科技部補助專題研究計畫成果報告
期末報告

以精實供應鏈成員觀點探討環境劇變下供應鏈回復力之關鍵影響因子

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計 畫 主 持 人 ： 謝承憲

報 告 附 件 ： 出席國際會議研究心得報告及發表論文

處 理 方 式 ：
1.公開資訊：本計畫可公開查詢
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中 華 民 國 103 年 07 月 29 日

中 文 摘 要 ： 社會經濟型態的快速變遷，導致臺灣的外食人口比例與日俱增，且由於 24 小時營運的便利商店密布，90%的臺灣居民可以在生活周遭沒有時間限制地接受便利商店的服務。便利商店成為滿足外食族群新通路，提供了多元的鮮食產品，包括冷凍食品、加熱食品、及現作鮮食…等。除了方便以外，在便利商店購買鮮食的顧客成長，主要來自於鮮食產品在品質及口味上的提升；不僅業者注重高品質的原料及生產履歷，年輕消費族群嘗鮮的意願也促進了便利商店食品市場的成長。然而，鮮食在上架販售前需要經過包括加工處理、輸配送及儲存等程序，鮮食屬於易腐性產品，會隨著時間產生質變，不恰當的物流可能會提高微生物汙染風險。該風險不僅縮短鮮食產品的保存期限，更可能導致食物中毒。是以，低溫供應鏈（冷鏈）即是針對溫度敏感的產品，在其調理、運輸及儲存的過程中，藉由冷藏、冷凍的包裝方式與獨特的物流計畫，提供低溫環境以減緩化學變化的機率，並保持運送品的完整性。

便利商店鮮食產品的冷鏈是指從製造端一直到市場端都利用不間斷的低溫環境或設備進行鮮食之處理，供應鏈系統中的每一環節皆保持需求的溫度是確保鮮食品質的原則。冷鏈系統需要適當的設備、程序、及人員（如運輸業者、包裝、加工、儲存、與配送易腐產品的工作人員），冷鏈管理在鮮食送達顧客手上的品質中扮演一個重要的策略角色。據此，本研究利用決策實驗室分析法（decision making trial and evaluation laboratory, DEMATEL）探討影響冷鏈回復力的關鍵影響因子，以臺灣全家便利商店的一家主要鮮食供應商為實際案例進行分析。本研究發展九項準則，包括產能利用率、冷藏車異常、供電系統異常、資訊系統異常、製造加工的溫度控制、包裝溫控、輸配送溫控、廢品率、第一線員工失誤率、及管理階層危機處理能力，以評估便利商店鮮食的冷鏈脆弱度。本研究所提方法有助於界定鮮食冷鏈物流系統之關鍵回復力因子與脆弱環節，從而提高險評估能力以減緩冷鏈系統的可能損失。根據分析結果，不完整資訊、食品加工過程溫控不準確、及第一線員工的失誤率，是臺灣便利商店鮮食冷鏈營運的關鍵變量。本研究建議應優先關注電子化資訊與交換系統及前線員工的教育訓練，以減輕在不適當溫度環境下處理與輸配送時的負面影響。

中文關鍵詞： 低溫供應鏈（冷鏈）、脆弱度、回復力、便利商店鮮食、決策實驗室分析法（DEMATEL）

英 文 摘 要 ：

英文關鍵詞： Cold chain, vulnerability, resilience, fresh food at

convenience store, decision making trial and evaluation laboratory (DEMATEL)

科技部補助專題研究計畫成果報告

（□期中進度報告/■期末報告）

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計畫主持人：謝承憲
共同主持人：
計畫參與人員：呂佳娣、傅少君

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□執行國際合作與移地研究心得報告
■出席國際學術會議心得報告

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中　華　民　國　103　年　7　月　29　日

一、中英文摘要

（一）中文摘要

社會經濟型態的快速變遷，導致臺灣的外食人口比例與日俱增，且由於 24 小時營運的便利商店密布，90%的臺灣居民可以在生活周遭沒有時間限制地接受便利商店的服務。便利商店成為滿足外食族群新通路，提供了多元的鮮食產品，包括冷凍食品、加熱食品、及現作鮮食…等。除了方便以外，在便利商店購買鮮食的顧客成長，主要來自於鮮食產品在品質及口味上的提升；不僅業者注重高品質的原料及生產履歷，年輕消費族群嘗鮮的意願也促進了便利商店食品市場的成長。然而，鮮食在上架販售前需要經過包括加工處理、輸配送及儲存等程序，鮮食屬於易腐性產品，會隨著時間產生質變，不恰當的物流可能會提高微生物汙染風險。該風險不僅縮短鮮食產品的保存期限，更可能導致食物中毒。是以，低溫供應鏈 (冷鏈) 即是針對溫度敏感的產品，在其調理、運輸及儲存的過程中，藉由冷藏、冷凍的包裝方式與獨特的物流計畫，提供低溫環境以減緩化學變化的機率，並保持運送品的完整性。

便利商店鮮食產品的冷鏈是指從製造端一直到市場端都利用不間斷的低溫環境或設備進行鮮食之處理，供應鏈系統中的每一環節皆保持需求的溫度是確保鮮食品質的原則。冷鏈系統需要適當的設備、程序、及人員 (如運輸業者、包裝、加工、儲存、與配送易腐產品的工作人員)，冷鏈管理在鮮食送達顧客手上的品質中扮演一個重要的策略角色。據此，本研究利用決策實驗室分析法 (decision making trial and evaluation laboratory, DEMATEL) 探討影響冷鏈回復力的關鍵影響因子，以臺灣全家便利商店的一家主要鮮食供應商為實際案例進行分析。本研究發展九項準則，包括產能利用率、冷藏車異常、供電系統異常、資訊系統異常、製造加工的溫度控制、包裝溫控、輸配送溫控、廢品率、第一線員工失誤率、及管理階層危機處理能力，以評估便利商店鮮食的冷鏈脆弱度。本研究所提方法有助於界定鮮食冷鏈物流系統之關鍵回復力因子與脆弱環節，從而提高險評估能力以減緩冷鏈系統的可能損失。根據分析結果，不完整資訊、食品加工過程溫控不準確、及第一線員工的失誤率，是臺灣便利商店鮮食冷鏈營運的關鍵變量。本研究建議應優先關注電子化資訊與交換系統及前線員工的教育訓練，以減輕在不適當溫度環境下處理與輸配送時的負面影響。

關鍵字：低溫供應鏈 (冷鏈)、脆弱度、回復力、便利商店鮮食、決策實驗室分析法 (DEMATEL)

（二）英文摘要

The socioeconomic changes in Taiwan increase the out-dining population. Owing to the high density of convenience stores (CVS) and their 24-hour operations, 90% of Taiwanese have access to CVS services in their communities without any temporal limitations. CVS provides a new channel of diverse fresh food products, including refrigerated, warmed, and freshly made comestibles, for people dining out. Along with the convenience factor, customers buy fresh food at CVS in increasing numbers owing to the significantly improved quality and taste of these foods. Not only operators' focus on quality ingredients and preparation from scratch, but younger consumers' willingness to try fresh food offered by CVS facilitate the growth of food service at CVS.

However, these products are treated in some steps, such as deal with processing, transporting and storing, before selling. The qualities of perishable food products degrade with time because the inappropriate logistics might increase the risk of microbial contamination. The contamination of microbial not only reduces the shelf life of products but also causes foodborne illness. Therefore, the cold chain involving the processes, transportation and storages of temperature sensitive products along a supply chain through refrigerated packaging methods and the logistical planning provides environments with lower temperatures to mitigate the rate of chemical reactions and to protect the integrity of these shipments.

The cold chain of fresh food at CVS refers to the incessant refrigerated handling of fresh food from the manufacture to the market. For the system, the desired temperature level is to achieve and maintain the quality of fresh food at every link of the supply chain. The cold chain system needs the appropriate facilities, processes, as well as participants such as packers, transport service suppliers, and workers to handle, store and transport the perishable produce. The cold chain management plays a strategic role for the quality of fresh food arriving to the consumers.

