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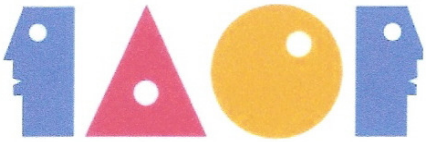
Table of Contents



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EXPLORING CUSTOMER VALUE OF INNOVATION ACHIEVEMENT: *ISM* AND *ANP* ANALYSIS ON RECYCLED PAPER FURNITURE

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Abstract

Innovation has long been crucial for progress in the furniture industry. Recycled paper furniture is a new type of green product that is a result of innovation in the furniture in-

dustry in Taiwan. However, few marketing studies have focused on recycled paper furniture, despite the gradual developments regarding this product in the furniture industry in recent years. Therefore, through interpretive structural modeling and an analytic network process, this study explored the customer value of recycled paper furniture products, arranging identified values into a hierarchy and subsequently calculating and analyzing the values therein. The findings of this study indicated that senses of belonging, pleasure, and pride are antecedents of customer value derived from recycled paper furniture. Environmental influence is the key factor affecting consumer willingness to purchase this type of furniture. When buying recycled paper furniture, consumers appear to support the concept of environmental protection. However, in reality, culture, opinion leaders, purchase situations, and sense of belonging are the main factors driving their purchase decisions.

Key Words: Value, Interpretive Structural Modeling (ISM), Analytic Network Process (ANP), Recycled Paper Furniture, Innovation

Introduction

In Taiwan, the furniture industry is a mature industry that has developed over the course of several years. Because of global competition, Taiwan's furn-iture industry has focused on innovation in its strategy designs. In this industry, product innovation is crucial. Product innovation refers to the development and launching of commercial products that are in some way unique or distinct from existing products in the market (Bisbe and Otley, 2004). As the global consumption of resources has increased and industrial pollution in various regions has continued to be poorly controlled, the importance of recycling as a means of environmental protection has gradually become widely recognized. Furthermore, consumers have started to consider environmental protection in deciding whether the products they use in daily life are recyclable. Thus, in recent years, public demand for green products has increased; additionally, enterprises have begun investing considerable resources into developing green products (Albino, Balice, Dangelico, and Iacobone, 2012; Florenthal and Arling, 2011; Tsai, 2011).

Similarly, the applications for paper recycling have increased substantially. For example, in the United States, the quantity of recycled paper grew from 2.91 million tons in 1990 to approximately 5.17 million tons in 2014 (American Forest and Paper Association, 2015). Recycled paper is generally transformed into recycled paper products, indicating that consumer demand for these products is growing. Consequently, recycled paper furniture, a type of furniture that can be recycled and reused, has been developed. Recycled paper furniture is a green product that is considered as a crucial option for achieving product innovation among furniture producers in Taiwan. Characterized by the two aspects of environmental protection and resource recycling, recycled paper furniture reduces the amount of logging for making paper products, promotes recycling and reuse of resources, and minimizes resource consumption. Before making a purchase, consumers usually have cer-

tain expectations regarding the product they wish to buy (Chen, 2016). Recycled paper furniture offers a means for consumers to contribute to protecting the environment conserving resources and satisfying their beliefs regarding the improvement of the world. According to Rokeach (1973), the enduring belief that one end-state of existence is preferable to another is referred to as a value.

In studying consumer behavior concerning green products, Balderjahn (1998) developed a causal model for green product consumers, observing that a positive attitude toward ecologically conscious living and environmental protection resulted in not only the purchase and use of green products, but also support for environmental groups. Engel, Kollat, and Blackwell (1995) suggested that when making purchase decisions, consumers are subject to environmental influences including family, social class, situation, culture, and personal beliefs. Balderjahn (1998) investigated the behavior of green product consumers, finding that although recycled paper furniture is a green product, when purchasing such products, consumers may not only want to support environmental protection, but also to satisfy other values that are more discrete. Moreover, the environmental influences proposed by Engel et al. (1995) were applied to consumer behavior in purchasing general products. Because recycled paper furniture differs considerably from general products, determining whether environmental influences affect the perceptions of recycled paper furniture consumers requires further investigation. Furthermore, the costs of materials, manufacturing, and design for recycled paper furniture are usually higher than those for traditional wooden furniture, indicating that achieving a substantial reduction in these costs is unlikely in the foreseeable future. Thus, discovering further key benefits of recycled paper furniture is crucial for enterprises in the furniture industry. This study addressed the following research questions:

1. Apart from supporting environmental protection, what other benefits do consumers derive from purchasing recycled paper furniture?
2. Do environmental factors affect recycled paper furniture consumers?
3. Why do numerous consumers purchase recycled paper furniture when it is usually more expensive than traditional furniture is?

Effectively identifying the key consumer values regarding recycled paper furniture products may facilitate development of the recycled paper furniture industry. However, recycled paper furniture is a relatively new innovative product on which few marketing studies have focused. Therefore, the present study explored customer values pertaining to recycled paper furniture, arranging the identified values into a hierarchy and subsequently computing and analyzing the values therein to determine recommendations for positioning recycled paper furniture products in the market.

Literature Review

Veryzer (1998) suggested that innovation encompasses the creation of new products, services, or development processes. Innovation is crucial to enterprises because organizational innovation

and product innovation are related to enterprise performance (Damanpour and Evan, 1984; Foster, 1986; Subramanian and Nilakanta, 1996; Tushman and Nalder, 1986; Wind and Mahajan, 1997). For furniture companies, developing recycled paper furniture and producing related products are typical examples of product innovation. Such companies consider developing an original product, creating a new brand, or modifying existing products as crucial options for product innovation (Kotler and Sindey, 1991).

Whether customers are loyal is a key factor in company success (Hassan, 2012). To maintain loyalty and long-term relationships regarding customers, companies must enhance product value as perceived by customers (Chang, Lee and Chen, 2008; Yang and Jun, 2009). Therefore, in addition to loyalty, customer-perceived value is a major factor of firm competitiveness (Dhevika and Subramani, 2012; Heung, 2008; Stan, Evans, Wood, and Stinson, 2008). Previously, scholars discussed customer value mainly from a perspective of economic benefits. For example, Zeithaml (1988) defined customer value as customers receiving what they desire in a product, receiving a product at a low price, receiving a high-quality product for the price paid, or receiving something of equal value in return for what was paid. From a broader perspective, Holbrook (1999) proposed four characteristics of customer value: experiential, preferential, relativistic, and interactive. Although these characteristics were apply to the context of general products, they remain relevant for recycled paper furniture products. Therefore, on the basis of Holbrook's aforementioned assertion, the characteristics of customer value concerning recycled paper furniture are listed as follows:

1. Value is an experience: For customers, perception of product value is deeply influenced by their experience in purchasing and using a product. Consumers have become more rational when making purchase decisions. In addition to supporting environmental protection, consumers of recycled paper furniture products focus more on the actual benefits derived from a product, such as its utility and whether the purchase environment is satisfactory. Numerous consumers who have had positive experiences using recycled paper furniture have become long-term buyers.
2. Value is generated from customer preferences: Customer value is closely related to whether a customer likes or favors a product. Consumers purchasing recycled paper furniture, which was designed with the aim of environmental protection, may like or favor such a product, deriving greater value because they identify with the aim of its design.
3. Value is relativistic: The value of a product is determined relative to that of other products. The same product or service can evoke various feelings in customers because the concept of price is relative. Therefore, for recycled paper furniture consumers, although environmentally friendly recycled paper furniture is generally set at a higher price than is traditional furniture with the same function, the value derived from environmen-

tal protection is higher than that derived from purchasing less expensive furniture.

4. Value is interactive: A product must involve customer interaction. If customers do not participate in this interaction, the product gains no substantive value. Recycled paper furniture is an increasingly innovative product because of its continual interaction with customers. Thus, this type of furniture is continually being designed to meet various consumer needs.

After clarifying the relationship between Holbrook's assertion and the customer value derived from recycled paper furniture products, it was observed in this study that the value of a product is determined by the subjective consumer perceptions. Therefore, this study examined the subjective perceptions of recycled paper furniture product consumers.

Materials and Methods

Consumers have differing subjective feelings toward the value derived from the same product (Holbrook, 1999; Lin, Lee, and Su, 2010). Because interpretive structural modeling (ISM) and analytic network processes (ANPs) are effective in analyzing subjective perspectives, this study utilized the 5W1H model proposed by Nagai (1989, 2001) to interview five marketing managers in Taiwan working in the field of recycled paper furniture. A causal association path regarding customer value factors for recycled paper furniture was constructed on the basis of ISM; this causal association path was converted into a customer value hierarchy to design an ANP questionnaire. From 2,667 valid customer profiles offered by Companies F and Y (two renowned green product companies in Taiwan), this study identified the top 10 customers with the highest number of purchases over the past 10 years. These customers were interviewed; data from the questionnaire was collected and analyzed using Super Decision software.

The following steps were performed according to Nagai (1989, 2001) and Chu, Chiang, Liang and Hwu (2012):

1. Use the 5W1H model to generate key Kansei words by comparing the basic characteristics of recycled paper furniture and traditional wooden furniture; arrange these words into a hierarchy according to their value.
2. Use the Kansei words as elements of customer value regarding recycled paper furniture:

$$A=(a_{ij}), i=j=1,2,\cdots,n \quad (1)$$

Subsequently, it was determined whether there existed a relationship between these elements, assumed to be a_i and a_j, and matrix *A*; $a_{ij}=1$ if a relationship exists and $a_{ij}=0$ otherwise.

$$A=[a_{ij}]=\begin{bmatrix} a_{11} & a_{12} & a_{13} & \cdots & a_{1n} \\ a_{21} & a_{22} & a_{23} & \cdots & a_{2n} \\ a_{31} & a_{32} & a_{33} & \cdots & a_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & a_{n3} & \cdots & a_{nn} \end{bmatrix} \quad (2)$$

After examining the elements to determine whether a relationship existed

between each pair of elements, the adjacency matrix and reachable matrix were calculated to construct the causal association path regarding customer value factors for recycled paper furniture.

$$B = A + I \tag{3}$$

$$B^n = B^{n+1} \equiv T \tag{4}$$

The causal association paths were then converted into a customer value hierarchy for recycled paper furniture for use in the ANP, and an interview questionnaire was designed to collect data from customers. According to Saaty (1996, 1999, 2001a, 2001b, 2005), and Saaty and Vargas (1998), the following steps were performed:

1. Convert the causal association path into a customer value hierarchy.
2. Using the consistency ratio (CR) and consistency index (CI) to measure the consistency of each factor and construct a super matrix by applying a vector of weights and pairwise comparison matrix.

$$W = \begin{array}{c} \\ e_{11} \\ C_1 \; e_{12} \\ \vdots \\ e_{1m_1} \\ e_{21} \\ C_2 \; e_{22} \\ \vdots \\ e_{2m_2} \\ \vdots \\ e_{n1} \\ C_n \; e_{n2} \\ \vdots \\ e_{nm_n} \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots\cdots & C_n \\ e_{11}\cdots e_{1m_1} & e_{21}\cdots e_{2m_2} & & e_{n1}\cdots e_{nm_n} \end{array} \\ \begin{bmatrix} W_{11} & W_{12} & \cdots & W_{1n} \\ W_{12} & W_{22} & \cdots & W_{2n} \\ \vdots & \vdots & \vdots\vdots\vdots & \vdots \\ W_{n1} & W_{n2} & \cdots & W_{nn} \end{bmatrix} \end{array}$$

$$C.I. = \frac{\lambda_{\max} - n}{n-1} \tag{5}$$

Consistency: CI ≦ 0.1

$$C.R. = \frac{C.I.}{R.I.} \tag{6}$$

Consistency: CR ≦ 0.1

3. Calculate the priority of the values in the hierarchy to generate an optimal solution.

Results and Discussion

Five marketing managers were interviewed to determine their perceptions in comparing recycled paper furniture and traditional wooden furniture in order to identify the characteristics of the Kansei words and compose a hierarchy of these words according to their value (See Table 1).

To determine whether there was a causal relationship among the 13 Kansei words, these words were compared in pairs to create the following customer value factor causal association matrix for recycled paper furniture (1 = causal association; 0 = otherwise):

As illustrated by Table 2, this study generated the customer value factor causal association path for recycled paper furniture shown in Figure 1.

Table 1. Kansei word coding

5W1H	Recycled paper furniture	Strength of the degree	Traditional wooden furniture	The characteristic of Kansei words	Coding	
What	High social expectations	>>	Low social expectations	Belonging sense	1	Belonging sense
	Happy feeling.	>>	Comfortable feeling	Pleasure sense	2	Pleasure sense
	Flaunt psychological	>>	Non flaunt psychological	Pride sense	3	Pride sense
	Rare	>>	Common	Scarcity	4	Scarcity
	Material in particular	>	Traditional wooden material	Uniqueness	5	Situation
Where	Convey seller concept clearly	>>	Convey seller concept less clearly	Situation	6	Social contribution
	Often as a gift	>	Normally as own use	Gifts giving	7	Concept identity
	Easy to cause others curious	>>	Hard to cause others curious	Social Contribution	8	Peer influence
	Renewable resources concept	>>	Less renewable resources concept	Concept Identity	9	Uniqueness
Where	Multifunction.	>	Single function.	Functionality	10	Gifts giving
Who	Being influenced by others to use.	>>	Start using by oneself usually.	Peer Influence	11	Functionality
How	Ideas flexible	>	Ideas traditional	Design creativity	12	Design creativity
	Reducing trees felled	>	Some artificial planting	Environmental protection	13	Environmental protection

In the next step, the customer value factor causal association path for recycled paper furniture was converted into the following customer value hierarchy for recycled paper furniture:

The customer value hierarchy for recycled paper furniture shown in Figure 2. was used to design an ANP questionnaire, which was used to interview 10 customers who made the highest number of purchases over the last 10 years from the 2,667 valid customer profiles. Data from the questionnaire responses were employed in the analysis, which was

Table 2. Customer value factor causal association matrix for recycled paper furniture

Kansei word	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Belonging sense			●	●	●	●	●	●	●				
Pleasure sense				●	●	●	●	●	●				
Pride sense				●	●	●	●	●	●				
Scarcity										●			
Situation												●	●
Social contribution										●		●	●
Concept identity										●		●	●
Peer influence											●	●	●
Uniqueness											●	●	
Gifts giving													
Functionality													
Design creativity													
Environmental protection													

performed using Super Decision software. The analysis results are shown in Tables 3 and 4.

According to the causal association paths for the customer value factors, this study yielded the following preliminary findings:

1. Senses of belonging, pleasure, and pride are antecedents of all customer value factors. The causal association paths suggest that the basic values driving consumers to purchase recycled paper furniture are environmental protection, design creativity, and functionality; these first-level hierarchy values were derived from the following second-level hierarchy values: concept identity, peer pressure, situation, scarcity, uniqueness, and social contribution. The third-level hierarchy values, namely the senses of belonging, pleasure, and pride, are antecedents of all customer values.

2. When making purchase decisions for recycled paper furniture, consumers are affected by environmental influences; those influences originally proposed by Engel et al. (1995) were related to general products rather than recycled paper furniture, which is clearly aimed at environmental protection and thus has a unique characteristic in comparison with

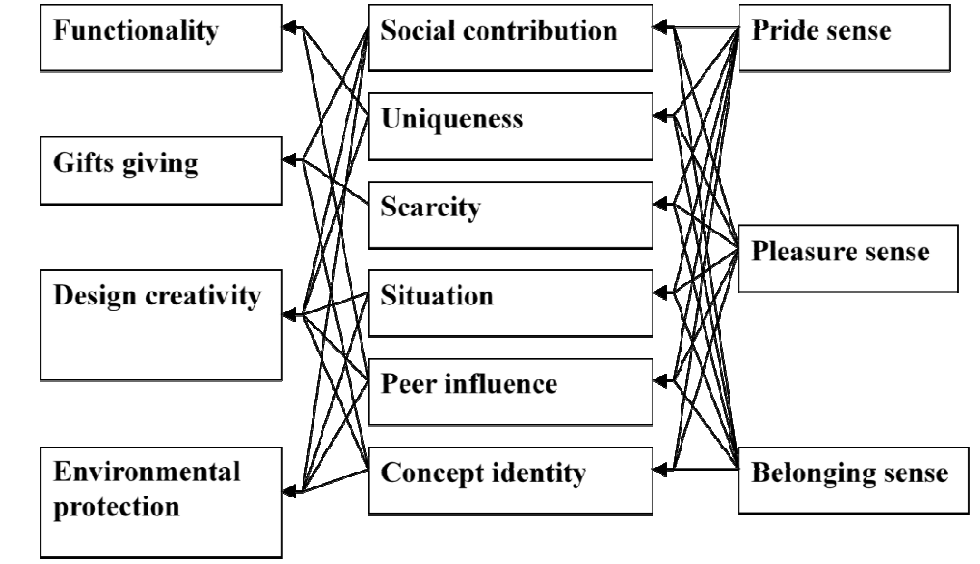

Figure 1. Customer value factor causal association path for recycled paper furniture

3. other products. Generally, consumers purchase recycled paper furniture products because these products promote environmental protection. However, in addition to values associated with environmental protection, this study derived four other values from the customer value hierarchy: sense of identity, peer pressure, situation, and sense of belonging. These values are similar and are closely related to the environmental influences proposed by Engel et al. (1995).

These four values are further discussed as follows:

Sense of identity (associated with "culture" among environmental influences): When recognized by most people in a society, a sense of environmental protection develops into a culture, which further engages more people in taking measures to protect the environment. Similarly, consumers of recycled paper furniture products are influenced by a sense of environmental protection, which drives them to purchase and use recycled paper products.

1. Peer influence (categorized as "peer influence" among environmental influences): People tend to seek to meet the expectations of other people. Similarly, consumers value the opinions of group leaders. When opinion leaders support the purchase of recycled paper products, consumers are subconsciously affected and therefore seek to purchase and use recycled paper furniture products.
2. Situation (categorized as "situation" among environmental influences): Whether consumers purchase or use recycled paper

Table 3. Factor weights under the first-level hierarchy

Factors \ Samples		A	B	C	D	E	F	G	H	I	J	Mean
Environmental protection		0.65	0.74	0.73	0.70	0.62	0.43	0.56	0.50	0.50	0.20	0.56
Each factor weight under environmental protection	Concept identity	0.32	0.21	0.22	0.26	0.14	0.50	0.12	0.19	0.45	0.10	0.25
	Peer influence	0.32	0.31	0.37	0.45	0.28	0.31	0.11	0.49	0.05	0.59	0.33
	Situation	0.32	0.44	0.37	0.26	0.55	0.14	0.67	0.21	0.25	0.06	0.33
	Social contribution	0.04	0.04	0.04	0.04	0.04	0.04	0.10	0.11	0.25	0.25	0.09
Design Creativity		0.06	0.07	0.10	0.12	0.11	0.27	0.11	0.17	0.17	0.27	0.14
Each factor weight under design creativity	Concept identity	0.26	0.22	0.22	0.22	0.15	0.54	0.05	0.22	0.22	0.06	0.22
	Peer influence	0.35	0.35	0.35	0.35	0.47	0.25	0.23	0.47	0.35	0.26	0.34
	Situation	0.26	0.35	0.35	0.35	0.30	0.10	0.59	0.22	0.13	0.04	0.27
	Uniqueness	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.04	0.47	0.53	0.13
	Social contribution	0.09	0.03	0.03	0.04	0.04	0.06	0.08	0.04	0.14	0.12	0.07
Gifts giving		0.24	0.12	0.06	0.05	0.04	0.04	0.29	0.17	0.17	0.04	0.12
Each factor weight under gifts giving	Concept identity	0.80	0.80	0.80	0.77	0.77	0.71	0.05	0.08	0.47	0.28	0.58
	Scarcity	0.07	0.07	0.08	0.16	0.07	0.23	0.16	0.05	0.07	0.06	0.10
	Social contribution	0.12	0.12	0.02	0.07	0.16	0.06	0.07	0.66	0.47	0.66	0.24
Functionality		0.06	0.07	0.10	0.12	0.23	0.27	0.04	0.17	0.17	0.50	0.17
Each factor weight under functionality	Peer influence	0.90	0.90	0.90	0.89	0.08	0.75	0.88	0.50	0.86	0.13	0.68
	Uniqueness	0.10	0.10	0.10	0.11	0.17	0.25	0.13	0.50	0.14	0.87	0.25

Table 4. Factor weights under the second-level hierarchy

Factors \ Samples		A	B	C	D	E	F	G	H	I	J	Mean
Concept identity	Belonging sense	0.82	0.80	0.82	0.80	0.77	0.74	0.66	0.04	0.29	0.06	0.58
	Pleasure sense	0.09	0.12	0.09	0.12	0.16	0.19	0.06	0.12	0.66	0.71	0.23
	Pride sense	0.09	0.07	0.09	0.07	0.07	0.06	0.28	0.07	0.05	0.23	0.11
Peer influence	Belonging sense	0.82	0.82	0.80	0.79	0.74	0.71	0.71	0.77	0.28	0.28	0.67
	Pleasure sense	0.09	0.09	0.12	0.15	0.19	0.23	0.06	0.16	0.66	0.66	0.24
	Pride sense	0.09	0.09	0.07	0.07	0.06	0.06	0.23	0.07	0.06	0.06	0.09
Situation	Belonging sense	0.82	0.09	0.79	0.82	0.79	0.66	0.74	0.66	0.28	0.16	0.58
	Pleasure sense	0.09	0.08	0.15	0.09	0.15	0.28	0.06	0.28	0.65	0.77	0.26
	Pride sense	0.09	0.12	0.07	0.09	0.07	0.06	0.19	0.06	0.07	0.07	0.09
Scarcity	Belonging sense	0.82	0.79	0.77	0.77	0.77	0.06	0.19	0.16	0.06	0.20	0.46
	Pleasure sense	0.09	0.15	0.07	0.07	0.07	0.23	0.06	0.07	0.28	0.20	0.13
	Pride sense	0.09	0.07	0.16	0.16	0.16	0.71	0.74	0.77	0.66	0.60	0.41
Uniqueness	Belonging sense	0.80	0.80	0.77	0.77	0.74	0.19	0.15	0.16	0.06	0.10	0.46
	Pleasure sense	0.07	0.10	0.07	0.16	0.06	0.06	0.07	0.07	0.28	0.26	0.12
	Pride sense	0.12	0.10	0.16	0.07	0.19	0.74	0.79	0.77	0.66	0.64	0.42
Social contribution	Belonging sense	0.82	0.80	0.82	0.80	0.80	0.81	0.74	0.57	0.06	0.74	0.70
	Pleasure sense	0.09	0.12	0.09	0.12	0.12	0.08	0.19	0.29	0.59	0.19	0.19
	Pride sense	0.09	0.07	0.09	0.07	0.07	0.12	0.06	0.14	0.34	0.06	0.11

3. products is determined by the following factors: a sense of environmental protection and satisfactory purchasing environment, the innovativeness and creativity of the design, the seller's understanding of the concepts applied by the furniture designer, and an effective transfer of these concepts to the consumers.
4. Sense of belonging (associated with "peer influence" among environmental influences): In a group or community where members often make group purchases of and use recycled paper furniture, newcomers often develop the same purchasing habits to establish a sense of belonging.

Using the ANP approach to analyze the questionnaire data and calculate the

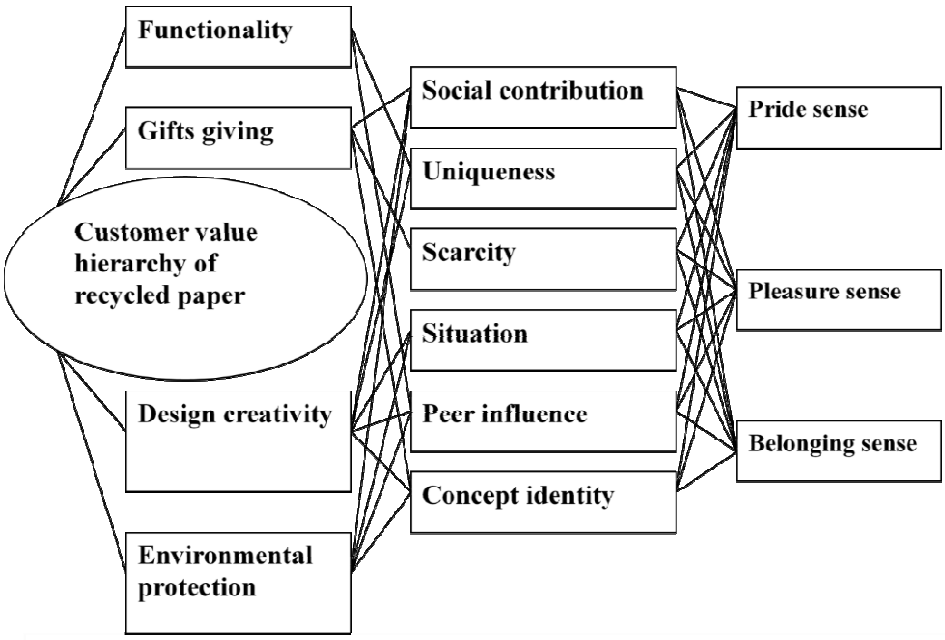

Figure 2. Customer value hierarchy for recycled paper furniture

weights of the value factors, it was determined that environmental influences are crucial to consumer decisions to purchase recycled paper furniture. According to the weights under the first-level hierarchy, environmental protection accounted for the highest weights, suggesting that customer values driving the purchase of recycled paper products are associated with a sense of environmental protection.

However, examining the weight values under the second- and third-level hierarchies revealed that the values with higher weights (including sense of identity, peer influence, situation, and sense of belonging) are associated with or can be categorized as environmental influences. This suggests that although consumers of recycled paper furniture pursue values derived from a sense of environmental protection, the main factors affecting their willingness to purchase such products are culture, opinion leaders, situations, and sense of belonging. Because of these environmental influences, consumers are willing to pay premium prices for recycled paper furniture, regardless of the lower prices of traditional wood furniture.

Conclusion

Previously, recycled paper furniture was positioned in the market mostly to convey a sense of environmental protection. However, because environmental influences have become a major factor in influencing consumer willingness to purchase recycled paper furniture products, such furniture products must be repositioned in the market because a sense of environmental protection is no

longer the sole factor concerning their purchase. According to the four values associated with environmental influences, this study offers the following conclusions:

1. Recycled paper furniture companies must create a new consumer culture: Recycled paper furniture companies must cooperate with nongovernmental organizations that support environmental protection to influence consumer lifestyles toward use of recycled paper products and incorporate a sense of environmental protection into a new consumer culture to further influence consumer purchasing decisions.
2. Recycled paper furniture companies must strengthen their cooperative relationships with opinion leaders from various groups: Opinion leaders tend to exert a strong influence on most members of corresponding members. Similarly, recycled paper furniture companies that cooperate with opinion leaders from different groups can produce marketing results that are more substantial with less effort. For example, companies can provide relevant resources to popular bloggers who have a strong influence on public purchasing behaviors, thereby promoting word-of-mouth marketing.
3. Recycled paper furniture companies must construct satisfactory purchasing situations (environment): For both virtual and brick-and-mortar stores, recycled paper furniture companies should create high-quality purchasing and stress-free settings to provide environments and services that enhance consumer willingness to purchase their products.
4. Recycled paper furniture companies must collaborate to set new trends: Such companies should focus on promoting their products within communities or groups to build supportive and cooperative relationships and collectively create a new meaning regarding the purchase of recycled paper furniture. This new meaning should not only represent a sense of fashion and personal taste, but also create a sense of group identify among people who purchase recycled paper furniture.

Implications for Policy and Practice

The findings of this study have the following implications:

1. Distribution and promotion strategies: Recycled paper furniture companies can refer to the factor weights in the proposed customer value hierarchy to develop appropriate distribution and promotion strategies for their target markets by adopting concentrated marketing methods.
2. Brand management: Recycled paper furniture companies must continue to invest in brand management resources. Although recycled paper furniture exhibits characteristics that are more distinct compared with those of more general products, imitating

a brand's strategy is considerably more difficult than is imitating its products. Thus, if recycled furniture companies focus on strengthening their brand and enhancing brand recognition, they are more able to increase public acceptance of their innovative products and considerably expand their market share.

3. Financial strategies: A company can possess and be in control of resources only up to a certain limit. Therefore, it must consider how to generate maximum profits from its investments. In managing a recycled paper furniture company, a company may regard numerous variables as critical and thus designate budgets in this regard to allow for strategy planning. Furthermore, designating budgets only for key value factors enables a company to maximize resources for each designated budget.
4. Research and development strategies: Although the effect of environmental influences is greater than that of product functionality for recycled paper furniture consumers, a recycled paper furniture company should not neglect the importance of improving product functionality when formulating research and development strategies. This is because the consumers generally consider the attribute of recycled paper furniture products with excellent functionality as an essential requirement.

Suggestions

In this study, it was observed that the mean weights for sense of pride were 0.41 and 0.42 under the categories of scarcity and uniqueness, respectively. Although this factor did not have the highest weight among all of the factors, future studies should explore sense of pride to determine the extent to which it affects consumer purchasing decisions regarding recycled paper furniture. In addition, when formulating strategies, recycled paper furniture companies should consider the factors of uniqueness and scarcity and adopt limited-edition strategies.

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DEVELOPING DECISION-MAKING SUPPORT SYSTEM USING RISK EFFICIENCY ON BUILDING PROJECTS IN TAIWAN

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Abstract

Many studies in risk management have been focused on management process, contract relation, and risk analysis in the past decade, but very few studies have addressed project risks from the perspective of risk efficiency. This study started with using Fault Tree Analysis (FTA) to develop a framework for the decision-making support system of risk management from the perspective of risk efficiency, in order for the support system to find risk strategies of optimal combination for the project manager by the trade-off between project risk and cost of project strategies. Comprehensive and realistic risk strategies must strive for optimal decisions that minimize project risks and risk strategies cost while addressing important data such as risk causes, risk probability, risk impact and risk strategies cost. The risk management in the construction phase of building projects in Taiwan upon important data has been analyzed, that provided the data for support system to include 247 risk causes. Then, 17 risk causes were extracted to demonstrates the decision-making support system of risk management from the perspective of risk efficiency in building project of Taiwan which could reach better combination type of risk strategies for the project manager by the trade-off between risk cost and project risk.

Keywords: risk management, risk strategy, Fault Tree Analysis, risk efficiency, decision-making support system

Introduction

The construction industry has become more uncertain and complex. The project managers should operate the project in the uncertainties of environmental of conditions, and control the risk of schedule delay or cost overrun.

As a result, the need for risk management has increased.

Many studies in risk management focused on management process, contract relation and risk analysis in the past decade (Tsai T.C and Yang M.L. 2009). Particularly in Taiwan, most risk management studies focused only on the relationships between stakeholders and the locations of responsibility, and were merely qualitative discussions (Wang, M.T. Chou, H.Y., 2003), (Charoenngam, C. and Yeh, C.Y., 1999). As risk management in Taiwan was generally processed empirically at jobsites, a theoretical algorithm was therefore necessary for the analysis of the reality of risk management, so that risk strategies could be set up and jobsite project risks could be quantitatively clarified in the construction phase of risk management.

In order to remedy the deficiency of risk management in Taiwan, there are two main purposes. The first is to extract the most important risk causes in Taiwan. The second is to investigate the correlations among risk cause, risk strategy, and risk strategy cost while applying Fault Tree Analysis (FTA) and Reliability Graph Analysis (RGA) to develop a framework for the decision-making support system of risk management from the perspective of risk efficiency. This is done in order for the support system to find the optimal combination type of risk strategies for the project manager by the trade-off between project risk and cost of project strategies. The first purpose for this study has already been analyzed in Tsai (2009), this study is focused on support system.

A basic definition of "risk efficiency" is simply "the minimum risk decision choice for a given level of expected performance", in which "expected performance" means a best estimate of what should happen on average, and "risk" means "the possibility of adverse departures from expectations" (Chapman, C. and Ward, S., 2004). The application of this concept can allow project managers to distinguish good luck from good management, and bad luck from bad management.

Review of Risk Management in Taiwan

Risk management in the construction phase of building projects in Taiwan has been analyzed that indirectly elicits important data such as risk causes, risk probability, risk impact. A brief review of the data is presented here. A detailed description of the data can be found in Tsai (2009).

Tsai (2009) adopted risk causes and categories from Tsai (2001), who brainstormed with 40 project managers to yield 650 clearly defined risk causes related to risk results and project stages in the construction phase (Tsai T.C and Yang M.L., 2009), (Tsai, T.C., Furusaka, S. and Kaneta, T., 2001). According to Table 1, 105 risk categories were found containing 247 risk causes generalized from the 650 originally suggested risk causes. Then, the accumulation contributing ratio of risk and distance of controllability are utilized as the two proposed criteria to extract the consensus critical risks of practitioners.

