were collected, ex post casualty-loss analysis was used to identify, classify and assess risks. The conclusions of this research include: (1) the primary perils of international transportation are damage, theft and wetting. These perils consisted of 93.43%. (2) 90.57% of total claim cases can be attributed to human negligence directly. The causes of losses include damage, non-delivery, theft and shortage. (3) The claim cases can be classified into two clusters by SOM: high-loss cluster and low-loss cluster. (4) The characteristics of loss between different transportation modes are different. (5) The majority of claim cases can be attributed to human factors, therefore, risk prevention and mitigation is the most economic and effective strategy.

Key Words: Integrated-circuit products, International transportation, Risk management

1. INTRODUCTION

The economic development of Taiwan has been highly depending on international trades. In recent years, electronic products become the most important category both in imports and exports. In the year of 2003, according to the statistical data provided by the Bureau of Foreign Trade, 16.3% of Taiwan's imports and exports came from integrated-circuit(IC) related products. Accompanied with the highly growing rate of Taiwan's IC industry, the international transportation activities also grow in a very fast pace. The understanding of perils, which could happen to IC products in the transportation process, has become an important issue. IC products possess the properties of small-volume, lightweight, and high-unit-price; therefore, the price could be very high when losses occur during the transportation. Effective risk management strategies can reduce the unexpected losses in the process of transportation. That is why it is so important to identify and assess the risks, to evaluate the degree of risks, and to develop risk management strategies for carriers and IC products manufacturers.

The ideas of “risk management” had been developed since the early 1950s. One of the earliest references about the concept of risk management appeared in the Harvard Business Review of 1956 (Gallagher, 1956). According to Gallagher, risk management is a scientific approach to deal with pure risks by anticipating possible accidental losses and designing and implementing procedures that minimize the occurrence of losses or the financial impacts of losses that do occur. There are two major techniques used by risk managers to deal with risks: risk control and risk financing. Risk control focuses on minimizing the risk of losses that the firm is exposed to; risk avoidance and risk reduction are the most common used techniques. Risk financing is concentrating on the arrangement of funds availability when losses happen. The tools of risk financing include retention and risk transfer. Risk management process can be divided into a series of individual steps: the determination of objectives, the identification of risks, the evaluation of the risks, the selection of risk treatment device, the implementation of the decision, and the evaluation and review. Identifying these individual steps helps to guarantee that important phases in the process will not be overlooked. (Vaughan and Vaughan, 2001)

Risk analysis and risk management had been broadly applied in the business operations in recent years (Colquitt, 1999; Chiou, 2000; Loderer and Pichler, 2001; Brown, 2001; Atkinson, 2003; Russ, 2004; Anthony and Tony, 2004). The concept of transportation safety has been migrated from the traditional “non-accident announce” to risk management. Risk management is developed into a new field of transportation research (Tsai, 2000). Wang (1997) listed the possible hazards when goods are transferred by air, by sea, and by land. He proposed that cargo owners have to investigate the risks occurred for each type of goods and to obtain appropriate insurance policies. Wang did not investigate the severity and the frequency caused by individual factors. Chang (1999) investigated the risks faced by the transportation industries includes the air transportation industry, the maritime transportation industry and inland transportation industry. He proposed that the aviation carriers should implement risk control and risk financing measures, the maritime carriers should obtain suitable insurance policies, the railway carriers should improve risk control measures, and the inland carriers also should implement risk control and risk financing measures.

Li and Cullinane (2003) defined the scope, concepts and methods of maritime risk management (MRM). They applied MRM to recognize and assess maritime liability hazards. The common liability hazards had been analyzed on a case-study basis. The measures of risk avoidance and risk reduction of maritime transportation had also been examined. Shiau (1996) investigated the perils of maritime transportation and liner transportation industry. He classified the perils of container transported by sea and analyzed the causes of perils in each operation phase. Shyu *et al.* (2000) collected data about losses during imports and exports processes, they analyzed the risk factors from the cargo owners’ point of view. The data of insured amount, incurred claim, and cargo category were analyzed to evaluate loss severity and loss frequency for different cargo types.

Nyce (2002) combined both traditional and innovative risk management techniques into one semester-long group case study, The Delta Air Lines case study was divided into three segments to focus on three distinct objectives: identification of horizon risk, analysis of workers' compensation claims, and estimating both total loss distributions and layers of loss due to airline crashes for potential capital market financing alternatives. Tsai *et al.* (1999) proposed a framework for aviation security management. He applied risk management concepts in designing procedures of aviation security management. The differences in the applications of risk management and insurance were clarified.

Shyu *et al.* (2001) analyzed claim cases obtained from a Taiwan's insurance company. They identified the relationships between the causes of cargo damages and the frequency of accidents. Preventive measures were suggested for IC products to reduce the rate of damages during international transportation. O'Connell (2004) also proposed methods to secure the safe arrival of cargo transported by sea.