Accordingly, this study explores the important impact factors of cold chain resilience using decision making trial and evaluation laboratory (DEMATEL). One of the major fresh food suppliers of FamilyMart in Taiwan is employed as the empirical case. This study develops nine criteria for assessing cold chain vulnerability of fresh food at CVS, including capacity utilization, the abnormalities of refrigerated vehicles, electronic power system, as well as information systems, temperature control in producing, packaging, and transportation, percent defective, error probability of first line staff, and managers' abilities of handling crisis. The methodology can determine the critical resilience factors and the weakest link in the fresh food cold chain logistics system so as to improve the risk assessment and loss mitigation of the cold chain system. According to the analytical results, non-perfect information, inadequate temperature control in food processing, and frontline employees error, are the critical variables with major impetuses in CVS fresh food cold chain operations in Taiwan. This study suggests that the electronic information and frontline employees' education should be first concerned to mitigate the impact of inadequate temperature control in both processing and distribution.

Keywords: Cold chain, vulnerability, resilience, fresh food at convenience store, decision making trial and evaluation laboratory (DEMATEL)

二、報告內容

INTRODUCTION

Supply chain vulnerability and the associated operational and financial risks represent the most pressing concern facing firms that compete in global markets nowadays because tiny events might dramatically disrupt operations of supply chain (Craighead et al., 2007). The coping capacities and resilience of supply chain become a major issue in recent studies (Sheffi and Rice Jr., 2005; Tang, 2006; Colicchia, et al., 2010). Due to the extended scope of supply chain, rapid economic growth, globalization, and social changes, supply chain members have faced significantly increased uncertainties. The supply chain might be vulnerable because vast amount of existing variations of components and materials that consumers desire which at the same time is relying on a short interval of time for delivery (Svensson, 2000). Particularly, the changes of industrial structures, such as extended chain store systems, various distribution types, changing retail channels, popular low-temperature products, professional logistics services, densely inhabitation, as well as the urbanization, facilitate the development of low-temperature supply chain (i.e. cold chain). In fact, most products served by cold chains are temperature sensitive. The alteration of temperature in transportation and storage, the package stability, along with time in picking and delivery, significantly affect the quality of cold chain.

In the global markets, the competitiveness of cold chain enterprise is impacted by the fluctuations in prices of products, small volumes of scale in agricultural products, the inefficiency in clearing customs and quarantine, as well as difficulty in controlling qualities. Especially, the insufficient infrastructures and technology of foreign cold chain members (e.g. unbalance between supply and demand caused by unsymmetrical information, along with the absence from integrated monitoring mechanism) increase the risk of broken cold chain. Cold chain is a subset of the total supply chain involving the production, storage and distribution of products that require temperature control for retaining their critical characteristics and associated value (Reed, 2005). Moreover, cold chain involves the transportation of temperature sensitive products in the supply chain through thermal and refrigerated packaging methods, along with logistics planning to protect the integrity of the shipments (Rodrigue et al., 2013).

Previous literatures in cold chain focused on the technology in temperature condition and monitor methodology, lacking the impact analyses in broken cold chains. Accordingly, this study aims to discuss the practical processes of cold chain operations, to develop a framework using decision making trial and evaluation laboratory (DEMATEL) for exploring the important impact factors of cold chain vulnerability based on the interdependencies among vulnerability factors, and to propose improvement strategies for cold chain operators. The socioeconomic changes in Taiwan increase the out-dining population, which achieves 70% of total population since 2007. Owing to the high density of convenience stores (CVS) and their 24-hour operations, 90% of Taiwanese have access to CVS services in their communities without any temporal limitations. CVS provides a new channel of diverse fresh food products, including refrigerated, warmed, and freshly made comestibles, for people dining out.

Along with the convenience factor, customers buy fresh food at CVS in increasing numbers owing to the significantly improved quality and taste of these foods. Not only operators' focus on quality ingredients and preparation from scratch, but younger consumers' willingness to try fresh food offered by CVS facilitate the

growth of food service at CVS. The market of fresh food at CVS has increased according to the innovatively new products, target marketing strategies, and the degree of dependence on CVS, rather than the densely spread channels. The annual market of fresh food at CVS exceeded 1 billion US dollars in Taiwan with the growth of 10.1% in 2012 (Industry and Technology Intelligence Services, 2013). This study thus employs the cold chain operations of fresh food at CVS as the empirical case. The following section provides a definition of cold chain vulnerability and clarifies the relevant factors, after which the DEMATEL is described in detail. Subsequently, the empirical vulnerability of major fresh food suppliers of FamilyMart in Taiwan, is discussed, and Section 5 provides conclusions and recommendations for future research directions.

COLD CHAIN RESILIENCE

Definition of Cold Chain

The cold chain is a physical process dominating the supply chain logistics of certain processed foods and can be applied to frozen, chilled and fresh perishable food products (Salin and Nayga, 2003). Cold chain logistics, comprised of equipments and processes that keep perishable products under controlled cold environment, deals with the production, processing, packaging station, cold storage warehouses, transportation, distribution centers, and retailer operations (Casper, 2007). A temperature variation will increase the risk of food poisoning and food spoilage. Each product needs a special temperature controlled environment in the distribution process for delivering the product to the store (James and James, 2010). Accordingly, the temperature control is a key role in the cold chain logistics, and to maintaining quality and integrity of the products (Kuo and Chen, 2010). Moreover, with the rapidly growing urban populations, the cold chain logistics is a primary way to ensure the qualities and safety of food (Coulomb 2008). Various issues in food safety have highlighted the needs for early identification of hazards negatively affecting cold chains and the subsequent mitigation, control, and prevention of the associated risks (Marvin and Kleter 2009).

The fresh food cold chain system represents the incessant refrigerated handling of fresh food from the farm to the market. For the system, the desired temperature level is to achieve and maintain the quality of fresh food at each link of the supply chain. The qualities of fresh food need professional and specialized facilities to handle the right temperatures from production to delivery for consumption. The facilities in a cold chain logistics system consist of pre-coolers, packing houses, refrigerated chambers and refrigerated vehicles. Pre-coolers are used to remove the heat quickly after harvest to obtain the acquired conditions while packing houses are absolutely necessary to prepare the fresh foods before entering the market such as trimming, cleaning, and sorting out the deficient products. Furthermore, refrigerated chambers provide the required storage environment in low-temperature for high quality fresh food while refrigerated container vans/trucks distribute and deliver the fresh food from the refrigerated chambers/packing houses (Yang and Cai, 2013). Fresh food cold chain controls the appropriate temperature for foodstuffs with a short durability and correct storage following the rule: “first in, first out” (Likar and Jevšnik, 2006), and minimizes the variation of temperature.

The cold chain of fresh food at CVS refers to the incessant refrigerated handling of fresh food from the

manufacture to the market. These products are treated in some steps, such as deal with processing, transporting and storing, before selling. The qualities of perishable food products degrade with time because the inappropriate logistics might increase the risk of microbial contamination. The contamination of microbial not only reduces the shelf life of products but also causes foodborne illness. The cold chain system needs the appropriate facilities, processes, as well as participants such as packers, transport service suppliers, and workers to handle, store and transport the perishable produce. The cold chain management plays a strategic role for the quality of fresh food arriving to the consumers.

Supply Chain Vulnerability

Vulnerability refers to susceptibility to damage without adaptation because of exposure to negative effects caused by external changes (Adger, 2006). Chambers (2006) expressed that vulnerability exists in systems having inferior resistance and coping capacities in insecure conditions. In other words, a system is vulnerable when exposed to risks, impacts, or pressures from disasters without having contingency capability. Based on the perspective of supply chain, Jüttner et al. (2003) defined supply chain vulnerability as the adverse consequence caused by risk sources and drivers considering the mitigation strategies. Christopher and Peck (2004) considered that supply chain vulnerability represents an exposure to serious disturbance, arising from risks within the supply chain as well as risks external to the supply chain. Moreover, supply chain vulnerability indicates a susceptibility and sensitivity to threats and hazards that substantially reduce its ability to maintain its intended function referring to a function of certain supply chain characteristics and the losses to a given supply chain disruption (Wagner and Bode, 2006).