The data are analyzed from multiple points of view to explore the co- relationship among risk cause, risk strategy, risk result and project stage, and to clarify the risk mechanism and the realities of risk management. It was found that 17 risk causes were significance ranking of risk with temporal sequencing change

over different project stages (e.g. before commence of construction, structure work, finish work and after final inspection) and project risk result over different project problem (e.g. safety problem, schedule delay, cost overrun, low quality and reputation down). These risk causes are listed as below.

1. B201.Higher construction cost due to material price rise

2. B901.Low profit due to unexpected low market demand

3. B1001.Low profit due to excessive competition

4. C102.Contract amount not proportionate to amount of work contracted

5. C401.Unspecified client/ designer/ contractor's liability

6. C402.Liability of incomplete design was carried over

7. C601.Relative engineering change cost is overlooked

8. C902.Drawing specifications not included in estimate

9. D605.Administration management having different interpretations on regulations

10. D1302.Malpractice of subcontracting for subcontractor referred by the client or local representative

11. E903.Neighboring community claims extra compensation

12. F709.Construction process fails to follow schedule

13. Gb202.Incompetent subcontractor

14. Ha602.Not using safety belt / safety measure properly

15. Hc501.Too many engineering change and too slow instruction fails approval on project amount

16. Hd402.Payment-related dispute

17. Hd801.Client's financial problem

According to above analysis, the extracted 17 risk causes, which were important in temporal sequencing, change over different project stages and project risk result over different project problem. The 17 risk causes would be used in the questionnaire was built to investigate the changes of the additional risk strategy; the correlations among risk cause, risk strategy, sub-contracting, strategy cost, and probability and impact of the 17 risk causes.

Investigation

The questionnaire survey was sent to 50 site managers with 10–15 years experience of building construction in Central of Taiwan from August to September 2015. Thirty-three effective samples were collected to develop a framework for the decision-making support system of risk management (as shown in Table 1).

In this research, risk strategy was used to reduce risks. However, managers always select simply risk strategy of construction plan rely on experience. Standard risk strategy means single risk strategy; it was listed in the construction plan of the building project. Additional risk strategy means numbers of risk

Table 1. The co-relationships among risk strategy, strategy cost of 17 risk causes

No	O_i	AS_{ir}	OP_{ir}	C_{ir}	Pa_{ir}	SS_i	C_i	Pb_i
1	B201	Allocate reasonable amount of reserve for construction expense	Proprietor	69.87	0.36	Conduct thorough market price evaluation	214.94	0.55
		Allow reasonable price hike in material cost estimation as contingent buffer	Headquarters	88.83	0.26			
		Conduct market price survey in pragmatic manner	Headquarters	16.96	0.40			
2	B901	Improve the quality of construction	Site office	74.41	0.29	Apply scrutiny in cost-related spending, while upholding construction project quality	177.71	0.34
		Fully knowledgeable about the market	Headquarters	38.11	0.32			
3	B1001	Cost analysis and price estimation	Headquarters	18.26	0.31	Set reasonable selling price and competition mechanism	207.52	0.47
4	C102	Implement contingent plans	Headquarters	51.75	0.31	Cost analysis and reasonable price estimation	150.57	0.41
		Cost analysis and estimation	Headquarters	15.10	0.31			
5	C401	Specify the liability of each party involved in the contract	Proprietor	11.68	0.33	Have the relevant liability clearly specified in the contract	103.31	0.48
		Hold periodical sessions for contract-related affairs discussions and liability definition	Proprietor	9.21	0.40			
6	C402	Reviews on relevant information and contribute suggestions	Headquarters	18.64	0.36	Allow sufficient communication to reduce pre-construction uncertainty	100.91	0.50
		Request the designing unit to provide drawing and construction manual	Designer	11.16	0.36			
7	C601	Specify the design modification fees in the contract	Proprietor	74.93	0.33	Have the relevant liability clearly specified in the contract	73.96	0.45
8	C902	Reasonable estimation on construction cost	Headquarters	21.28	0.39	Detect the cause prior to construction	231.68	0.78
9	D605	Specify the liability in the contract in case of regulation change proprietor	Proprietor	9.82	0.29	Set up a law information centre	33.96	0.38
10	D1302	Implement feasibility evaluation	Headquarters	15.20	0.20	Implement a sound communication system	61.01	0.34
11	E903	Implement protective measures	Site office	24.98	0.35	Verify the title of the premise prior to construction while build friendship with the local residents	85.74	0.53
		Provide information session prior to construction and keep communication open with local residents	Site office	13.68	0.33			
12	F709	Respond and tackle problems in timely manner	Site office	18.83	0.36	Improve the competence of construction planning and progress scheduling as well as managing ability	99.47	0.50
		Lay out plans for construction projects with progressing schedule	Site office	18.86	0.34			
13	Gb202	Conduct stringent qualification review for contract bidding parties	Headquarters	13.09	0.35	Have the qualification requirements clearly defined, and implement bidding party evaluation	76.69	0.52
		Respond and tackle problems while working on solution	Site office	10.72	0.38			
14	Ha602	Tighten up surveillance	Site office	10.00	0.30	Provide training programs on workers safety on regular basis	55.90	0.50
		Further education on personnel safety	Site office	8.58	0.32			
15	Hc501	Proprietor requested to simplify engineering change procedure and paperwork	Headquarters	10.30	0.36	Arrange to have the clause specified in the contract	54.26	0.53
16	Hd402	Keep close contact with the proprietor	Headquarters	24.03	0.31	Carry out the construction plan as per the schedule, and writing out expense slip in timely manner	85.85	0.41
		Report expense in timely manner, while allowing periodical account settlement	Site office	17.90	0.28			
17	Hd801	Rely on bank guarantee	Proprietor	44.51	0.25	Have the mechanism of the payment terms stipulated in the contract	92.08	0.34

O_i : risk cause i, i=1,…,247

AS_{ir} : additional risk strategy r for risk cause i, r=1, …,m

OP_{ir} : contractor who executes additional strategy r for risk cause i

C_{ir} : the average cost of additional risk strategy r for risk cause i (thousand)

Pa_{ir} : after additional risk strategy r for risk cause i, the average probability of risk cause i

SS_i : standard risk strategy for risk cause i

Pb_i : the average probability of standard risk strategy for risk cause i

C_i : the average cost of standard risk strategy for risk cause i (thousand)

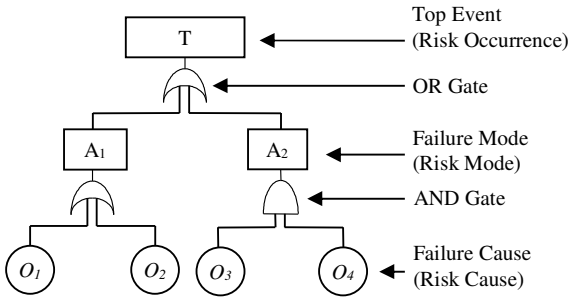

Figure 1. Legend of Fault Tree (FT) and risk cause

strategies; it may contain two or three above risk strategies to reduce risks. For instance, standard risk strategy of "E903. Unexpected community compensation claim" was "verify the title of the premise prior to construction while build friendship with the local residents" but additional risk strategies were "implement protective measures" and "provide information session prior to construction and keep communication open with local residents"

Development of Quantitative Analysis

The main purpose of decision- making support system employing risk efficiency in building project was to develop quantitative analysis, and to achieve this purpose. This research used Fault Tree Analysis (FTA) to analyze project risk.

Fault Tree Analysis (FTA)

FTA is an analytical method for the finding the major causes of failures and to assess the probabilities of failures in systems or facilities. It is widely used in safety engineering of mechanic and aviation industry. Basically, it uses logic gates of AND gate and OR gate to describe the relationship of these failure factors by Fault Tree (FT) (See Figure 1). FT can establish a causal scenario that is called accident sequence, which is composed of various failure interactions across devices, software, materials, and humans. When the probabilities of failure causes are given as input, the occurrence probability of top event can be assessed, and the quantitative/ qualitative importance of failure causes can be identified in the mean time.

Minimal Cut-Sets

In order to develop the quantitative analysis of this study, FTA was used to analyze project risks. Normally, there are a number of cut-sets in an FT, but minimal cut-sets mean these sets are the necessary and sufficient conditions for the occurrence of top event. The minimal cut-sets of Figure 4 can be identified by using Boolean algebra to be minimal cut-sets $\{O_1\}$, $\{O_2\}$ and $\{O_3, O_4\}$. In the premise in which the basic events of risk causes are independent from one another, the probability of risk occurrence is defined as Equation (5) in FTA (Inoue, I., 1979). As the interpretation in minimal cut-sets, the meaning Equation (1) is when every risk cause i in any minimal cut-set K_j (j=1, …, k) occurs, then risk will occur.

$$g(q)=\coprod_{j=1}^{k}\prod_{i=K_j} q_i \qquad (1)$$

where:

g(q): probability of risk occurrence
q_i: probability of risk cause *i* including minimal cut-sets K_j

Dual Structure of FTA and RGA

In reliability engineering, RGA is used to analyze the reliability of systems in production. Some redundancy devices may be added to increase the reliability of such systems to an acceptable level. Further, the character of dual structure between FT and RG is facilitated. For example, the failure causes of O_1, O_2, O_3 and O_4 in the FT of Figure 1 can be transferred to the activities labeled with R_1, R_2, R_3, and R_4 in the RG of Figure 2.

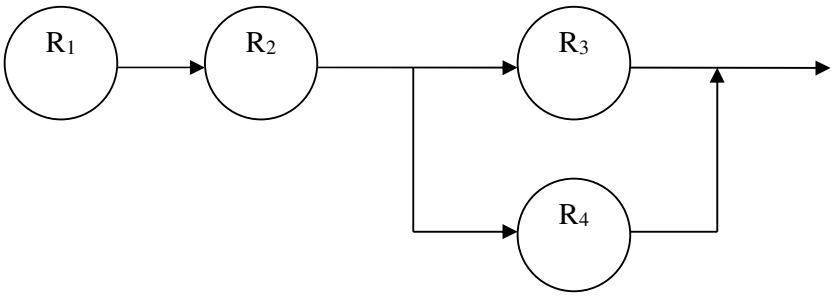

Figure 2. Reliability Graph

By comparing the failure probabilities of different FT's, the effectiveness of risk strategies can be assessed.

Analytical Procedures

Risk Identification and Risk Relationship

The risk causes of the projects can be categorized into internal risks and external ones (Zhi, H., 1995). Normally, the rational plans are used to deal with the internal risk in project management, and emergent plans are adapted to external risk of external environment. So the risk occurrence of project is associated with management and failure of adaptation to external environment (Figure 3). In order to clearly interpret and demonstrate the analysis steps, this research uses the method of modularization that takes partial FT as a cut-set or a basic event of top event. Thus, the analysis level is close to the independent risk causes of X1 to X6.

Thus, the project risk reduction and additional risk strategies cost can be calculated, by the additional risk strategy before and after. The reduction and additional cost would be used to evaluate risk strategy efficiency.

$$g(Pb)=\coprod_{j=1}^{k}\prod_{i\in K_j} Pb_i \qquad (2)$$

where:
g(Pb): before additional risk strategy *r*, the probability of project risk occurrence
Pb_i: before additional risk strategy *r*, the average probability of risk cause *i*
k: amount of minimal cut-sets in an FT
K_j: minimal cut-sets *j* in an FT

$$Pa_i = Pb_i \prod_{r=1}^{m} \frac{Pa_{ir}}{Pb_i} \qquad (3)$$

where:
Pa_i: modified the probability of risk cause i
Pa_{ir}: after additional risk strategy r, the average probability of risk cause i
m: numbers of risk strategies

$$g(Pa) = \coprod_{j=1}^{k} \prod_{i \in K_j} Pa_i$$

where:
$g(Pa)$: after additional risk strategy, the probability of project risk occurrence

$$SC = \sum_{i=1}^{n} SC_i = \sum_{i=1}^{n} \sum_{r=1}^{m} C_{ir}$$

where:
SC: amount of the cost of risk strategy, used to evaluate risk cause
SC_i: the cost of risk strategy, used to evaluate risk cause i
C_{ir}: the average cost of additional risk strategy r for risk cause i
n: numbers of risk cause i

Comparing the Effectiveness of Risk Strategies

As shown in Table 2, many risk strategies were used to deal with various risk causes to reduce project risk. For instance, risk strategies "Develop alternative plan" and "Cost analysis and estimate" were used to deal with designer-related risk cause "C102. Contract amount unproportionate to amount of work contracted" and "Hc501.Too many engineering change and too slow instruction fail project amount to be confirmed", and the combination type of risk strategies would turn out to be "Proprietor requested to simplify engineering change procedure and paperwork", etc.

The results of the calculation from preparing and analyzing FT along with the risk strategy cost and the amount of reduction by the risk strategy could be used to evaluate the risk strategies.

Framework of Decision-Making Support System

The framework of the decision-making system in risk management was proposed from two viewpoints of data search and risk analysis, as illustrated in Figure 4.

Risk Data Search System

The system of data search was composed of three parts, which were "risk data base", "analysis support", and "presentation of search". In order for the decision-making system to be used easily at the jobsite, the spreadsheet (for instance, Microsoft Excel) was mainly adopted as the interface for the presentation of search and analysis. The data was retrieved form the database by the analysis support designed by VBA (Visual Basic for Application Edition) programming, and the result was shown on the spreadsheet in a dialogue mode.
The risk data retrieval was divided into hierarchies, and these hierarchies were linked mutually. First, some elements of risk causes concerning the project were retrieved. For instance, risk causes often generated for some types of projects could be selected from the elements of project usage, project scale, and project location, etc., and then possible risk results and the value of the risk reduction were presented by the risk strategies often used for these risk causes. In addition, the scenario of the trade-off of risk and cost in the project was simulated from the relations among the risk, the cost of the forecast damage, the risk strategies, and the strategies cost, etc. through the selection in a dialogue mode. In other words, a primary/qualitative

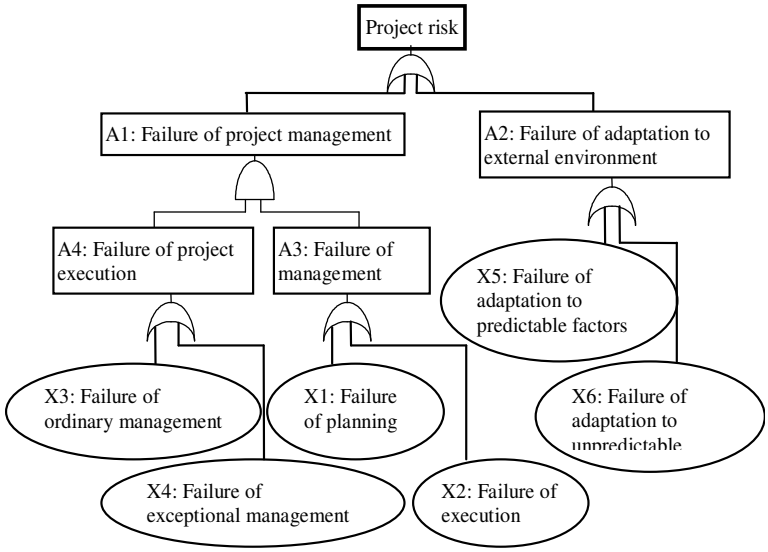

Figure 3. FT of General Model

analysis concerning each risk occurrence cause in the project risk could be preceded according to historical data.

Risk Analysis System

The system of risk analysis was composed of three parts, which were "process of optimization", "analysis support", and "expression of search/ analysis". The result of the analysis was presented on the spreadsheet. The computational algorithm of the data exchange with the database in the optimization process was supported mainly by using the VBA programming in the analysis support. Optimization was divided into two levels, of which the first was called partial optimization, which was used to select risk strategies against individual or multiple risk causes. The second level of optimization was called total optimization, which was used to search the proper risk strategies by the combination type of constrained conditions of the project risk. The optimization process was a process for which the alternative provided by certain constrained conditions.

First, the data used for the analysis should be identified by the elements concerning the project. For instance, the elements might be the project usage, the project scale, and the project location etc. The risk data about risk causes, often generated for such project types, should be inputted. Next, the user decided whether to use historical data of database or not. And, the user should determine whether to use the relations provided by the database among the risk cause, the cost of the forecast damage, the risk strategies, and the strategies cost, etc., or to simply reset the data. In addition, the constrained conditions concerning the project and the objectives of the analysis were set up with the risk strategies being set at the condition of certain cost or the necessary cost; for instance, in order for the project risk generated by the quantitative analysis to be kept

at certain level. As to the question of whether the results meet the demands, it all depended on the setting of such conditions.

Finally, the system would show the alternatives that meet the conditions of the constraints, thus providing support for the user in decision-making.

Selection of Risk Strategies

In order to reduce project risk, the combination type of risk strategies and the cost were evaluated by the risk analysis system mentioned above. The condition was to search for the combination type of risk strategies, with the project risk reduction being kept above 0.1, and the risk strategy cost below US 250 thousand. Figure 5 showed the risk strategy search result, and was compared with all other combination types of risk strategy, while #8 combination type appeared to allow the largest amount of potential for the reduction of project risk, and #18 combination type appeared to allow the smallest amount of potential.

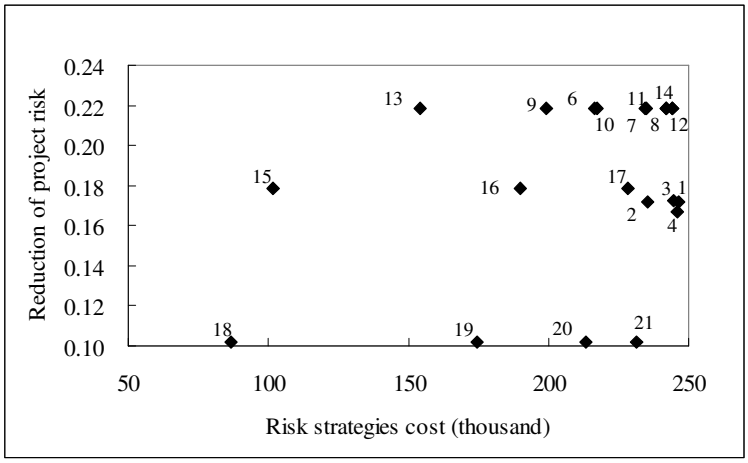

Figure 5. Combination Types of Risk Strategies

Table 3. Risk Strategies of Type 13

Risk Cause	Risk Strategy	Subcontractor
C102.	Implement contingent plans	headquarters
	Cost analysis and evaluation	headquarters
C902.	Reasonable estimation on construction cost	headquarters
D1302.	Conduct feasibility evaluation	headquarters
Hc501.	Proprietor requested to simplify engineering change procedure and paperwork	headquarters
E903.	Implement protective measures	Site office
	Provide information session prior to construction to improve communication with local residents	Site office

As to the question of what combination type was the best, the answer might vary from person to person. Normally, #13 combination type of risk strategy appeared to require the least cost while allowing the most reduction of project risk; therefore, it could be regarded as the best combination type. Table 3 illustrated risk strategies of Type 13 combination, which is believed to be the optimal type of combination.

In a particular case where the management was expected to apply risk strategy management by spending about 5 million dollars to reduce 0.22 of the project risk, the types of risk strategy combinations for the contract-related risk causes of "C102. Contract amount is not suitable to scope of work" included "Develop alternative plan" and "Cost analysis and estimate", with only one type of risk strategies combination "implement feasibility evaluation" for the risk cause "D1302.Malpractice of subcontracting for subcontractor referred by the client or local representative", and also only one type of risk strategies combination "Reasonable construction cost estimation" for the risk cause "C902. Cost details on drawing not included in Quotation". The combination type of risk strategy for the designer-related risk cause "Hc501. Too many engineering change and too slow instruction fail project amount to be confirmed" was "Proprietor requested to simplify engineering change procedure and paperwork". With regard to the safety & environment-related risk cause "E903 Unexpected community compensation claim", the risk strategies included the combination types of "Implement protective measure" and "Provide information session prior to construction and keep open communication with neighboring community".

On the other hand, it should be noted that optimal risk strategies were not only found in technical aspect but also in other aspects of construction projects such as contract, safety and environment, partners (e.g. designers), if the goal of improvement on risk management was going to be reached.

Conclusions

Project managers are normally accustomed to conventional ways of project operation and they tended to regard project risks as accidents. When a project is run under the uncertainty of the construction environment, the managing of diverse situations at jobsite may lead to difficulties such as schedule delay and risk cost overrun, making project operation even more complex.

In this research, the fundamental data of project risk was analyzed from some viewpoints through the investigation of actual situations of the construction site. The important risk causes were extracted by Pareto diagram, and distance of controllability. Otherwise, used FTA to develop a quantitative analytical method and developed a user- friendly interface for decision-making system by the correlation of risk cases, risk strategy and risk strategy cost. As a result, the following two achievements were obtained: Clarifying the important risk causes, and Proposing framework of the decision-making system of risk management from the perspectives of risk efficiency in building project of Taiwan which could search better combination type of risk strategies for the project manager by the trade-off between risk cost and project risk.

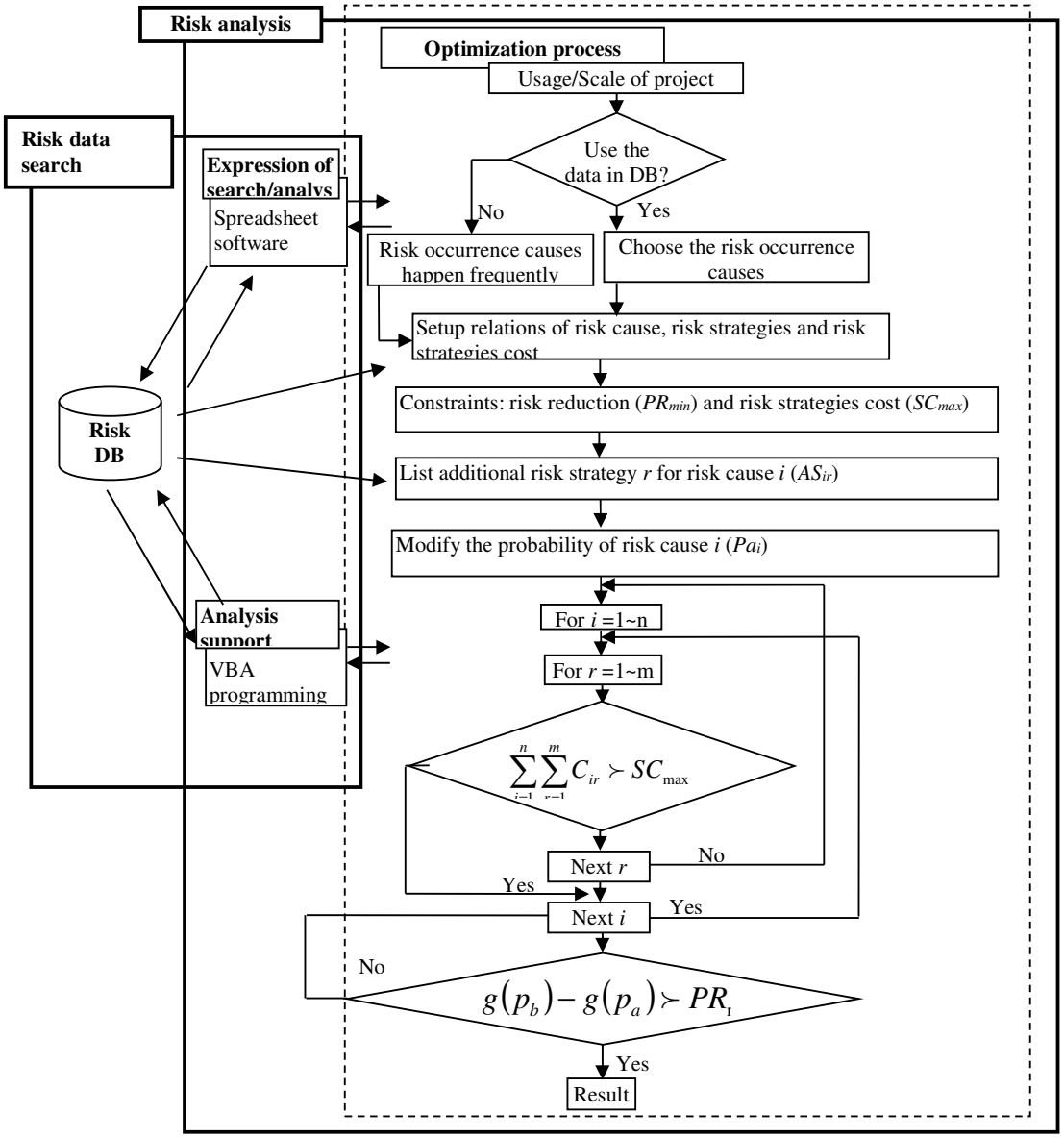

Figure 7. The Framework of the Decision-Making Support System

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RESEARCH ON TAIWAN THEME PARKS' EXPERIENCE MARKETING STRATEGY AND REVISIT WILLINGNESS, PURCHASE WILLINGNESS AND RECOMMENDATION WILLINGNESS

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Abstract

Pine & Gilmore think the time for experience economy has already come. People are no longer satisfied with the simple provision of products and services. Only products which ensure people of considerate feelings together with comfortable environment and service can unforgettable, personalized experience and unique values be created, and market segmentation and differences be achieved accordingly. Schmitt (2011) also emphasizes that people no longer focus merely on product function and efficiency. Instead, they focus on customer experience and consumption scenario. Experience marketing is a brand new concept which is capable of continuously creating innovative experience economy in life and scenarios, shaping sensational experience and thoughts recognition, and further changing consumption behavior and generating profit. Domestic theme parks are now facing high competition pressure. They should be able to create another blue sea if they can think outside the box of high investment cost and, instead, provide more experience scenarios to attract tourists. Based on experience economy concept, this research utilizes experience economy theory to explore if five experience marketing strategy affects consumers' consumption willingness, revisit willingness and recommendation willingness. To verify this research's assumption, researcher visited 269 tourists in targeted theme parks. The result indicates that experience marketing strategy indeed is capable of dra-

matically affecting consumers' consumption willingness, revisit willingness and recommendation willingness. This research also provides recommendations to theme parks based on the result.

Keywords: Experience Economy, Experience Marketing Strategy, Consumption Willingness, Revisit Willingness, Recommendation Willingness

Preface

We learned from the "Tourism Bureau 2012 Fellow Countrymen Travel Status Survey" report that there were a total of 156,260,000 domestic travel times for Taiwanese people in 2014, up 0.62% as compared with the one for 2013 and an average of 7.47 times per person per year (Tourism Bureau, Ministry of Transportation and Communications, 2015). Total travel times will reach 181.27 million travel times if accompanying children younger than 12 years old are included. As per estimates from Taiwan Tourism Bureau, total travel expense for Taiwanese people in 2014 shall reach as high as NT$309.2 billion dollars. We learn from these statistics that each Taiwanese people will have one travel behavior for roughly every two months, with each one spending about NT$1,979 dollars on tourism related expenses. If we include influx of foreign tourists, tourism industry indeed poses certain influence over Taiwan's economic development.

In addition to overall tourism perspective information, Tourism Bureau, Ministry of Transportation and Communications, works hard to attract even more tourists to visit theme parks. In 2012, Taiwan amusement parks' investments in new facilities exceeded NT$3.5 billion dollars. A total of 9.12 million man times of tourists had been attracted to amusement parks and a total of NT$5.8 billion dollars of revenue had been generated accordingly. The total number of people visiting amusement parks in 2013 had exceeded 10 million man times. It is also forecasted that the number of tourists visiting amusement parks across Taiwan during winter vacation at the end of 2014 shall reach 1.35 million man times due to the long winter vacation. This is an increase of roughly 50 percent as compared to those visited amusement parks during the winter vacation of 2013 (Tourism Bureau, Ministry of Transportation and Communications, 2015). Although we can have a rough understanding of domestic tourism market's prosperity from statistics

mentioned above, this is also because of continuous opening of amusement parks. As such, level of competition in amusement park market has also increased dramatically.

Previously, most amusement parks in Taiwan advertised on their hardware equipment of mechanical amusement facilities. However, investments in amusement hardware facilities are costly. Furthermore, with the rise of environmental protection awareness, acquisition of lands needed for various constructions all have to go through environmental impact assessment as well as various constructions of soil & water conservation. This not only increases difficulty in adding new amusement facilities, it also has negative influence on attracting consumers who emphasize on environmental conservation. Owners of amusement parks should therefore consider t transformation strategy other than "hardware competition." Investments only in large scale amusement facility will lead to a red sea strategy. Everyone continues to invest in even bigger amusement facilities under cut-throat competition. This will generate investment competition pressure to amusement park industry. Nevertheless, customer's experience is only limited to riding service of amusement facilities. They can't have even more theme experience or feelings of quality services from amusement parks. Accordingly, this research will conduct exploration from the perspective of experience marketing strategy to see if any influence has been generated to consumers' consumption willingness, revisit willingness and recommendation willingness after amusement park's introduction of experience marketing.

Explorations of Documents

Experience Marketing Strategy

Paula (2013) quotes Pine & Gilmore's "experience economy" concept, which was raised in the book of "The Experience Economy", and considers: the time for experience economy has already come. People are no longer satisfied with the simple provision of products and services. Only products which ensure people of considerate feelings together with comfortable environment and service can unforgettable, personalized experience and unique values be created, and market segmentation and differences be achieved accordingly. Schmitt (2011) also presents the same concept in "Experiential Marketing" and emphasizes that people no longer focus merely on product function and efficiency. Instead, they focus on customer experience and consumption scenario. Experience marketing is a brand new concept which is capable of continuously

creating innovative experience economy in life and scenarios, shaping sensational experience and thoughts recognition, and further changing consumption behavior and creating new survival niche and space for products and maximizing product values. Appealing measures from traditional marketing are no longer capable of attracting and satisfying consumer's needs. Instead, they are replaced by the concept of experience marketing. Traditional marketing only focuses on promoting product function and efficiency and it treats customers as reasonable decision makers. On the other hand, experience marketing deviates itself from traditional marketing thinking. Mainly through the creation of new experiences for consumers, it triggers consumers' excitement in their sense, mind and thinking, and as such leaves unforgettable joyful memory in the consumers' minds. (Farshad, Kwek & Amir, 2012).

To ensure marketing people's systematic understanding of marketing strategy anchored on the foundation of experiences, Schmitt further divided experience marketing into 5 categories of sense, emotion, thinking, action and relevance. Experience marketing strategy surrounds consumers with marketing measures which allow consumers to generate creative thinking and surprises and obtain sensational satisfaction as well as feelings towards products or services. Accordingly, these 5 strategic experience modules are capable of jointly creating valuable quality assets. Table 1 of this research lists out experience marketing strategies and goals (Maklan & Klaus, 2011) as follows:

Sense Marketing: This is mainly focused on consumer's senses (vision hearing, smelling, tasting and touching) in order to trigger purchase motive. Sense of value is therefore enhanced through consumer's sense of happiness or satisfaction.

Emotion Marketing: This allows consumers to obtain certain experiences from their purchase environment and process, and further generate good feelings towards product and brand. Therefore, marketing people should know how to trigger customer's feelings and design scenarios for such stimulation.

Thinking Marketing: New thinking directions have been proposed to allow consumers to re-assess and re-think benefits from new products and services. Creation of surprises is the key to success. Transfer of model: creation of surprises is the key to success. Therefore, marketing people should understand customer's knowledge

structure as well as resources to attract concentration.

Action Marketing: This emphasizes that consumers experience the result of change after their bodies, habits and lifestyles have been changed.

Relevance Marketing: Marketing is conducted using interaction relationship between consumer's psychology and society and culture. Sense of group recognition is created to enhance brand acceptance Schmitt (2011).