In order to lower the loss of IC products owing to accidents when they are delivered, we will make an overall study to understand the risk factors during international transportation and the characteristics of risk factors of ICs products. The purpose of this paper is fourfold. First, we use Self Organization Map (SOM) to verify risk categories of IC products during international transportation. Second, we explore the characteristics of claim data by SOM. Third, we construct the model of risk measurement by collecting data. Fourth, we will propose risk management suggestions for carriers and IC products manufacturers.

2. METHODOLOGY

We adopt the ex post Casualty-Loss Analysis method which is for the purpose of search improved methods in the future by past loss experience and claim characteristics. It let us know how and when the claim happened, how many casualties happen, and how much money lost by using this analysis method. Based on the results of the analysis, we can further assess the degrees of risks and draft the risk management plan.

2.1 SOM Model

A SOM network assumes a topological structure among the cluster units. There are m cluster units, arranged in a one- or two-dimensional array, and input signals are n-tuples [Kononen (1989)]. This network architecture can be visualized as shown in Figure 2.1.

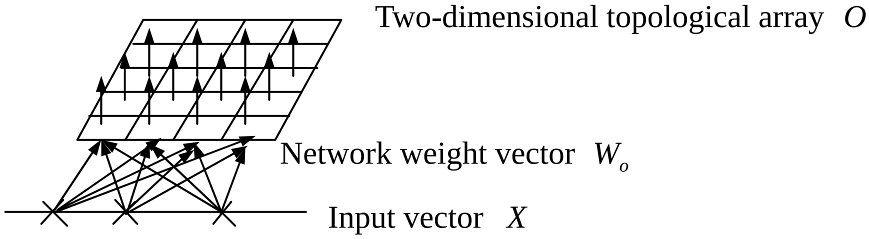


Figure 2.1 SOM Network Architecture

The weight vector for a cluster unit serves as an exemplar of the patterns associated with that cluster. During the self-organization process, the cluster unit whose weight vector matches the input pattern most closely (typically, the square of the minimum Euclidean denoted as show in equation (1)) is chosen as the winner denoted as O^* in equation (2). The updating process is given by equation (3).

$$\|X_i - W_o\| \equiv \sum_i [X_i - W_O]^2 \tag{1}$$

$$\|X_i - W_{o^*}\| \equiv \min_i \|X_i - W_o\| \tag{2}$$

$$\Delta W_o = +\eta \cdot (X - W_o) \cdot R\_factor_o \tag{3}$$

Where X_i is the vector of the i th input pattern, W_o is the weight vector. η refers to the learning rate and is a slowly decreasing function of time. R_factor_o refers to the topological neighborhood parameter and is set as follows in this paper.

$$R\_factor_o = \exp(-r_o / R) \tag{4}$$

In which, R is the radius of topological neighborhood and r_o is neighborhood distance defined by $\sqrt{(O_x - O_x^*)^2 + (O_y - O_y^*)^2}$.

It can be shown from equation (4) that if r_o=0, then R_factor_o=1 and if $r_o = \infty$, then R_factor_o=0. In other words, in the neighborhood area, the greater the neighborhood distances, the smaller the neighborhood parameter and the smaller the update of the weight. Furthermore, R and η are updated through equations (5) and (6).

$$R = R\_rate \cdot R \tag{5}$$

$$\eta = \eta\_rate \cdot \eta \tag{6}$$

Where R_rate and η_rate are the updating factors. From equation (5) and equation (6) it can be seen that the neighborhood radius and the learning rate slowly decrease as the clustering process progresses. This is referred to as the convergence of SOM.

2.2 Data

Our sampling data were obtained from a Taiwanese insurance company, which is one of the largest companies in the property insurance industry. The data include all 140 claims in the year 2000. The data items considered for analysis include insured amount, premium, incurred claim, imports or exports, destination, cause of loss and transportation mode. Based on the data collected, only pure risks were analyzed and their management strategies were proposed.

Due to the value of incurred claim depends on the value of insured amount underwritten. To avoid the magnified influences from the absolute values of losses in analyzing the relationship between perils and risks, two relative measures for loss were used in the data mining processes to classify risks. A_1 is the ratio of incurred claim and premium, which is defined as loss ratio. A_2 is the ratio of incurred claim and insured amount, which is defined as claim ratio. Two other measures were introduced to count the effects from the cause of loss and the transportation mode. C_1 represents the cause of loss. C_2 represents the method of transportation. These four variables consist of the SOM input vectors, denoted by X = { A_d, C_d | d=1,2}.