Wanger and Neshat (2010) developed the quantitative supply chain vulnerability index considering the relationships among operation elements and impact factors using Graph theory. The vulnerability factors and their importance to a supply chain vary because of spatiotemporal and enterprise characteristics. Sheffi and Rice (2005) calculated supply chain vulnerability by a function of consequences and the probability of natural hazards, accidents, and intentional disruptions. Operators should concern in the highest vulnerability events with high probability along with severe consequences, for example, expelled partnership with critical supply chain members, conflicts between labor and capital, and insufficient quality control. The categories of supply chain vulnerability include demand side involving delay of delivery, interruption of distribution network, and uncertainty (Hallikas et al., 2004; Wagner and Bode, 2006; Wanger and Neshat, 2010; Fazli and Masoumi, 2012), supply side consisting of production capacity, quality, human resource, sensitivity, and resilience (Wagner and Bode, 2006; Pettit et al., 2010), as well as structure of supply chain comprised of reliability, connectivity, lean storage, and agile operations (Pettit et al., 2010; Fazli and Masoumi, 2012).

Cold chain involving the processes, transportation and storages of temperature sensitive products through refrigerated technology and the logistical planning provides environments with lower temperatures to improve quality and security of food. The control and record of temperature are essential for cold chain (Montanari, 2008). Previous studies determined the necessary condition for success cold chain as the appropriate refrigerated facilities in processing, transportation, and storage (Zhang et al., 2003; Kuo and Chen, 2010). Food cold chain is characterized by strict shelf life constraints, long lead times, and specific requirements for logistics processes such as warehousing and transportation (van der Vorst et al., 2005). As a consequence of the on-going need of performance increases, a leaner cold chain, eliminating less value-added activities and

reducing inventory, leads to increased vulnerability of disruption (Vlajic et al., 2012).

METHODOLOGY

The decision-making trial and evaluation laboratory (DEMATEL), developed based on graph theory, has been used to discuss and solve complicated and intertwined problem groups according to the improvement in understanding of a specific problematique and a cluster of intertwined problems. The DEMATEL enabling planners and operators to determine and solve problems visually confirm interdependence among variables and aid in the development of a directed graph to reflect the interrelationships between variables (Huang et al., 2008). There are four steps in operating DEMATEL: calculating the average matrix; calculating the normalized initial direct-influence matrix; deriving the total relation matrix; and proposing the impact-relations map. The end product of the DEMATEL process (e.g. the impact-relations map) is a visual representation of the mind by which the respondent organizes his/her own action in the world. This organizational process must occur for the respondent to keep internally coherent and to reach his/her personal goals.

Respondents were asked to indicate the non-negative direct-influence that they believe each factor exerts on each of the others according to a scale ranging from 0 to 1. A link v_{ij} from variable C_i to variable C_j determines to what extent C_i affects C_j. From any group of direct matrices of respondents, Eq. 1 represents the average matrix $\boldsymbol{V}$ where the diagonal elements of matrix $\boldsymbol{V}$ are all set to zero, and n denotes number of factors concerned in the system. Then a matrix $\boldsymbol{X}$ by using a simple matrix operation on $\boldsymbol{V}$ in which the normalization coefficient λ are indicated as Eq. 2. The normalized initial direct-relation matrix $\boldsymbol{X}$ (shown in Eq. 3) shows the initial influence which a factor exerts and receives from another. Each element of matrix $\boldsymbol{X}$ portrays a contextual relationship among the elements of the system and can be converted into a visible structural model—an impact-relations map—of the system with respect to that relationship.

$$\boldsymbol{V} = \begin{array}{c} \\ C_1 \\ C_2 \\ C_i \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & C_j & C_n \end{array} \\ \begin{bmatrix} 0 & v_{12} & \cdots & v_{1n} \\ v_{21} & 0 & \cdots & v_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ v_{n1} & v_{n2} & \cdots & 0 \end{bmatrix}_{n \times n} \end{array} \tag{1}$$

$$\lambda = \frac{1}{\max\left(\max \sum_{i=1}^{n} v_{ij},\ \max \sum_{j=1}^{n} v_{ij}\right)} \tag{2}$$

$$\boldsymbol{X} = \lambda \quad \boldsymbol{V} \tag{3}$$

A continuous decrease of the indirect effects of problems along the powers of matrix $\boldsymbol{X}$, e.g. $\boldsymbol{X}^2$, $\boldsymbol{X}^3$, …, $\boldsymbol{X}^\infty$, guarantees convergent solutions to the matrix inversion, similar to an absorbing Markov chain matrix. The total relation matrix $\boldsymbol{T}$ is defined as Eq. 4, where $\boldsymbol{I}$ refers to the identity matrix. The element of the matrix $\boldsymbol{T}$, t_{ij},

denoting the full direct- and indirect-influence exerted from factor C_i to factor C_j are employed to calculate the active and reactive degree of each factor in the system.

$$\boldsymbol{T} = \sum_{k=1}^{\infty} X^k = \lim_{m\to\infty} X(I + X^2 + \cdots + X^{m-1}) = \lim_{m\to\infty} X(\frac{I - X^m}{I - X}) = X(I - X)^{-1} \quad (4)$$

Equation 5 shows the affecting ability D_i representing the sum of influence exerted from factor C_i to the other factors, whereas R_j reveal the sum of influence that factor C_j received from the other factors (shown as Eq. 6). Then the "prominence" $(D_i + R_j)_{j=i}$ providing degree of importance role of C_i in system and also gives an index that shows the total effects both given and received by C_i. Moreover, the "relation" $(D_i - R_j)_{j=i}$ indicates the net effect that C_i donates to the system. A positive "relation" denotes that C_i belongs to the cause group, whereas C_i is a net receiver if "relation" is negative (Falatoonitoosi et al., 2013).

$$D_i = \sum_{j=1}^{n} t_{ij} \quad (5)$$

$$R_j = \sum_{i=1}^{n} t_{ij} \quad (6)$$

The applicability of the DEMATEL is widespread in industrial planning, such as marketing strategies of LCD-television based on consumer behavior (Chiu et al., 2005), airline safety measurement and improvement strategies (Liou et al., 2007), human resource according to global managers' competencies (Wu and Lee, 2007), portfolio selection based on capital asset pricing model (Ho et al., 2011), and organic light emitting diode technology selection (Shen et al., 2011).

EMPIRICAL RESULTS

A fresh food manufacturer providing instant food at four degrees Celsius to FamilyMart in Taiwan is employed to analyze cold chain vulnerability and verify the systematic interdependency assessments. Eleven experts, including scholars, managers in sections information, quality management, research and development, as well as operation site, were invited to determine the causal relationships between each pairwise of vulnerability factors in fresh food cold chain operations. Based on the reviewed literatures along with the empirical processes illustrated in Fig. 1, facilities including food processing equipment and low-temperature vehicles, procedures including temperature control in processing and transportation, and human resource management including operational accuracy and crisis management skills were determined as the critical constructs in fresh food cold chain operations. Experts built a consensus in nine vulnerability factors such as idle time of low-temperature facilities, abnormality of refrigerated vehicles, abnormality of power supply, non-perfect information, inadequate temperature control in food processing, inadequate temperature control in distribution and delivery, unqualified food products, error caused by frontline employees, and crisis handling ability of managers.

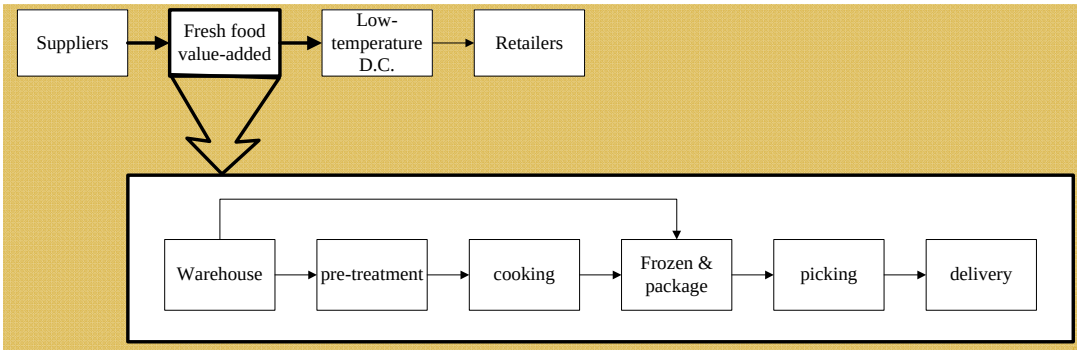


Figure 1. Operational processes of fresh food cold chain

Table 1 shows a 9×9 causal impact matrix ***V*** in Eq. 1, where the systematic relationship of each variable is identified. Each cell in the impact matrix reveals how the vertical variable directly influences the horizontal variable, e.g., the cell corresponding to the forth column and third row shows how abnormality of power supply influences the non-perfect information.