Consumption Willingness

Voon, Ngui and Agrawal (2013) pointed out that consumer's attitude towards a certain product or brand together with influences from external factors constitute consumer's purchase willingness. Purchase willingness can be deemed as a consumer's subjective preference in selecting a certain product and it is confirmed to serve as an important indicator in predicting consumer behavior. Khalek, Ismail and Ibrahim (2015) considered that purchase willingness is the possibility of consumer's intention to purchase such product. It is therefore a probability, possibility and willingness of customer's willingness to purchase a certain product. Saqib, Mahmood, Khan and Hashmi (2015) pointed out that consumer's purchase willingness is usually determined by his/her perceived obtainable benefit and value. Purchase willingness is then further developed accordingly. Amin, Rezaei and Tavana (2015) presented a method to measure consumer's purchase willingness. Measurement is conducted by measuring probability of consumer's willingness to purchase product, consumer's probability to purchase product if he/she has already determined to do so, and the probability of recommending others to purchase product. Hu (2013) considered that customer loyalty should emphasize more on behavioral indicators. He presented four indicators to measure consumer's purchase willingness: repeated purchase, purchase the same company's other product, other's recommendation and degree of immunity over competitor. Irianto (2015) presented perspectives of "customer consumption rate, repeated purchase rate, recommendation rate" to measure purchase willingness. Kim and Chung (2011) contended that, to measure consumer's purchase willingness, measurements should be conducted on consumer's loyalty which includes re-purchase willingness, willingness to purchase more products in the future and willingness to recommend to others. Yap and Cheng (2015) considered that measurements for purchase willingness include considering purchase of such product, possibility of purchasing such product and

willingness to recommend others to purchase such product. Liew and Mohammad (2015) pointed out that purchase willingness should be measured on items including willingness to select to purchase, worth of purchasing as well as recommendation to other friends and relatives to purchase. This research takes measurement scales presented by Dodd (1991) and others for reference and utilizes three indicators of consumer's possibility of purchasing such product, possibility of considering purchasing such product as well as possibility of recommending friends or relatives to purchase such product to serve as variables in measuring purchase willingness.

In summary, this research finds that most previous researches utilized possibility to purchase product or service (consumption willingness), willingness to recommend product or service to others (recommendation willingness) as well as repeated purchase rate (re-purchase rate) to measure consumption willingness.

Given the fact that subjects for this research are tourists who visit theme parks, this research defines consumption willingness as consumption in amusement park (consumption willingness), willingness to recommend friends or relatives to visit amusement park (recommendation willingness) as well as willingness to revisit this amusement park (revisit willingness).

Design of Research

Research Structure & Questionnaire Items

Author of this article had personally visited theme parks to collect tourists' views on theme park experience marketing strategies (including experience marketing strategies of sense, emotion, action, thinking and relevance), re-visit willingness, purchase willingness and recommendation willingness, and constructed theme park experience marketing strategies based on related findings. The structure of this research is illustrated in Figure 1 and explanations of variables encompassed by respective research perspectives are as follows: (1). Experience Marketing Strategy: This research defines five experience strategies in accordance with "Experience Marketing Strategy" defined by Schmitt (2000), and drafts experience marketing strategy items suitable for this research under references from experience marketing strategy item design by Wu, Min-Fong (2003); (2). Consumption Willingness: Under references of consumption willingness scale raised by Dodd (1991) and others, this research presents items of consumption willingness, recommendation willingness and revisit willingness to

explore tourist's willingness to revisit theme park within one year, consumption willingness within theme park as well as willingness to recommend theme park.

This research utilizes Likert Scale to measure five experience marketing strategies and consumption willingness. Measurement scale for experience marketing strategies are 5 points for very agree, 4 points for agree, 3 points for average, 2 points for disagree and 1 point for very disagree. Measurement scale for consumption willingness is 5 points for high willingness, 4 points for willingness, 3 points for average, 2 points for no willingness and 1 point for extremely no willingness.

Result of Analysis

Background of People Interviewed

This research interviewed 269 tourists which include 140 females (52%) and 129 males (48%). As for marital status, not-married people account for the major part with 151 of them (65%) and there are 118 (44%) people already married. There are 100 people aged between 31 - 40 (37%). People aged under 30 (33%) come in the 2nd place and people aged between 41-50 (17%) come in the 3rd place. As for education background, 121 of people interviewed graduated from university (45%). People with college education background (22%) come in the 2nd place and the 3rd is people with education background above graduate school (18%). On occupation side, people working in industries account for the most part, with 65 (24%) of the them. The next is people working in military, public sector and education sector, with 55 (20%) of them. The 3rd place is people working as freelancers, with 50 (19%) of them. With respect to family monthly income, there are a total of 134 people interviewed with monthly family income of 50,001-80,000 dollars (50%). The 2nd place is people with income of 80,001-100,000 dollars, a total of 60 (22%) of them. As for source of information to visit amusement park, 88 people (33%) are simply walking by amusement park. The 2nd place is from webpage, a total of 81 (30%) of them. The 3rd place is promotion form friends or relatives, with a total of 50 (19%) of them.

Multiple Regression Analysis

(1) Revisit Willingness Regression Analysis.

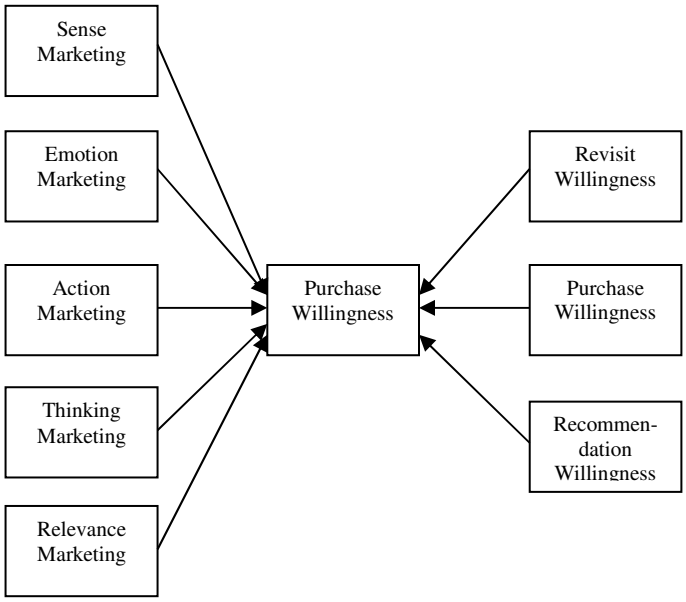

Figure 1. Structure of This Research

Table 2. Perspectives of Questionnaire and Items

Perspective	Items
Sense Marketing Strategy	1. Architecture and landscape in theme park seem to allow me to be immersed in an exotic scenario. 2. Many creative and exciting amusement facilities in theme park give me sweet memory. 3. I learn a lot from observing wild animals in close range in theme park. 4. I enjoy a lot for being able to watch wonderful festival and theme activities in theme park. 5. I'm able to play freely in the spacious outdoor activity space in theme park. 6. Resort hotel in theme park allows me to enjoy high end accommodation quality. 7. I'm able to release my pressure because it seems like that you're in other countries when you play in the theme park.
Emotion Marketing Strategy	1. My impression on theme park is enhanced from staff's considerate services. 2. I will directly think of theme park when exciting and creative amusement facilities are mentioned. 3. Coming to theme park allows me to feel joyful and relax atmosphere. 4. I will directly think of theme park when cute wild animals are mentioned. 5. I will directly think of theme park when foreign immigrant exploration history is mentioned. 6. I will directly think of theme park when words of spacious and natural are mentioned. 7. I will directly think of theme park when South East Asia culture is mentioned.

Perspective	Items
	8. I will directly think of theme park when mysterious West Asia culture is mentioned.
Thinking Marketing Strategy	1. Theme architectures in amusement park make me feel surprised. 2. Theme villages in amusement park allow me to understand culture characteristics of each country. 3. Festivals and events allow me to understand more of different cultures. 4. Wild animals in amusement park can enhance my knowledge on ecology and animals.
Action Marketing Strategy	1. Allowing tourists to be integrated into festivals and events related to Taiwan culture will be more attractive to tourists. 2. Allowing tourists to be integrated into festivals and events related to world cultures will be more attractive to tourists. 3. More people will be attracted if amusement parks can regularly hold guided ecology events. 4. More people will be attracted if amusement parks can hold experience events for parents and kids to participate together.
Relevance Marketing Strategy	1. More people will be attracted if amusement parks can work with together with surrounding communities and groups in holding events. 2. More people will be attracted if amusement parks can work together will various levels of schools in holding events. 3. It will be more attractive to tourists if designated company or group's preferential benefits are offered. 4. It will be more attractive to tourists if amusement parks can work together with government in holding events. 5. It will be more attractive to tourists if amusement parks can work together with private sector enterprises in holding events. 6. People will be more impressed if amusement parks can invite well-known people for promotion. 7. It will be more attractive to people if amusement parks can offer event discounts to surrounding communities. 8. It will be more attractive to people if amusement parks can design discounted package itinerary. 9. It will be more attractive to people if amusement parks can issue membership card and offer discounts.
Willingness	1. Your willingness to revisit this amusement park within one year 2. Your willingness for consumption in this amusement park within one year 3. Your willingness to recommend this amusement within one year

According to multiple regression analysis findings, sense marketing, emotion marketing, thinking marketing, action marketing and relevance marketing are all capable of forecasting (affecting) revisit willingness. With respect to sequence of influence on marketing strategy, action marketing possesses the biggest influence (β=.411) which is then followed by emotion marketing (β=.393). The 3rd one is

relevance marketing (β=.356) and the 4th one is sense marketing (β=.259) and the 5th is thinking marketing. This means that revisit willingness of tourists interviewed is mainly influenced by action marketing which is then trailed by other experience marketing strategies.

Table 3. Regression Analysis Summary over Factors Affecting Re-Visit Willingness

	B	Standard Deviation	β	Significance
Constant	.695	.156		.000
Sense Marketing	.302	.187	.259	.000***
Emotion Marketing	.421	.198	.393	.000***
Thinking Marketing	.199	.174	.168	.001**
Action Marketing	.511	.157	.411	.000***
Relevance Marketing	.401	.155	.356	.000**
R Square			.432	
Adjusted R Square			.412	
F(p)			32.312 (.000***)	

** p <.01, *** p <.001

(2) Consumption Willingness Regression Analysis. As per findings from multiple regression analysis, action marketing, relevance marketing and sense marketing are capable of predicting (affecting) consumption willingness. With respect to the sequence of their influence power over experience marketing, action marketing possesses the biggest influence (β=.403) which is followed by relevance marketing (β=.356), and sense marketing comes in the third place (β=.303). This means that consumption willingness of tourists interviewed is mainly influenced by action marketing which is trailed by influences from relevance marketing and sense marketing.

(3) Recommendation Willingness Regression Analysis. As per findings from multiple regression analysis, relevance marketing, emotion marketing, action marketing and sense marketing are all capable of predicting (affecting) recommendation willingness. With respect to the sequence of their influence power over marketing strategy, relevance marketing possesses the biggest influence (β=.372) which is then trailed in the following sequence by emotion marketing (β=.353), action marketing (β=.299) and sense marketing (β=.222). This means tourist's recommendation willingness is mainly influenced by relevance marketing

Table 4. Regression Analysis Summary over Factors Affecting Consumption Willingness

	B	Standard Deviation	β	Significance
Constant	.782	.211		.000
Sense Marketing	.192	.112	.303	.005**
Emotion Marketing	.198	.121	.102	.428
Thinking Marketing	.145	.123	.109	.221
Action Marketing	.512	.092	.403	.001**
Relevance Marketing	.399	.172	.356	.000***
R Square	.399			
Adjusted R Square	.381			
F(p)	17.112 (.000***)			

** p <.01, *** p <.001

Table 5. Regression Analysis Summary over Factors Affecting Recommendation Willingness

	B	Standard Deviation	β	Significance
Constant	.556	.110		.000
Sense Marketing	.231	.199	.222	.001**
Emotion Marketing	.401	.083	.353	.000***
Thinking Marketing	.124	.139	.126	.062
Action Marketing	.311	.187	.299	.001**
Relevance Marketing	.592	.111	.372	.000***
R Square	.399			
Adjusted R Square	.376			
F(p)	21.732 (.000***)			

* p <.05, ** p <.01, *** p <.001

which is followed by emotion marketing. Action marketing ranks the 3rd and sense marketing comes in the 4th.

3. One-Way ANOVA

(1) Population Variable One-Way ANOVA in Sense Marketing Strategy. Married people (M = 3.51) recognize and prefer sense marketing strategy more than not-married people (M = 3.12) do. People interviewed with more than 51 years old (M = 3.71) and aged between 41-50 recognize and prefer sense marketing strategy more than people aged between 31-40 (M = 3.11) and younger than 30 years old (M = 3.13) do. People interviewed with education backgrounds of graduate school and above (M = 4.01), college (M = 3.83) and university (M = 3.69) recognize and prefer sense marketing strategy more than people with education background below high school and occupational school. People interviewed with monthly family income of 80,001-100,000 dollars (M = 4.01) recognize and prefer sense marketing strategy more than people with income of below 50,000 dollars (M = 3.29) do.

(2) Population Variable One-Way ANOVA in Emotion Marketing Strategy. People interviewed with education background of above graduate school (M = 3.97) and university (M = 3.92) recognize and prefer emotion marketing strategy more than people with education background of college (M = 3.19) do. People interviewed with monthly family income of 80,001-100,000 dollars (M = 4.03) recognize and prefer emotion marketing strategy more than people with monthly family income of 50,001-80,000 dollars (M = 3.17) do.

(3) Population Variable One-Way ANOVA in Thinking Marketing Strategy. Married people (M = 4.04) recognize and prefer thinking marketing strategy more than not married people (M = 3.59) do. People aged 31-40 years (M = 4.05) recognize and prefer thinking marketing strategy more than people aged 41-50 years (M = 3.51) and above 51 years (M = 3.48) do. People interviewed with education background of university (M = 3.97), above graduate school (M = 3.86) and college (M = 3.85) recognize and prefer thinking marketing strategy more than people with education background of below high/occupational school (M = 3.11) do.

(4) Population Variable One-Way ANOVA in Action Marketing Strategy. People interviewed with education background of university (M = 4.08) and above graduate school (M = 3.98) recognize and prefer action marketing strategy more than people with education back-

ground of college (M =3.11) and below high/occupational school (M = 3.10) do. People interviewed with family income of 80,001-100,000 dollars (M = 4.03) and above 100,001 dollars (M = 3.96) recognize and prefer action marketing strategy more than people with family income below 50,000 dollars (M = 3.33) do.

Discussion

1. Action Marketing, Emotion Marketing, Relevance Marketing, Sense Marketing and Thinking Marketing Will Influence Tourist's Revisit Willingness.

Action marketing, emotion marketing, relevance marketing, sense marketing and thinking marketing can all influence tourists' revisit willingness. With respect to action strategy, action experience marketing strategy can be enhanced if amusement parks can frequently hold guided ecology exhibition event, festival events related to Taiwan culture as well as experience events in which both parents and children can all participate. As for emotion marketing, exciting and creative amusement facilities together with cute wild animals can be used to attract tourist' attention. On relevance marketing, amusement parks can offer preferential tour package to surrounding communities and invite well-known figure to promote them in order to enhance tourist' revisit willingness. As for sense marketing, amusement parks can enhance festival and theme events, encourage tourists to visit theme villages featuring respective countries of the world, and offer close range animal observation and interaction to attract tourists. Through certain guided tour services and introduction of wild animals and festival events, thinking marketing will be able to enhance tourist' impression and, as a result of this, tourists will want to visit amusement parks again.

2. Action Marketing, Relevance Marketing and Sense Marketing Will Influence Tourist' Consumption Willingness.

Action marketing, relevance marketing and sense marketing can all predict (influence) consumption willingness. With respect to the sequence of influence power over marketing strategy, action marketing possesses the biggest influence, with relevance marketing on the 2nd place and sense marketing comes in the 3rd place. This means amusement parks should first start planning action and relevance marketing and sense marketing if they want to enhance tourist' consumption willingness within amusement parks. This research considers that amusement parks should design experience events from the perspective of creation in order

to reinforce tourist' emotion and understanding of amusement parks, offer preferential treatments and satisfy tourists' sensational enjoyment and enhance tourists' consumption willingness.

3. Relevance Marketing, Emotion Marketing, Action Marketing and Sense Marketing Will Influence Tourists' Recommendation Willingness.

Relevance marketing, emotion marketing, action marketing and sense marketing will all influence tourists' recommendation willingness. With respect to the sequence of marketing strategies' influence power, relevance marketing possesses the biggest influence, which is then followed in the sequence of emotion marketing, action marketing and sense marketing. If amusement parks want to aggressively enhance tourists' recommendation willingness, they can first offer some preferential treatments and look for appropriate promotion figure to strengthen tourists' recommendation willingness, enhance tourists' feelings of amusement facilities and wild animal zones; offer events or guided ecology tours which allow parents, children and community residents to experience; hold festival events which are related to Taiwan culture and which are supported by the holding of festivals and theme events to encourage tourists to visit theme villages featuring countries around the world; and hold close-range wild animal observation and interaction to attract tourists.

4. Married, Relatively Older, Higher Education Background with Higher Family Income Recognize and Prefer Sense Marketing Strategy.

Compared to not married people, married people tend to recognize and prefer sense marketing strategy. People interviewed aged above 51 years and 41-50 years recognize and prefer sense marketing strategy more than people aged 31-40 or below 30 do. People interviewed with education background above graduate school, college or university recognize and prefer sense marketing strategy more than those with education background below high/occupational school do. People interviewed with monthly family income between 80,001- 100,000 dollars recognize and prefer sense marketing strategy more than those with an income of below 50,000 dollars do.

5. People with Higher Education Background and Family Income Recognize More with Emotion Marketing Strategy.

This research finds that people interviewed with education background above

graduate school or university recognize and prefer emotion marketing more than those with education background of college do. People interviewed with monthly family income between 80,001-100,000 dollars recognize and prefer emotion marketing strategy more than those with monthly family income between 50,001-80,000 dollars do.

6. People Who Are Married, Younger with Higher Education Background Recognize and Prefer Thinking Marketing Strategy.

People interviewed who are married recognize and prefer thinking marketing strategy more than those who are not married do. People interviewed aged between 31-40 recognize and prefer thinking marketing strategy more than those aged between 41-50 and above 51 do. People interviewed with education background of university, above graduate school and college recognize and prefer thinking marketing strategy more than those with education background below high / occupational school do.

7. People with Higher Education Background and Higher Income Recognize and Prefer Action Marketing Strategy.

People interviewed with education background of university or above graduate school recognize and prefer action marketing strategy more than those with education background of college or below high/occupational school do. People interviewed with monthly family income between 80,001-100,000 dollars and above 100,001 dollars recognize and prefer action marketing strategy more than those with monthly family income below 50,000 dollars do.

8. Relevance Experience Marketing Strategy Can be Utilized to Enhance Tourists' Revisit, Consumption and Recommendation Willingness.

This research finds that relevance experience marketing strategy has strong influence over tourists' three willingness. Therefore, under the purpose to aggressively enhance tourists' willingness, relevance marketing strategy should first need to construct and implement key points. As such, this research also provides recommendations as follows: 1. Offer event preferential treatment to surrounding communities. For instance, discounts on entry with ID card or offering of consumption coupon. 2. Amusement parks design guided ecology tour and route planning. Introduction will be made by tour guide to enhance tourists' emotion

towards amusement park. 3. Offer recognition cards to visiting tourists to allow them to accumulate points. Preferential treatment or gift will be delivered when certain amount of points have been accumulated. 4. Invite stars or renowned figures with positive image to promote for amusement park, and collaborate with schools to hold ecology events or field teaching events together. 5. Enter agreement with government institutes or companies to offer preferential treatments from related collaborating units.

9. Utilization of Action Experience Marketing Strategy to Enhance Tourists' Revisit, Consumption and Recommendation Willingness

As per findings from regression analysis, action experience marketing can also be utilized to predict tourists' revisit, consumption and recommendation willingness and it is also very powerful. As such, this research also presents suggestions as follows: 1. Amusement park can hold certain experience events which are related to ecology, animal or festival activities. For instance, events allowing tourists to experience feeding animals in close range, guided ecology tour and explanation. 2. Amusement parks can utilize methods of allowing tourists to play the role of one-day amusement park employee or actor. This will enhance tourists' understanding and feelings towards amusement parks. 3. Amusement parks can hold DIY competitions. For instance, they can allow tourists to pick out animals designated by amusement parks among a variety of different animals. Or, they can allow tourists to experience festival event preparation process. 4. Amusement parks can hold experience events which allow parents and children to have fun together. For instance, spac-ious outdoor space in amusement parks can be utilized to hold painting event, music performance, essay recitation or some intellectual competitions which allow parents and children to have fun together. 5. Amusement park provides locations for surrounding communities to hold events within amusement park. Amusement parks can also allow surr-ounding communities to hold events in the space or buildings within amusement parks. This not only increases reputation. It also enhances surrounding community residents' good feelings towards amusement parks.

10. Utilization of Sense Marketing Strategy to Enhance Tourists' Revisit and Recommendation Willingness

This research finds that tourists love wild animals, festivals and events, exciting and creative amusement facilities as

well as theme villages full of exotic tastes in amusement parks a lot. They also hope that in the future they can enjoy more experience events and preferential treatments in amusement parks. As such, this research has presented recommendations as follows: 1. Encourage tourists to visit all theme cultural villages within amusement park. They're entitled to receive a little gift if they collect every stamp from each theme cultural village. 2. Amusement park can actively contact schools of various levels to provide them with guided ecology tour and explanation of related knowledge. They can also provide ticket discounts to attract more schools' attention. 3. Amusement parks can design and plan for more festival events related to Taiwan culture to allow tourists to be immersed in and to understand the beauty of Taiwan culture. 4. Amusement parks provide experience events which allow tourists to play roles so that tourists can be deeply integrated into atmosphere in theme village and become very impressed about amusement parks.

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International Journal of Organizational Innovation

THE EFFECTS OF GENERAL PERSONALITY TRAITS AND COGNITIVE BELIEFS ON ELEMENTARY SCHOOL TEACHERS' USE OF AN EDUCATIONAL PORTAL IN TAIWAN

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Abstract

Rapid advances in the Internet and information technologies have greatly facilitated the use of digital teaching materials and technologies in school education. To support and improve teachers' teaching effectiveness, educational authorities have established educational portals for teachers to share teaching materials, and to discuss and interact with each other. However, many elementary teachers have less desire to use educational portals. Therefore, understanding which factors affect their use of an educational portal is a major concern. The study builds a theoretical model affecting elementary teachers' use of Easy Teaching Web of Taiwan by integrating general personality traits (conscientiousness, openness to experience, extraversion) and cognitive beliefs (perceived playfulness and perceived usefulness) into one model. This study is one the first to examine the effects of conscientiousness, openness to experience, and extraversion on elementary teachers' use of an educational portal. Data were collected from 512 teachers in 25 elementary schools in Taipei, Taiwan. The partial least squares approach was used to evaluate causal links of the model, it was found that conscientiousness, openness to experience, and extraversion can influence teachers' use of an educational portal through beliefs (perceived playfulness and perceived usefulness). The practical implications are discussed, and further studies are suggested.

Key Words: Conscientiousness; Openness to Experience; Extraversion; Perceived Playfulness; Perceived usefulness; Educational Portal; Elementary School Teacher

Introduction

There have been huge developments of educational technologies and digital teaching materials in the education industry. National and local education authorities in many countries have established educational portals to support teachers' teaching. Teachers can share teaching materials and resources and exchange information and views from the educational portals. However, since it is difficult for teachers to choose appropriate systems and technologies for their teaching in the classroom, many teachers may seldom or rarely use the educational portals. In addition, less research has been investigated which factors affect elementary school teachers' use of an educational portal. Therefore, exploring the factors that can influence elementary teachers' use of an educational portal is a priority concern.

This study selects general personality traits as important factors to explain and predict elementary school teachers' use of an educational portal. We hypothesize that three general personality traits (conscientiousness, extraversion, and openness to experience) are antecedents of two cognitive beliefs (perceived usefulness and perceived playfulness). Since few studies have empirically investigated the antecedents of perceived usefulness and perceived playfulness and the mediating roles that perceived usefulness and perceived playfulness play in the teachers' use of an educational portal. Thus, this research intends to fill the research gap by combining general personality traits, cognitive beliefs, and use of an educational portal into one model.

Theoretical Background

The Five-Factor Model (FFM) of Personality

Personality is a stable set of characteristics and tendencies that determine the commonalities and differences in thoughts, feelings, and actions of people (Maddi, 1989). The classification of personality is now known as the FFM, and the factors are referred to as the Big Five. The FFM includes agreeableness, extraversion, conscientiousness, openness to experience, and emotional stability (Barrick & Mount, 1991).

Theoretical Development

The theoretical model for this study (Figure 1) draws from the FFM and cognitive beliefs. According to the model, it reveals the causal relationships among general personality traits (conscientiousness, openness to experience, and extraversion), cognitive beliefs (perceived usefulness and perceived playfulness), and use of an educational portal.

Conscientiousness

Individuals high in conscientiousness are responsible, organized, self-disciplined, self-motivated, achievement-oriented, and task-oriented (Barrick & Mount, 1991). High conscientious individuals are eager to achieve their goals (Costa & McCrae, 1992) and to pursue high levels of job performance.

In the context of education and learning, prior results found that conscientious students have better academic performance (Conard, 2006).

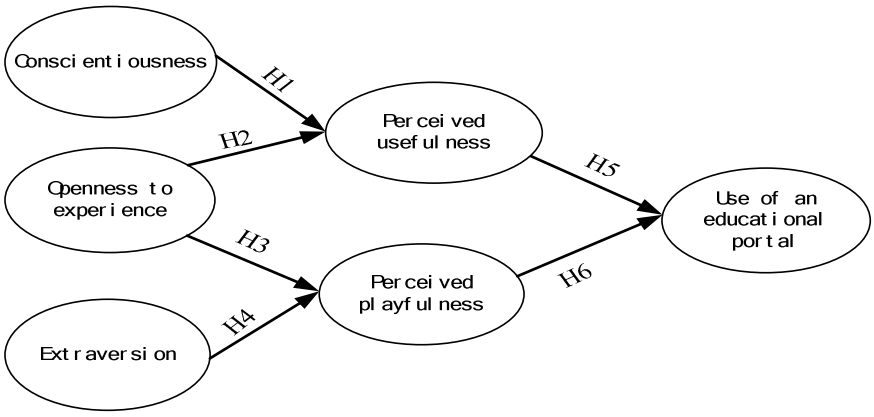

Figure 1. The research model

Conscientious people are more likely to carefully consider which technologies can provide opportunities to succeed and improve their performance. Accordingly, we can expect high conscientious teachers would may perceive usefulness of the educational portal because it provides practical and accessible teaching materials and resources for their teaching in class. We thus hypothesized:

H1: Conscientiousness has a positive effect on perceived usefulness.

Openness to experience

Openness to experience is defined as the extent to which individuals are intelligent, knowledgeable, creative, imaginative, and curious (Goldberg, 1992). High openness individuals are very curious about their inner and outer environments, and they are likely to try new and different things. They tend to hold positive attitudes and perceptions towards learning and actively seek new information and approaches to exhibit their creativity (Barrick & Mount, 1991). Thus, since accessing and exploring the educational portal is a new way for high openness teachers to obtain useful materials and to express their creativity in class, they may perceive greater usefulness of the educational portal than closed teachers. Accordingly, the following hypothesis is tested:

H2: Openness to experience has a positive effect on perceived usefulness.

High openness individuals are more likely to explore and try new things, and they tend to enjoy the trial process (McCrae & Costa, 1997). A computer-based assessment acceptance study by Davis and Yi (2012) reported that openness to experience directly predicts computer playfulness. Accordingly, the following hypothesis is proposed.

H3: Openness to experience has a positive effect on perceived playfulness.

Extraversion

Those high in extraversion are social, active, energetic, talkative, out-

going, and enthusiastic (Barrick & Mount, 1991). Individuals with extraversion are more likely to enjoy the relationship and interaction with people.

Since extraverts prefer to search and share new and different information on the Internet to satisfy their needs for interpersonal interactions, we expect extravert teachers are more likely to enjoy obtaining new and interesting teaching materials from the educational portal to share with their colleagues and students (Amiel & Sargent, 2004). Thus, we expect extravert teachers will enjoy participating online forum of the educational portal. Thus, the following hypothesis is proposed.

H4: Extraversion has a positive effect on perceived playfulness.

Perceived usefulness

Perceived usefulness was defined as the degree to which users believe that using a specific application system would enhance their job performance in an organizational context (Davis, 1989). Since elementary school teachers are required to prepare diverse teaching materials to meet the needs of students, teachers are highly motivated to search for useful teaching materials in response to their teaching requirements. Thus, the following hypothesis is proposed.

H5: Perceived usefulness has a positive effect on the use of an educational portal.

Perceived playfulness

Perceived playfulness was defined as the extent to which the individual perceives that his or her attention is focused on the interaction with the specific application system; is curious during the interaction; and finds the interaction intrinsically enjoyable or interesting (Moon & Kim, 2001). Since an educational portal provides a convenient platform for teachers to share interesting teaching materials, elementary teachers who experience playfulness and flow while using the portal are likely to use it. Therefore, the following hypothesis is proposed.

H6: Perceived playfulness has a positive effect on the use of an educational portal.

Material and Methods

The educational portal: Easy Teaching Web (ET Web)

The educational portal analyzed in this study was the ET Web (etweb.tp.edu.tw), which was created by and for teachers with the support of the Department of Education, Taipei City Government. The ET Web established in 2006 and has been maintained continuously until now. The main purpose of the ET Web is to improve teachers' teaching efficacy and performance. The ET Web has provided teaching resources, forums, teaching tips, news, and information. The teaching resources section provides different subjects of teaching resources including Mandarin, English, math, society, science and life technology, health and physical education, arts and humani-

ties, and integrated activity areas, etc. The teaching materials at the portal, which are shared and uploaded by teachers, included approximately 2600 teaching resources by 2014. The forums section provides channels for teachers to discuss their teaching problems and to share their teaching experience. The teaching tips section provides useful guides and tools for classroom management and administrative operations. The news and information section provides timely and important educational news and information.

Measures

All research variables were measured using multi-item scales. Items selected for the constructs of the research mainly adapted from prior studies to ensure content validity.

The three of Big Five personality traits (openness to experience, extraversion, and conscientiousness) all were measured by 6 items extracted from the 44 item questionnaire of the Big Five Inventory (BFI; John, Donahue, & Kentle, 1991). The scale for perceived playfulness was measured by 6 items adapted from Moon and Kim's (2001) study. Items measuring perceived usefulness were taken and modified from previous studies (Davis, 1989). The use of an educational portal was measured by two items adapted from Moon and Kim's (2001) study. All above items were scored on a Likert scale from 1 to 5, with a 1 rating indicating strong disagreement and a 5 rating indicating strong agreement.

Subjects

The data for this study were gathered through questionnaire survey. A questionnaire was designed and sent to 25 elementary schools in Taipei, Taiwan. The elementary school teachers completed self-reported questionnaires. The survey was conducted from April to June 2015. A total of 750 surveys were distributed and a total of 531 responses (70.8%) were received. Due to missing data and outliers, this study obtained an effective response rate of n=512 (68.3%).

The subject pool consisted of 355 (69.3%) female and 157 (30.7%) male respondents. About half of the participations (256 out of 512, 50%) were between 30 and 39 years old. The subjects averaged 13 years of teaching experience and 457 subjects (89.3%) had used the Internet more than 14 years. All teachers had completed one college or university degree.

Data analysis

The partial least squares (PLS) approach was conducted to test the research model. The PLS is a structural equation modeling (SEM) technique and can simultaneously examine the measurement model and the structural model in one model.

Results

Assessment of the measurement model

The PLS was used to assess the psychometric properties of the scale. Psychometric properties of the scales were assessed in terms of internal

Table 1. Assessment of the measurement model

Variables	CR	Cronbach' alpha
Conscientiousness (CON)	0.90	0.86
Openness to experience (OPE)	0.88	0.84
Extraversion (EXT)	0.90	0.86
Perceived usefulness (PU)	0.91	0.87
Perceived playfulness (PP)	0.92	0.90
Use of an educational portal (UEP)	0.90	0.78

consistency, convergent validity, and discriminant validity. The study used composite reliability values (CR) and Cronbach's alpha coefficients to assess reliability and internal consistency of constructs. The results in Table 1 showed that all CR and Cronbach's alpha coefficients exceeded the 0.70 threshold suggested by Bagozzi and Yi (1988). The results showed that all constructs exhibited adequate internal consistency and reliability.

To evaluate discriminant and convergent validity, the study examined whether all items loaded greater than 0.7 on their respective construct. Cross-loadings of items are given in Table 2. Due to low factor loading for item CON5, the study dropped the item. The modified loadings showed a clear discriminant and convergent validity for all constructs. Table 2 also demonstrates satisfactory convergent validity since average variance extracted (AVE) for all constructs exceeded 0.50 (Fornell & Larcker, 1981). Since above analyses exhibited adequate internal consistency, convergent validity, and discriminant validity, hence, the results indicated acceptable psychometric properties.

Assessment of the structural model

Figure 2 reveal the results of the path analysis. The estimated path effects (β value), levels of significance (P value), and explained variance using a bootstrapping procedure (N=1000). To evaluate the full model, the resulting structural model shows R^2 of 0.55 for the use of an educational portal.