The natures of air transportation and marine transportation are different. It is helpful to investigate the relationship between the cause of loss and the transportation mode. Risk classification reveals the characteristics of the cause loss by different transportation method. Risk control measures could be developed for the carriers and the shipper when IC products are transported to reduce the amplitude of loss.

3. EMPIRICAL RESULTS

3.1 The Analysis of Perils

After reviewing and analyzing all the claim cases, the possible causes of loss during the imports and exports transportation processes for IC product can be classified into 9 categories. The perils are listed as in a descending order according to the number of claims of each peril. Figure 3.1 shows the relative frequency of each peril. They are:

(1) Damage: abrasion, collision, dint, tear, cracking, scratching, bending etc.
(2) Theft: whole or part of the cargo stolen.
(3) Wetting: the damage caused by water.
(4) Shortage: shortage of cargo upon arrival.
(5) Non-delivery: the cargo undelivered for unknown reasons.
(6) Jettison: When the vessel and the cargo on board are in the status of danger, part of cargo is abandoned for the safety of other cargo. The cargo abandoned due to the defects of the cargo itself is not included.
(7) Fire: the cargo is damaged in the process of transportation due to fire directly or indirectly.
(8) Collision: the cargo was damaged due to the collision of conveyance.
(9) Sweating: the cargo was damaged due to the evaporation of other cargo or packaging materials in the same vessel.

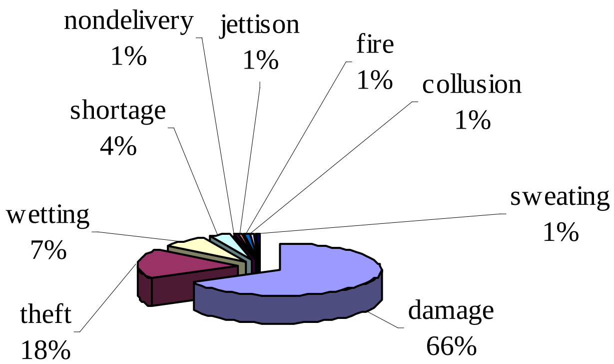


Figure 3.1 The Relative Frequency of Each Peril

The most common peril to cause loss was goods damaged. There were 94 claim cases due to goods damaged. It occupied 67.14% of total claim cases. The causes for damages included unsuitable packaging, negligence during loading and unloading operations. The goods stolen or lost were second in the number of claim cases. There were 27 claim cases due to goods stolen or lost. It occupied 19.86% of total claim cases. The causes for goods stolen or lost included the complex composition of handling personnel during terminal operations, the qualification of carriers, and the qualification of forwarders. Wetting was the third largest peril. There were 10 claim cases due to wetting. The percentage was 7.14%. The causes for wetting included the loading and unloading in the rain, seawater overboard, and unsuitable packaging. Shortage is the number four peril of loss. There were 5 claim cases. The percentage is 3.57%. The causes for shortage when goods delivered included negligence and dishonesty.

From the above analyses, we concluded that the majority of losses were from human errors.

90.57 % of losses accounted were caused by human negligence directly. These perils included damage, theft, goods lost, and goods shortage. 9.43% of losses can be attributed to human negligence indirectly. These perils included wetting, jettison, fire, collision and sweating.

3.2 Risk Classifying and Data Mining

SOM is used to categorize risks and to mine data for the purpose of understanding the characteristics of goods loss. The characteristics will be utilized to develop effective risk management strategies.

The input data of SOM include loss ratio, claim ratio, cause of loss and transportation mode. An 8 by 8 output SOM matrix is used for the depiction of the network topology. To make the results converge. The learning rate was set as 0.1, the neighborhood radius was set as 4, and convergence was achieved after 500 learning cycles. Learning convergence diagrams and Sammon's Mapping (Note: Sammon's Mapping is used to test whether the results derived from SOM have converged fully. The SOM classification is complete if the graphical topology has no overlaps or knots.), as shown in Figure 3.2 and Figure 3.3 The training and testing errors both are only 0.026.