Table 1. Causal impact matrix

Active \ Passive	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Idle time of low-temperature facilities	0	0	0.2	0	0.1	0	0	0	0
(2) Abnormality of refrigeration vehicles	0.1	0	0	0	0	0.1	0.7	0	0
(3) Abnormality of power supply	0.3	0	0	0.6	0.6	0	0.6	0	0
(4) Non-perfect information	0.3	0	0	0	0.6	0.6	0	0.6	0.5
(5) Inadequate food processing temperature	0	0.4	0	0	0	0	0.5	0.4	0
(6) Inadequate delivery temperature	0	0.7	0	0	0	0	0.8	0.2	0
(7) Unqualified food products	0	0.2	0	0	0	0	0	0.3	0
(8) Error caused by frontline employees	0.3	0.6	0	0.7	0.7	0.3	0.2	0	0
(9) Crisis handling ability of managers	0.7	0	0	0.6	0.5	0.3	0.2	0.4	0

According to Eq. 2, this study substituted $\lambda = 1/3$ into Eq. 3, calculated the inverse matrix using Microsoft Excel 2007 software, and determined the total relation matrix ***T*** based on Eq. 4. Table 2 shows the total relation of each factor in matrix ***T*** ranging from 0.001 to 0.356, with a mean value of 0.117, a median at 0.052, and a standard deviation of 0.115. In order to explain the structural relationship among the factors while keeping the complexity of the system to a manageable level, it is necessary to identify a threshold level to filter out the negligible effects (Li and Tzeng, 2009). Experts built the consensus in the threshold calculated by the mean value plus standard deviation (0.117+0.115=0.232) to assist in obtaining adequate information to simplify the impact-relations map for further analysis and decision-making.

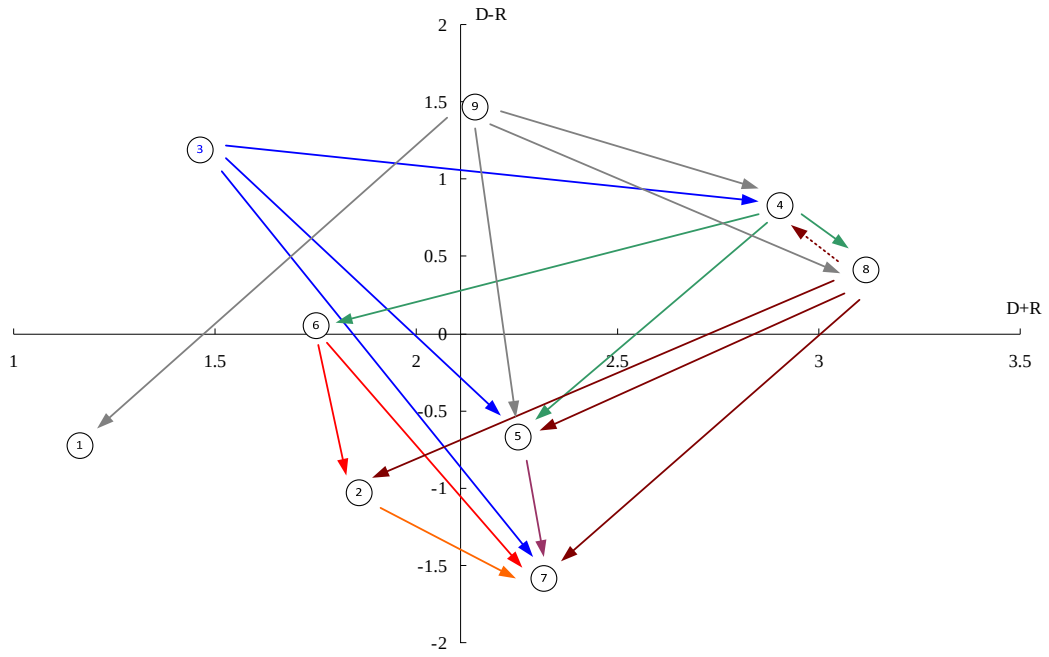
Figure 2 reveals the impact-relations map with direct/indirect influence in which unqualified food products (7) play a passive role in the fresh food cold chain as the performance of cold chain operations, whereas abnormality of power supply (3) and crisis handling ability of managers (9) represent the major factors affecting, but rarely affected by, the cold chain operations. Idle time of low-temperature facilities (1) plays a buffering role with insignificant relationships in the proposed fresh food cold chain system. Notably,

non-perfect information (4) and error caused by frontline employees (8) are determined as critical vulnerability factors in fresh food cold chain operations because of both high level of “prominence” and “relation” in which the sole feedback loop exists (shown as the dot arrow in Fig. 2).

Table 2. The total relation matrix for cold chain vulnerability factors

Factor*	Total relation									$D+R$	$D-R$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)		
(1)	0.011	0.013	0.067	0.017	0.054	0.006	0.028	0.014	0.003	**1.158**	**-0.729**
(2)	0.039	0.034	0.003	0.008	0.011	0.039	0.256	0.032	0.001	**1.848**	**-1.001**
(3)	0.150	0.100	0.010	0.240	0.291	0.068	0.303	0.127	0.040	**1.459**	**1.200**
(4)	0.196	0.193	0.013	0.118	0.342	0.282	0.214	0.334	0.186	**2.917**	**0.840**
(5)	0.030	0.200	0.002	0.043	0.052	0.034	0.244	0.176	0.007	**2.255**	**-0.677**
(6)	0.025	0.291	0.002	0.028	0.034	0.027	0.356	0.115	0.005	**1.739**	**0.027**
(7)	0.019	0.102	0.001	0.028	0.035	0.021	0.044	0.117	0.005	**2.315**	**-1.570**
(8)	0.166	0.336	0.011	0.279	0.339	0.186	0.266	0.146	0.046	**3.108**	**0.442**
(9)	0.306	0.156	0.020	0.277	0.307	0.192	0.231	0.272	0.046	**2.147**	**1.467**

** Note: Numbers in parentheses refer to the corresponding vulnerable factor mentioned in Table 1.*



** Note: Numbers in circles refer to the corresponding vulnerable factor mentioned in Table 1.*

Figure 2. Impact-relations map with direct/indirect influence

Although the efficiency and accuracy of information has been improved in cold chain operations nowadays, it is still relatively vulnerable due to the interdependency with other factors. The analytical results express that unqualified food products, the major reactive factors representing the outcome of cold chain operations, are extremely vulnerable because any inappropriate operation negatively influents the security and quality of food products. Of priority concern should be to improve perfect information and frontline employees’ education for mitigating the impact of inadequate temperature control in both processing and

distribution, along with performance of equipment and vehicles. Practically, it is recommended to enhance electronic data interchange to increase information accuracy, to invest in automatic temperature monitoring facilities to issue an early-warning, and to adopt sufficient education and training to employees for improving the capacities of non-defect processes as well as handling unexpected crisis.

CONCLUSIONS

This study utilizes DEMATEL to assist decision makers in determining the vulnerability of fresh food cold chain based on the causal relationships among operations. Based on a literature review and interviews with experts, this study proposed nine vulnerable factors in fresh cold chain operations. One of the major fresh food suppliers of FamilyMart in Taiwan was employed as the empirical case. Impact-relations map was performed to help decision makers understand how vulnerable factors affect cold chain vulnerability and subsequently adopt appropriate strategies for improvement in cold chain performance. The causal impact matrix is helpful for determining which operation to protect superiorly.

According to the analytical results, non-perfect information, inadequate temperature control in food processing, and frontline employees error are the critical variables with major impetuses in CVS fresh food cold chain operations in Taiwan. A failure consideration of interdependency misdirects resource allocation to improve cold chain vulnerability. This study suggests that the electronic information and frontline employees' education should be first concerned to mitigate the impact of inadequate temperature control in both processing and distribution. The developed method helping decision makers prioritize resource allocation to improve fresh food cold chain serviceability in uncertainty, contributes to a semi-quantified assessment framework rather than the traditional qualified interdependency analyses. This study needs to be treated circumspectly, as the results may reflect in part the way in which the data were collected.