As can be seen, the results showed that conscientiousness had a significant effect on perceived usefulness (β=0.31, P<0.001). H1 was supported. Openness to experience had a significant effect on perceived usefulness (β=0.36, P<0.001) and perceived playfulness (β=0.37, P<0.001). Thus, H2 and H3 were both supported. Extraversion had a significant effect on perceived playfulness (β=0.26, P<0.001) and hence H4 was supported. Perceived usefulness (β=0. 22, P<0.001) and perceived playfulness (β=0. 58, P<0.001) both significantly influenced the use of an educational portal. H5 and H6 were supported.

Table 2. AVE and PLS cross-loadings

	UEP	EXT	PU	PP	CON	OPE
AVE	**0.79**	**0.60**	**0.72**	**0.67**	**0.64**	**0.56**
UEP1	**0.90**	0.28	0.49	0.66	0.32	0.38
UEP2	**0.91**	0.35	0.58	0.64	0.35	0.38
EXT1	0.23	**0.74**	0.28	0.21	0.35	0.19
EXT2	0.33	**0.75**	0.39	0.34	0.42	0.26
EXT3	0.27	**0.72**	0.30	0.28	0.39	0.32
EXT4	0.26	**0.82**	0.38	0.28	0.41	0.25
EXT5	0.32	**0.82**	0.42	0.34	0.35	0.26
EXT6	0.36	**0.77**	0.45	0.31	0.45	0.34
PU1	0.55	0.45	**0.85**	0.57	0.42	0.46
PU2	0.48	0.38	**0.81**	0.52	0.35	0.44
PU3	0.52	0.41	**0.86**	0.55	0.36	0.38
PU4	0.58	0.42	**0.86**	0.56	0.47	0.42
PP1	0.52	0.35	0.50	**0.75**	0.31	0.31
PP2	0.45	0.14	0.35	**0.70**	0.22	0.33
PP3	0.65	0.33	0.57	**0.88**	0.32	0.40
PP4	0.64	0.34	0.55	**0.87**	0.29	0.36
PP5	0.60	0.32	0.58	**0.85**	0.37	0.42
PP6	0.63	0.37	0.59	**0.84**	0.36	0.41
CON1	0.31	0.48	0.45	0.31	**0.86**	0.36
CON2	0.35	0.45	0.41	0.33	**0.87**	0.38
CON3	0.26	0.36	0.36	0.29	**0.80**	0.37
CON4	0.32	0.42	0.32	0.28	**0.75**	0.30
CON6	0.35	0.33	0.34	0.34	**0.71**	0.44
OPE1	0.27	0.19	0.31	0.31	0.30	**0.72**
OPE2	0.31	0.29	0.46	0.38	0.40	**0.84**
OPE3	0.26	0.32	0.36	0.30	0.35	**0.75**
OPE4	0.41	0.30	0.41	0.38	0.39	**0.74**
OPE5	0.28	0.25	0.40	0.31	0.30	**0.72**
OPE6	0.42	0.30	0.42	0.38	0.39	**0.70**

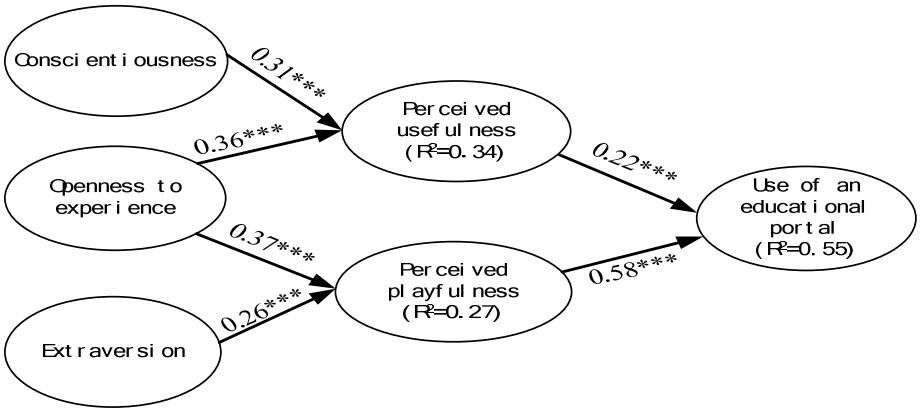

Figure 2. Model parameters for the research model: ***P<0.001

Implications

The practical implications for policymakers, school administrators and system designers when implementing and designing educational portals are outlined below.

First, the educational portals can provide in-depth, sophisticated teaching who are likely to have positive beliefs about learning and searching teaching materials from the educational portals.

Second, low conscientious, low openness, and introvert teachers might have negative cognitive beliefs about the use of educational portals. Therefore, we suggest that elementary school administrators may consider these traits during the selection process.

Third, the analytical results indicated that perceived playfulness is the most important indicator of the use of an educational portal. Thus, policymakers and school administrators can actively provide more interesting content.

Conclusions

The objective of the study was to provide policymakers and researchers with an improved understanding of how elementary school teachers respond to an educational portal and how to increase elementary school teacher' use of the portal. The analytical results described above have three main contributions for national and local education authorities and researchers:

First, since less research has investigated how general personality traits affect teachers' use of an educational portal, the theoretical contribution of the current study is to explore and validate the effects of three of the Big Five personality traits (conscientiousness, openness to experience, and extraversion) on elementary school teachers' use of an educational portal through cognitive beliefs.

Second, since our analytical results showed that conscientiousness, openness to experience, and extraversion all play an important role in predicting teachers' use of an educational portal, policymakers, school administrators, and systems designers can provide more customized content and functions based on teachers' personality traits.

Finally, the results found that cognitive beliefs, including perceived usefulness and perceived playfulness, have more explanatory power than any one of these factors alone. Therefore, the model could add more value on educational portal acceptance and use research.

Limitations and Future Studies

First, as this study used a snapshot approach, a longitudinal approach should be considered in future research. Second, this study explores the effects of general personality traits on teachers' use of an educational portal. Future studies can extend the effects of other personality factors on teachers' use of an educational portal.

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International Journal of Organizational Innovation

THE CASE STUDY OF STUDENT'S MOTIVATION IN LEISURE PARTICIPATION AND LEISURE OBSTRUCTION AT ELEMENTARY LEVEL IN TAIWAN.

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Abstract

The purpose of this study is to explore the current situation of the fifth and sixth graders' participation motivation and obstructive factors of leisure sports in elementary schools in Houli District of Taichung City. It further compares the differences between different demographic variables. The research tool was self-compiled "questionnaire concerning the schoolchildren's participation motivation and obstruc-

tive factors of leisure sports in elementary schools". The subjects were the fifth and sixth graders of elementary schools in Houli District of Taichung City. The questionnaire survey was conducted on random sampling. The population was elementary school students in Taichung City in 2014 academic year. The survey period was from January 10, 2015 to January 26, 2015. A total of 570 valid questionnaires were retrieved. The data were analyzed with descriptive statistics using SPSS for Windows 18.0. The differences of participation motivation and obstructions of leisure sports under demographic variables (school, grade, gender, family background) were analyzed with t test and one-way ANOVA. The research results are as follows:
1. Among students' participation motivations of leisure sports in elementary schools in Houli District of Taichung City, most of them engage in leisure sports to enhance their physical ability.
2. There are significant differences in the fifth and sixth graders' participation motivation of leisure sports in elementary schools in Taichung City under different demographic variables.
3. The obstructive factors of leisure sports are widespread. Poor sports environment is the factors hindering most of the schoolchildren from participating in leisure sports.
4. There are differences in the obstructive factors of the fifth and sixth graders' leisure sports in elementary schools in Taichung City under different demographic variables.
5. There is a negative correlation between students' participation motivations of leisure sports in elementary schools in Houli District of Taichung City and the obstructive factors of leisure sports.

Key Words: elementary school, fifth and sixth graders, leisure sports, participation motivation of leisure sports, obstructive factors

Introduction

As society continues to age quickly, people are developing a higher awareness of health and greater needs for leisure activities. Since the weekly two-day-off system was completed implemented by the government since 2001, people have also become more aware of the importance of "leisure" and "sports" to a better quality of life and life-long health. However, as it could be clearly seen from an examination on the educational practices under

this light, although the Ministry of Education has been working to promote educational reforms in recent years, the values hidden behind the saying "The worth of other pursuits is small, the study of books excels them all." are still deeply rooted in the minds of most parents. By thus prioritizing academic studies, the importance of leisure to children in terms of their need for recreation, sense of achievement and greater physical health is ignored. To make things worse, due to the explosion of the Internet and information technology in our times, a great number of students are addicted to online games, making friends online, Facebook and other social networking sites. This means that the leisure choices for our youngsters have been completed changes. Sports, which used to be a favorite means of relaxation in the past, are thus abandoned (Wang, 2003). How to motivate our students to participate in leisure sports again and build a sound body via regular exercise, therefore, has become a common concern for the whole society.

Primary school students are the future of a country. Their somatic fitness, therefore, is closely linked to the overall competitiveness of a country. Given that primary education is foundational to every other higher education and that primary students of higher graders are standing at the critical juncture between childhood and adolescence, the establishment of a correct outlook at this point is more than necessary. Cheng (1994) suggested that leisure sports are different from other leisure activities in that they embodied both leisure and sports, hence the many benefits they could bring about. They constituted a unique activity unparalleled by other leisure activities. In even better cases like physical leisure activities, a multiplicity of physiological benefits had been detected like greater cardio-respiratory fitness, stronger muscle strength, better bone health and weight management (Wankel & Berger, 1991). Since primary school is the beginning of primary education and learning, our children, if enabled to establish a current outlook toward leisure sports and so motivated as to be glad to do sports outdoors, will have a positive mental and physical development and better chances to develop a good leisure sports habit when they come of age. With primary students of higher grades as the subjects of researcher, therefore, this study is set out to probe into the factors that are related to their participation in leisure sports. In the past, studies on the participation in leisure sports were concerned mostly with the analysis of the two variables of motivation and constraints. Since motivation is the driving force behind all aspects

of human behavior (Yoon and Uysal, 2005), participation motivation and participation behavior is correlated. Participation constraints, on the other hand, will inhibit or reduce the number of participation and sense of joy in relevant activities. They will interfere with participation in such a continuous manner that the person concerned will find it impossible to participate in such activities again (Crawford & Godbey, 1987; Jackson, 1988). It is moreover found in past studies that leisure participation and constraints are also correlated. Individuals will be faced with different constraints as their motivation and need for leisure participation varies. The extent of leisure constraints, likewise, is directly influential on the individuals' leisure participation degree and intention (Iwasaki, 2003). With participation and constraints as the two variables, therefore, this study is set out to probe into their relationship with the leisure participation of primary students of higher grades.

Houli District is located along TRA Taichung line. Although boasting a mere population of a little more than 50,000, the Houli Horse Farm and Hofung Bicycle Green Way there constitute the destination of numerous tourists in the holiday season. In recent years, the District Office has been working on several construction projects, the results of which include a swimming pool and two sports parks. Local residents are therefore provided with broader sports space and better sports environment. The Office has moreover held various events and competitions for participants from around the country. In this way, the awareness of leisure sports, as well as the number of participants in these sports, is substantially increased. Although there are only six primary schools in Houli District, every school is featured by the development of different sports, thus enabling the students to improve physical and mental health, cultivate interest, extend social network, learn to work as a team, manage stress, etc. via participating in these sports activities. Based on this idea, this study sets out to investigate the relationship between the leisure participation of primary school students of higher grades in Houli District, participation motivation and leisure constraints with the aim to understand the reasons for the students' leisure participation and identify the leisure constraints. It is hoped that the results of the study could be used as references for relevant authorities in their formulation of strategies, thus increasing the participation in leisure sports and creating more opportunities for such participation. The ultimate goal is to motivate the primary school students to set a higher physical fitness

goal and cultivate their interest and ability to participate in leisure sports in the future.

The purposes of this study thus include:

1. To understand the motivation factors and constraints for the primary school students of Houli District in terms of their participation in leisure sports.
2. To analyze the motivation factors and constraints for the participation of primary school students in leisure sports in cases of demographic differences.
3. To analyze the relevant circumstances concerning the motivation factors and constraints for the participation of primary school students in leisure sports.

Method

Research Structure

On the basis of the research purposes and findings drawn from relevant literature review, the following hypotheses are proposed in this study:

H1: Demographic variables are significantly different from participation motivation in leisure sports.

H2: Demographic variables are significantly different from leisure sports constraints.

H3: Participation motivation in leisure sports and leisure sports constraints are significantly negatively correlated to each other.

Research Subjects

Pretest Sample

Wang (1999) suggested, "The size of the pretest sample should be at least 100 in order to meet the statistical objectives." This study selected the samples randomly from the two classes of five-graders and two classes of six-graders in Neipu Elementary School, who were then given the pretest questionnaire. A total of 150 questionnaires were distributed. After the eight invalid ones (not fully filled in) were removed, there were a total of 142 questionnaires, making the collection rate of valid questionnaires 94.6%.

Test Sample

After an analysis was conducted on the results of the pre-test questionnaire, a revised questionnaire was distributed in the six primary schools in Houli District on January 12, 2015 to randomly selected samples. This study

used "absolute precision" to evaluate the required sample size (Huang, 2000). Considering that reliability of standard deviation is 0.95 when the deviation between population and sample is set at 5% and confidence interval at 95%, it is calculated that the sample size should be 385 to ensure the precision required by the research and 384 samples should be selected when the reliability is 95% for the study to be representative. In order to avoid that the sample size should be find lacking, a total of 600 questionnaires were distributed. After the 30 invalid ones (not fully filled in) were removed, there were a total of 570 questionnaires, making the collection rate of valid questionnaires 95.0%.

Research Tools

This study uses the "Questionnaire on the Motivation and Constraints for Primary School Students in Houli District, Taichung City to Participate in Leisure Sports" as research and data collection data. This questionnaire is thus hereby elaborated as follows.

(1) Basic personal information: including gender, name of school, grade, participation in sports teams, sports environment and educational background of parents, as the basis for further analysis.
(2) Questionnaire on the motivation to participate in leisure sports: The questionnaire in this study is designed after referring to mainly to such studies as Heapes (1978), Iso-Ahola (1982), Murray(1983), Klint and Weiss(1987), Murray and Nakajima(1999), Weissinger and Bandalos (1995) and constructed thus of such three dimensions as sense of achievement, physical fitness and interpersonal relationship. According to the survey data provided by the respondents, the 5-point Likert scale, ranting from 5 (strongly agree) to 1 (strongly disagree). The lower the score is, the more satisfied the respondent is with the experience and vice versa.
a. Item analysis: After the pretest questionnaires were collected, an item analysis was conducted based on SPSS for Windows 18.0 to see the internal consistency between the questions. In order to avoid the occurrence of excessive rejection, any item with a significance level lower than 0.05 was deleted. After the item analysis, a reliability test was conducted via Cronbach's α estimate to obtain the Alpha coefficient value for the sports participation motivation at its various dimensions, as well as the Alpha coefficient value after the questions were deleted. According to the results of the item analysis, no questions were deleted.
b. Factor analysis: After the item analysis was conducted on the questionnaires, KMP Measure of Sampling Adequacy was performed respectively on the var-

ious sections of the questionnaire to make sure the adequacy approximated 1 and Bartlett's Test of Sphericity (Chiu, 2000) was carried out. Since the test results were significant, factor analysis was deemed appropriate for this study. Principal component analysis and Varimax rotation were then used to extract the common principal factors, by which the question items whose factor loading did not reach 0.30 were deleted. According to the results, no question items were deleted. From the 20 question items, three factors were extracted, by the correlation with which the constructs were renamed. The first factor was named as "sense of achievement", the second as "physical fitness" and the third as "interpersonal relationship", which accounted for 55.616% of the total explained variation.

c. Reliability analysis: A reliability analysis was then conducted on the three constructs of the sports participation motivation, the Alpha coefficient of reliability of which were found respectively to be: 0.901 for "sense of achievement", 0.773 for "physical fitness" and 0.7908 for "interpersonal relationship".

(3) Questionnaire on leisure sports constraints: The questionnaire is designed mainly after summarizing the research tools of such studies as Hanin (1980), Crawford & Godbey (1987), Boothby, Tungatt, and Townsend (1981), Crawford, Jackson and Godbey (1991) and Dishman, (1991). The questions in this questionnaire are concerned with the two constructs of individual performance and emotional factors, and sports ground, facilities and interpersonal factors and the scoring is based on the 5-point Likert scale.

a. Item analysis: A Cronbach's α estimate was conducted to obtain the Alpha coefficient value for the sports participation motivation at its various dimensions, as well as the Alpha coefficient value after the questions were deleted. According to the results of the item analysis, no questions were deleted.

b. Factor analysis: From the 20 question items, two factors were extracted, by the correlation with which the constructs were renamed. The first factor was named as "individual performance and emotional factors" and the second as "sports ground and facilities and interpersonal factors", which accounted for 66.174% of the total explained variation.

c. Reliability analysis: A reliability analysis was then conducted on the two constructs of satisfaction with the sports, the Alpha coefficient of reliability of which were found respectively to be: 0.942 for "individual performance

and emotional factors" and 0.937 for "sports ground and facilities and interpersonal factors".

Result & Discussion

Analysis of the Demographic Features

After integrating the data, it is shown that 53.0% of the primary students are members of sports teams and 90.9% of them like to have PE classes. In terms of the grade the students are in, 51.8% of them are fifth graders. This is consistent with Iso-Ahola (1989) that leisure motivation will change with times and stages of life.

Participation motivation in leisure sports

It is found in this study that the main motivation for primary school students of higher grades to participate in leisure sports include "the chances to improve one's physical fitness", "the desire to better one's sports skills", "the hope to learn a certain leisure sport", "the possibility of weight control" and "the urge to make more friends". As is shown by the research findings, primary school students of higher grades are aware of the fact that having exercises could improve one's physical health, hence their higher motivation toward "sense of achievement" and "physical fitness". This result is consistent with Klint and Weiss (1987), Murray and Nakajima (1999), and Vallerand and Rousseau (2001).

Analysis on Leisure Sports Constraints

It is found in this study that the main constraints for primary school students of higher grades to participate in leisure sports include "poor sanitation of the sports ground and facilities", "lack of spare time", "lack of adequate information" and "the unfamiliarity with the sports rules". This result is consistent with Crawford & Godbey (1987), Boothby, Tungatt, and Townsend (1981), Iso-Ahola and Mannell (1985) and Crawford, Jackson and Godbey (1991).

Comparison of the differences in the participation motivation and constraints for leisure sports when it comes to the demographic variables

Regarding differences in the participation motivation in leisure sports when it comes to the demographic variables, as can be seen from Table 1, among the various constructs of participation motivation in leisure sports in relation to the demographic variables, the most significant differences are seen in construct of "sense of achievement". This means that students in this

district hold starkly different expectations toward self-fulfillment in the exercises. If these differences could be reduced, more students in this area are sure to participate in leisure sports. Moreover, significant differences are detected in "experience in different school teams", "experience in sports clubs" and "interest in sports" when it comes to the demographic variables, meaning that relevant sports experience is influential on participation motivation. It is therefore advisable to establish school teams and work vigorously to develop and design opportunities for club participation and sports in order to stimulate the students' motivation in sports participation. Of all the demographic variables concerning primary school students of higher grades, significant differences are detected in sports participation motivation when it comes to "gender", "experience in different school teams", "experience in sports clubs" and "interest in sports". When it comes to "differences between schools", differences are found in "sense of achievement" and "interpersonal relationship" and not in any other constructs.

H1: Significant differences are found in the participation motivation of primary students of higher grades in Houli District, Taichung City in leisure sports when it comes to the demographic variables.

After tested by appropriate statistical methods, the results (see Table 1) are found to coincide with those proposed in Ebben, and Brudzynski (2008), Ingledew and Markland (2008).

(2) Differences in the constraints for leisure sports when it comes to the various demographic variables

As shown in Table 2, among the various constructs of leisure sports constraints in relation to the demographic variables, equally significant differences are seen in the constructs of "individual performance and emotional factors" and "sports ground, facilities and interpersonal factors". This means that individual performance and sports facilities are of equal importance to the students in this district. If the teachers could give the students so much more information and encouragement that they could be better satisfied with their own performance, the participation constraints for these primary school students are sure to be reduced. Moreover, significant differences are detected in "experience in different school teams", "experience in sports clubs"

Table 1. Summary on the significant differences in relation to participation motivation

Demographic variables	Participation motivation in leisure sports			Results of the hypothesis test
	Sense of achievement	Physical fitness	Interpersonal relationship	
Gender	*	*		Partially supported
Grade				Not supported
Experiences in different school teams	*	*	*	Totally supported
Experiences in sports teams	*	*	*	Totally supported
Size of the sports ground				Not supported
Interest in sports	*	*	*	Totally supported
Differences among schools	*		*	Partially supported
Teaching mode of the teachers				Not supported
Educational background of the parents				Not supported

* represents that significant differences are detected in this dimension

and "interest in sports" and "differences between schools" when it comes to the demographic variables, meaning that these factors are greatly influential on constraints for the primary school students of higher grades to participate in leisure sports. "Differences between schools", in particular, are so important because school tend to develop their own characteristic sport.

H2: Differences among demographic variables in relation to the constraints for leisure sports of primary students of higher grades in Houli District, Taichung City are not significant.

After tested by appropriate statistical methods, the results (see Table 2) are found to coincide with those proposed in Allison and Makin (1999), Arzu, Tuzun, and Eker. (2006), Hohepa, Schofield, Kolt (2006), Ebben, and Brudzynski (2008).

Analysis of the correlation between the participation motivation and constraints for leisure sports

Table 2. Summary on the significant differences in relation to the constraints

Demographic variables	Leisure sports constraints		Results of the hypothesis test
	Individual performance and emotional factors	Sports ground, facilities and interpersonal factors	
Gender	*		Partially supported
Grade			Not supported
Experiences in different school teams	*	*	Totally supported
Experiences in sports teams	*	*	Totally supported
Size of the sports ground			Not supported
Interest in sports	*	*	Totally supported
Differences among schools	*	*	Totally supported
Teaching mode of the teachers			Not supported
Educational background of the parents			Not supported

* represents that significant differences are detected in this dimension

In this section, a Pearson product - moment correlation analysis is conducted on the three constructs of leisure sports participation motivation (sense of achievement, physical fitness and interpersonal relationship) and the two constructs of the constraints (individual performance and emotional factors, sports ground, facilities and interpersonal factors) in order to probe into the correlation between the motivation and constraints for primary school students of higher grades to participate in leisure sports. As has been proposed in Chang (1999), the correlation should be deemed as low when the correlation coefficient is below .30, middle when the correlation coefficient is .30~.70, high when the correlation coefficient is .70~.90 and extremely high when the correlation coefficient is over .90.

As can be seen from the results, between the participation motivation and constraints for leisure sports, except for the significantly positive correlation when it comes to "interpersonal relationship, only middle or low negative correlation has been detected. In other words, an increase in the sports participation motivation will result in a reduction in the constraints. This result is consistent with Caroll and Alexandris (1997), Iwasaki (2003). The differences in the motivation to participate in leisure sports caused by "interpersonal relationship" might be traced back to the fact that interpersonal relationship is at the same time a source of constraints for primary school students of higher grades.

Table 3. Table of Detailed Relevant Analyses of the Various Constructs of the Motivation and Constraints for Leisure Sports Participation

Variable		Participation motivation in leisure sports		Participation constraints for leisure sports		
Variable	Dimension	Sense of achievement	Physical fitness	Interpersonal relationship	Individual performance and emotional factors	Sports ground, facilities and interpersonal factors
Participation motivation in leisure sports	Sense of achievement		-	-	-	-
	Physical fitness	.710*		-	-	-
	Interpersonal relationship	-.316*	-.283*		-	-
Participation constraints for leisure sports	Individual performance and emotional factors	-.401*	-.317*	.862*		-
	Sports ground, facilities and interpersonal factors	-.328*	-.286*	.916*	.833*	

*p<.05

Table 4. Table on the Analysis of the Correlation between the Motivation and Constraints for Leisure Sports Participation and on the Hypothesis Test

Participation motivation in leisure sports	Leisure sports constraints			Results of the hypothesis test
		Individual performance and emotional factors	Sports ground, facilities and interpersonal factors	
	Sense of achievement	*	*	Supported
	Physical fitness	*	*	Supported
	Interpersonal relationship	*	*	Supported

*p<.05

H3: Participation motivation in leisure sports and leisure sports constraints are significantly correlated to each other when it comes to the primary students of higher grades in Houli District.

Conclusion

1. Motivation factors for the primary school students of Houli District in terms of their participation in leisure sports.

The sports participation motivation of primary school students of higher grades is mainly comprised of such three factors as "sense of achievement", "physical fitness" and "interpersonal interactions", as ranked by their influence.

2. Constraints for the primary school students of Houli District in terms of their participation in leisure sports.

In terms of the overall scores, "sports ground, facilities and interpersonal factors" outscores "individual performance and emotional factors".

3. Demographic variables and participation motivation in leisure sports.

Of all the demographic variables concerning primary school students of higher grades, significant differences are detected in sports participation motivation when it comes to "gender", "experience in different school teams", "experience in sports clubs" and "interest in sports". When it comes to "differences between schools", differences are found in "sense of achievement" and "interpersonal relationship" and not in any other constructs.

4. Demographic variables and constraints for leisure sports.

Of all the demographic variables concerning primary school students of higher grades, significant differences are detected in sports participation constraints when it comes to "gender", "experience in different school teams", "experience in sports clubs" and "interest in sports". When it comes to other demographic variables, no significant differences are found.

5. Correlation between the participation motivation and constraints for leisure sports.

Between the participation motivation and constraints for leisure sports, except for the significantly positive correlation when it comes to "interpersonal relationship, only middle or low negative correlation has been detected.

Suggestions

1. Suggestions for the educational personnel devoted to promoting physical education in schools.

(1) 'Sense of achievement" is a vital component of the sports participation motivation for primary school students of higher grades. It is suggested therefore that planners of PE courses should place the emphasis on courses that could increase peak experience and incur effective feedbacks.

(2) As can be seen from the results of this study, an important driving factor behind "sense of achievement" is "the possibility to increase one's physical fitness". It is therefore necessary for PE teachers of primary school students of higher grades to respond to the needs of the students for greater physical fitness and increase their satisfaction with their individual performance. It is also advisable to inculcate the knowledge concerning physical fitness to students of different grades in a gradual manner.

(3) Of all the constraints for primary school students of higher grades to participate in leisure sports, "sports ground, facilities and interpersonal relationship" is the most important. Planners of PE courses are therefore suggested to take the current teaching and learning environment on the campus and select an appropriate sports ground for the course. Only in this way could the constraints be reduced and increase the students' satisfaction with the courses.

(4) "Gender", "experiences in different school teams", "experiences in sport teams", "interest in sports" and "differences among schools" are important in terms of both the motivation and constraints for leisure sports participation. It is therefore suggested that gender equality be taken into consideration during course design and the opportunities for sports participation be diversified so that the students could have more participation experiences. It is moreover advisable to design fun teaching and physical activities to increase the students' participation motivation and reduce the participation constraints.

2. Suggestions for future studies.

The subjects of this study are limited only to the primary school students of higher grades in Houli District, Taichung City. If future researchers should set out to probe deeper into relevant issues on primary school students of higher grades, it is advisable to extend the scope of research subjects to include primary school students of higher grades from other cities and counties so that the study could be broad and longitudinal in nature. Qualitative studies devoted to the analysis of underlying meaning of the data are also suggested so that the deeper and more objective investigations could be conducted on the issue of the motivation and constraints for the participation in leisure sports.

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INFLUENCE ON KINDERGARTEN TEACHER'S JOB SATISFACTION FROM KINDERGARTEN ORGANIZATION CULTURE AND WORK PRESSURE

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Abstract

After its official implementation of Integration of Early Childhood Care and Education Policy in 2012, Taiwan has become the first country across Asia to implement Integration of Early Childhood Care and Education. However, numerous early childhood education entrepreneurs and teachers speak frankly that Integration of Early Childhood Care and Education has given too little time to early childhood education entrepreneurs, teacher adjustment, the number of students in classes, equipment, personnel allocation ad adaption, let alone temporary childcare and night-time childcare's tremendous pressure on kindergarten teachers. All these may affect kindergarten teacher's teaching performance. Therefore, this research intends to explore what job satisfaction and work pressure are for current kindergarten teachers, and if kindergarten organization culture and teacher's work pressure also affect job satisfaction. To collect kindergarten teachers' comments, this research utilizes questionnaires to interview 188 Taipei public and private kindergarten teachers. The result indicates that teachers interviewed have universally asserted that their workloads are heavier than previous ones and their sense of work achievement and sense of remuneration satisfaction have been lowered dramatically since the implementation of Integration of Early Childhood Care and Education. To enhance teacher's job satisfaction,

we can start from thinking of perspectives of workload, inter-personal relationship, work feedback, teamwork and teaching autonomy. Accordingly, this research has presented some research recommendations.

Keywords: Kindergarten, Organization Culture, Work Pressure, Job Satisfaction

Preface

Ever since the year of 2000, child-bearing ages for women of child-bearing age in Taiwan have increased year by year. The number of babies given birth has been decreasing. Going forward, population could turn into negative growth (Department of Household Registration, Ministry of The Interior, 2012). Decreased population over the years has created heavy burdens of recruitment difficulty and operation pressure for kindergartens. Kindergarten is the first to suffer from fewer children. For public kindergartens, they have dropped from 66 children per kindergarten in 1993 to 54 children per kindergarten in 2004 (18% reduction). As for private kindergartens, they have dropped from 112 children per kindergarten to 86 children per kindergarten (23% reduction). Fewer children have already impacted kindergartens (Ministry of Education, 2006).

In addition to the issue of fewer children, numerous public and private kindergartens and day-care centers have presented related discussions on the Integration of Early Childhood Care and Education Policy since Taiwan's official launch of this policy back in 2012. Such discussions included: after integration of early childhood care and education, kindergartens will increase temporary childcare and night-time childcare in order to reduce burdens on dual-income families; related laws and regulations are not yet in place; both teachers and funding are insufficient. Starting from 2012, teacher/ student ratio will be changed to 1: 8 (current ratio is 1:13) across the board. This has created different impacts to kindergartens and day-care centers respectively, and it also leads to the doubt that kindergarten teacher standards are being lowered accordingly. Numerous kindergarten entrepreneurs and teachers have spoken frankly that Integration of Early Childhood Care and Education has given too little time to early childhood education entrepreneurs, teacher adjustment and adaptation. It is very difficult to get the number of students in classes, equipment and personnel allocation to comply with requirements at the first time, let alone temporary childcare and night-time childcare's tremendous pressure on kindergarten teachers (Duan, Hui-Yin, Ma, Tsu-Lin, 2013).

From these it is understood that kindergarten teachers not only face with fewer children impact, they also need to explore more diversified recruitment channels and teaching pressure, and need to work together with kindergartens to co-adjust and co-adapt to changes incurred from Integration of Early Childhood Care and Education. On the other hand, as per

Wang, Mei-Chin's (2013) research finding, almost all kindergarten teachers feel the burden generated from work pressure. The higher kindergarten teacher's perception of work pressure is, the lower their job satisfaction is.

Mclaughlin indicated in his long term case study comparison research report presented in 1995 that the reason for performance differences from students in two schools might be because of teacher-learning community formed among teachers in the school with better performance. There were close interaction, cohesion, passion and commitment among teachers. Accordingly, the whole school presented a positive organization culture (Deal & Peterson,1999). As such, organization culture is also a critical factor affecting teacher's job satisfaction and performance (Cheng, Jun-Yuan, 2013; Sun, Kuo-Hwa, 2013; Lee, Jin-Jin, 2013; Wang, Su-Jen, 2013; Liu, Sho-Ji, 2012).

Therefore, this research intends to explore current kindergarten teacher's job satisfaction and work pressure under fewer-children wave and new launch of Integration of Early Childhood Care and Education policy, and if kindergarten organization culture and teacher work pressure also affect job satisfaction. It is hoped that result of this research could serve as a feedback and reflection on policy promotion.

Document Exploration

Organization Culture

Research conducted by scholars, including Ouchi, have considered that organization culture represents perception of value, belief or religion owned and shared by all members of the organization (Ouchi, 1981). Tunstall and Tucker considered that organization culture represents custom, habit, ritual or symbol of an organization (Tunstall, 1986). Peter and Waterman considered that organization culture is a behavioral pattern or behavioral norm complied by all members of the organization (Peter & Waterman, 1982). While some scholars considered that organization is organization member's attitude or cognition (Robbins, 2000), law of communication (Schein, 1993), or communication of information (Borman & Motowidlo, 1993). There are also some scholars who considered organization culture as a fundamental hypothesis of philosophical level which serves as the ultimate instruction guideline for organization members 'thinking and problem solving" (Schein, 1993; Cheng, Jun-Yuan, 2013).