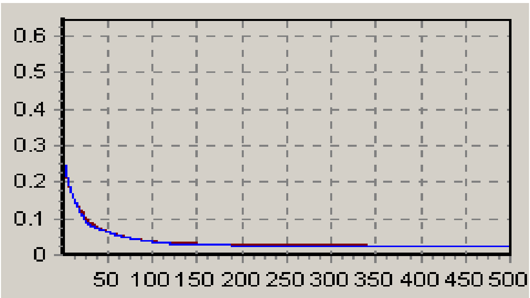


Figure 3.2 Network Learning Convergence Diagram

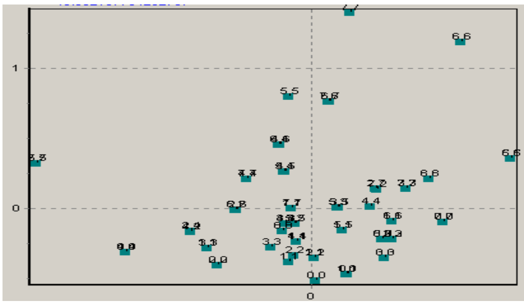


Figure 3.3 Sammon's Mapping of SOM

The visualizations of the results are shown in Figure 3.4 and 3.5. Figure 3.4 shows the results of classification by using SOM. Figure 3.5 is the output matrix. The number in each cell of the matrix represents the number of sampling data in that particular category. After reviewing the characteristics of these matrix data, we found out that the data in the lower right corner (the first cluster) are small in the values of loss ratio, claim ratio and the data in the upper left corner (the second cluster) are with big values.

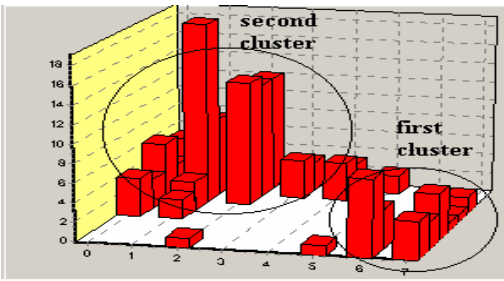
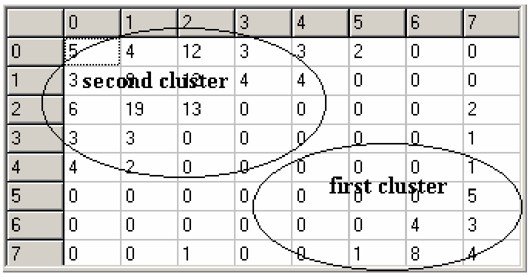


Figure 3.4 Classification by SOM



	0	1	2	3	4	5	6	7
0	5	4	12	3	3	2	0	0
1	3	8	12	4	4	0	0	0
2	6	19	13	0	0	0	0	2
3	3	3	0	0	0	0	0	1
4	4	2	0	0	0	0	0	1
5	0	0	0	0	0	0	0	5
6	0	0	0	0	0	0	4	3
7	0	0	1	0	0	1	8	4

Figure 3.5 Output Matrix of SOM

The characteristics of each cluster are shown in Table 3.1. The number of claim cases in the first cluster is 29. The average loss ratio is 1569, average claim ratio is 0.93, and the average loss severity is NT$607,543. The main cause of loss is damage with percentage of 55.18%. Number two cause of loss is theft with percentage of 27.58%. Number three is wetting with percentage of 13.79%. And lost is the number four cause of loss with percentage of 3.4%. In this cluster, 89.64% were transported by air with average loss of NT$548,021. The other 10.34% were transported by sea with average loss of NT$1,123,394. The number of claim cases in the second cluster is 111. The average loss ratio is 69.4, average claim ratio is 0.041, and the average loss severity is NT$97,183. The main cause of loss is damage with percentage of 70.27%. Number two cause of loss is theft with percentage of 16.21%. Number three is wetting with percentage of 5.4%. And shortage is the number four cause of loss with percentage of 4.5%. In this cluster, 71.18% were transported by air with average loss of NT$102,870. The other 28.82% were transported by sea with average loss of NT$83,143. The first cluster is defined as high-loss cluster because of the high loss ratio, high average claim ratio, and high average loss severity. The second is defined as low-loss cluster. The average loss of the high-loss cluster is about 5 times larger than the average loss of the low-loss cluster. Most of the claim cases in the high-loss cluster were transported by air. The main cause of loss is damage that occupies 55.18%. The second cause of loss is theft that occupies 27.58%. When IC products are transported by air, it is important to implement control measures about damage and theft. As of the low-loss cluster, the main cause of loss is damage, too. It occupies 70.27%. The characteristics of each risk cluster are listed in Table 3.2.

Table 3.1 Data Statistics after SOM Classification

Cluster			first	second
Number of claim cases			29	111
Average loss ratio			1,569	69
Average claim ratio			0.93	0.04
Average amount of losses			607,542	97,183
Transportation mode	Maritime transportation	Relative loss frequency	10.34%	28.82%
		Average loss severity	1,123,394	83,143
	Air transportation	Relative loss frequency	89.66%	71.18%
		Average loss severity	548,021	102,870
Perils	Damage		55.18%	70.27%
	Theft		27.58%	16.21%
	Wetting		13.79%	5.4%
	Shortage		---	4.5%
	Non-delivery		3.4%	---
	Jettison		---	0.9%
	Fire		---	0.9%
	Collusion		---	0.9%
	Sweating		---	0.9%

*Note: In December 2000, one U.S. dollar was worth about NT$34.