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科技部補助專題研究計畫成果報告自評表

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

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■ 達成目標

□ 未達成目標（請說明，以 100 字為限）

□ 實驗失敗

□ 因故實驗中斷

□ 其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：□已發表 ■未發表之文稿 □撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

其他：（以 100 字為限）

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性），如已有嚴重損及公共利益之發現，請簡述可能損及之相關程度（以 500 字為限）

本研究內容與原計畫相符，針對低溫供應鏈脆弱度與回復能力之國內外相關文獻進行回顧與評析，以提供相關單位作為冷鏈系統因應災害風險之學術研究與實務規劃設計的參考。冷鏈時為臺灣物流相關產業重要利基之一，建置冷鏈脆弱度與回復力之評估架構，得為先期業者進行跨國冷鏈服務之規劃重點，並有助於後續布局與聯盟整合策略之研擬。雖災害發生時，供應鏈脆弱度與回復力多涉及經濟面向損失之討論，並非災害應變之首要關心，然以國家經濟、社會運作及產業發展角度論之，供應鏈脆弱度與回復力仍有助於減災階段之風險管理，尤其在冷鏈部分更有助於提升臺灣廠商營運之穩健性與國際競爭力。

本研究初步成果分別投稿至 the 5th International Conference on Transportation and Logistics 及 the 19th International Conference of Hong Kong Society for Transportation Studies 且獲接受發表，後續將尋求國際學術期刊發表之機會。

附件五

國科會補助專題研究計畫出席國際學術會議心得報告

日期：103 年 1 月 11 日

計畫編號	NSC102－2410－H－263－010－		
計畫名稱	以精實供應鏈成員觀點探討環境劇變下供應鏈回復力之關鍵影響因子		
出國人員 姓名	謝承憲	服務機構 及職稱	致理技術學院行銷與流通管理系 助理教授
會議時間	102 年 12 月 14 日至 102 年 12 月 16 日	會議地點	香港海景嘉福酒店
會議名稱	(中文) 第 18 屆香港交通研究學會國際學術研討會 (英文) the 18th International Conference of Hong Kong Society for Transportation Studies		
發表題目	(中文) 台灣好行之目標客群行銷策略-以日月潭線為例 (英文) Target marketing strategies of tourist shuttle bus operation: An empirical case in Sun Moon Lake, Taiwan		

一、參加會議經過

香港交通研究學會國際學術研討會為每年 12 月舉辦之運輸領域研討會，本次為第 18 屆由香港大學承辦，於 2013 年 12 月 14 日至 16 日假海景嘉福酒店舉辦，國際化程度高，除亞洲地區學者外，亦吸引來自於澳洲、紐西蘭、丹麥、法國、德國、義大利、荷蘭、羅馬尼亞、瑞士、土耳其、阿拉伯聯合大公國、英國、美國、巴西、加拿大與奈及利亞與會者超過 200 位。

受補助者於 12 月 13 日抵港，12 月 14 日上午八時前往會場參與開幕與 keynote speech 及三場 plenary speech。午餐時與香港交通研究學會理事長 Prof. William H. K. Lam、Travel Behaviour & Society 期刊主編 Prof. Becky P. Y. Loo 及國內學者進行交流。是日下午前往 poster 論文區發掘新興議題並與論文作者進行討論，爾後參與 B4 場次口頭發表，針對台灣好行服務與行銷策略建議進行說明，並與與會者針對該議題進行意見交換。第二日參加大會安排之 Social tour，進一步了解香港運輸相關發展脈絡，第三日上午參加另外三場 plenary speech 後，即因班機安排前往機場返國，未及參與閉幕及晚宴活動。參與會議所獲得之資訊彙整於「與會心得」、而相關活動照片於臚列於「其他」。

二、與會心得

Keynote speech 邀請香港特區政府運輸及房屋局 Professor Anthony Cheung Bing-leung 以「百萬人移動的藝術」為主題進行講演，針對香港新市鎮與相關捷運系統的發展、

土地使用分區管制 (以將軍澳新城鎮為例)、公路客運轉乘系統 (含場站設施規劃與 ATIS 應用) 等概念進行說明，也讓與會者更了解香港公共運輸可擔負九成以上旅次的部份原因。

美國喬治亞學院的 Prof. Patricia L. Mokhtarian 針對旅行時間價值與運具選擇行為的關聯性作了深刻的剖吸與探討，英國肯特大學的 Prof. Roger Vickerman 則探討運輸服務的定價行為、也說明公私夥伴關係 (Public-Private Partnerships, PPP) 在英國扮演的角色；香港大學財經學院的 Dr. Timothy D. Hau 以大眾運輸永續發展的觀點，分別以推式 (私有運具使用收費) 與拉式 (大眾運輸票價) 來分析最佳的運輸定價策略。美國加州大學河濱分校的 Prof. Richard Arnott 則以路邊停車周轉率與使用率的最佳化目標設定為題進行分享，美國伊利諾大學香檳分校的 Prof. Mei-Po Kwan 以地理資訊的角度，探討運輸研究中不確定的地理環境議題的性質與來源，並分析機動性與健康的關聯性；英國牛津大學地理與環境學院的 Dr. Tim Schwanen 則提出了重塑程序 (re-imaging process) 在運輸領域研究的應用，並與與會學者針對新方法概念進行交流。

感謝國科會計畫對於本次國際研討會之經費補助與支持，除了吸收世界各地優秀學者所提供的研究資訊之外，對於這種直接面對面交流與觀摩的機會，與會者提出的最新成果和交流思想對運輸課題的研究開發有激盪的作用，且在不同國情下規劃管理的觀點都能促進更多方法的提升、也更能夠提升國內的研究水準，並提高臺灣在國際學術研究上的能見度。

三、發表論文全文或摘要

TARGET MARKETING STRATEGIES OF TOURIST SHUTTLE BUS OPERATION: AN EMPIRICAL CASE IN SUN MOON LAKE, TAIWAN

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ABSTRACT

To ease the congestion of tourism destinations, the tourism authority developed the Taiwan Tourist Shuttle Bus (TTSB) services to seamlessly connect main transit terminals. However, the ridership of TTSB services possessed insignificant improvement because TTSB operators follow a traditional transit bus rather than tourism vehicle. Sun Moon Lake route is employed as an empirical case to explore the tourist preference for modal choice in scenic areas, identify the attributes of target tourists based on clustering analysis, and provide improvement strategies for TTSB. Results reveal that connecting, promoting and interpreting undeveloped scenic spots en route of TTSB services represents the target marketing strategies for the "Cook's tour" and "exploring" tourists. Increasing the reliability and safety of TTSB services along with strategic alliance from local hospitality industries is helpful to attract "hedonism" and "risk averting" tourists. This helps planners and operators assess performance of subsidies and adopt appropriate improvements.

Keywords: Taiwan Tourist Shuttle Bus, modal choice, tourist attribute, target marketing

1. INTRODUCTION

Tourism industries play an essential role during economic transition in Taiwan because of the growth of tourism population and expenditure on recreation. The total visitor expenditures have achieved 11.77 billion US Dollar, contributing about 2.5% gross domestic product (GDP) in Taiwan. In fact, 2.62 millions inbound tourists travel by themselves occupying 35.83% of visitors in 2012 (Tourism Bureau, 2013). Authorities of tourism destinations should provide sufficient public transportation networks to satisfy the basic traveller needs, such as accessibility, mobility, reliability and safety (Feng and Hsieh, 2009), because most inbound backpackers undertake their trips using public transportation services. In addition to inbound backpackers, domestic tourists have increased significantly due to developments of economy and transportation, changes of social patterns, along with increases of income and leisure time, becoming the major market of scenic areas in Taiwan. This brings the congestion, delays as well as social externalities of tourism destinations in weekends and holidays. The pressure of tourism and leisure travel in scenic area increased due to congestion, parking stress along with environmental and community impacts (Dickinson et al., 2009). Much research focused on modal switch from private vehicles to less polluting alternatives

(Bamberg et al., 2007; Stradling et al., 2007). 60.9% of tourism trips are completed using private vehicles, followed by tourist coaches on group tours (11.6%). The ridership of transit bus in tourism trips is only 9.9% (Tourism Bureau, 2013) because of insufficient frequency and service quality. Based on the survey of satisfaction in Taiwan scenic areas, only 65% of respondents satisfied the convenience of public transportation accessing scenic areas, locating at the bottom of the service quality.