Ebert and Griffin (2000) further explained that organization culture can assist an organization to achieve the following purposes: 1. Organization culture can lead employee to work hard and assist employee to work toward common goal; 2. Organization culture can assist new employee in learning expected behavioral pattern; 3. Organization culture provides each company with its unique features. Robbins (2000) also pointed out that organization culture can serve as a meaning determination and control mechanism in order to guide and shape organization member's attitude and behavior. Additionally, some scholars presented organization culture measurement perspectives which can serve as references for this research (Wang, Mei-Chin, 2013; Wang, Su-Jen, 2013; Lee, Jin-Jin, 2013) : Schein

(1993) first categorized organization culture nature into 6 perspectives of: 1. Routine behavioral pattern. 2. Norm. 3. Perception of values. 4. Policy. 5. Rules. 6. Climate and atmosphere. Campbell (1990) presented 15 perspectives after organizing related documents: 1. Confliction solution. 2. Culture management. 3. Customer orientation. 4. Reform orientation. 5. Employee participation. 6. Definite goal. 7. Human resource orientation. 8. Organization identification. 9. Duty emphasis. 10. Management style. 11. Organization focus. 12. Organization integration. 13. Performance orientation. 14. Remuneration orientation. 15. Mission structure. Martin (1992) also did a research and pointed out that modern organization culture should emphasize teamwork, employee autonomy, sense of trust, aggressive innovation and flexibility (Sun, Kuo-Hwa, 2013). Huang, Yin-Shan and Chi, De-Chang (2004) divided organization culture measurement scale into perspectives of operation philosophy, customer orientation, teamwork and active innovation.

Work Pressure

Liu, Shi-How (2013) and Chou, Jia-Yo (2005) quoted Michie's (2002) views on pressure and asserted that pressure is the result of interaction between an individual and organization environment. When an individual is placed in an uncertain, uncontrollable, intimidating or unknown environment, physically and mentally negative reaction may be generated once pressure is beyond an individual's ability to handle (Liu, Si-How, 2013; Hsieh, Jia-Yi, 2012; Jiang, Jia-Shun, 2012; Wu, Min-Jun, 2012; Lee, Chin-Min, 2011; Hsiao, Kuo-Cang, 2011). Work pressure generally refers to pressure reaction incurred as a result of work related incident. A comprehensive look at current domestic education environment changes indicates that teachers are not merely engaged in teaching and solving confusion. They now need to assume several different roles and, needless to say, work pressure incurred is tremendous (Hsieh, Jia-Yi, 2012; Wu, Min-Jun, 2012). This research also organized previous teacher work pressure related definitions which are listed in the following Table 1.

Table 1. Definitions of Teacher Work Pressure

Scholar	Year	Definitions of Teacher Work Pressure
Kyriacou & Sutcliffe	1978	This is a kind of teacher's negative emotional reaction (such as anger, anxiety or depression) generated from requirements imposed on teacher by teacher work role, and this may be accompanied by physiological changes which may lead to sickness.
Needle	1980	Teacher work pressure originates from differences between teacher's needs, perception of values as well as expectation and career remuneration or work requirements, and teacher's ability to meet with these needs.
Moracco & Mcfadden	1981	Teacher's work, teacher's perception of work requirements' threat to self–respect and happiness, and coping mechanism used

Scholar	Year	Definitions of Teacher Work Pressure
		to maintain stable condition will trigger changes to mental stable condition as well as physiological changes.
Lee, Mei-Lin	2004	Upon a teacher's engagement in work related teaching activity, and when faced with potential work scenario factors or threatening requirements, negative emotional feelings and nervous state incurred as a result of an individual's inability to adapt accordingly. ◦
Huang, Shu-Ron	2004	With respect to teaching duty of a teacher, his or her own perception of threat or negative feelings and even anxiety, nervous emotion or mental/physical disease generated from interaction process with people, things or situations in the environment of school.
Wu, Zong-Da	2004	When a teacher is faced with school work environment and in fields of teaching, administration, counselling and role playing, his/her imbalance generated between internal perception and external environment which leads to mental, physiological and cognitive sense of pressure as well as negative emotion and behavioral reaction.
Pan, Shu-Jen	2009	During interaction process between early child education and teaching teachers and kindergarten scenario, negative feelings generated from teaching, administration, students, parents, colleagues and superiors. This is a sign of influence of work exhaustion.
Kuo, Shu-Jen, Chen, Yi-Jun	2010	During teacher's conducting of teaching in school, sense of disturbance, threat, hopeless and even negative emotion generated when faced with expectation or requirements from students, parents, colleagues and superiors as well as limits from resources or environment.

Job Satisfaction

As early as 1935, Hoppock first presented the concept of job satisfaction in his book of "Job Satisfaction." Hoppock thinks job satisfaction includes worker's mental and physiological sense of satisfaction over environment. It can be described as a worker's subjective reaction to work scenario. Similarly, scholar Locke (1973) also defined job satisfaction as "positive or happy emotional state generated from an individual's assessment of his/her work or work experience." As such, job satisfaction mainly refers to an individual's subjective emotional reaction to work. Such perception of work will be affected by numerous factors and form a kind of comprehensive sense of job satisfaction. It can be understood roughly from the following three meanings: overall definition, expectation discrepancy definition ad frame of reference definition (Chen, Ji-

Qiang, 2013; Wu, Gwan-Shen, 2012; Chiu, Yu-Qi, 2012; Chang, Chun-Zi, 2009).

(1) Overall Satisfaction

Overall concept emphasizes on worker's attitude, perception, assessment and reaction to work and surrounding environment. This is a summarized and simple description method (Huang, Shu-Ron, 2012; Yang, Ya-Jun, 2012; Xue, Zong-Huang, 2008; Su, Hui-Jen, 2012).

(2) Expectation Discrepancy

Expectation discrepancy measures job satisfaction in a comparative point of view. It mainly compares worker's expectation/wish with actual perception (Huang, Shu-Ron, 2012; Yang, Ya-Jun, 2012; Xue, Zong-Huang, 2008; Su, Hui-Jen, 2012).

(3) Frame of Reference

This is built on the theory that population background, such as gender, age, education level, income, duty seniority, service years and so on, affects an individual's perception of job satisfaction (Huang, Shu-Ron, 2012; Yang, Ya-Jun, 2012; Xue, Zong-Huang, 2008; Su, Hui-Jen, 2012; Pon, Jia-Sin, 1979).

Research Methodology

Research Structure

To understand if kindergarten teacher's job satisfaction is affected by organization culture and work pressure, this research hereby presents the following structure. With respect to organization culture, this research integrates theories from related scholars and defines organization culture as: organization culture comes from years of accumulation of an organization's common vision and mission (operation philosophy), perception of values (core concept), belief, custom and habit, ritual and symbol and behavioral norm. Because of this, it is different from other enterprise organization's culture presentation, and it is the congregation of employee cohesiveness and driving force of customer orientation and aggressive innovation. This research takes references from theories presented by scholars of Robbins (1996), Post and Coning (1997), Harper and Utley (2001), Huang Yin-Shen and Chi, De-Zhang (2004), and it categorizes organization culture measurement scale into perspectives of customer orientation, teamwork and active innovation.

As for work pressure, this research takes references from work pressure measurement scales presented by scholars of Borg and Riding (1993), Chaplain (1995), Kelly and Bethels (1995), Alison and Berthelsen (1995) and Pearson and Moomaw (2005), and designs measurable kindergarten teacher work pressure measurement scale based on characteristics and work environments of the ones interviewed. It also defines overall work pressure as measurement over kindergarten teacher's level of pressure perception with respect to inter-personal relationship, level of perception with respect to kindergarten or colleague's interference with teaching autonomy, level of perception with respect to work load as well as perception of work feedback.

With respect to job satisfaction, this research takes reference from a research on re-building public and private institute organization member's job satisfaction measurement scale conducted by Tsai,

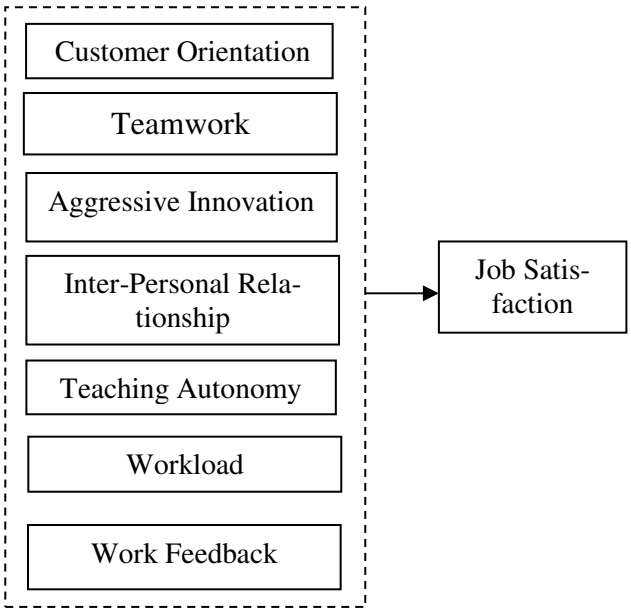

Figure 1. Structure of This Research

Min-Hong (2008). Through statistics methodologies of item analysis and factor analysis, Tsai, Min-Hong re-built a job

Questionnaire Measurement Methodology and Structure

(1) Organization Culture

With respect to measurement methodology, this research utilizes Likert Scale to measure kindergarten teacher's perception on organization culture (very agree 5 points, agree 4 points, average 3 points, disagree 2 points, very disagree 1 point). Measurement scale includes the following three perspectives:

A. Customer Orientation: This mainly measures if employees understand customer service standard, and if they are able to meet with different customers' needs and respect customers.

B. Teamwork: This is to understand levels of collaboration, communication and coordination among organization employees.

C. Aggressive Innovation: This measures the level of organization member's pursuit of innovation and change, and if employees are performing duties actively and aggressively and provide innovation actively.

(2) Work Pressure

With respect to work pressure measurement, this research utilizes Likert Scale to measure kindergarten teacher's perception on work pressure (very agree 5 points, agree 4 points, average 3 points,

disagree 2 points, very disagree 1 point). Through measurements on pressure readings of these four perspectives, it indicates that kindergarten teacher's work pressure is higher if the reading is higher. Definitions for the following four perspectives are:

A. Inter-Personal Relationship: Interaction between teachers and administration personnel, among teachers and between class children and parents; ◦

B. Teaching Autonomy: Level of teacher's self-control in teaching which includes design, planning and utilization of classes;

C. Workload: Kindergarten teacher's scope and duty of work which includes all teaching (regarding design, implementation of teaching in class, operation of class ad children's learning) and non-teaching administrative work, i.e., amount of workload a teacher can assume which includes appropriateness in allocation of time and amount of work;

D. Work Feedback: Feedback on kindergarten teacher's work salary and individual's promotion and development.

(3) Job Satisfaction

According to job satisfaction categorization by Tsai Ming-Hong (2008), job satisfaction includes six perspectives of "Sense of Work Achievement", "Remuneration Satisfaction", "Superior Satisfaction", "Work Support", "Colleague Relationship" and "Promotion Opportunity."

A. Sense of Work Achievement: Level of work achievement satisfaction from contents of work and from doing the work;

B. Remuneration Satisfaction: Level of satisfaction over salary and benefits obtained from working;

C. Superior Satisfaction: Level of satisfaction over direct superior;

D. Work Support: Level of satisfaction over various resources needed during work process as well as support needed to complete work;

E. Colleague Relationship: Level of satisfaction over getting along and communication with colleagues working together;

F. Promotion Opportunity: Level of satisfaction over promotion channel and opportunity from work.

This research utilizes Likert Scale to measure kindergarten teacher's perception on work pressure (very agree 5 points, agree 4 points, average 3 points, disagree 2 points, very disagree 1 point).

Background of People Interviewed

People interviewed in this research are teachers working in public or private kindergartens in Taipei City. Researcher went to pre-agreed kindergartens with questionnaire interviewers to conduct interview. Interview period started from Oct. 3rd 2014 to Oct. 29th, 2014. It took people interviewed roughly 10 minutes to fill in each questionnaire. In the event

of any question raised during filling in a questionnaire, it is answered by researcher and interviewer personally. At the end of the day, this research retrieved a total of 188 questionnaires. Gender for all teachers interviewed is female with 52 of them under the age 30, 81 of them aged between 31 to 40 and 55 of them aged between 41 and 50. 134 of them come with university (including college) education background with 54 of them received master's degree. 133 of them have service years of below 10 years and the remaining of people interviewed have service year of more than 11 years. 156 teachers also assume administrative duty in kindergarten.

Research Analysis

1. Analysis of Satisfaction over Work Pressure and Job Satisfaction Before and After Integration of Early Childhood Care and Education

(1) Work Pressure

According t-test result, interviewed teachers consider their work load is even heavier after Integration of Early Childhood Care and Education. This indicates that teachers consider they now assume more workload on teaching (regarding design and implementation of class teaching, operation of class and children learning) and non-teaching administrative work - i.e., workload a teacher can assume which includes appropriateness of allocation of time and amount of work - as compared with workload before policy implementation.

(2) Job Satisfaction

With respect to job satisfaction, teachers interviewed considered that their sense of work achievement and sense of remuneration satisfaction have all been lowered dramatically after implementation of Integration of Early Childhood Care and Education policy. This indicates that teachers considered that their level of work achievement satisfaction from contents of work and from doing the work have been lowered dramatically after implementation of Integration of Early Childhood Care and Education policy. Furthermore, the level of salary and remuneration satisfaction obtained from work is also lower.

2. Analysis of Linear Structural Equation

To test if research structure presented in this research matches with interviewed people's comments, this research organizes critical test items and threshold values of linear structural equation as follows. It is observed that all test items exceed threshold values and they are all in the good scope. This indicates that pattern for this research matches with interviewed people's comments. According to linear structural equation result, work load, inter-personal relationship, work feedback, teamwork and teaching autonomy affect teacher's job satisfaction. That is, kindergarten teachers' job satisfaction is higher if their work amount is lowered, inter-personal relationship is better, salary feedback and promotion development is better, kindergarten teamwork capability is stronger and their level of teaching control is higher.

Table 2. Analysis of Satisfaction over Work Pressure

Perspective	Average Reading Before Integration	Average Reading After Integration	t value	Significance
Inter-Personal Relationship	3.28	3.33	3.846	.092
Teaching Autonomy	2.56	2.49	1.992	.102
Workload	3.35	4.01	11.154	.001***
Work Feedback	2.81	2.77	2.752	.099

*** $p < .001$

Table 3. Analysis of Job Satisfaction

Perspective	Average Reading Before Integration	Average Reading After Integration	t value	Significance
Work Achievement	3.87	3.11	10.293	.003**
Remuneration Satisfaction	3.72	3.03	9.395	.011*
Superior Satisfaction	3.63	3.71	.963	.328
Work Support	3.23	3.31	.057	.811
Colleague Relationship	3.51	3.60	3.271	.712
Promotion Opportunity	3.33	3.19	3.985	.072

* $p < .05$, ** $p < .01$

Conclusion and Recommendations

According to t-test result of this research, interviewed teachers generally commented that their workload is heavier and their sense of work achievement and sense of remuneration satisfaction are lowered dramatically after implementation of Integration of Early Childhood Care and Education policy. To further understand actual situation, this research also questioned kindergarten teachers of causes on their comments. Several teachers reflected that government promotes this policy too quickly. On the software side, the majority of kindergartens find it difficult to lower teacher/student ratio within short time. As for hardware, numerous kindergartens have to make modifications on their existing facilities in limited amount of time. This causes heavy operation and eacher pressure on kindergartens. Furthermore, salary has not be adjusted accordingly. This also creates heavy burden to teacher and kindergarten's operation. To enhance kindergarten teacher's job satisfaction, this research considers that, according to linear structural equation result of this research, we can start from thinking in the fields of workload, inter-personal relationship, work feedback, teamwork and teaching autonomy. Accordingly, this research hereby presents the following comments:

1. Government and kindergarten can establish consulting channel to mitigate teacher's workload

According to finding of this research, teachers recently feel pressured on issues of Integration of Early Childhood Care and Education, promotion of education reform as well as the rise of perceptive parents' awareness of power to participate in school affairs. This is further aggravated by the new launch of education policy. With respect to various issues to some kindergarten teachers, they have to deal with heavy work load in school, adapt to changes in education environment while, in the meantime, assume huge responsibility to support their families or raise children, and they specifically suffer from higher pressure. As such, education organization must utilize teacher's own needs and adaptation ability as basis for reference when drafting education policy in order to avoid sense of exhaustion generated from teacher's exhausted response to ill-communicated education policy. In addition to maintaining smooth communication channel which is equal, reciprocal and professional, it is even more important to aggressively guide teachers to face with current complicated education environment in a more positive attitude. On specific practices, author of this article considers that education related administration organization and school must establish smooth teacher consulting and life guidance system which will be equipped with professional education and mental counseling personnel in order to assist some senior teachers to obtain emotional balance in their responsibility life between family and school as well as to establish good adaption capability.

2. Fulfill kindergarten internal support system to lower sense of work pressure

According to finding of this research, kindergarten teachers suffer from huge

amount of work and heavy burden but they cannot receive recognition or deserved feedback from work. Therefore, under the circumstance of huge amount of work and heavy burden, kindergarten internal support system is indeed very important. This research recommends that we can start from the following points: establishment of horizontal and vertical communication to really understand teacher's needs and opinions and provide appropriate support and assistance. Furthermore, enhancement of interaction opportunity among colleagues such as network activities, gathering, teaching learning activity, experience and emotion sharing should be implemented. Senior teachers will conduct experience inheritance activities such as consulting on issues of administration, teaching and inter-personal relationship in order to lower new teacher's work pressure and learning of better interpersonal communication skills. As for kindergarten parent's support, activities such as teacher-parent networking event can be conducted to allow parents to understand kindergarten teaching concept and class operation pattern and to enhance mutual understanding and smoothness of communication channel. In addition, parents can be recruited to participate in kindergarten volunteer activities to encourage parents with specialties to assist in teaching activities by exploring their expertise, and to allow parents to experience hard work involved in teaching.

3. Enhance communication between kindergarten and teachers

To enhance kindergarten teacher's teaching autonomy, work feedback, interpersonal relationship, and to lower their workload, this research tries to present the following recommendations to kindergartens:

(1) Supervisors can try to treat communication as a task which must be performed daily

This research suggests that, in order to enhance communication between kindergarten and teacher, kindergarten can treat communication as a task which must be performed daily, or an important thing-to-do item. Kindergarten can arrange the best timing for communication with teacher depending daily working condition. If time allows, kindergarten can routinely appropriate 15 minutes daily to take turns conduct conversation with teachers. This conversation is not necessarily confined to indoors. Location for such conversation can also be resting room or recreation area. On one hand, this allows understanding of each teacher's current condition and real-time response and feedback to teacher's comments. On the other hand, this can also motivate them.

(2) Adopt appropriate communication channel

Kindergarten can first examine its own strong points before selecting communication channel suitable for itself and selecting teachers who are most capable of receiving its message in a correct manner. For instance, some communication is only suitable for face to face communication which includes kindergarten's publishing of some formal news in a hope to solve conflicts within kindergarten. While some communication is appropriate for relax and

casual communication such as random meal gatherings which allow colleague to talk about their lives.

(3) Establish other appropriate opinion expressing channel and fulfill feedback mechanism

This research considers that, for some issue, it is inconvenient for teacher to express face-to-face their comments to kindergarten, or they are concerned that their expression of comments will receive kindergarten's attention. With respect to such issue, this research recommends to install suggestion box or employee hotline in kindergarten. No matter what the form is, it is critical that teachers should be ensured to express their views anonymously. Furthermore, kindergarten must take those views seriously and offer real-time feedback message (feedback comments are needed regardless if views are adopted or not adopted) as long as there are views expressed by kindergarten teachers. In the meantime, kindergarten is recommended to offer rewarding feedback to teacher in due time if teacher's suggestion or comments come with positive meaning.

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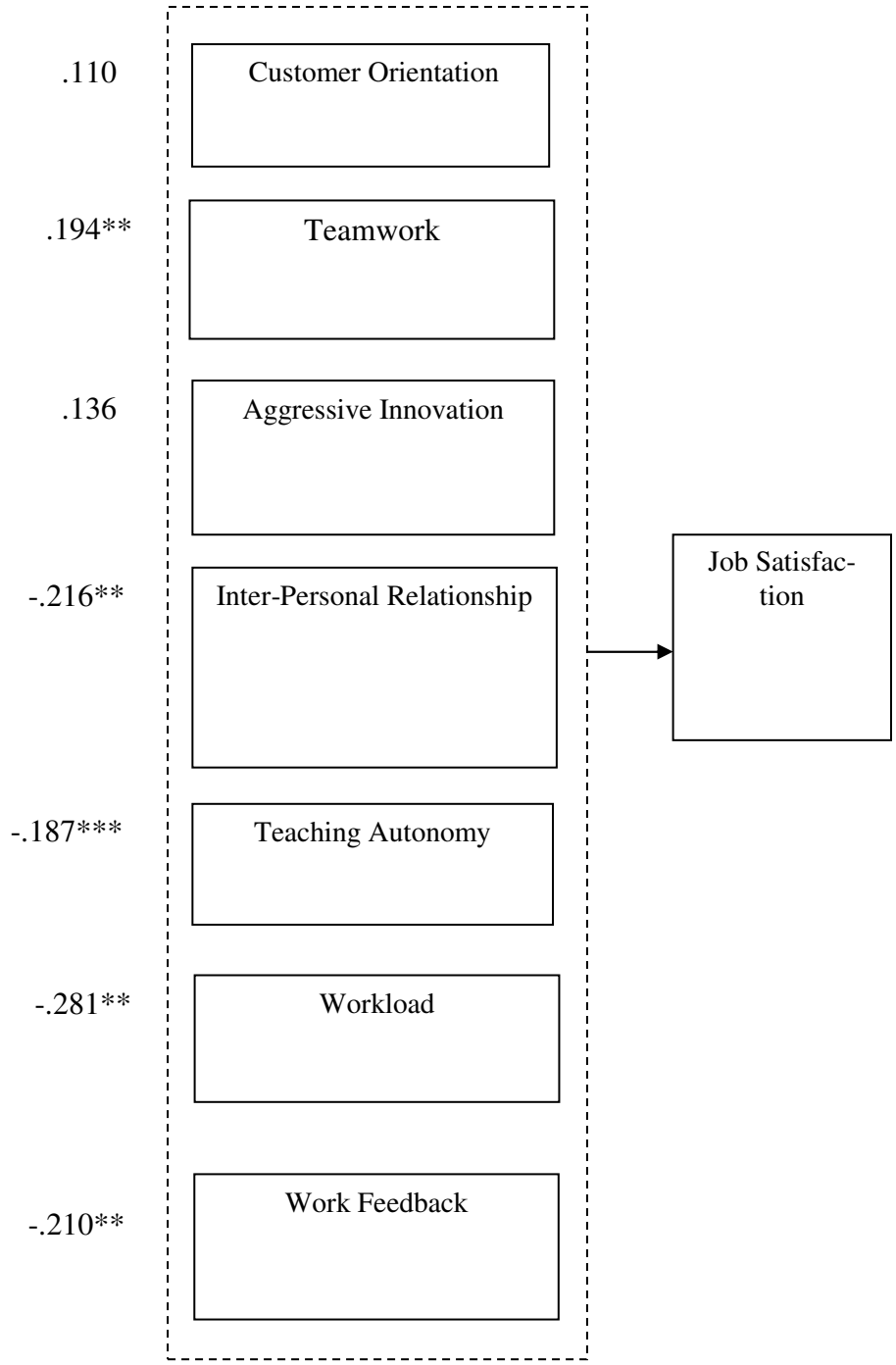
Table 4. Summary of Linear Structural Equation Threshold Values

Equation Appropriateness	Threshold Value	Equation of This Research Appropriateness	Assessment
Absolute Appropriateness Indicator			
Likelihood-Ratio χ^2	$p \geqq .05$	86.29***	Good
GFI	$\geqq .90$	.955	Good
AGFI	$\geqq .90$	.916	Good
SRMR	$\leqq .05$	.012	Good
RMSEA	$\leqq .08$	.071	Good
RMR	$\leqq .05$	.045	Good
Value-Added Appropriateness Indicator			Good
NFI	$\geqq .90$	.914	Good
NNFI	$\geqq .90$	.923	Good
RFI	$\geqq .90$	.918	Good
IFI	$\geqq .90$	.920	Good
CFI	$\geqq .90$	.929	Good
Simple Appropriateness Indicator			Good
PGFI	$\geqq .50$	.612	Good
PNFI	$\geqq .50$	.602	Good
PCFI	$\geqq .50$	.592	Good
Likelihood-Ratio χ^2/df	$\leqq 3$	2.21	Good

Figure 2. Illustration of Factors Affecting Job Satisfaction



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THE RESEARCH OF DYNAMIC IMAGES USING EFFECTS IN CHILDREN WEBPAGE

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Abstract

The population of children using Internet has been increasing year by year and the webpage for children also springing up slowly. Nowadays the design form of interfaces for Dynamic Websites provides more varieties, interactive levels and also commonly applied to the interfaces of children' webpage. It becomes the current trend for websites interaction. However, the interactive navigation interfaces for dynamic websites are more complicated than the conventional interfaces for static websites. Therefore, although the Internet provides various information displays, it relatively becomes a burden for children while browsing and finding the needed target.

Navigation interface is the major factor influences user's experience on website, therefore, to realize children's preference and need for dynamic website's navigation interface will facilitate the design of children's dynamic multimedia websites. Consequently, the usability and the convenience of children' webpage design will become children' image for Internet and affect children' opinion of it.

Based on the children' webpage features of WWW in Taiwan's domestic government and non-government organizations, the first stage of this study took the National Elementary School children as the object and used the Semantic scale questionnaire as a pre-test to investigate and classify the dynamic navigation interface website's presentation in order to realize present tendency and usage of children website's navigation interfaces.

The second stage of this study is to investigate children' Semantic scale questionnaire, according to the website of such interface classification, in order to realize how the dynamic navigation interfaces affect children on the visual and operational aspects, and provide appropriate suggestions as the reference for the design of children's multimedia dynamic websites.

According to the study result, it takes the shortest time for children to finish the task in the medium navigation visual attraction degree website, and the next is the lower degree, and then the higher one. This indicates that the extremes of navigation visual attraction degree websites are negative for task achievement speed. As to the task accuracy aspect, this study found out the visual attraction degree did not affect directly to the task accuracy for children users. For the emotion sensation aspect, the study result indicates the visual attraction degree of children websites affects remarkably positive to the feeling of usability and fun aspects of children, but not for the joyful, website quality feeling, and visual attraction degree aspects.

Key Words: Dynamic website, children' webpage, vision

Introduction

Background of Research

The Internet has become an indispensable part of life, thanks to continued technology breakthroughs. Meanwhile, online usage among children and youths 19 years or younger has been on the rise.

In Taiwan, junior high and elementary school students are required to take information technology courses. According to a January 2011 survey by the Taiwan Network Information Center (TWNIC), online usage among this group has reached 100% (Figure 1, TWNIC, 2011), making it Taiwan's biggest online population.

Rapid development of the Internet has led to more diverse webpage interface designs to suit different groups. Specifically, many government agencies have set up websites for children, most of whom are quite familiar with the Internet as they are required to learn or do homework via the Web.

Given such, children's website designers are faced with the challenge of creating pages that are useful, attractive and user-friendly, in the process helping children gain confidence and social skills (Weng, 2009).

Motivation for Research

While many children's websites claim to include children-friendly features (Cai, 2003), this is not always the case – oftentimes the interaction and image designs of these websites are not suitable for operation by children, many of whom have expressed dislike and impatience for these sites. (Nielsen, 2002).

Yet technological progress has led to a wider range of interfaces. For example, a dynamic interface design may be attractive to children yet may also lower the user's productivity (Scaller,

Chow, Marth, Heo & Allison-Bunnell, 2004).

Objectives of Research

Based on the children' webpage features of WWW, this study is going to investigate and classify the dynamic navigation interface website's presentation in order to realize present tendency of website's navigation interfaces. The second stage of this study is to investigate children according to the website of such interface classification to realize children's preference and needs of dynamic navigation interfaces, and provide appropriate suggestions as the reference for the design of children's multimedia dynamic websites.

Research Question

How do the image design and usability interaction design of children's versions of government websites affect Taiwan children and their satisfaction level?

Literature Review

Many scholars cite cognitive psychology in their research on interaction design. With the help of related literature, this chapter discusses the human-interaction principle and explores the relationship between the designer and the user, in order to investigate how dynamic webpage image and interaction designs affect children and their satisfaction level.

Information-Processing Theory of Learning

Information-processing theory of learning explains how humans receive and process information through observation, awareness, recognition, conversion, and memorization (Chang Chun-hsing, 2007), and is often used

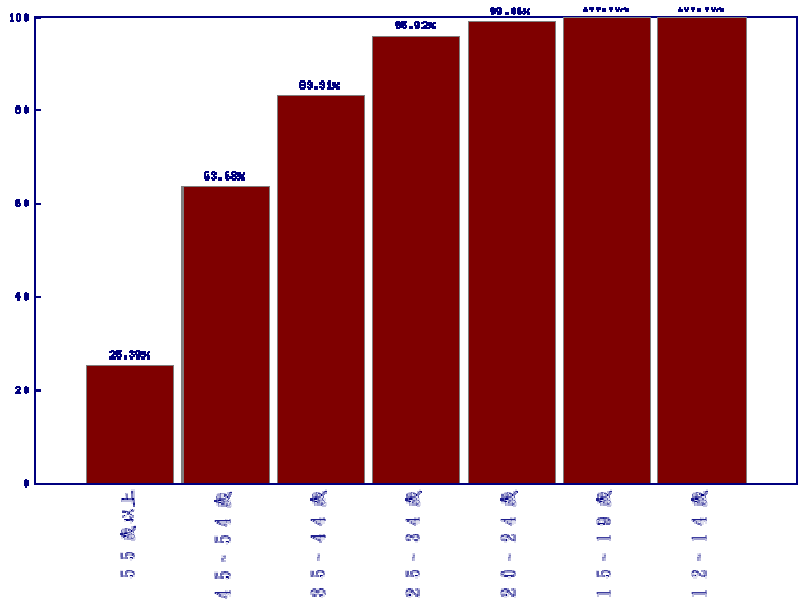

Figure 1: Online usage by Taiwan's different population groups

According to Zhang (2007), any information content design must first catch the attention of the user, who can then go on to study the content. Therefore, interaction and image design often uses various gimmicks to attract users. This research discusses dynamic webpage operability and image design, and the way the user organizes and processes information received through the senses.

Web Navigation Interface

The most important goal of children's website development is to enable children to learn and get entertained through images and interactive features of the websites (Misirli & Odabasi, 2009). Children's websites nowadays have copious animation, videos and images that eclipse traditional hyperlink webpages. Yet do children really understand the message conveyed by the images, and benefit from the interactive features of the websites? This is something worth exploring.

In addition, Kuo (2004) points out besides usability, children's websites must also emphasize interaction and pleasure of usage. Interaction design is a process by which the designer creates an experience allowing the user to raise productivity, communicate and interact (Sharp, Roger & Preece, 2007). Meanwhile, "human computer interface" is the communication channel between the user and the computer (Li, Wei, Shi, Qiu, 1988). Human computer interface determines the usability, operability and friendliness of websites. According to previous research, human computer interface must include the following principles:

Consistency
User Control
Use of Metaphors
Feedback provision

Dynamic Webpage Navigation

Fleming (1998) & Krug (2002) believe that under a particular circumstance, websites can be navigated by a user who, with a particular goal or purpose in mind, is conscious of his/her location through the information given. Navigation, meanwhile, is a moving process by which the user finds, selects and reaches a target.

Wallace and Kupperman (1997) note children do not exercise sound judgment over information from the Web and usually take it as fact. Experiments further show that children believe Internet-retrieved information as the "truth" (Schacter, Chung & Dorr, 1998).

Shackel (1991) defines usability as having the following: (1) effectiveness; (2) learnability; (3) flexibility; and (4) attitude. Sharp, Rogers & Preece (2007) further point out usability facilitates learning and is linked to effectiveness, efficiency, safety, functionality, learnability and ease of remembering.

Research On Children's Website Images

According to Druin (2008), University of Maryland has over 20 years of experience researching children's interaction interfaces, along with Design Partner. Results of their research show that image interfaces expedite children's efforts to find, browse and check information, and speed up their

ability to understand the architecture of websites. Wang (2007) did a survey on children's website images and concluded that children prefer headlines placed on the center top position of the webpage and favor a blue background (RGB=0,219,255).