Table 3.2 Characteristics of the Two Cohorts Classified by SOM

Cohort	Definition	Characteristics
First cohort	High-loss cluster	High average loss ratio, high average claim ratio, high average loss severity
Second cohort	Low-loss cluster	Low average loss ratio, low average claim ratio, low average loss severity

3.3 The Relationship between Transportation Modes and Perils

A clear understanding of the relationships between the transportation mode and the cause of loss will help developing the risk preventative measures. From the results of data mining, we observe that the frequency and amplitude of loss have a strong dependency on the transportation mode. Generally speaking, the average amplitude of losses when cargos were transported by air was higher than those transported by sea. The statistical results are listed in Table 3.3.

Table 3.3 Descriptive Statistics between Transportation Modes and Perils

Transportation mode / Perils	Maritime		Air	
	Average loss severity	Relative loss frequency	Average loss severity	Relative loss frequency
Damage	169,987	71.43	143,341	65.71
Theft	170,168	14.29	513,743	20.00
Non-delivery	---	---	34,788	0.95
Wetting	45,568	2.86	166,198	8.57
Shortage	---	---	50,098	2.86
Jettison	56,990	2.86	---	---
Fire	767,410	2.86	---	---
Collusion	14,526	2.86	---	---
Sweating	45,763	2.86	7,658	1.90
Total	172,307*	100	213,098*	100

Note：* indicates average loss severity of different transportation modes

3.4 Risk Assessment

Severity and Frequency are the major indicators used for risk assessment. All possible combinations of transportation modes and perils are located in Figure 3.6, the risk-mapping map. In this map, we observe that damage and theft in maritime transportation and theft in air transportation belong to high severity and high frequency group. In the group of high severity and low frequency, we have wet damage in air transportation. In the group of low severity and high frequency, we have damage in air transportation. All the other combinations belong to low severity and low frequency group.

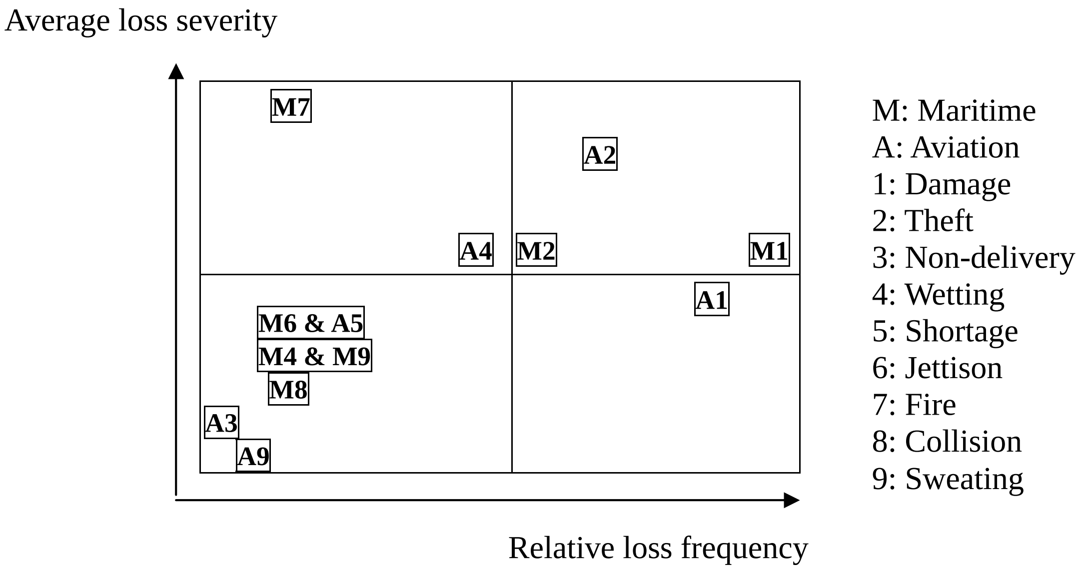


Figure 3.6 Risk Mapping

4. RISK MANAGEMENT STRATEGIES

4.1 Selection of Risk Management Strategies

The selection of best risk management strategies is according to the combination of loss severity and loss frequency for each peril. Figure 4.1 shows the strategies can be taken in different scenario.