To ease the congestion of tourism destinations from private vehicles in peak days and satisfy the demand of backpackers to travel via public transportation, the central tourism authority developed the Taiwan Tourist Shuttle Bus (TTSB) services to connect the main transit terminals and tourism destinations seamlessly since 2009. However, the ridership of TTSB services has possessed insignificant improvement because of the operational business following a traditional transit bus rather than tourism vehicle. Understanding the demands and features of tourists thus is an important issue to facilitate TTSB services within tourism advantages and to evaluate performance of subsidies in which the central tourism authority subsidizes 70 thousand US dollars for each route annually. The discussions about valid marketing strategies of TTSB service are absent from previous studies. Accordingly, this study analyzes the modal choice preferences in scenic areas based on the attributes and utilities of tourists to determine the potential markets of TTSB service. This assists authorities in understanding the tourists' willingness to ride, developing strategies to improve the ridership of public transportation in tourism trips, and helps TTSB service providers operate independently.

Sun Moon Lake route in central Taiwan is selected from 24 routes of TTSB services as the empirical case to explore the tourists' modal choice preferences using questionnaire survey. In terms of understanding the representation of transportation in tourism destination areas, the vehicles of intercity transportation shuttled by TTSB service are excluded from this study. The TTSB Sun Moon Lake route has operated since April 2010, originating from the central business district in Taichung City and connecting stations of railway and high-speed railway. The price of single journey ticket is 6.3 US Dollars operating in total route length 86 kilometres and single trip duration 90 minutes. The local authority proposed a 40% off multimodal package cost 19.99 US Dollars including the TTSB round trip ticket, ropeway, lake tour boat, and bicycle rental. The ridership of the TTSB Sun Moon Lake route improved from 47 thousand passengers in 2010 to 97 thousand passengers in 2011.

2. IMPACT FACTORS OF TOURISM MODAL CHOICE

Along with the travel time and costs, the trip purpose, socioeconomic factors, and individual attitude are important in travel choice (Parkany et al., 2004; Anable, 2005; Stradling et al., 2007). The choice behaviours of tourism trips are different from commuting ones because tourists have to consider the needs of accompanists, and the needs are various according to the number of participants as well as the closeness of relationships. In addition, tourists accompany their children show more willingness to use private vehicles (Dickinson and Robbins, 2008). Moreover, the baggage, another major difference between tourists and commuters, is proportioned to the tour duration, decreasing the mobility in travel. A luggage

container might facilitate the use of private vehicles in tourism trips (Dickinson and Robbins, 2008). Frequency, which is defined as the number of daily public transportation connections and the quality of public transport, measures average waiting time at the beginning of the trip. The relatively lower frequency of public transportation causes inconvenience as well as inefficient waiting time to tourists and limits its market share (Asensio, 2002).

Based on the socioeconomic perspectives, females are more willing to reduce car use and prefer for public transport (Asensio, 2002) because of their stronger ecological norms and weaker car habits (Matthie et al., 2002). In fact, female tourists occupy 64% of the TTSB riders (Tourism Bureau, 2011). The younger non-work trip travellers prefer to use public transportation to complete their trips (Hensher and Rose, 2007). Numerous scholars indicated that the preference to use public transportation is inversely proportional to income (Limtanakool et al., 2006; Dickinson et al., 2009). In Taiwan, 21.4% of respondents cancelled their tourism due to the unaffordability (Tourism Bureau, 2013). The TTSB services assist lower income tourists in decreasing the threshold of sightseeing and thus improving their quality of life. The tourists with shorter distance from their homes to the scenic areas preferred to use private vehicles (Prideaux, 2000). The main mode travellers used in daily trips significantly impacts the modal choice preference (Schmöcker et al., 2006). Moreover, the household vehicle ownership positively affects the willingness to drive private cars (Feng et al., 2010).

To determine the target market of TTSB services, this study considered not only the general characteristics of passengers but the specific attributes of tourists. Yoon and Uysal (2005) indicated that the motivation of tourist behaviour requires more than an understanding of their needs and wants. Moscardo and Pearce (2004) applied an experiential approach focusing on motivational differences for various sub-groups of car based tourists. The evaluations of the physical products of destination as well as the psychological interpretation of a destination product are necessary for human actions (Uysal and Noe, 2003). Dickinson et al. (2009) suggested a need to look beyond tourism to more generic work on transport behaviour drawing on social psychology for a more theoretical analysis of transport behaviour decisions. Bamberg et al. (2007) focused on pro-environmental modal choice behaviour motivated by self-interest and by pro-social motives. These motives interact in a dynamic and evolving context, and the tourist motivation is seen as a multidimensional concept that explains tourist decision (McCabe, 2000). Mohammad and Mat Som (2010) concluded that the push motivations of tourists include fulfilling prestige and spiritual needs, enhancing relation, seeking relaxation, sightseeing variety, escaping from daily routine and gaining knowledge, while the pull ones involve events and activities, easy access and affordable, history and culture, adventure, natural resources and heritage sites.

3. RESEARCH FRAMEWORK

3.1 Methodology

The discrete choice model has been extensively adopted to analyze the selection of one

among a set of alternatives (Schmöcker et al., 2006; Frenkel, 2007; Dubin, 2007; Wong et al., 2008). The principle of utility maximization assumes that an individual will select the alternative with the highest utility from a universal but finite number of alternatives. The discrete choice model may not be the newly advanced methodology; however, it is an appropriate approach to easily determine the user behaviours through economic rationality (Si et al., 2010). The stated preference survey was utilized to propose scenarios of improvements in which strategies increasing the probability for choosing TTSB services based on the perspectives of authorities in transportation as well as tourism were provided. Chen (2004) suggested the improvements of public transportation in scenic areas including travel time shortening, sufficient information, efficiency in shuttles, discounts, tourism elements in transits, and connection between neighbour tourism destinations. To improve the ridership of the TTSB services, some scenarios were developed to increase the utility of public transportation users as the pull strategies, along with to regulate the usage of private vehicles for pushing, simultaneously.

According to the impact factors of tourism modal choice based on literatures, this study proposed the utility (*V*) function of tourists in binary logit model (shown as Equation 1). The subscript *P* and *C* denote public TTSB service and private vehicle, respectively. Generic variables include travel time (*TT*) and travel cost (*TC*). Alternative specific variables for TTSB service involves accommodation coupon (*AC*), in-vehicle tour guide and interpretation (*INT*), tourist creativity (*CR*), experience preference (*EXP*), acceptable risk level (*RIS*), physical strength (*STR*), environment friendly concept (*ENV*), number of companions (*COM*), age (*AGE*), resident regions (*REG*), daily habit of using vehicles (*DV*), household vehicles (*HV*), experiences in driving car (*CD*), experience in riding motorcycle (*MR*), and experience in taking public transit (*PEX*), whereas alternative specific variables for private vehicles consist of time for seeking parking space (*PT*), and parking costs (*PC*).

$$\begin{aligned} V_P &= \beta_0 + \beta_1 TT_P + \beta_2 TC_P + \beta_3 AC_P + \beta_4 INT_P + \beta_5 CR_P + \beta_6 EXP_P + \beta_7 RIS_P \\ &\quad + \beta_8 STR_P + \beta_9 ENV_P + \beta_{10} COM_P + \beta_{11} AGE_P + \beta_{12} REG_P + \beta_{13} DV_P \\ &\quad + \beta_{14} HV_P + \beta_{15} CD_P + \beta_{16} MR_P + \beta_{17} PEX_P \\ V_C &= \beta_1 TT_C + \beta_2 TC_C + \beta_{18} PT_C + \beta_{19} PC_C \end{aligned} \qquad (1)$$

3.2 Scenarios

Tourism package including the round trip tickets, accommodations, food and drink and related discounts is helpful for attracting tourists. Hakone Free Pass issued by JR Japan with which passengers can unlimitedly take the railway, cable car, ropeway, sightseeing boat, and buses in Hakone in two days. The tourism package assists in strategic alliances among the local tourism industries and increasing the benefits. This study thus designed the 60% off packages involving accommodation, food and drink, as well as souvenirs, respectively.