Dynamic Webpage Image Design

Newman & Landay (2000) note that web design includes three major elements, namely navigation design, information design, and visual design. The goal is to facilitate website operation, enhance visuals and diversify images to maximize the user experience.

Hsu (2001) has discussed the relationship between the styles and visual elements of websites and their overall quality, and has categorized enterprise websites based on their visual elements. Chuang (2001) has discussed web images and user interface usability based on the following elements of websites: theme, hyperlinks, background, color, style, text arrangement, animation and sound effects.

Research on computer and Internet usage among children has led to the observation that their behavior, ways of thinking, preferences and value differ from those of adults. As children are mostly incapable of absorbing complex information, they will benefit from websites with interface and image designs that are immediately comprehensible.

Methodology

Based on the children' webpage features of WWW, this study is going to investigate and classify the dynamic navigation interface website's presentation in order to realize present tendency of website's navigation interfaces. The second stage of this study is to investigate children according to the website of such interface classification to realize children's preference and needs of dynamic navigation interfaces, and provide appropriate suggestions as the reference for the design of children's multimedia dynamic websites.

Sample Collection

This research is centered on the dynamic webpage interaction interface design and image design of children's versions of governmental websites. The study only investigates a website's "homepage," or the first page of the website, and excludes websites that: are educational in nature, are under construction, bridge one site to another, have not been updated for some time, are not dynamic, and are subsidiary to other sites.

Website Image Element Analysis

This section analyzes children's website interaction interfaces through content analysis, which quantifies and describes communicative contents – such as text, videos and music – with an objective and systematic approach. As such, content analysis can be helpful to quantify and describe children's websites.

Experiment

The purpose of the experiment is to find children's response to websites collected for this research. Semantic scale questionnaires are used to assess the usability of these websites. The target of the experiment is a group of

fifth and sixth graders from New Taipei City Shuangxi Elementary School who have prior experience of using personal computers and the Internet. A total of 80 people took part in the experiment during the after-school hours at the school's computer room.

Independent Variables.

The independent variables of the experiment are children's websites of different operational types, which will be subject to content analysis and group analysis.

Dependent Variables.

Include satisfaction level and operability.

Control variables.

Include styles and contents of websites.

Research Tools

The first part of the experiment assigns five fact-finding tasks to the students, who are to complete the tasks on the websites provided. Usability of the websites will be assessed based on the accuracy rate and the time taken to complete the tasks.

The usability assessment questions have clear and definite answers. The students are given multiple choice questions and are required to mark the beginning and finishing time as appeared on the bottom right corner of the screen.

The second part probes the satisfaction level with children's websites. Results from the two experiments will be integrated to understand children's first impression of the overall interface design and image design of the websites. The research uses Perceived Usefulness, Perceived Ease of Use and Perceived Enjoyment for different usage scenarios.

Experiment Procedure

The experiment involves 80 fifth and sixth graders from New Taipei City Shuangxi Elementary School, who are given five clearly instructed fact-finding tasks. The experiment was held in the computer room of the school and began after the teacher gave instructions on how it was to be conducted. The teacher also reminded the students to write the beginning and finishing time for performing the tasks. The second stage requires the students to complete questionnaires on the websites' operability and the students' satisfaction level. Once completed, the questionnaires were collected by the teacher and recorded by the computer.

Analysis And Discussions

This chapter analyzes the results of the experiment to explore how different image design interfaces affect usability and children's satisfaction level.

The websites are divided into four types based on their dynamic interaction design: (1) text-frame; (2) map guidance; (3) scenario exploration; and (4) image-text.

Analysis of Experiment Participants

The participants were fifth and sixth graders from New Taipei City Shuangxi Elementary School, whose average age was 11. There were 48 boys and 32 girls.

Usability Analysis

During the first stage, the participants were randomly given websites with the four dynamic interactive design types and were asked to complete the five tasks. The results are shown in Table 4-1. An analysis of the data found scenario exploration had the lowest accuracy rate yet allowed the tasks to be completed in the shortest time. This indicates children have an easier time understanding and performing tasks on websites based on a scenario exploration design.

Dynamic Website Image Design And Satisfaction Level

Based on the Likert scale, the experiment requires the students to complete Semantic scale questionnaires, which include a list of questions regarding the usability, interactivity and image design of the websites:

Table 4-1 Task Completion Data

Design type	No. of people	Accuracy rate	Standard variation	Completion time (sec.)
Text-frame	20	94.16	12.231	180.3
Map guidance	20	91.24	13.122	106.3
Scenario exploration	20	86.42	18.864	92.1
Image-text	20	94.21	14.192	160.2

Table 4-2 Image Design And Satisfaction Level Questionnaire

Category	Questions
Usability	Q1: This site allows me to answer questions fast. Q2: This site allows me to answer questions accurately. Q3: This site helps me save time. Q4: This site is helpful to me.
Interactivity	Q5: This site is easy to operate. Q6: This site allows me to find information I need fast. Q7: I can easily understand how this site operates. Q8: I feel this website is easy to use.
Image design	Q9: I feel this website is interesting. Q10: I feel this site's image design attracts me. Q11: I feel the site's images help me understand the functions of the site. Q12: I feel the site's images help me understand what each button is for.

Table 4-3 Data Analysis

Category		SS	df	MS	F	p
Overall satisfaction level	Interclass	499.158	3	166.386	4.690	.004**
	Intraclass	5251.053	148	35.480		
	Total	5750.211	151			
Usability Q1~Q4	Interclass	72.368	3	26.708	3.994	.045*
	Intraclass	1299.632	148	8.781		
	Total	1372.000	151			
Interactivity Q5~Q8	Interclass	80.125	3	26.708	3.994	.009**
	Intraclass	989.711	148	6.687		
	Total	1069.836	151			
Image design Q9~Q12	Interclass	54.237	3	18.079	4.360	.006**
	Intraclass	613.632	148	4.146		
	Total	667.868	151			

**p<.01 *p<.05

Conclusions And Suggestions

This research aims to explore how the image design and usability interaction design of children's versions of government websites affect Taiwan children and their satisfaction level. An analysis of data led to the following conclusions and suggestions. In terms of usability, variations in the degree of visual attraction on these sites have no direct impact on the accuracy rate with which the children completed their website tasks. In terms of interactivity, websites with medium level of dynamic visual attraction allowed the shortest completion time, followed by websites with the lowest level of visual attraction. Websites with a high level of dynamic visual attraction resulted in the longest task completion time, indicating children's websites with extreme visuals may adversely affect the time by which students perform tasks. Meanwhile, results of the image design questionnaire show that the visual attraction of children's websites is directly proportionate with the perceived usability and enjoyment of the sites. Meanwhile, visual attraction of the websites does not have a noticeable impact on the perceived quality of websites and the pleasure of using them.

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CONTRIBUTING CAUSES OF EMPLOYEE LOYALTY OF SERVICE PERSONNEL IN INTERNATIONAL HOTELS

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Abstract

Employee loyalty is a topic frequently mentioned in hospitality research. Despite the benefit of employee loyalty, hoteliers in Taiwan seem to be troubled by the phenomenon of 'turnover culture'. This study examined the contributing causes of employee loyalty on the one hand and highlighted the differences between these causes and their current practices on the other hand. We surveyed 161 international hotel employees as survey participants. The PLS-SEM technique was applied to analyze the data. The re-

sults demonstrated that proper monetary reward, opportunity for learning, career development, and communication with supervisors are the major contributors to employee loyalty. The conclusion provides not only a direction for practitioners to consolidate employee loyalty but also an explanation of how this will benefit the organization.

Key Words: Employee Loyalty, Service Personnel, International Hotel, Organization, Hospitality

Introduction

In Taiwan, the hotel industry has been recognized as a potential prospect in the growth of service industry. However, the growth is impeded by high turnover rates of employees in the hotel industry. The hospitality industry in particular suffered an increasingly high turnover of employees resulting from role stress, burnout, and low level of socialization (Chen and Chen, 2012; Chen, 2011). Organizations in the hotel industry face difficulties in retaining employees, especially it is relatively difficult to identify exact factors that contribute to employee satisfaction and the resultant loyalty.

Employee satisfaction is considered as an overall feeling about the job or as a related set of attitudes about various aspects of the job (Spector, 1997). Employee Satisfaction is also defined as a pleasurable or positive emotional state resulting from the appraisal of one's job or job experience (Locke, 1976). Further, according to Allen and Grisaffe (2001), loyalty is a psychological state and it characterizes the relationship of an employee with the organization for which they work and that has implications for their decision to remain with the organization. Employee loyalty is attachment to the organization and employee believes strongly in organizational goals and values (Mathieu & Zajac, 1990). Higher employee loyalty indicates stronger desire to maintain membership of the organization.

Past theoretical discussions demonstrated how employee loyalty facilitate service quality and customer loyalty (Yee et al., 2010) and ensure the long-term profitability and success of an organization (Heskett et al., 2008; Heskett et al., 1997; Loveman, 1998). Such links are particularly relevant in service industries where customers have more contacts with employees than with the organization. Job satisfaction and employee loyalty are both complex concepts, as each combines a set of perspectives, tangible and intangible, personal and interpersonal, institutional and external dimensions. Employee attributes, as well as the investigation of to what extent employee attributes influence job commitment

and performance wasn't extensively studied (Becker and Gerhard, 1996; Meyer et al., 2004). Research investigating the link between employee attitude and behavior revealed that employee job satisfaction is strongly related to employee loyalty (Hom and Griffeth, 1994; Stum, 1998; Ting, 1996). There are disputes as regards how to maintain employee loyalty. Ineson and Berechet (2011) addressed a worry about employee complacency associated with long-term employment, and the loss of motivation to advance.

On the other hand, Lincoln (1996) suggested that welfare corporatism may maximize employee commitment and is beneficial to long-term organizational efficiency. Reichheld and Teal (2001) also indicated that loyalty is the key to organizational success. Employee loyalty is an essential issue of hospitality industry, with the diversity of economic, geographical and cultural contexts implicates a niche for further research. In view of the on-going issues of deteriorating salary and increased turnover ratio in Taiwan's hospitality industry, this study endeavored to provide an empirical perspective. We focused on discussing the constituting factors of employee loyalty on the one hand and how these factors influence employee loyalty behaviors, such as willingness to commit to and assumption of more responsibility on the other hand. In addition to providing managers with a guide to improving employee loyalty, this research result is expected to help organizations gain competitive advantages.

Literature Review

Employees are recognized as important organizational asset and ultimately, firms invest considerable capital in the human resources. Organizational cost incurs due to employees quitting their jobs, subsequent hiring of replacement personnel (Darmon, 1990), and new-hire training (Wasmuth and Davis, 1983). General costs for administration (Hom and Griffeth, 1994) could be tremendous in terms of personal, work-unit and organizational readjustment (Hom and Griffeth, 1994; Lee and Mitchell, 1994). As we usually focus on employees to examine loyalty, attitudes to employee loyalty are dyadic: both employer and employee are involved in this professional and hierarchical relationship, and both should be aware of the importance of loyalty, and the benefits it brings (Ineson et al., 2013). High turnover ratio symbolizes the lack of employee loyalty, which is attributable to factors including lack of job satisfaction, poor working conditions, low monetary reward, inadequate career development, low level of self-fulfillment, better alternative of jobs, and work-family conflict (Carraher, 2011; Michaels and Spector, 1982; Milman, 2003; Mowday, 1981; Wasmuth and Davis, 1983). Employee turnover is a critical issue for many

hotels, and some practitioners even viewed turnover as a part of hospitality industry culture as a whole (i.e., a so-called turnover culture) (Yang, 2008).

International hotels in Taiwan are characterized by this sort of turnover culture. Many employees use turnover as a pattern to bounce earnings and promotional opportunities for their next jobs. A recent study of the hotel industry in Taiwan conducted by Yang (2008) demonstrated that organizational socialization contributes to job satisfaction and commitment and minimized newcomer turnover intention. Organizational socialization is a dynamic learning and adjustment process that enables an individual to assume an organizational role that fits both organizational and individual needs (Light and Keller, 1985). Yang (2009) also mentioned that job satisfaction affects affective commitment and hence influences turnover intentions. Newcomers enjoy observing and reading job-related information to learn how to perform tasks, implying that organizational socialization and job stress is correlated to job satisfaction.

Employee loyalty is a recognized predictor of turnover intention and behavior. As suggested by Davidson et al. (2010), turnover problem is a great challenge to human resource strategy and organization performance, and the stake of turnover is high. According to Hinkin and Tracey (2000), there are five cost categories related to labor turnover: separation costs; recruitment costs; selection costs; hiring costs; and loss of productivity costs. By applying the computer-assisted software to calculate labor turnover cost, their study showed unexpectedly high costs associated with labor turnover, and highlighted the responsibility of managers and human resources personnel in retaining staff with practices beyond financial benefits. Turnover also implies a part of organizational knowledge is lost with the employees who left. Argote (2012) described knowledge depreciation as loss of value analogous to currency depreciation. Knowledge depreciation occurs in at least five ways: when employees leave without transferring their knowledge; when existing organizational knowledge becomes obsolete (e.g. because the company temporarily loses competitiveness); when new creative products and services are rendered sub-standard by a dated knowledge or unprofitable products; when knowledge is incompletely or selectively transferred; and when organizational knowledge becomes difficult to access.

Such depreciation has negative impacts on organizational performance, including decreased productivity, a decay of customer satisfaction, unmet delivery commitments, inappropriate managerial decision-making, and mistaken strategic behavior (Argote and Ingram, 2000). The problem of

knowledge depreciation is quite significant in Taiwan, especially in terms of employee turnover without transferring knowledge and incomplete or selectively transferred knowledge. Employee turnover often leads to operational disruption, consequently limiting organizational performance. Ineson and Berechet (2011) examined attitudes influencing loyalty of Romanian hotel managers, supervisors, and operatives. They found reasons for employee loyalty are mainly intangible, linked to workmates, bosses, and customers. Gender, age, job level, and tenure have only limited influence on loyalty. Job satisfaction focuses on opportunities for personal skills' development, utilization of strengths, and achievement of workplace objectives.

Respect for management of and pride in the company is of critical importance to retention; lack of career development plans and opportunities for promotion were key reasons associated with turnover. In a survey on US lodging industry employees, Costen and Salazar (2011) found training and development as a critical factor of induction of employee satisfaction. Their result indicated that when employees perceive greater opportunity to enhance their skill and knowledge in the organization, they exhibited higher level of job satisfaction, loyalty, and intention to stay. Employees will not only be loyal for monetary and emotional reasons, but also be for the opportunity to improve and learn new skills. If there is no longer any opportunity to learn from current jobs, employees may show less satisfaction, and consider leaving for a better position.

Research Method

Hypotheses

Ineson et al. (2013) proposed five facets of the potential reasons that cause employee loyalty in hospitality context, namely commitment to manager and company, job condition, personal benefit, service attitude, and career development. Although the relation between employee loyalty drivers and job satisfaction contributors were established in their research, it is still not clear whether the employee loyalty drivers will influence actual loyalty behaviors. Employee loyalty refers to a service employee's feeling of attachment to his/her employing organization.

Therefore, we proposed the following hypotheses:

H1: Commitment to manager and company has positive effect on employee loyalty.

H2: Job condition has positive effect on employee loyalty.

H3: Personal benefit has positive effect on employee loyalty.

H4: Service attitude has positive effect on employee loyalty.

H5: Career development has positive effect on employee loyalty.

Procedures and Data Collection

To test our hypotheses, we chose to collect data from five of the 5-stars international hotels in Taiwan. Convenience sampling method was applied to collect our sample participants. This study was conducted on personnel working with hotels classified by the Taiwan Bureau of Tourism as 5-star international hotels. For geographical balance, two from the north, one from the middle and 1 from the south of Taiwan were respectively selected for the study.

The research team first sought the cooperation and consent of the hotel management, and then distributed our questionnaires to participants with management's assistance. The surveyed subjects included common employees without managing responsibility from various departments, namely lobby, restaurant, sport and health club, spa, accommodation, housekeeping and clean service, human resource management and general management. Subjects were randomly chosen from the employee name list provided by hotel management. Of the 180 distributed questionnaires, 161 were valid after data verification. The recovery rate was 89.4%.

Measuring instrument

To measure the five dimensions of employee loyalty antecedents, we adopted the questionnaire of Employee Loyalty Scale by Ineson et al. (2013), which consists of 21 items. The Cronbach's Alpha for the scale is 0.90. The five facets of the scale are commitment to manager and company, job condition, personal benefit, service attitude, and career development. We assessed employee loyalty by psychological measures so we were able to capture a service employee's feelings toward his/her service organization. A five-point Likert type scale anchored at 1= "strongly disagree" and 5="strongly agree" was deployed. Demographic information including age, gender, seniority and income were also collected. Subjects were guaranteed that all information provided in the questionnaire are strictly confidential and will be used only for scientific purpose. Expert validity was employed by this study. Five experts from the food and drinks industry were invited to examine the content of the research scale. The revised scale was finally implemented for investigation.

Participants

In this study, males made up 43.9%, and females comprised 56.1%

Table 1. Overall quality criteria

	AVE	CR	α	*R2*	Comm.	Redundancy
Commitment	0.717	0.869	0.853	0	0.717	0
Job condition	0.681	0.939	0.920	0	0.681	0
Personal benefit	0.775	0.954	0.937	0	0.775	0
Service attitude	0.529	0.899	0.898	0	0.529	0
Career development	0.697	0.882	0.872	0	0.697	0
Employee loyalty	0.752	0.958	0.940	0.689	0.752	0.515

Table 2. Factor loadings and inter-construct correlations

	Loadings	1	2	3	4	5	6
1 Commitment	.716-.881	**0.847**					
2 Job condition	.784-.901	0.581	**0.825**				
3 Personal benefit	.841-.896	0.365	0.522	**0.880**			
4 Service attitude	.681-.813	0.374	0.603	0.475	**0.854**		
5 Career development	.785-.917	0.654	0.696	0.318	0.301	**0.835**	
6 Employee loyalty	.842-.904	0.444	0.633	0.418	0.213	0.418	**0.867**

Note: values on diagonal are square root AVE

Table 3. Hypotheses testing results

	Path coefficient	*T-statistic*	*p-value*
H1: Commitment → Employee loyalty	0.517	4.707	<0.001
H2: Job condition → Employee loyalty	0.429	5.016	<0.001
H3: Personal benefit → Employee loyalty	0.466	3.274	0.001
H4: Service attitude → Employee loyalty	0.134	1.880	0.062
H5: Career development → Employee loyalty	0.381	4.032	<0.001

Note: T-statistics obtained by performing 1000 samples bootstrapping process

of the total respondents. Concerning marriage status, 17.2% were married, and 81.8% remained single. With respect to age, 51.1% were between 19 and 25, followed by the 26~32 group, at 24.4%. As regard years of service, the 3~5 year group ranked No.1 at 24.4%, followed by the 6~10 year group, at 18.9%. As to monthly payment, the majority of them (68.8%) earned below 30,000 dollars, followed by the 30001~40000 group, at 18.1%.

Results

This study used PLS-SEM, a statistical method that combines factor analysis, correlation and regression analysis to analyze the collected data. The reliability and validity results, according to Chin (2010); Hair et al. (2011) (see Table 1, 2), indicate that the measurement model is adequate. Specifically, the factor loadings of all latent variables are all above 0.700 (except for one item in "service attitude", which has 0.681). The values of average variance extracted and communality are all above 0.500. These two combined suggest good convergent validity of the measurement model. The values of square root average variance extracted of all latent variables are greater than inter-construct correlations, suggesting good discriminate validity.

The composite reliability and internal consistency range from .853 to .958, indicating good reliability of our measurement model. The value of redundancy is 0.515, suggesting adequate fit of the structural model.

For hypotheses testing, the path coefficients and statistical significance are reported (see Table 3). Specifically, 'commitment', 'job condition', 'personal benefit', and 'career development' have positive and statistically significant effects on 'employee loyalty', which are in support of proposed hypotheses 1, 2, 3, and 5. Hypothesis 4 is not fully supported that the effect of 'service attitude'is not significant in terms of the 95% confidence interval. The result shows that service attitude is not a statistically significant contributor to employee loyalty.

It is not surprising to find commitment of manager and company as an important factor leading to employee loyalty (Ineson et al., 2013; Silva, 2006). A good leader and manager can always inspire followers to become better. The other intangible reason, i.e. "service attitude, " does not influence employee loyalty as much as commitment does. A probable explanation would be that service attitude measure shows how much an employee feels comfortable in serving customers, in which he/she can always choose another job to continue serving. It is understandable that service attitude is not a significant factor. On the other hand, the tangible factors including job condition, personal benefit, and career development significantly influence employee loyalty as demonstrated by other researchers (Ineson et al., 2013; Ineson and Berechet, 2011; Meyer et al., 2004; Yang and Cherry, 2008).

Organizations that provide proper monetary compensations, opportunity for training and development, and friendly work environment easily arouse employee loyalty, in which employees are more likely to stay, commit, and take more responsibility for the organizations.

Discussion and Conclusion

Employee loyalty is an important issue for service organizations. It can help employee retention (Stum, 1998), improve customer satisfaction and loyalty (Loveman, 1998; McCarthy, 1997), and create organizational growth and profit (Heskett et al., 1997; Reichheld and Teal, 2001; Yee et al., 2010). In contrast, where there is no employee loyalty, problems with employee turnover (Watrous et al., 2006) and turnover cost (Beadles et al., 2000; Hinkin and Tracey, 2000) will arise and consequently impact organizational performance. For years, hoteliers in Taiwan have placed less stress on the training and development of employees because of 'turnover culture.' They have been unaware that training and development is a major contributor to employee loyalty, and the benefit that follows is significant. When faced with "turnover culture," employers tend to say, "Why do we have to waste resource on training employees who are destined to leave. Better potential employees can always be found in the human resource market.' However, it is this misconception that leads to lack of employee loyalty and high turnover ratio. Based on the result of this study, we are convinced that consummate training and development system and adequate monetary reward will certainly induce employee loyalty.

Granted, we are sure employees will show higher level of intention to stay, and take more responsibility, thus helping improve organizational performance. Communication is another critical issue for dejected employee loyalty. Managers of organizations in Taiwan often enforce authoritarian leadership, which inevitably lacks communication with employees is. Managers should communicate with their employees with care and patience instead of simply getting rid of the trouble makers. Although Beadles et al. (2000) claimed that turnover of disqualified employees is functional and beneficial, it is more often we find employees leaving only because they cannot adapt to their supervisor's leadership style. Practitioners should face the problem caused by turnover culture and endeavor to consolidate employee loyalty for long-term organizational development.

In their study of 1,900 American hotel employees, McDougal and Frame (2004) pointed out employee loyalty is highly correlated to empowerment in work environment. Loyal employees are very willing to recommend their boss to others and remain at their position for more than three yeas. Ghiselli, La Lopa and Bai (2002) mentioned enhancing employment training and development is a significant indicator of employ loyalty.

The characteristics of the work team also tighten the interactive relations between employees. All employees need to develop sense of coexistence. In addition to payment, other incentives may also elevate employee service zest, motivate employees and make them more confident. As a consequence, employees feel more affiliated to the hotel, which again arouses their loyalty. Other research also evidenced this fact (Huang, 2001; Gerfin, 2004).

Research Limitations and Suggestions

Due to manpower and budget shortage, the researchers collected data

provided by exclusively employees with international tour hotels in Taiwan. Forthcoming research is suggested to take international hotels with different management styles into consideration, thus preventing research bias. Most of the respondents had less-than-10-year job experience. Further study is advised to collect data from employees with work experience in hotels for more than 10 years. It is interesting to know whether job experience can influence employee loyalty.

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EXPLORING CUSTOMERS' POST-DINING BEHAVIORAL INTENTIONS TOWARD GREEN RESTAURANTS: AN APPLICATION OF THEORY OF PLANNED BEHAVIOR

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Abstract

The primary objective of the present study was to explore the ecological formation of restaurant customers' post-dining behavioral intentions toward the green restaurant, by applying the Theory of Planned Behavior (TPB). The findings suggested that the TPB has a good fit to the data, and has a predictive power for behavioral intentions. Corresponding to the theory, the results of the analysis was presented for the three constructs of the TPB model which is composed of attitude, subjective norm, and perceived behavioral control. Each construct has a positive effect on customers' post-dining behavioral intentions to behave in desirable ways to revisit the green restaurant and to spread positive word-of-mouth recommendation about the green restaurant. The findings provided insight into the consumers' decision making processes and offered practical guidelines for green management in the context of restaurant industry. Research implications and suggestions are discussed.

Key Words: Theory of Planned Behavior, Attitude, Subjective Norm, Perceived Behavioral Control, Green Restaurant

Introduction

In the past few years, the public awareness of environmental issues has been on the increase. Consumers have increasingly understood that their purchasing behaviors would more or less influence the development of the environment on the earth, and have started to increase the consumption of the ecologically friendly products (Han et. al.,

2010). Thus, the green consumption has become an important social trend that protects the environment and saves the earth (Kim & Choi, 2005). More and more restaurant customers are increasing to patronize restaurants that follow green practices. Consequently, managers in different types of restaurant operations have increasingly taken measures to adopt green practices to enhance their positive firm image (Chan & Wong, 2006).

"Green" is not simply a color. The concept of "green" stands for: eco-friendly, social justice, economic development, and health (Wang et. al., 2013). Lorenzini (1994) has defined green restaurants as new or renovated establishments that are designed, constructed, operated, and demolished in an environmentally friendly and energy efficient manner. As an industrial renowned green organization, the Green Restaurant Association has established a recognized green restaurant certification in the U.S. to declare that the green restaurants must meet seven environmental categories: water efficiency, waste reduction and recycling, sustainable durable goods and building materials, sustainable food, energy, reusables and environmentally preferable disposables, and chemical and pollution reduction (GRA, 2016). Being a green restaurant, the restaurant can help position itself differently in today's competitive business environment. Following the emergence of the green concept, many studies (Hu et al., 2010; Chou et al., 2012; Namkung and Jang, 2013) have been engaged in the context of green restaurant management.

Researches about the formation of restaurant customers' desirable post-dining behavioral intentions toward the green restaurant have been limited. Therefore, the present study's objective to explore restaurant customers' post-dining behavioral intentions toward the green restaurant would offer insight into the consumers' decision making process, and help us comprehend customers' dining behaviors. In green studies, researchers have identified the green consumers with the methods of demographics and behavioral aspects. It is evidenced that education is positively associated with environmental involvement, but on the contrary, age is adversely associated (Barber et al., 2010).

Researches about the green restaurant have been primarily explored in the western countries. Few equivalent studies have been conducted in Asia, particularly in the context of Taiwan. The concept of promoting green restaurants has recently become popular in Taiwan. As such, the present study has endeavored to investigate the determinants to predict customers' desirable post-dining behavioral intentions toward the green restaurant setting situated in Taiwan. The primary objectives of the present study are twofold: 1) to examine the effects of the three constructs of the Theory of Planned Behavior, including attitude, subjective norm, and perceived behavioral control on the customers' post-dining behavior intentions toward the green restaurant, and 2) to test the influence of the consumer demographics on the selection of patronizing the green restaurant.

The present study is organized as follows. A review of the literature relat-

ed to the Theory of Planned Behavior and behavior intention is presented. Research methodology includes data collection, sample demographics, and data analysis. Finally, the conclusions of the present study are discussed.

Literature Review

Theory of Planned Behavior

The Theory of Planned Behavior (TPB), first proposed by Ajzen (1985) concerns the human behavioral decision making process and the motives behind the related behavior (Chou et al., 2012). TPB is composed of three main conceptual constructs: attitude, subjective norm, and perceived behavioral control. According to TPB, one person's behavior depends on one's behavioral intention (Chou et al., 2012). TPB has been applied to behavioral studies to investigate the ecological behavior in the tourism and hospitality context (Kim et al., 2013). For instance, Kim et al. (2013) tests the TPB model with the anticipated regret, and investigates the model's explanatory power of customers' intention to patronize the green restaurants. Jeong et al. (2014) explored the link among three elements including customers' perceived green practices, perceived green image of a restaurant brand, and attitudes toward a restaurant brand in an investigation of Starbucks' customers. Based on the above mentioned researches, applying the TPB is possible to measure the influence of customers' decision in patronizing green restaurants, and explain customers' desirable post-dining behavioral intentions in this study.

Attitude.

Attitude is the first construct of the Theory of Planned Behavior. It refers to one person's perception of favorability or unfavorability to engage in a behavior (Chou et al., 2012). It stands for the perceived consequences of one's behavior (Eagry & Chailen, 1993). In addition, attitude can be cited as the perception of an object or behavior, which displays favor or disfavor, good or bad, like or dislike (Ajzen & Fishbein, 2000). It is recognized as a predictor to realize one's behavioral intentions (Kwun, 2011). Many studies proved that attitude has a positive impact on behavioral intention. For instance, customers could patronize a green restaurant as visiting a friendly environment to eat fresh and healthy food, and feel socially esteemed (Han et. al., 2010). They are assumed to perform conservation as they care about the well-being of the earth (Griskevicius et al., 2010). From this aspect, customers' recognition of a restaurant that is environmentally friendly can affect their attitudes toward patronizing green restaurants (Chen, 2010).

Subjective Norm.

Subjective norm is the second construct of the Theory of Planned Behavior. It is prostrated as the perceived social pressure to perform the behavior (Ajzen, 1991). It is the perceived opinions of certain significant others, including families, friends, coworkers, supervisors, and business partners. They all can play an important role to influence one's behavior. Therefore, subjective norm signifies the perceived desire of significant others to approve or disapprove one spe-

cific behavior. These norms are one person's recognition of the social pressures to proceed an behavior. The influence of subjective norms is very obvious in the Chinese context. Chinese try to meet the expectation of the significant people about what is right or not right, subject to their social culture (Cheng & Lam, 2008). These norms similarly apply to Taiwan, a Chinese context, in which the present study investigated this research. In this particular study, when significant others perceive patronizing a green restaurant is the right behavior, one would enhance his intention to follow suit.

Perceived Behavioral Control.

Perceived behavioral control is the third construct of the Theory of Planned Behavior. It is prostrated as the perceived ease or difficulty of conducting a behavior (Ajzen, 1991). It evaluates the recognition of how well one person can control certain determinants that facilitate or limit his behavior to perform in a particular situation (Cheng & Lam, 2008). In the setting of healthy behavior regarding food, a number of researches tested the relationship between perceived behavioral control and behavioral intention (Wong & Mullan, 2009). In the meantime, many studies have proved that one's behavior is positively affected by his self-confidence to conduct a behavior (Baker et al., 2007). Their findings show that when one person has less control over a behavior, his behavioral intention will be lower for the desired activity. In the restaurant setting, perceived behavioral control has been applied to predict customers' expressions of satisfaction, which reveals a positive effect on behavioral intention (Cheng et al., 2006).

Behavioral Intention

Behavioral intention relates to the stated likelihood of an individual's engagement in a specific behavior (Oliver, 1997). It is perceived that behavioral intention is an antecedent determinant to predict the future behavior (Quelette & Wood, 1998). The concept of behavioral intention in marketing and consumer behavior has been broadly investigated as a result of the high predictive power of intention toward an actual behavior (Jani & Han, 2013). Consumers tend to conduct actual behaviors when their intentions to carry out the behavior turn to be strong (Ajzen & Fishbein, 2000; Kim et. al., 2013). In general, behavioral intentions are postulated to predict two main desirable intentions: to revisit the service providers, and to spread positive word-of-mouth recommendation about the providers. When the behavioral intention is favorable, there is a possibility that a restaurant customer will revisit the restaurant and spread positive word-of-mouth recommendation to others with whom they are related. When the behavioral intention is negative, there is a high possibility that a restaurant customer will not visit the restaurant again, and may spread negative referrals about the restaurant to others. These intentions, eventually, will influence the restaurant's business, either positively or negatively (Jani & Han, 2013). Therefore, the present study focuses on the exploration of two main behavioral intentions: the willingness to revisit green restaurants and the willingness to spread positive

word-of-mouth recommendation about the green restaurants in Taiwan.