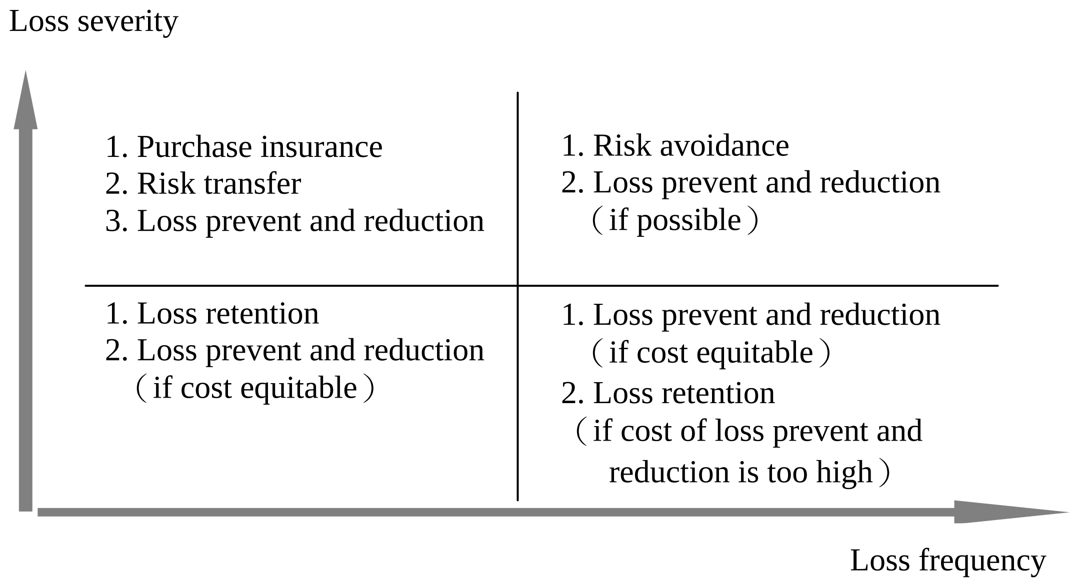


Figure 4.1 Risk Management Strategies

Source：Kung *et al*. (1995)

For the perils belong to the high severity and high frequency group, risk avoidance and loss prevention and mitigation are best techniques. Insurance, risk transfer, loss prevention and loss mitigation are used for perils belong to the high severity and low frequency. Loss prevention and mitigation and retention are used for perils belong to the low severity and high frequency group. As for the low severity and low frequency group, retention and loss prevention and mitigation are used.

According to the common practices mentioned above, the insured can draft deductible clause when damages are caused by wet damage, shortage, abandon, fire, collision and humid damage. Or the insured can transfer the risk through the international trade term to consignee. Besides, loss prevention and mitigation is always required for pure risks. If the causes of damages were identified in advance, proper controls over the transportation process could greatly reduce losses because of human errors. Different major causes of damages in transferring IC products can be identified due to different transportation modes. Following strategies should be implemented to control losses.

4.2 Loss Prevention Strategies for Air Transportation

4.2.1 Goods Damage

Most IC products are fragile high technology products. Collision and tilting accidents will do a lot of damages to IC products during loading and unloading operations. Good practices for these operations can cut down the number of damages.

(1) To improve the packaging of IC products
Excessive vibration and tilting sensors can be added on the outside surface of package box. Actions should be taken if abnormal signals were detected to avoid worsening situations and clarify responsibility.

(2) To choose qualified operation company
Qualified terminal stevedoring companies with reputation provide fast and secure loading operations. If accidents did happen, the loading operation should stop at once. The terminal stevedoring company should provide a report about the accident. A survey company should be appointed to facilitate the followed claim processes.

(3) To enhance the quality of truck drivers
Lots of damage losses came from car accidents. Therefore, it becomes very important to improve the quality of truck drivers. The time allowed for drivers to deliver cargo should be reasonable to mitigate drivers' time pressure, then speeding can be avoided.

4.2.2 Theft and Shortage

Base on the characteristics of high-unit-price, small-volume, easy-to-transport, and easy-to-resale for IC products, IC products has become a primary target for thieves. The main strategic thinking to prevent theft is to deliver the products to consignee as quickly as possible to reduce the chances of theft.

(1) To improve the packaging of IC products
Too much simplified packaging like paper box and clear mark identifying IC products incubate the chances for theft. Improved packaging can prevent easy access for thieves. The increased cost compared to the huge losses is relative low. It is a cost effective strategy.

(2) To choose carriers, forwarders, and customs brokers carefully
Carriers, freight forwarders, and customs brokers are the other parties possess the knowledge of cargo content and shipping details beside the shipper and the consignee. To choose these agents with care can lower the risk of inside job and assure on-time delivery.

(3) To count exactly when cargo is delivered
It is hard to clarify the responsibility when theft happened if the cargo is not counted exactly at delivery. Weight, number and time should be noted when the cargo is transferred to the carrier for transportation. Any extra-ordinary conditions should be recorded in the extra-ordinary reports. The carrier should be noticed and the survey company should be hired to ensure the claim process.

(4) To avoid overnight stay in terminal
There are a large volume of cargo and people in and out an air cargo terminal daily. The complex composition in working force provides chances for thieves to steal. Overnight stay of IC products in an air cargo terminal should be avoided.