Along with the in-vehicle travel time, the inefficient out-of-vehicle transfer waiting time negatively impacts the satisfaction of multi-modal passenger transportation in the eastern Taiwan (Institute of Transportation, 2010). Transfer between public transport modes has become a significant part of the move towards seamless travel by public transport (Steer

Davies Gleave, 1998). Hine and Scott (2000) argued that seamless public transport is designed to make public transport more attractive and user friendly via improvements to service quality, reliability, safety and infrastructure. Therefore, this study developed scenarios where the TTSB service operator reduces the transfer waiting time from 30 minutes to 10~20 minutes.

The interpretations in articulating and affirming nationalist sentiment is important, especially in relation to the emotional and subjective nature of heritage encounters and experiences (Park, 2010). The interpretations of heritage and cultures in Mi'kmaw attract the interests of tourists (Lynch et al., 2011). This study assumes that TTSB service differs from traditional public transportation by the tourism interpretation, and employs various interpretation scenarios in which the services provided by drivers, electronic guide devices, along with professional tour guides, respectively.

Dickinson (2009) argued that tourists should be required to pay more for the car parking they use for visitor responsibility. However, visitors were clearly unwilling to pay additional costs (especially car parking costs) which limits their ability to redress their impacts. Nowadays, tourists driving private cars spend almost non-additional time for seeking parking space and the fees are 3.3 US Dollar for all day parking. This study thus proposed three parking cost scenarios, including 5, 6.7, and 8 US Dollar, while other three seeking time scenarios where 10, 20, and 30 minutes are required to spend, to analyze the impacts of restrained car use on the utilities of modal choice.

4. EMPIRICAL RESULTS

The questionnaires were delivered from Dec. 2012 to Feb. 2013 including New Year holidays, the Chinese New Year, and the winter vacation. 432 questionnaires were delivered in which 408 are effective samples. 87.75% of the drivers in the sample were aged 18 to 50 and 46.32% were male. 67.65% of the respondents use non-public transportation to Sun Moon Lake of which 51.23% drive private vehicles. The reasons for tourists who are absent from taking TTSB service (multiple choice items) revealed the following: insufficient TTSB information (72.1%), followed by the habits of using private cars (22.1%) and the limitations on schedule (18.8%), inconvenient transferring (15.6%), as well as unavailable luggage storage (10.9%). According to 18 scenarios developed based on Taguchi orthogonal array involving two alternatives as well as above five improvement strategies. Each respondent fulfilled six scenarios, bringing an extended sample size of 2,448 (408×6). The initial utility function specification includes alternative specific constants, generic variables and alternative specific variables. Analogous to the t-test in linear regression, the asymptotic *t*-test is used to test whether a particular parameter differs from zero. The likelihood ratio allow assessment of overall goodness-of-fit of the model. The likelihood ratio index (rho-squared), a goodness-of-fit measure similar to R^2 in linear regression, is employed to compare different model specifications. The estimation results of the choice model are indicated in Table 1.

Table 1. Estimation results of the choice models

Attribute	Parameter Estimates (*t*-value)				
	All samples	Cook's tour	Hedonism	Explorer	Risk averting
Alternative Specific Constant					
Taiwan Tourist Shuttle Bus (TTSB)	-1.155	-0.289	-0.632	0.249	0.039
Private vehicles **(Baseline)**	--	--	--	--	--
Generic Variables					
Monetary cost	-0.004 (-2.92)	-0.008 (-2.80)	--	-0.001 (-2.87)	-0.001 (-2.82)
Travel time	-0.001 (-5.15)	-0.001 (-2.43)	--	--	--
Alternative Specific Variables					
Package with food and drink – specific to TTSB	--	0.445 (2.26)	--	--	--
Package with accommodation – specific to TTSB	0.556 (5.79)	1.217 (5.78)	0.506 (2.73)	--	0.699 (3.13)
Professional tour guide – specific to TTSB	0.252 (2.42)	0.386 (2.15)	--	--	--
Parking time – specific to private vehicles	-0.021 (-3.33)	--	-0.022 (-2.07)	-0.036 (-3.05)	--
Parking fees – specific to private vehicles	-0.003 (-2.31)	--	--	--	--
Age – specific to TTSB	0.237 (2.47)	--	0.578 (3.37)	--	--
Gentle – specific to TTSB	--	--	--	-0.974 (-4.46)	--
Income – specific to TTSB	--	--	--	--	0.234 (2.09)
Household cars – specific to TTSB	-0.505 (-4.51)	--	-0.538 (-2.29)	-0.630 (-2.55)	--
Driving experience – specific to TTSB	-0.028 (-3.22)	-0.433 (-1.96)	-0.040 (-2.47)	-0.051 (-2.61)	--
Tour experience					
by car – specific to TTSB	--	-0.487 (-2.57)	-0.463 (-2.14)	--	--
by public transit - specific to TTSB	0.824 (4.29)	--	1.727 (2.98)	1.744 (4.11)	--
by sightseeing bus – specific to TTSB	--	0.731 (2.03)	0.858 (2.34)	-1.118 (-2.63)	--
Tourist attributes		**N/A**	**N/A**	**N/A**	**N/A**
Creativity – specific to TTSB	-0.163 (-2.32)				
Experiential tourism – specific to TTSB	-0.164 (-2.64)				
Temporal concept – specific to TTSB	0.149 (2.45)				
Physical exertion – specific to TTSB	0.237 (3.88)				
Log-likelihood at zero	-1696.824	-490.748	-436.483	-411.729	-349.346
Log-likelihood at convergence	-1484.373	-418.470	-385.646	-319.211	-293.888
Likelihood ratio index (rho-squared)	0.125	0.147	0.117	0.225	0.159
Sample size	2448	708	630	594	504

Note: --: insignificant parameters at $p<0.05$.

N/A: the tourist attributes are not considered the independent variables in estimation of clusters.

The tourists are clustered into four groups based on their cognition on attributes such as confidence, creativity, experiential tourism, slow-pace, temporal concept, acceptable uncertainty, sense of direction, frugality, physical exertion, and environmental protection via K-means. The “Cook’s tour” tourists possessing confidence, fast-pace, risk seeking, and lower exercise consumption, prefer unusual trials but lack perseverance, while “hedonism” tourists are initiative in planning, risk averting, thriftless, physical exertion averting, environmental unfriendly, and willing to pay higher for better journey. The “exploring” tourists with confidence, creativity, and temporal concepts leaning towards the experiential, slow, and pocket saving tours enjoy adventures as well as in-depth travel like the backpackers, whereas “risk averting” tourists with relatively conservative attributes represent the followers depending on the reliable planner and schedules in tourism.

Based on the tourist attributes for all samples in Table 1, the TTSB services connecting famous destinations rather than unwrought scenic areas limit the willingness to visit of tourists with creativity, while the relative fewer stations of TTSB reduce the utilities of experiential tourism. TTSB services attract tourists with temporal concept along with who prefer to embark their physical exertions on tourism rather than on driving. Moreover, the parameter estimates of generic variables are statistically significant and of the right sign. All improvement strategies are effective to increase the probability to use TTSB except the package with round trip tickets of TTSB, food and drink. The all sample analysis confirms the assumptions of induction for participants and necessary market segment determination.

Along with the travel costs, the experiences of driving and tour modes by which visiting the Sun Moon Lake affect the choice preference of “Cook’s tour” tourists. The packages and professional in-vehicle guide services pull “Cook’s tour” tourists for using the TTSB. The value-added services, such as discount package provided by alliance, interpretation by cultural-historical professionals, and tour planning for sparsely populated destination assist “Cook’s tour” tourists in increasing the ridership of TTSB. Notably, the estimates of travel time are insignificant in choice model of clusters with the exclusion of “Cook’s tour,” because TTSB tourists consider in-vehicle travel time as tour period and seamless transfer time between intercity transportation and TTSB services. Slow-pace, a necessary condition for tourists willing to escape from busy lives and seeking pleasure and relaxation of body and mind, evidences the insignificance of travel time.