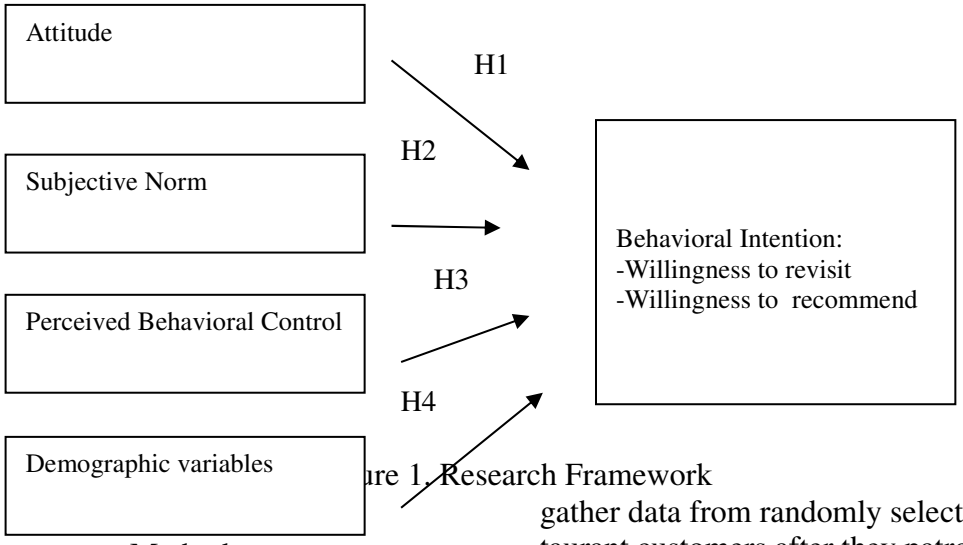
Based on the review of theoretical literature, the present study therefore proposed the following hypotheses:

H1: Attitude has a significant and positive effect on the post-dining behavioral intentions.

H2: Subjective norm has a significant and positive effect on the post-dining behavioral intentions.

H3: Perceived behavioral control has a significant and positive effect on the post-dining behavioral intentions.

H4: Customers' willingness to revisit the green restaurant and willingness to spread positive word-of-mouth recommendation about the green restaurant in Taipei depends on the different demographic variables.



ure 1. Research Framework

Method

Research Design

The present study explores customers' post-dining behavioral intentions toward the green restaurant setting in an emerging nation, i.e., Taiwan. The self-administered survey designed to minimize participant effort was employed to gather data from randomly selected restaurant customers after they patronized five green restaurants in Taipei, Taiwan. The sample restaurants all adopt green practices in their establishments and are all recognized as green restaurants by an industrial green organization, or news media in Taiwan.

The questionnaire consists of four parts, the first about such respondent demographic information as age, gender, income, educational level, occupation,

classification of vegetarian, and reason for vegetarian. Derived from an extensive review of the literature, eleven statements were designed to measure respondents' perception of green restaurants. Statements to ask participants to measure their perception were on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) constituting the second part of the survey instrument. The third part measured customers' behavioral intentions in two primary constructs: willingness to revisit the green restaurant and willingness to spread positive word-of-mouth recommendation about the green restaurant. Each behavioral intention was also measured on the five-point Likert-type scale ranging from 1 (very unlikely) to 5 (very likely). Prior to actual survey administration, a pilot test was performed among customers of one green restaurant in Taipei in order to identify and eliminate any ambiguity in the questionnaire.

Data Collection and Analysis

Five questionnaires were even distributed to five green restaurants respectively. Customers were asked to fill out questionnaires while they finished their meals and were waiting for their bills. Respondents were not offered incentives for completing the questionnaires.

In total, 476 surveys were returned, and 455 were considered eligible for data analysis after 21 were excluded as a result of incomplete responses, what gave response rate of 95%. Frequency distributions were calculated to form respondents' demographic and dining profiles. To ensure validity and reliability of the survey questions, factor analysis and Cronbach's alpha coefficients were computed (Cronbach, 1951).

Results and Discussion

Demographic Profile of Respondents

Table 3. presents the descriptive statistics that shapes the demographic profiles of the survey respondents. The number of female respondents (52.9%) was greater than that of male (47.1%). About 75% of the survey participants were aged between 21 and 60, with most aged between 41 and 60. About 51% of respondents reported marital status as married. About 51% of respondents indicated higher education from college or above. Around 80% of the respondents were employed in public, manufacturing, and commercial organizations, with the majority in manufacturing and commercial. In terms of the monthly incomes, about 86% of the surveyed respondents declared incomes exceeding US$2,000 with the largest percentage of respondents reporting the highest level of income. Thus, demographic information indicates that respondents generally have relatively high levels of monthly income, and have work backgrounds in manufacturing and commercial. About 32% of the respondents reported to be vegetarian, accounting for the largest group of diners, with the rest of 25%, lacto-ovo

Table 3. Demographic Profile of Respondents (N = 268)

Variable	**N**	**%**
Gender		

Male	214	47.1
Female	241	52.9
Age		
Under 20	24	5.4
21- 40	132	29.1
41- 60	209	45.8
Above 61	90	19.7
Marital Status		
Married	232	51.1
Single	184	40.3
Others	39	8.6
Educational Level		
Under High School	55	12.1
High School	165	36.4
College	197	43.4
Graduate school and above	38	8.1
Occupation		
Student	42	9.2
Public	93	20.4
Manufacturing	152	33.4
Commercial	121	26.6
Others	47	10.4
Monthly Income (USD)		
Under 1,000	58	12.8
1,001-2,000	198	43.5
2,001-3,000	143	31.4
Above 3,000	56	12.3
Classification of Vegetarian		
Vegetarian	144	31.7
Lacto-ovo vegetarian	116	25.4
Occasional vegetarian	88	19.4
Non-vegetarian	107	23.5
Reason for Vegetarian		
Religious faith	163	35.8
Health concerns	176	38.7
Environmental views	61	13.4
Others	55	12.1

vegetarian; 19%, occasional vegetarian; and 24%, non-vegetarian. Among those, who declared of being vegetarian, about 36% of respondents reported religious faith as the main reason for it, with the rest of 39%, health concerns; 13%, environmental views; and 12%, others.Table 4 presents the relations of customers' attitude, subjective norm and perceived behavioral control with two post-dining behavioral intentions – willingness to revisit and willingness to recommend.

Table 4. Correlation analysis of influencing factors and behavioral intention

Q	Influencing Factor	Willingness to Revisit	Willingness to Recommend
	Attitude		
1.	My patronizing a green restaurant is necessary.	0. 23**	0.36**
2.	My patronizing a green restaurant is good.	0. 23**	0.39**
3	My patronizing a green restaurant is beneficial.	0. 17**	0.25**
4	My patronizing a green restaurant is enjoyable.	0. 16**	0.19**
	Subjective Norm		
5	The public green policies are one of the major factors to influence me to patronize a green restaurant.	0. 33**	0.17**
6	My family and friends think that I should patronize a green restaurant.	0. 31**	0.14*
7	My family and friends want me to patronize a green restaurant.	0. 15**	0.24**
8	The green information provided by the environmental protection groups is one of the major factors to influence me to patronize a green restaurant.	0. 16**	0.15**
	Perceived Behavioral Control		
9	I have the self-esteem to patronize a green restaurant.	0. 12**	0.18**
10	I have the capability to patronize a green restaurant.	0. 15*	0.16**
11	It is easy for me to patronize a green restaurant.	0. 17**	0.35**

*p<0.05 , **p<0.01

The results have been computed with the use of Ordinary Least Squares (OLS) method, which, thanks to its simplicity and understandability is frequently used in survey analysis (Nathan and Holt, 1979). As presented in Table 4, all customer opinions that green restaurants play a significant role in mitigating the degradation of the natural environment (Q1, Q9, Q10) are positively related to the willingness to revisit and the willingness to spread the positive word-of-mouth recommendation about the green restaurant. Similarly, all questions related to the customers' preferences in restaurant choices, particularly the superiority of green restaurants over the "conventional" ones (Q2, Q3, Q4, Q7), also have a positive effect on the customers' willingness to revisit and their willingness to recommend green restaurants to others. Interestingly, when customers have been asked about the influence of public green policies (Q5), family's green values (Q6) or environmental protection groups (Q8) on their choice of green restaurants, all responses, regardless the source of influence, revealed positive relation on customers' willingness to revisit and willingness to recommend. All results presented in Table

4 are statistically significant at 95% or 99% level.

Table 5 presents the estimation of internal consistency with the use of Cronbach's alpha test. As this test is best suitable for continuously scored variables, it was employed here to test the internal consistency reliability of survey answers within areas of Attitude, Subjective Norm, and Perceived Behavioral Control. In order to further test the factorial validity of data obtained with questionnaire, the factor analysis has been conducted.

Table 5. Results of validity and reliability

Construct (Factor)	**Question Number (Item)**	**Cronbach *α* *(Internal Consistency)***	**Loading Factor**	**Cumulative Variance (%)**
Factor 1	Attitude	0.78		53.68
	Q1		0.79	
	Q2		0.77	
	Q3		0.75	
	Q4		0.71	
Factor 2	Subjective Norm	0.77		56.28
	Q5		0.78	
	Q6		0.77	
	Q7		0.73	
	Q8		0.75	
Factor 3	Perceived Behavioral Control	0.81		66.23
	Q9		0.88	
	Q10		0.85	
	Q11		0.76	

The values of Cronbach's alpha test for scores related to Attitude, Subjective Norm, and Perceived Behavioral Control equals 0.78, 0.77 and 0.81 accordingly, which means that 78%, 77% and 81% of the variance in the score accordingly is reliable variance, thus the internal consistency is ensured. As presented in Table 5, all factor loadings, which represent the correlation between the variables and the factor, achieved values higher than 0.7 what indicates that each factor extract sufficient variance from the item variable, and none questions had to be eliminated. All three factors

Table 6. Regression analysis of behavioral intention models

Factor	Willingness to Revisit	Willingness to Recommend
Attitude	0.26**	0.36***
Subjective Norm	0.39	0.05
Perceived Behavioral Control	0.06	0.15**
R^2	0.05	0.23

** p <0.01, ***p<0.001

contain a small number of variables, thus in all cases more than 50% of cumulative variance is explained and equals 53.68, 56.28 and 66.23 for Factor 1, 2 and 3 respectively.

The regression analysis between behavioral intentions and influencing factors revealed positive relations in all areas, although statistical significance has been achieved solely for the attitude and perceived behavioral control in case of willingness of recommendation. The explanatory power of the model is quite low, as achieved solely 5% in case of willingness to revisit and 23 % in the case of willingness to recommend.

Table 7. Relation between different demographics in their influence on behavioral intention

Variable	Willingness to Revisit Mean	Willingness to Recommend Mean
Gender		
Male	4.23	4.31
Female	4.25	4.29
Age		
Under 20	4.15	4.17
21- 40	4.25	4.21
41- 60	4.33	4.28
Above 61	4.28	4.35
Marital Status		
Married	4.11	4.77
Single	4.13	4,26
Others	4.17	4.33
Education Level		
Under High School	3.75	4.00
High School	4.36	4.23

College	4.47	4.34
Graduate school and above	4.28	4.31
Occupation		
Student	4.18	4.14
Public	4.15	4.28
Manufacturing	4.37	4.34
Commercial	4.32	4.27
Others	4.41	4.38
Monthly Income (USD)		
Under 1,000	4.26	4.26†
1,001-2,000	4.36	4.20
2,001-3,000	4.36	4.42
Above 3,000	4.39	4.37
Classification of Diet		
Vegetarian	4.26	4.39†
Lacto-ovo vegetarian	4.45	4.38
Occasional vegetarian	4.18	4.34
Non-vegetarian	4.36	4.21
Reason for Vegetarian		
Religious faith	4.38	4.35
Health concerns	4.26	4.30
Environmental views	4.31	4.38
Others	4.25	4.18

†p<.10

As the results presented in the Table 7 indicate, responding female are more willing to revisit the green restaurant than male, although the latter declared higher willingness to recommend the green restaurant. The willingness to recommend the green restaurant is the higher, the higher the age of respondents, although the willingness to revisit not – as is significantly higher among the middle-aged respondents (41-60) than younger and older customers. Married individuals who participated in the sur

vey are less interested in revisiting the green restaurant than single or those who are in informal relationships, although they declared the highest willingness to recommend the restaurant than the rest of those polled.

These respondents, who graduate from college or high school demonstrated higher willingness to return and recommend the green restaurant than those, who did not graduate from high school. Interestingly, students who answered the questionnaire, declared the lowest willingness to revisit and recommend the green restaurant among all surveyed. The result of the survey also suggested, that the willingness to return is the higher, the higher declared income of re-

spondents, although this relation is slightly different when willingness to recommend was measured. Here, these two groups of respondents who declared the highest income also stated that they are very willing to recommend a green restaurant, however the group who did not express their high willingness was not the one with the least earning (below US$1,000) but the one who earn in the average (US$1,001-2,000). The survey revealed that the vegetarian diet did not significantly influence the high willingness to revisit a green restaurant, as it was almost similarly reported among the lacto-ovo vegetarians as well as the non-vegetarian. These findings are different when willingness to recommend has been asked. In this case, those who stated as being vegetarians (always or occasionally) declared significantly higher willingness to recommend a green restaurant than the respondents who perceived themselves as being non vegetarian. These respondents who declared as being vegetarian because of religious beliefs or environmental concerns are also more willing to revisit green restaurants as well as recommend them than those, who choose to be vegetarian for health concerns or other reasons.

Conclusion

The primary objective of the present study is to explore restaurant customers' desirable post-dining behavioral intentions toward the green restaurant. The customer's behavioral intentions in the present study are expressed as the willingness to revisit the green restaurant and willingness to spread positive word-of-mouth recommendation about the green restaurant. The present study adopted the Theory of Planned Behavior to conduct the investigation.

Researches about exploring restaurant customers' desirable post-dining behavioral intentions are limited in Taiwan. This study represents one of the initial attempts to adopt the Theory of Planned Behavior to examine factors to predict the ecological formation of behavioral intention in a green restaurant context in Taiwan. The results of the present survey among customers of three green restaurants in Taipei allowed to positively verify the first three hypotheses of the present study. Table 4 presents the correlation analysis of customers' attitude, subjective norm and perceived behavioral control on the two post-dining behavioral intentions: the willingness to revisit green restaurants and the willingness to spread positive word-of-mouth recommendation about the green restaurant. All analyzed components of the attitude, subjective norms and perceived behavioral control are positively related to the behavioral intentions. All the results achieved statistical significance. Thus, the hypothesis H1, H2 and H3 has been verified positively.

The reliability and validity of the questionnaire have been tested with the use of Cronbach alpha test and factor analysis. Obtained results of the first test confirmed the internal consistency of the influencing factor scores, while the results of the factor analysis further ensured that all questions have been relevant, and none of them should be eliminated.

Although the regression analysis between behavioral intentions and influ-

encing factors revealed positive relations in all areas (Table 6), however the explanatory power of the model is very low in both cases. These results suggest that there are also different factors (apart from Attitude, Subjective Norm, and Perceived Behavioral Control) which influence the willingness to revisit the green restaurant in Taipei and the willingness to spread positive word-of-mouth recommendation about the green restaurant in Taipei.

Customers' willingness to revisit the green restaurants in Taipei and their willingness to recommend in relation to different demographic variables is presented in Table 7. As the conducted survey revealed, different variables, including gender, age, marital status, education level, occupation, monthly income, classification of diet and reason for vegetarian affect the customers' behavior intentions to revisit the green restaurant and to spread positive word-of-mouth recommendation about the green restaurant. However, due to the lack of statistical significance in almost all results, the hypothesis 4 could not be verified positively.

This study contributes to academic discussion on the customers' behavioral intention in the context of green restaurant. By analyzing the factors influencing customers' willingness to revisit and to recommend green restaurants, the present study has significant managerial implications, particularly in the area of marketing as well as in the area of value creation for stakeholders. Finally, by investigating the influence of environmental policy on customers' behavior, this research is of great important for policy makers. Therefore, a good understanding of the determinants of favorable post-dining behavioral intentions such as saying positive referrals about the restaurant, recommending the restaurant to others, and repeating patronage can provide practical guidance for restaurant practitioners (Hu, et. al., 2010). Furthermore, by examining the different levels of customers' green behaviors in demographics, the present study establishes a research framework that can explain and predict restaurant customers' behavioral intentions toward the green restaurant.

The present study has some limitations. First, as explanatory power of the model is low both for willingness to revisit green restaurants in Taipei and willingness to spread positive word-of-mouth recommendation about green restaurants in Taipei, it means that other factors, not analyzed in this study stronger affect customers' behavioral intention in case of green restaurants in Taipei. Second, the survey has been conducted solely in green restaurants in Taipei, what posts significant limitations in terms of results' generalization. On the basis of the above, further research in terms of different influencing factors and bigger geographical scope is recommended.

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THE INVESTIGATION OF RAW DATA PATTERN LEADING TO ERRONEOUS GREY PREDICTION

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Abstract

Grey theory, especially grey model GM(1,1), is widely applied in various academic fields, particularly in forecasting science, and appeared in hundreds of research papers. Grey model GM(1,1) is famous for its simple mathematics and few collected raw data needed. As few as four raw data are sufficient for conducting grey model GM(1,1) forecasting. Unfortunately, the necessary and sufficient grey model GM(1,1) condition that the grey development coefficient *a* cannot equal to zero is omitted originally. Therefore, the singular phenomenon occurs when raw data are in certain permutation. In this research, the most common four raw data case is discussed and the method of symbolic operation is used to explore what type of raw data pattern will cause grey development coefficient *a* equals to zero leading to erroneous grey prediction. The result shows that the grey development coefficient *a* equals to zero when the second and fourth data are identical. This important conclusion could provide pre-examination tool for checking suitability of raw data for GM(1,1) forecasting.

Key Words: Grey prediction, symbolic operation, L'Hopital's Rule, Grey theory, permutation

Introduction

The Grey Model, which is abbreviated as GM, was proposed by Professor Deng in 1980s (1982). Subsequently, it has developed rapidly and is applied extensively in the field of forecasting science for various academic fields, such as industry, economy, natural phenomenon, etc., during the last three decades. The reasons why grey theory is popular are easy mathematics and limited raw data needed, typically as few as four data (Liu, 2007).

There are various types of grey models. Among those, GM(1,1) is the most popular because of its simple mathematics together with satisfactory forecasting accuracy. Basically, grey model is the idea of regression by solution of differential equation instead of tradition polynomial. Therefore, GM(1,1) stands for grey model with first order differential equation and one dependent variable. Up to now, Grey model GM (1,1) is widely applied in many fields and attains satisfactory forecasting accuracy. However, a number of scholars have diligently endeavored to improve the forecasting accuracy of grey model GM(1,1). For example, Hsu and Wang (2007) employed an improved GM(1,1) model to determine the correct range of the grey development coefficient *a* and grey input *b* through Bayesian analysis to improve the forecast accuracy. Li et al. (2007) combined GM(1,1) with a Markov chain model to predict the business trends of Chinese international airlines, and employed the Taylor approximation method to obtain superior prediction precision. The new prediction model is termed T-MCGM(1,1).

Chen et al. (2008) developed the nonlinear grey model NGBM(1,1) to predict the trends of Taiwan's main trade partners' foreign exchange rates against the U.S. dollar. The results proved that the novel NGBM model is feasible and efficient. Hsu et al. (2009) presented MFGM, an integration prediction method that included a grey model, Fourier series, and Markov state transition matrix and provided superior predictions of the turning time of the Taiwan weighted stock index. Tien (2009) presented a grey prediction model called FGM(1,1) that applied a more compact algorithm to address the disadvantages of the GM(1,1) model. Wang et al. (2010) improved the prediction performance of the modified GM(1,1) model through optimization by adopting a novel approach. This involved a unique method of minimizing the error sum of squares by determining the weighted coefficients of the first and last item from a sequence of raw data.

The modified GM(1,1) model provides superior prediction abilities compared to other predictive methods because it employs Fourier series fitting to forecast the highly noisy data of the U.S. dollar to Euro parity. Kayacan et al. (2010) investigated different grey models such as GM(1,1), Grey Verhulst model, modified grey models using Fourier Series. The result showed that among these grey models, the modified GM(1.1) using Fourier series in time is the best in model fitting and forecasting. Li and Wen (2011) proposed a residual GM(1,1) model and used a Markov state transition matrix to improve its forecast accuracy by assessing the residual predictive value using a reliable mechanism. Truong and Ahn (2012) presented a

novel grey model, SAGM, for improving the prediction performance of the GM(1,1) model by addressing the identified disadvantage. Lin et al. (2012) presented the ultimate grey model, that is, EFGM(1,1). By combination of a Fourier series and exponential smoothing method, EFGM(1,1) shows its excellent prediction in increasing forecasting accuracy.

A family of grey forecasting models was selected to develop a reasonable prediction approach using the GM(1,1) model for all aspects of economic activities and natural sciences. Because of the contributions made by these scholars, the prediction ability of the grey model GM(1,1) was significantly improved. Unfortunately, none of research found the intrinsic defect of GM(1,1). Chen and Huang (2013) found a necessary and sufficient condition for grey model GM(1,1) is omitted and a meaningless prediction result is achieved subsequently. That is the grey development coefficient *a* could not equal to zero in the grey model GM(1,1). It is called singular phenomenon. The importance of this condition is the same as the denominator cannot be zero in a fraction or negative number is not allowed to appear in the square root sign. This condition is simple but extremely important. Once omitted, the prediction could be meaningless. In order to avoid erroneous forecasting, the prior check of raw data has been strongly suggested. In this research, various types of permutation of raw data are investigated by symbolic operation method to find out under what situation this phenomenon occurs. The research result shows in typical four raw data case when second and fourth digit are identical. The grey development coefficient is equal to zero. This result could provide researches, who apply GM(1,1) in his fields, a mean to avoid possible wrong forecasting result.

The mathematical model of GM(1,1)

The derivation of traditional GM(1,1)

In Grey theory, the accumulated generating operation (AGO) technique is applied to reduce the randomization of the raw data. These processed data become monotonic increase sequence which complies with the solution of first order linear ordinary differential equation. Therefore, the solution curve would fit to the raw data with high precision. In the following section, the derivation of GM(1,1) is briefly described:

Step 1: Assume that the original series of data with *m* entries is

$$x^{(0)} = \left\{x^{(0)}(1), x^{(0)}(2), \cdots, x^{(0)}(k), \cdots x^{(0)}(m)\right\}, (1)$$

where raw material $x^{(0)}$ stands for the non-negative original historical time series data set.

Step 2: Construct $x^{(1)}$ by one time accumulated generating operation (1-AGO), which is

$$x^{(1)} = \left\{x^{(1)}(1), x^{(1)}(2), \cdots, x^{(1)}(k), \cdots x^{(1)}(m)\right\}, (2)$$

where $x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i)$ and k=1,2,3,…,m.

Step 3: The 1-AGO is monotonic increase sequence which is similar to the solution curve of first order linear differential equation. Therefore, 1-AGO could

be fitted by the solution curve of following equation:

$$\frac{d\hat{x}^{(1)}}{dt} + a\hat{x}^{(1)} = b, \quad (3)$$

where $\hat{}$ represents grey predicted value, a and b are model parameters.

Step 4: The model parameters a and b can be solved by discretization of Eq.(3)

$$\frac{d\hat{x}^{(0)}}{dt} = \lim_{\Delta t \to 0} \frac{\hat{x}^{(1)}(t+\Delta t) - \hat{x}^{(1)}(t)}{\Delta t}. \quad (4)$$

If the sampling time interval is unity, then let $\Delta t \to 1$, and therefore the Eq.(4) reduces to

$$\frac{d\hat{x}^{(1)}}{dt} \cong x^{(1)}(k+1) - x^{(1)}(k) = x^{(0)}(k+1) \quad (5)$$

where k=1,2,3,….

The predicted value $\hat{x}^{(1)}$ is approximated by background value $z^{(1)}$ and is described as below:

$$\hat{x}^{(1)} \cong Px^{(1)}(k) + (1-P)x^{(1)}(k+1) = z^{(1)}(k+1) \quad (6)$$

where k=1,2,3,….

Here P is traditionally set to be 0.5 in the original model. And the source model can be obtained

$$x^{(0)}(k) + az^{(1)}(k) = b, \quad (7)$$

where k=1,2,3,….

By substituting raw data into Eq.(7), the model parameters a and b could be solved by least square method as follow:

$$\begin{bmatrix} a \\ b \end{bmatrix} = \left(\boldsymbol{B}^T\boldsymbol{B}\right)^{-1}\boldsymbol{B}^T\boldsymbol{Y}_N \quad (8)$$

where $\boldsymbol{B}$ and $\boldsymbol{Y}_N$ are defined as follows

$$\boldsymbol{B} = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -z^{(1)}(m) & 1 \end{bmatrix}, \quad \boldsymbol{Y}_N = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(m) \end{bmatrix} \quad (9)$$

Step 5: To solve Eq.(3) together with initial condition, $\hat{x}^{(1)} = x^{(0)}(1)$, the particular solution is

$$\hat{x}^{(1)}(k+1) = (x^{(0)}(1) - \frac{b}{a})e^{-ak} + \frac{b}{a}, \quad (10)$$

where k=2,3,4,….

Hence, the desired prediction output at k step can be estimated by inverse accumulated generating operation (1-IAGO) which is defined as

$$\begin{aligned} \hat{x}^{(0)}(k+1) &= \hat{x}^{(1)}(k+1) - \hat{x}^{(1)}(k) \\ &= (1-e^{a})(x^{(0)}(1) - \frac{b}{a})e^{-ak} \end{aligned} \quad (11)$$

where k=1,2,3,….

The singular phenomenon of GM(1,1)

The singular phenomenon that grey development coefficient a equals to zero was proposed by Chen and Huang (2013). When a=0 occurs, the L'Hopital's Rule (Stewart, 2003), which uses derivatives to help evaluate limits involving various types of indeterminate forms, must be applied to solve the indeterminate form of $0\cdot(-\infty)$ in Eq. (11). The deriving process is shown below:

$$\lim_{a \to 0} \hat{x}^{(0)}(k+1) = \lim_{a \to 0}(1-e^{a})[x^{(0)}(1) - \frac{b}{a}]e^{-ak} \quad (12)$$

The above problem is encountered when a approaches to zero and which is called the indeterminate form.

Solving Eq.(12) by rearranging it as follow:

$$\lim_{a\to 0}\overset{\wedge^{(0)}}{x}(k+1)=\lim_{a\to 0}(1-e^{a})[x^{(0)}(1)-\frac{b}{a}]e^{-ak}$$
$$=\lim_{a\to 0}\frac{1-e^{a}}{e^{ak}\Big/x^{(0)}(1)-\frac{b}{a}} \quad (13)$$

Differentiate both numerator and denominator and the above result shows that

$$\lim_{a\to 0}\overset{\wedge^{(0)}}{x}(k+1)=b\,, \quad (14)$$

From the conclusion, the prediction value will be grey input b when grey development coefficient a equals to zero.

Error analysis

To examine the model precision in this study, error tests are required to determine the error between the forecast value and actual value. Therefore, three statistical measures are adopted, namely relative percentage error (*RPE*) analysis, average relative percentage error (*ARPE*), and the rolling grey model (*RGM*) error analysis, to assess the model's precision.

The three measures are defined as follows:

$$RPE=\varepsilon(k)=\frac{x^{(0)}(k)-\overset{\wedge^{(0)}}{x}(k)}{x^{(0)}(k)}\times 100\% \quad (15)$$

where k=2,3,4,…,m. $x^{(0)}(k)$ is the actual value and $\hat{x}^{(0)}(k)$ is the forecast value. The total model precision can be defined by average relative percentage error (*ARPE*) as follows

$$ARPE=\varepsilon(avg)=\frac{1}{m}\sum_{k=2}^{m}\left|\varepsilon(k)\right|\times 100\%, \quad (16)$$

where k=2,3,4,…

$$RGM=\varepsilon(RGM,k+1)=\frac{x^{(0)}(k+1)-\overset{\wedge^{(0)}}{x}(k+1)}{x^{(0)}(k)}\times 100\% \quad (17)$$

where $k+1\leqq m$. $x^{(0)}(k+1)$ is the actual value and $\hat{x}^{(0)}(k+1)$ is the forecast value.

The grey rolling model (*RGM*) uses the forward sequence data to calculate the residual percentage and is a reasonable model for determining the variation tendency because the *RGM* parameters are updated continuously. The model is reconstructed when a new observation is obtained.

Symbolic operation analysis

Since singular phenomenon has been found and the solution, by L'Hopital's rule, has been proposed, the next question is how to do prior check of raw data to avoid it. This is research topic of this paper. In this study, the method of symbolic computation is adopted to calculate the general case. The situation when grey development coefficient a equals to zero will be found after a series of computation.

The symbols α, β, γ, and δ are used to substitute the original four-point observation values and performed calculations using symbolic operation. Four cases are examined as follow:

Case (a): Four symbols in the series are identical ($\alpha, \alpha, \alpha, \alpha$)

Case (b): Three of the four symbols in the series are identical, and only one ($[\frac{3!}{3!}]$) such sequence existed, namely ($\alpha, \beta, \beta, \beta$)

Case (c): Two of the symbols in the series are identical, and three ($[\frac{3!}{2!1!}]$) such sequences existed, namely ($\alpha, \beta, \beta, \delta$), ($\alpha, \beta, \gamma, \beta$), and ($\alpha, \beta, \gamma, \gamma$)

Case (d): Four symbols all differed and existed in the sequences of ($\alpha, \beta, \gamma, \delta$).

Note: above four cases are with fixed initial value α.

Four cases are calculated by MATLAB and their corresponding results are shown in Table 1. It shows that the grey development coefficient a becomes zero when the second and fourth symbols are identical, such as ($\alpha, \alpha, \alpha, \alpha$), ($\alpha, \beta, \beta, \beta$) and ($\alpha, \beta, \gamma, \beta$). In the case of which grey development coefficient a does not equal to zero, the term (β-δ) or (β-γ) appears in the fraction. The only chance to have zero solution is to let $\beta=\delta$ or $\beta=\gamma$. Here, the conclusion has reached that grey development coefficient a becomes zero if and only if the second and fourth data are identical in the raw data. Also from table 2, the grey development coefficient a is not affected by the initial value α.

Practical Case Study

GM(1,1) adopts four raw data to calculate the model parameters a and b. Chen and Huang (2013) found the forecasting result will be erroneous when grey development coefficient equals to zero and they also proposed method to overcome. In this subsequent work, a prior check criterion has been developed. That is to check equality of second and fourth digit before using GM(1,1) forecasting. If this step is neglected, the possibility of erroneous result might occur.

Therefore, the correct steps to perform GM(1,1) forecasting with four data are:

Step 1. Prior check of raw data,

Step 2. Different predictors used based on step 1.

The proposed flowchart for applying GM(1,1) model is shown in figure 1.

In order to show the importance of proposed procedure, an example of OECD oil demand from 2010 to 2014 is adopted as a practical case.