(5) To choose non-stop route for IC products transportation
Trans-shipment creates stay time within an air cargo terminal. Theft cases did happen during the loading, unloading, and transferring operations. To reduce the risk, non-stop routes should always be the first choice to ship IC products.

4.2.3 Wetting

Electronic products are fragile against water damage. Any contact with water could cause total loss. Total waterproof packaging is a must-do requirement.

(1) To use total-water-proof packaging
Paper boxes only provide minimal waterproof effect. Plastic film is recommended for improved waterproof function. Warning signs are also required to remind workers during transportation process.

(2) To avoid operations in the rains
Lots of wetting claim cases happened because of operations in the rains. The loading and unloading operations should be avoided while it rains. If the operation had to perform in a rainy day, waterproof cover should be used.

4.3 Loss Prevention Strategies for Maritime Transportation

4.3.1 Damage

(1) To choose inland carriers carefully
Car collisions, tilting over, unsteady loading, and over-capacity loading was the most common accidents during inland transportation. The majority cases were caused by human factors. Unqualified trucks cause some accidents. Qualified firms with appropriate monitoring system are better choices to prevent this type of loss.

(2) To choose un-stuff/consolidation and inland carriers with care
Inland carriers with comprehensive operating rules can reduce cargo damage owing to negligence. Good un-stuff/consolidation operation can secure the cargo in containers to lower

the happening of cargo damage.

(3) To avoid improper packaging
In order to prevent goods from tilting over in the transportation process, special attentions should be paid to those products with unusual shapes or unbalanced weights to ensure proper packaging are in place.

(4) To avoid unbalanced container loading
Unbalanced loading usually happened when the shipper loaded container. In this situation, cargo could dislocate and damage when transported. The shipper should hire professionals to load special types of cargo which balanced loading is difficult to be arranged.

4.3.2 Theft and Shortage

(1) To divide shipment of large quantity into several shipments and using non-stop routes
With the characteristics of small-volume and high-unit-price, the amount of losses becomes very high when a large amount of IC products are transported in a single shipment. Separate shipments can effectively reduce the severity of loss when it happens. Burglary cases usually happened during transferring, loading, and unloading operations. Another way to reduce the theft or shortage cases is to use non-stop route for IC products transportation.

(2) To choose inland carriers and maritime carriers with care
Good inland carriers have appropriate operating procedures in delivering cargo. Minimal stops and stop time is a good practice. The driver should be accompanied with an assistant when IC products are carried to ensure the safety of cargo. Established maritime carriers have the ability to repay if accidental loss happened.

(3) To choose forwarders and customs brokers with care
Companies with well-established monitoring system for the transportation processes can lower the possibility of inside theft events. Good forwarders should monitor the un-stuff/consolidation operation carefully to ensure the safety of cargo.

(4) To deliver cargo as soon as possible after cargo arrival
It is a both risk control effective and cost effective practice to cut down the stay time in freight station or warehouse.

(5) To check documents and count cargo in each phase of transportation
To clarify the responsibility, the documents should be checked and the cargo should be counted in each transferring phase. Any abnormal condition should be noted on the receipts. Extra-ordinary reports should be filed.

(6) To change packaging marks over a random period of time
The packaging marks should be changed from time to time to maintain cargo security and trade secrets. The changing over logos and marks could avoid being a long term primary target of thieves.

(7) To reinforce cargo packaging
Paper boxes are easy to be damaged. Good wrapping materials are strong enough to withhold casual sabotage attempts. Although the cost of packaging is increased, the risk of cargo been stolen can be greatly reduced.

4.3.3 Wetting and Sweating

(1) To use water-proof materials for packaging
Plastic film should be wrapped over the paper boxes to prevent wetting and sweating from happening. Warning signs should be marked to alert operation staff. The packaging materials (such as wooden case) should be dry; otherwise the cargo could be damaged due to sweating of packaging materials.

(2) To choose appropriate container
The shipper should check the conditions of containers. Damaged or broken containers should be avoided to ensure that the containers possess enough strength in confronting maritime transportation environment.

(3) To choose forwarders and un-stuff/consolidation companies with comprehensive operation rules
The companies with comprehensive operation rules pay more attention in handling electronic products during the un-stuff/consolidation processes. The guiding rules about operations in rainy days and in bad weather are important to avoid wetting damages.

(4) To choose maritime carriers with care
Qualified maritime carriers with reputation have appropriate guiding rules in making operation decisions when facing bad weathers or sea-worthiness situations. Thus, the risk of cargo damage can be lowered.

(5) To be alert of seasonal weather changes in destination
Certain countries or areas have long seasons of rainy days, therefore, all cargos go in those areas should be paid more attention in waterproof wrapping.