The household cars as well as the experiences of driving and previous tour modes influence the modal choice of “hedonism” tourists. The monetary cost is insignificant at t=-1.53, verifying that “hedonism” tourists focus on comfort and quality of tourism trips than economizing expenditures. The extra time for seeking parking space pushes “hedonism” drivers and “explorers” to TTSB services. However, the male “explorers” prefer to use private vehicles, and so do “explorers” with more household cars and longer driving experiences. In fact, previous tour by sightseeing bus providing restrained accessibility as well as mobility negatively impacts the preference to take TTSB. Thus, the target marketing strategies, including densely spread flag stops and little

headway improving the accessibility and mobility of TTSB, promotions of unwrought scenic areas en route of TTSB, and TTSB interpretation services facilitating in-depth tours are suggested for “explorers.” The “risk averting” tourists, the followers depending on the reliable planner and schedules, are not direct target market of TTSB. However, the promotions within the reliability and safety of TTSB services, particularly via word-of-mouth, increase the willingness of “risk averting” tourists indirectly.

5. CONCLUSION

To ease the congestion of tourism destinations from private vehicles in peak days, the central tourism authority developed the Taiwan Tourist Shuttle Bus (TTSB) services to seamlessly connect the main transit terminals and tourism destinations since 2009. Moreover, 24 routes of TTSB services are developed to assist three million foreign backpackers in improving their accessibility and mobility to scenic areas in Taiwan. However, the ridership of TTSB services has possessed insignificant improvement because of the operational business following a traditional transit bus rather than tourism vehicle. Accordingly, understanding the demands and features of tourists is an important issue to facilitate TTSB services within tourism advantages and to evaluate performance of subsidies in which the central tourism authority subsidizes 70 thousand US dollars for each route annually.

TTSB Sun Moon Lake route is employed as an empirical case to explore the tourist preference for modal choice in scenic areas, determine the critical socioeconomic factors impacting choice preference, identify the attributes of target tourists based on clustering analysis, and provide improvement strategies for TTSB. Questionnaire data analyzed by statistic tests and stated preference are utilized to examine the significant influences of tourism trip characteristics, such as travel packages, interpretations, and limitation of private vehicle uses, on tourist preference for modal choice in scenic areas. The parameters are estimated by Logit model. The analytical results reveal that more than 70% tourists taking non-TTSB service to tour are absent from information about TTSB, followed by private vehicle use habits. Along with traffic regulations including prohibited entry and restricted parking, target marketing refers to an efficient promotion of TTSB services to improve the operations.

Tourists are divided into four groups based on K-means clustering. The “Cook’s tour” tourists prefer unusual trials but lack perseverance, while “hedonism” tourists willing to pay higher for better journey. “Explorers” enjoy adventures as well as in-depth travel, whereas “risk averters” represent the followers depending on the reliable planner and schedules. According to the significant parameters of market segment analyses through Logit model, connecting, promoting and interpreting undeveloped scenic spots en route of TTSB services refers to the target marketing strategies for the tourists belonging to the Cluster “Cook’s tour” and “explorers.” Increasing the reliability and safety of TTSB services along with strategic alliance from local

industries of hospitality, catering, and travel agencies is helpful to attract tourists in Cluster "hedonism" and "risk averters." Planners and operators can assess performance of subsidy strategies according to the proposed model, and adopt appropriate improvement strategies to increase ridership of TTSB services and mitigate the traffic issues in scenic areas.

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四、建議

香港交通年會雖僅為單一地區學會所主辦之研討會，但其國際化程度令人驚訝，與會人員來自於超過 35 個國家/地區，近年來大陸地區學生的參與積極度增加，其研究能量亦不可小覷，雖臺灣地區在相關的運輸研究仍具一定優勢，但學生 (尤以碩士班研究生以降較為明顯) 多以參與國內活動為滿足，一方面可能也受限於英語能力較為不足，較缺乏與國際學術交流接軌之機會，未來若能在經費許可且甄選合適人選前提下，提供學生出國參與國際研討會，相信有助於提升學生的國際化視野。

五、攜回資料名稱及內容

Proceedings in electronic format, Conference Programme including Abstract Compendium (hardcopy) with over 150 papers accepted for presentation at the conference, covering a wide spectrum of research topics.

六、其他

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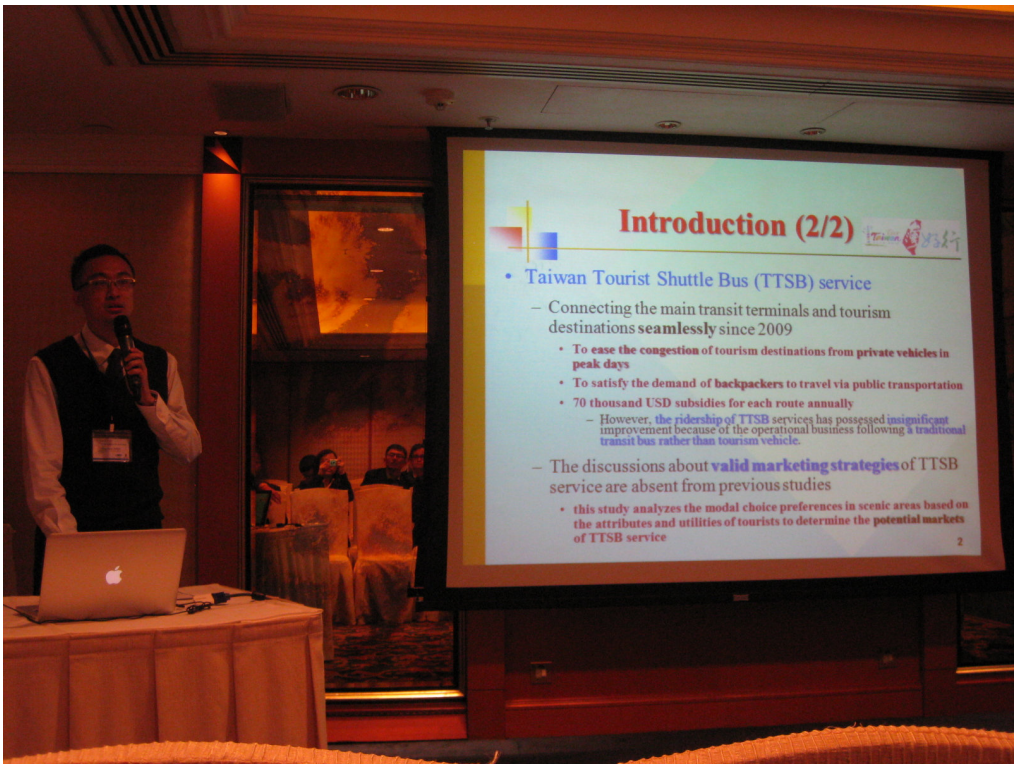
於主會場內留影

大會開幕剪綵儀式（暨慶祝新期刊發行）



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回答與會者提問並進行交流

科技部補助計畫衍生研發成果推廣資料表

日期:2014/07/29

科技部補助計畫	計畫名稱: 以精實供應鏈成員觀點探討環境劇變下供應鏈回復力之關鍵影響因子
	計畫主持人: 謝承憲
	計畫編號: 102-2410-H-263-010- 學門領域: 交通運輸

無研發成果推廣資料

102 年度專題研究計畫研究成果彙整表

計畫主持人：謝承憲	計畫編號：102-2410-H-263-010-
計畫名稱：以精實供應鏈成員觀點探討環境劇變下供應鏈回復力之關鍵影響因子	

成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	1	0%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	1	1	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	0	1	0%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	2	2	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	無

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

科技部補助專題研究計畫成果報告自評表

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

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：□已發表 ■未發表之文稿 □撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

其他：(以 100 字為限)

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）(以 500 字為限)

本研究內容與原計畫相符，針對低溫供應鏈脆弱度與回復能力之國內外相關文獻進行回顧與評析，以提供相關單位作為冷鏈系統因應災害風險之學術研究與實務規劃設計的參考。冷鏈時為臺灣物流相關產業重要利基之一，建置冷鏈脆弱度與回復力之評估架構，得為先期業者進行跨國冷鏈服務之規劃重點，並有助於後續布局與聯盟整合策略之研擬。雖災害發生時，供應鏈脆弱度與回復力多涉及經濟面向損失之討論，並非災害應變之首要關心，然以國家經濟、社會運作及產業發展角度論之，供應鏈脆弱度與回復力仍有助於減災階段之風險管理，尤其在冷鏈部分更有助於提升臺灣廠商營運之穩健性與國際競爭力。

本研究初步成果分別投稿至 the 5th International Conference on Transportation and Logistics 及 the 19th International Conference of Hong Kong Society for Transportation Studies 且獲接受發表，後續將尋求國際學術期刊發表之機會。