5. CONCLUSIONS

IC products are small in volume, light in weight, and high in unit price. The loss of manufactures, carriers, and insurers could be very high if the cargo had not arrived destination safely. We apply risk management concepts in dealing with IC products in the transportation process of imports and exports. The data of claim cases of year 2000 were collected, ex post casualty-loss analysis was used to identify, classify and assess risks. Thus, risk management strategies were proposed. The conclusions of this research include:

(1) The primary perils of international transportation are damage, theft and wetting. These perils consisted of 93.43%.

(2) 90.57% of total claim cases can be attributed to human negligence directly. The causes of losses include damage, non-delivery, theft and shortage.

(3) SOM was used to classify risks and mine data. The losses according to SOM can be classified into two clusters: high-loss cluster and low-loss cluster. The average loss of high-loss cluster is about 6 times of the average loss of the low-loss cluster. The majority of claim cases in the high-loss cluster use air transportation. The largest cause of loss is damage that occupies 55.18%. Theft is the second largest cause with 27.58%. When IC products are

transported by air, it is important to implement control measures about damage and theft. As of the low-loss cluster, the largest cause of loss is damage, too. It occupies 70.27%.

(4) The average loss of IC products transported by air is larger than that transported by sea. The differences in the characteristics of loss between different transportation modes are identified.

(5) According to the transportation mode, different risk management strategies should be applied. The cause of loss in the majority of claim cases can be attributed to human factors, therefore, risk prevention and mitigation is the most economic and effective strategy.

REFERENCES

Anthony, M. & Tony, M. (2004) Development of a model for risk management at corporate, strategic business, and project levels, **Journal of Structured and Project, Vol. 10, No. 1**, 79-85.

Atkinson, W. (2003) Enterprise risk management at Wal-Mart, **Risk Management, Vol. 50, No. 12**, 36-39.

Brown, B.A. (2001) Enterprise risk management, **Risk Management, September**, 43-50.

Chang, H.L. (1999) Operation risk and strategies of transportation industry in Taiwan, **The Conference on How to Evaluate and Manage Earthquake Risk**, Risk Management Society of Taiwan, Taipei, Dec. 1999.

Chiou, C.F. (2000) Risk management of enterprise, **Risk Management Journal Quarterly, Vol. 6,** 38-48.

Colquitt, L.L., Hoyt, R.E., and Lee, R.B. (1999) Integrated risk management and the role of the risk manager, **Risk Management and Insurance Review, Vol. 2, No. 3**, 43-61.

Gallagher, R.B. (1956) Risk management: A new phase of cost control, **Harvard Business Review** (September-October).

Kohonen, T. (1989) **Self-organization Maps and Associative memory** (3rd ed.), Springer-Verlag.

Kung, Y.M., Chen, S.S., and Ling, F. K. (1995) **Insurance – Theory and Practice** (1st ed.), Taipei: Hwa-Tai.

Li, K.X. and Cullinane, K. (2003) Maritime economics & logistics, **Rotterdam, Vol. 5, No. 3**, 268-284.

Loderer, C. and Pichler, K. (2000) Firms, do you know your currency risk exposure? Survey result, **Journal of Empirical Finance, Vol. 7,** 317-344.

Nyce, C. (2002) Incorporating enterprise risk management into the curriculum: The Delta Air Lines case study, **Risk Management and Insurance Review, Vol. 5, No.1**, 67-78.

O'Connel, J. (2004) Marine cargo security, **Risk Management, Vol. 51, No. 3,** 30-37.

Russ, B. (2004) Enterprising views of risk management, **Journal of Accountancy, Vol. 197, No. 6**, 65-71.

Shiau, M.S. (1996) The research in risk management of shipowers' container operation, National Taiwan Ocean University, Department of Shipping and Transportation Management, Master Thesis.

Shyu, W. H., Lu, J. S., Tseng, W. J., and Yang, Y. L. (2000) Risk factor analysis and strategies of cargo in maritime transportation, **The 7th Conference on Transportation Safety of ROC**, 271-279.

Shyu, W.H., Yang, Y.L., and Tseng, W.J. (2001) Risk assessment of IC goods in international transportation, **Journal of underwriting, Vol. 11**, 205-218.

Tsai, M.C. (2000) Developing public transport safety management and safety regulations by using risk management skills, **Transportation Planning Journal, Vol. 29, No. 1**, 188-212.

Tsai, M.C., Hong, M.S., and Ye, C.Z. (1999) Integration of risk management and insurance for air transportation safety, **The 6th Conference on Transportation Safety of ROC**, 538-551.

Vaughan, E.J. and Vaughan, T.M. (2001) **Risk Management.** New York: John Wiley & Sons.

Wang, C.M. (1997) Study of cargo transportation risk, **Journal of National Taichung Institute of Commerce, Vol. 29**, 21-31.