Practical Case: OECD Oil Demand from 2010 to 2014

In order to show the importance of prior check of raw data, an example of OECD oil demand from 2010 to 2014 is adopted for practical case study. The data is retrieved from oil market report from International Energy Agency (http://omrpublic .iea.org/). The OECD oil demand from 2010 to 2014 is 47, 46.5, 45.9, 46, ad 45.9 million barrels per day, respectively. When the rolling forecasting is adopted, the first four data are used as raw data, which are 47, 46.5, 45.9 and 46. The forecasting result is showed on the row 1 on Table 2. The

Table 1: MATLAB results for the four cases calculated by symbolic operation

observation data				the grey development coefficient a
$x^{(0)}(1)$	$x^{(0)}(2)$	$x^{(0)}(3)$	$x^{(0)}(4)$	
Case (a):				
α	α	α	α	0
Case (b):				
α	β	β	β	0
Case (c):				
α	β	β	δ	$\frac{2(\beta-\delta)(2\beta+\delta)}{7\beta^2+\delta^2+4\beta\delta}$
α	β	γ	β	0
α	β	γ	γ	$\frac{2(\beta-\gamma)(\beta+2\gamma)}{\beta^2+7\gamma^2+4\beta\gamma}$
Case (d):				
α	β	γ	δ	$\frac{2(\beta-\delta)(\beta+\gamma+\delta)}{\beta^2+3\gamma^2+\delta^2+3\beta\gamma+3\beta\delta+3\gamma\delta}$

Table 2: OECD Oil Demand from 2010 to 2014
Unit: million barrels per day

year	2010	2011	2012	2013	2014	
raw data	47.0	46.5	45.9	46.0	45.9	
predicted data	47.0	46.4	46.1	45.9		a=0.00543,
point error	0%	0.25%	0.51%	0.25%		b=46.76
average error			0.34%			
Erroneous predicted data		46.5	49.5	32	32	a=0
point error		0%	7.84%	30.43%	30.28%	b=45.9
average error				22.85%		
Correct predicted data		46.5	45.9	45.9	45.9	a=0
point error		0%	0%	0.22%	0%	b=45.9
average error				0.07%		

Source: Oil Market Report by International Energy Agency released by January, 2014 (http://omrpublic.iea.org/archiveresults.asp?formsection=full+issue) *Expert Systems with Applications, 37*(8), 5640-5644

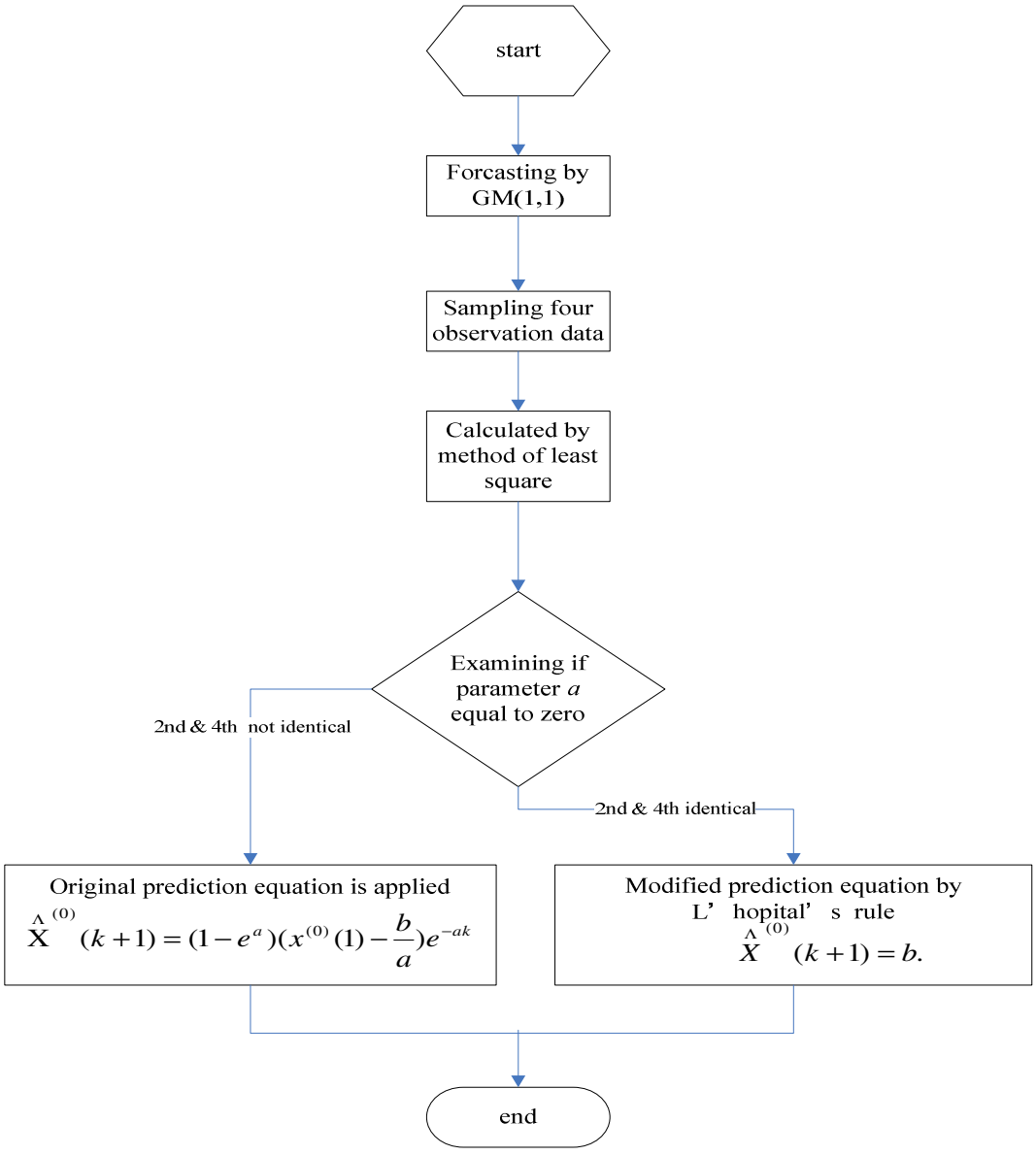

Figure 1. The proposed flowchart for applying GM(1,1)

point errors are 0.25%, 0.51%, and 0.25% (the first point is excluded) and the average error is 0.34%. That is to say the modelling precision is 99.66%. The forecasting result is satisfactory. Once the new data collected, the rolling mechanism is initiated. The oldest data is substituted by the newest one. The new raw data become 46.5, 45.9, 46, and 45.9, respectively. The forecasting result is showed on the row 2 on the Table 2. The

point errors are 7.84%, 30.43%, and 30.28% and the average error is 22.85%. The modelling precision reduces drastically from 99.66% (first case) to 77.15%. The reason why the modelling precision is reduced is the negligence of prior check of raw data. Examining the raw data, the second is 45.9 and the fourth is 45.9 which are identical. Also the grey development coefficient is zero. Therefore, the traditional GM(1,1) is invalid. The revised methodology is shown on figure 1 and the correct result is shown on row 3 on the table 2. The point errors are 0%, 0.22%, and 0% and the average error is 0.07%. The modelling precision is 99.93%. From this practical case, the importance of prior check is shown. If the examination of raw data is omitted, the totally erroneous forecasting result might reach.

Conclusion

Because of the high-accuracy forecasting ability with small data sets, typically four observation data needed, the GM(1,1) grey prediction model has motivated numerous scholars to conduct relevant researches, resulting in an increasing number of new discussions on prediction, which has expanded the depth and scope of the applications of GM(1,1) grey prediction theory, especially on the energy related issue based on the literature review. But, grey predictors should cautiously scrutinize the raw data pattern before conducting grey modeling to prevent erroneous prediction because of absence of necessary and sufficient condition that grey development coefficient a cannot be zero. If a=0, the prediction equation, , $\hat{x}^{(0)}(k+1) = (1-e^{a})(x^{(0)}(1) - b/a)e^{-ak}$, will result indeterminate form $0 \cdot (-\infty)$ and the new prediction value should be calculated by. $\lim_{a \to 0} \hat{x}^{(0)}(k+1) = b$. In this research, the most common four raw data case is discussed by symbolic operation method. Through vigorous symbolic manipulation, the research result shows if ($\alpha, \beta, \gamma, \delta$) holds the property that second and fourth figure are identical, i.e. β=δ. The grey development coefficient a will equal to zero. And the new prediction value will be grey input b. Therefore, prior check of raw data permutation pattern should be performed to avoid erroneous prediction result.

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SUPER EFFICIENCY MODEL USING A CONSTANT AS "TOTAL WEIGHTED SUM OF INPUT" CONSTRAINT

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Abstract

Efficiency assessments often involved employing the CCR or BCC model to evaluate the efficiency scores, but multiple efficiency units frequently render discrimination indiscernible, and the Anderson & Peterson (AP SE) model was proposed to solve this problem; however, an infeasible solution often occurs in the AP SE model. The present study proposes an SE model with a constant total weighted sum of the input as a constraint to solve the infeasible solution. With one lemma and one theorem, the study proves that adding one constant as a constraint is crucial to solving the infeasibility problem.

Key Words: Data envelopment analysis, AP super efficiency, CCR model, Infeasibility, Discrimination power

Introduction

Data envelopment analysis (DEA) is a nonparametric method requiring no prior knowledge of a production function. It is a decision making unit (DMU) that can be used to measure the relative efficiency of multi-input–multi-output variables of similar characteristics. Charnes, Cooper, and Rhodes (1978) first rewrote the efficiency assessment of fractional programming as an efficiency assessment model for linear programming. Regarding the efficiency rating assessed by the CCR model, the most significant characteristic was that under identical conditions, the optimal weight of various efficiency measurements are generated according to the ratio of the weighted sum of the output to the weighted sum of the input of various,

from which the highest efficiency score can be derived. However, multiple efficiency units are often generated in this method, rendering discrimination between efficient DMUs indiscernible.

Accordingly, Anderson and Peterson (1993) proposed the AP super efficiency (SE) model, which excludes the data set of a DMU from the assessment model; the advantage is in not emphasizing specific characteristics, thus the method is more objective. However, because the data set is excluded from the assessment, many cases yield efficiency scores of >1; hence, the method is named "super efficiency." The method has improved the discrimination of efficiency assessments and enables ranking of an originally efficient DMU (Anderson & Peterson, 1993; Chen, 2004; Ebadi, 2012; Pan, Liu, Peng, & Wu, 2011; Ray, 2008; Xue & Harker, 2002). However, Thrall (1996) was first to report that infeasibility problems often occur in the AP SE model under CCR constant returns to scale (CRS). Zhu (1996) and Cooper et al. (2001) have shown that when there are data values of "0" in a DMU, problems in ranking occur in the SE model under CCR CRS. Seiford and Zhu (1998) noted that the assumption that the data are absolute values proves that although CRS can be ranked, Banker, Chames and Cooper (1984) (BCC) variable returns to scale (VRS) cannot. Xue and Harker (2002) explained that the infeasibility problem also occurs in the SE model under VRS, rendering ranking impossible. Cheng, Qian, & Zervopoulos (2011) explained that for SE in the CCR model, for, when any individual output, the AP SE model also generates an infeasible solution. To solve the SE infeasibility problem on paper, various scholars have proposed new SE models (Chen, 2005; Cook, Liang, Zha, & Zhu, 2009; Khodabakhshi, 2007; Tavassoli, Saen, & Faramarzi, 2014). In particular, Chen (2005) proposed taking $(1-\alpha)/(1+\beta)$ as the target and incorporated some nonlinear equations into the model; although this solved the infeasibility problem, due to the inclusion of nonlinear equations, the calculation process became complex. Therefore, Cheng et al. (2011) and Bao et al. (2014) again proposed linear programming models to solve the nonlinear AP model for the infeasibility problem proposed by Chen (2005).

Based on the aforementioned dissertations, the present study proposes an SE model with a constant total weighted sum of the input as a constraint (CTWS SE) to solve the infeasibility shortcoming of the AP SE model. The remainder of this paper is organized as follows. Section 2 presents the CCR, BCC, and AP SE models. Section 3 introduces our proposal and employs one lemma and one theorem to explain its feasibility. The proposed model is applied to two examples in Section 4, the results of which show that the proposed model can comprehensively solve the infeasibility problem of the AP SE model. Finally, conclusion is drawn in Section 5.

CCR, BCC, and AP SE Models

CCR Model

(a) Input-oriented original model

The CRS multi-input–multi-output efficiency assessment CCR model was

based on the efficiency measurement concept (Charnes et al., 1978; Farrell, 1957), as shown in Equation (1):

$$Max.\ \theta_k = \sum_{r=1}^{s} u_{rk} y_{rk}$$

$$s.t. \qquad \sum_{i=1}^{m} v_{ik} x_{ik} = 1 \qquad (1)$$

$$\sum_{r=1}^{s} u_{rj} y_{rj} - \sum_{i=1}^{m} v_{ij} x_{ij} \le 0,\ j = 1,...,n$$

$$u_{rk}, v_{ik} \ge \varepsilon \quad \mathrm{r} = 1,...,\mathrm{s},\ \ \mathrm{i} = 1,...,\mathrm{m}$$

where
θ_k: relative efficiency rating of the kth DMU, k = 1, 2, …, n.
u_{rk}: weight produced by the rth item of the kth DMU.
v_{ik}: weight inputted by the ith item of the kth DMU.
yrk: rth input of the kth DMU.
x_{ik}: ith input of the kth DMU.
y_{rj}: rth output of the jth DMU.
x_{ij}: ith input of the jth DMU.
ε: extremely small positive real number (generally $\varepsilon = 10^{-4}$ or $\varepsilon = 10^{-6}$).

(b) Input-oriented dual model

The input-oriented dual model is shown in Equation (2):

$$Min.\ \theta_k - \varepsilon(\sum_{r=1}^{s} s_r^{+} + \sum_{i=1}^{m} s_i^{-})$$

$$s.t. \qquad \sum_{j=1}^{n} y_{rj} \lambda_j - s_r^{+} = y_{rk}$$

$$\theta x_{ik} - \sum_{j=1}^{n} \lambda_j x_{ij} - s_i^{-} = 0 \qquad (2)$$

$$\lambda_j,\ \ s_i^{-}, s_r^{+} \ge 0$$

$$r = 1,...,s,\ \ \mathrm{i} = 1,...,\mathrm{m},\ \ j = 1,...,n$$

θ unrestraint

BCC Model

(a) Input-oriented original model

Banker et al. (1984) amended the CCR model, emphasizing the VRS BCC model. The input-oriented mathematical model is expressed in Equation (3):

$$Max.\ \theta_k = \sum_{r=1}^{s} u_{rk} y_{rk} - u_0$$

$$s.t. \qquad \sum_{i=1}^{m} v_{ik} x_{ik} = 1 \qquad (3)$$

$$\sum_{r=1}^{s} u_{rj} y_{rj} - \sum_{i=1}^{m} v_{ij} x_{ij} \le 0,\ j = 1,...,n$$

$$u_{rk}, v_{ik} \ge \varepsilon$$

u_0 is unrestraint, $\mathrm{r} = 1,..,\mathrm{s},\ \ \mathrm{i} = 1,..,\mathrm{m}$

(b) Input-oriented dual mode

$$Min.\ \theta_k - \varepsilon(\sum_{r=1}^{s} s_r^{+} + \sum_{i=1}^{m} s_i^{-})$$

$$s.t. \qquad \sum_{i=1}^{m} \lambda_j y_{rj} - s_r^{+} = y_{rk},\ \ r = 1,...,s$$

$$\theta x_{ik} - \sum_{i=1}^{m} \lambda_j x_{ij} - s_i^- = 0, \quad i = 1,...,m$$

$$\sum_{j=1}^{n} \lambda_j = 1 \qquad (4)$$

$$\lambda_j, s_i^-, s_r^+ \geq 0, \quad j = 1,..., \mathrm{n}$$

$$\theta \ unrestra \mathrm{int}$$

AP Super Efficiency Model

(a) CCR AP SE model

To solve the problem of multiple efficient DMUs in a CCR efficiency assessment, Andersen and Peterson proposed omitting efficient DMU_k values from the efficiency frontier ($\lambda_k = 0$) and using the remaining DMUs as a basis for a new frontier and calculating the distance for the eliminated DMUs to reach the new frontier [1]. Because the omitted DMUs are not enveloped by an efficiency border, the derived efficiency score is occasionally greater than 1; this method is called the AP SE mode, the mathematical model of which is expressed in Equation (5):

$$Min. \ \theta_k - \varepsilon(\sum_{r=1}^{s} s_r^+ + \sum_{i=1}^{m} s_i^-)$$

$$s.t. \quad \sum_{i=1}^{m} \lambda_j y_{rj} - s_r^+ = y_{rk}, \ r = 1,...,s \qquad (5)$$

$$\theta x_{ik} - \sum_{i=1}^{m} \lambda_j x_{ij} - s_i^- = 0, \quad i = 1,...,m$$

$$\lambda_k = 0$$

$$\lambda_j, s_i^-, s_r^+ \geq 0, \quad j = 1,..., \mathrm{n}$$

(b) BCC AP SE model

The BCC AP SE model can be obtained by adding the constraint $\sum_{j=1}^{n} \lambda_j = 1$ to Equation (5).

SE Model with a Constant Total Weighted Sum of the Inputs as a Constraint (CTWS SE)

The AP SE model can solve the multiple efficient DMUs problem. However, the infeasibility problem commonly occurs. Thus, this study employed the weighted sum of the output of DMU_k as the objective, the weighted sum of the output of DMU_k was not constrained to not being greater than the input of the weighted sum of the input, and the constant total weighted sum of the inputs as a constraint in our proposed SE model, which is expressed in Equation (6):

$$Max. \ \mathrm{O}_k$$

$$s.t. \quad \sum_{\mathrm{r}=1}^{\mathrm{s}} \mathrm{u}_{\mathrm{r}} \ y_{rj} = \mathrm{O}_j$$

$$\sum_{\mathrm{i}=1}^{\mathrm{m}} \mathrm{v}_{\mathrm{i}} \ x_{ij} = I_j \qquad (6)$$

$$\mathrm{O}_j - I_j \leq 0, j = 1,....., n, \ \ j \neq k$$

$$\sum_{j=1}^{n} I_j = n$$

where $\sum_{j=1}^{n} I_j = n$ is the crucial design constraint of the proposed model because it ensures a solution for Equation (6).

Lemma 1.

Because only $\sum_{j=1}^{n} I_j = n$ is related to the input variable of the various DMU_j values, the following discussion analyzes only the weight v_i of the various input variables. If v_i has a solution, then Equation (6) has a solution.

$$\sum_{i=1}^{m} v_i x_{ij} = I_j, \quad j = 1,.....,n \tag{7}$$

$$\sum_{j=1}^{n} I_j = n \tag{8}$$

Equation (7) and (8) together have $n + 1$simultaneous equations. This lemma proves that these simultaneous and those of Equation (8) and (9) have the same solution.

$$\sum_{i=1}^{m} v_i x_{ij} = I_1 \tag{9}$$

Proof:

The proof of this lemma is simple:

Using $\sum_{j=1}^{n} I_j = n$ of Equation (8),

subtract $\sum_{i=1}^{m} v_i x_{ij} = I_j, \quad j = 2,.....,n$ of Equation (7) to obtain:

$$\sum_{i=1}^{m} v_i x_{ij} = n - I_2 - I_3,...,-I_n = I_1 \tag{10}$$

The simultaneous equation solution $\sum_{j=1}^{n} I_j = n$ in Equations (10) and (8) is identical to that of the $n + 1$ simultaneous equations derived from Equations (7) and (8) of Lemma 1. Q.E.D.

Theorem 1. In Lemma 1, all $v_i, \quad i = 1,...,m$ have a solution. After a solution is obtained for all $v_i, \quad i = 1,...,m$, the efficiency score of each DMU can be determined.

Proof:

Assuming there are n DMUs, each DMU has m variables. This theorem is divided into the following levels and discussed separately as follows:

(a) If $m = 1$, then

$$x_{11} v_1 = I_1 \tag{11.1}$$

$$x_{21} v_1 = I_2 \tag{11.2}$$

$$x_{n1} v_1 = I_n \tag{11.n}$$

$$I_1 + I_2 + ... + I_n = n \tag{11.n+1}$$

Then, (11.1)+(11.2)+…+(11.n) = $(x_{11}+x_{21}+...+x_{n1})v_1 = n$

Thus, $v_1 = \dfrac{n}{x_{11}+x_{21}+...+x_{n1}}$, has a solution.

(b) If $m=2$, then

$$x_{11}v_1 + x_{12}v_2 = \mathrm{I}_1 \qquad (12.1)$$

$$x_{21}v_1 + x_{22}v_2 = \mathrm{I}_2 \qquad (12.2)$$

$$x_{\mathrm{n}1}v_1 + x_{\mathrm{n}2}v_2 = \mathrm{I}_{\mathrm{n}} \qquad (12.n)$$

$$\mathrm{I}_1 + \mathrm{I}_2 + ... + \mathrm{I}_n = n \qquad (12.n{+}1)$$

Then, $(12.1)+(12.2)+...+(12.n)$ =

$$(x_{11}+x_{21}+...+x_{n1})v_1 + (x_{12}+x_{22}+...+x_{n2})v_2 = \mathrm{n} \qquad (13)$$

Let $(13) - [(12.2)+...+(12.\mathrm{n})]$ be Equation (12.1), then (12.2), …, (12.n) of Equations (12.1) to (12.n+1) are "redundant" equations. Hence, only simultaneous equations of (12.1) and (12.n+1) needs to be solved. When solving the two equations, the following two situations might occur:

(i) $\dfrac{x_{11}}{x_{11}+x_{21}+...+x_{n1}} \neq \dfrac{x_{12}}{x_{21}+x_{22}+...+x_{n2}}$, then it is known that v_1, v_2 can be solved.

Let

(ii) $\dfrac{x_{11}}{x_{11}+x_{21}+...+x_{n1}} = \dfrac{x_{12}}{x_{21}+x_{22}+...+x_{n2}} = p_1$,

then $\dfrac{I_1}{n} = p_1$, thus $I_1 = n \times p_1$,

similarly $I_2 = n \times p_2 \ldots$, $I_{\mathrm{n}} = n \times p_{\mathrm{n}}$。

$$n = I_1 + I_2 + ... + I_n = (p_1 + p_2 + ... + p_n) \times n$$

Thus, if $p_1 + p_2 + ... + p_n = 1$

then v_1, v_2 can be solved (for a detailed explanation , please see the explanation for if $m > 2$)

(iii) If $m > 2$, then the expansion of $\sum_{j=1}^{n} I_j = n$ in Equation (12.n+1) should be

$$x_{j1}v_1 + ... + x_{jm}v_m = n \text{ or}$$

$$(\sum_{j=1}^{n} x_{j1})v_1 + (\sum_{j=1}^{n} x_{j2})v_2 + ... + (\sum_{j=1}^{n} x_{jn})v_m = n \qquad (14)$$

The expansion for Equation (12.1) can be rewritten as

$$x_{11}v_1 + x_{12}v_2 + ... + x_{1m}v_m = I_1 \qquad (15)$$

In Equations (14) and (15), the variables $v_1.v_2....v_m$ indicate that the relationship between the coefficients of any two random variables v_r, v_k can only have the following two situations:

(1) If the coefficient ratio of any two random variables v_r, v_k are unequal,

$\frac{x_{1r}}{\sum x_{ji}} \neq \frac{x_{1k}}{\sum x_{jk}}$, and $r \neq k$, then v_i, $i = 1,...,m$ has a solution.

(2) The coefficient ratio of any two variables v_r, v_k are identical and

$$\frac{x_{1r}}{\sum xji} = \frac{x_{1k}}{\sum x_{jk}} = p, \quad r,k = 1,...,m,$$

then identical to $m = 2$ in (b), can let $p_1 = \frac{I_1}{n}$, $p_2 = \frac{I_2}{n}$, ..., $p_m = \frac{I_m}{n}$,

then

$$I_1 + I_2 + ... + I_m = p_1 \times n + p_2 \times n + ... + p_m \times n = (p_1 + p_2 + ... + p_m) \times n = n$$

thus $p_1 + p_2 + ... + p_m = 1$

Because n is given, all p_i values can be obtained. Herein, Equations (14) and (15) have been combined into one equation; thus, if each input variable x_i and the total input variable for all DMUs exhibit a proportional relationship, then each variable v_i, $i = 1,...,m$ has a solution.

Lemma 1 and Theorem 1 are mainly directed at the SE model with a constant total weighted sum of the input as a constraint of CRS (i.e., the CCR model). If the problem is an SE assessment of VRS (i.e., the BCC model), then by simply incorporating the dummy output variable ($y_{s+1,j} = 1$, $j = 1,...,n$) into each o_j in Equation (6) and the note "@free(u_{s+1})" into the constraints in the model, the VRS SE model can be displayed as the CRS SE model.

Case Description

The following examples demonstrate the application of the CCR SE and BCC SE models.

Example 1:

To explain the application of Equation (6), we illustrate the case study of CRS CCR from (Khodabakhshi, 2007). In this example, there are nine DMUs, each of which has two input variables and two output variables y. With the given data set substituted into Equation (6), the efficiency score of the proposed model can be obtained. The last three columns of Table 1 shows the results:

In the original paper by Khodabakhshi (2007), the example was adopted to test the CCR SE model; therefore, we can directly apply Theorem 1. For example, Equation (16) shows DMU_4 integrated into the proposed model:

$$\max = O_4;$$

$$3*u_1 + 1*u_2 = O_1;$$

$$1.5*u_1 + 3*u_2 = O_2;$$

$$2.5*u_1 + 5.5*u_2 = O_3;$$

$$4*u_1 + 1*u_2 = O_4;$$

$$3*u_1 + 5.5*u_2 = O_5;$$

$$4.8*u_1 + 4*u_2 = O_6; \qquad (16)$$

Table 1. Scores for the AP SE and CTWS SE Model for the Case Study on Khodabakhshi (2007)

DMU	Input x_1	Input x_2	Output y_1	Output y_2	AP SE model [13]	CTWS SE model (n=9)	CTWS SE model (n=15)	CTWS SE model (n=20)
1	1.5	2	3	1	0.84375	0.87437	0.87437	0.87437
2	2	1	1.5	3	0.9375	0.7200	0.7200	0.7200
3	1.2	1.5	2.5	5.5	2	1.5560	1.5560	1.5560
4	3	0	4	1	Infeasible	1.3072	1.3072	1.3072
5	0.5	3	3	5.5	Infeasible	0.5756	0.5756	0.5756
6	2	3	4.8	4	1.825	0.9600	0.9600	0.9600
7	3	2.5	3.5	3	0.5892	0.5887	0.5887	0.5887
8	3	4	4	4	0.5806	0.5548	0.5548	0.5548
9	4	1	5	5	Infeasible	0.8599	0.8599	0.8599

$3.5*u_1+3*u_2=O_7$ $\quad$ $3*v_1+2.5*v_2=I_7;$

$4*u_1+4*u_2=O_8$ $\quad$ $3*v_1+4*v_2=I_8;$

$5*u_1+5*u_2=O_9$ $\quad$ $4*v_1+1*v_2=I_9;$

$1.5*v_1+2*v_2=I_1;$ $\quad$ $O_1-I_1\le 0$

$2*v_1+1*v_2=I_2;$ $\quad$ $O_2-I_2\le 0;$

$1.2*v_1+1.5*v_2=I_3;$ $\quad$ $O_3-I_3\le 0;$

$3*v_1+0*v_2=I_4;$ $\quad$ $O_5-I_5\le 0;$

$0.5*v_1+3*v_2=I_5;$ $\quad$ $O_6-I_6\le 0;$

$2*v_1+3*v_2=I_6;$ $\quad$ $O_7-I_7\le 0;$

$O_8 - I_8 \le 0$;

$O_9 - I_9 \le 0$;

$I_1 + I_2 + I_3 + I_4 + I_5 + I_6 + I_7 + I_8 + I_9 = 9$

Thus, $O_4 = 0.9687$, $I_1 = 0.7410$, and $\frac{O_4}{I_4} = \frac{0.9687}{0.7410} = 1.3072$.

Table 1. shows the results of applying the AP SE model in the original proposal. The results indicate that three DMUs is infeasible. After an assessment of the proposed model, these DMUs yielded a rational efficiency score. Subsequently, we applied three constants (n = 9, n = 15, and n = 20) to obtain the efficiency scores of all DMUs. The results were identical; thus, the last three columns of $\sum_{j=1}^{n} I_j = n$ can be any positive number larger than n, and the results of the efficiency assessment remain the same.

Example 2:

To explain the application of Equation (6), we present the case study of VRS (BCC) from Xue and Harker (2002). The example contains six DMUs, each of which was one input variable x and one output variable y. When the data set in Table 2. is substituted into Equation (6), the SE score of the proposed model can be obtained. The last three columns of Table 2 shows the results.

For instance, Equation (17) shows DMU_4 integrated the proposed model:

$\max = O_4$;

$2 * u_1 + u_2 = O_1$;

$5 * u_1 + u_2 = O_2$;

$9 * u_1 + u_2 = O_3$;

$11 * u_1 + u_2 = O_4$;

$9 * u_1 + u_2 = O_5$;

$2 * u_1 + u_2 = O_6$; (17)

$2 * v_1 = I_1$;

$3 * v_1 = I_2$;

$5 * v_1 = I_3$;

$7 * v_1 = I_4$;

$7 * v_1 = I_5$;

$3 * v_1 = I_6$;

$O_1 - I_1 \le 0$

$O_2 - I_2 \le 0$;

$O_3 - I_3 \le 0$;

$O_5 - I_5 \le 0$;

$O_6 - I_6 \le 0$;

Table 2. Scores for the AP SE and CTWS SE model for case study on Xue and Harker (2002)

DMU	Input x	Output y	AP SE (Xue & Harker, 2002)	CTWS SE score (n=6)	CTWS SE score (n=9)	CTWS SE score (n=12)
1	2	2	1.5	1.4999	1.4999	1.4999
2	3	5	1.095	1.0952	1.0952	1.0952
3	5	9	1.133	1.1333	1.1333	1.1333
4	7	11	Infeasible	0.9183	0.9183	0.9183
5	7	9	0.714	0.7142	0.7142	0.7142
6	3	2	0.667	0.6667	0.6667	0.6667

$I_1 + I_2 + I_3 + I_4 + I_5 + I_6 = 6$;

@free(u_2);

Thus obtain $O_4 = 1.428571$, $I_1 = 1.555556$, and $\frac{O_4}{I_4} = \frac{1.428571}{1.555556} = 0.9183$.

Because this is a VRS (BCC) problem, adding a dummy output variable ($y_{2,j}$=1) to each o_j, and "@free(u_2)" to the constraint, this example applies Theorem 1 when implementing the proposed model to obtain the efficiency scores of the each of the other DMU_j, as shown in the last three columns of Table 2. In the table, the result for DMU_4 in the original paper is infeasible. After an assessment using the proposed model, an efficiency score of 0.9183 was obtained. In our example, regarding the assessed efficiency score of the total weighted sum of the input constraint, where n = 6, n = 9, and n = 12, the results are identical; the value of n needs only be greater than the total number of DMUs. Thus, this example also proves that the proposed model is robust.

Conclusions

Although applying the AP SE model in DEA in CCR and BCC efficiency assessments can remedy the problem of indiscernible discrimination of efficiency assessments, the infeasibility problem often occurs during the evaluation. Many scholars have proposed solutions to the infeasibility problem from various perspectives.

The present study employed the weighted sum of the output O_k of the extreme DMU_k as the objective; subsequently, this value was not constrained to not being greater than the weighted sum of the inputs I_k and the constant total weighted sum of the input constraint $\sum_{j=1}^{n} I_j = n$. To ensure the

feasibility of the proposed model, we proposed one lemma and one theorem to explain its theoretical basis. Additionally, we applied the proposed model in two examples, the results of which prove that the proposed model comprehensively solves the infeasibility problem. Furthermore, according to our initial study, the right-hand side of $\sum_{j=1}^{n} I_j = n$ is *n*, which can be set to any positive number, and as long as it is greater than the total number of DMUs, it does not affect the efficiency score assessment results.

Theorem 1 mainly targets the application of the CCR model. However, if there is an SE problem with the BCC model, then simply incorporating a dummy output variable and letting the weight of this variable be free sign (@free), the BCC model problem can be smoothly evaluated using the CCR AP SE model.

The following conclusions can be drawn from Theorem 1:

(a) If Equation (6) is rewritten as a dual model, it has the same effect as $\lambda_k = 0$ in the general AP SE model; Equation (6) lacks only the constraint $\mathrm{I}_k = 1$. In the traditional AP model, because of the absence of the $\sum_{j=1}^{n} I_j = n$ constraint, the number of equations may be greater than the number of variables, causing infeasibility in some AP SE models.

(b) If the constraint $\sum_{j=1}^{n} I_j = n$ is added to the dual model of the AP SE model, then a solution can be found for all DMUs.

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INTEGRATING SERVICE SCIENCE AND INFORMATION SYSTEM TECHNOLOGY: A CASE STUDY

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Abstract

Through providing sufficient information, gaps between transaction parties caused by information asymmetry can be filled. This study examined literature data and applied a case study method to integrate service science and information system technologies to develop a series of service design tools, which were subsequently used to create an innovative information service (IIS) system. The case study examined the information system used by a real estate company for the display and sale of houses. The service design tools were used to facilitate communication between a design team and a real estate company. Hihouse, a house display and sale service system used by a real estate company, was employed as an example to demonstrate practical applications. The IIS service design tool set comprised numerous components, which are listed as follows: a) an innovative information service blueprint, a design blueprint that demonstrated IT application in the IIS system; b) a service touch list, which showed the use of IT in a system to design and plan service encounters; and c) service exchange script, which illustrated the process in which service information was exchanged between front-stage interaction interfaces, back-stage interaction services, and support processes in the IIS system.

Key Words: Service design, Service innovation, Innovative information service (IIS)

Introduction

Continued service innovation is the only viable method for maintaining service quality (Ottenbacher 2007). Technological innovation can facilitate radical service innovation as well as optimise existing services (Grissemann et al. 2013; Harrington and Ottenbacher 2013) and is thus regarded as one of the driving forces of service innovation. An example of continued service innovation is the

information technology (IT) industry (McLennan 2004; Den Hertog et al. 2010; Tsaih et al. 2012). The rapid development of IT has led to numerous innovative creations, enabling highly efficient interactions between people, organisations, information systems (ISs), communication systems, and heterogeneous devices, leading to service innovation breakthroughs and making service procedures more accessible to customers, optimising existent services (Hanseth et al. 2012; Grisot et al. 2014).

Specialised goods or services or goods with product features that are difficult to understand reduce the purchase intention of customers because of information asymmetry. Information asymmetry means that information is known by only one party of a transaction and not the other (Kelly and Ljungqvist 2012). In a market environment, this indicates that one party of the transaction possesses complete transaction-related information, whereas the other party lacks this information. In other words, information asymmetry occurs when two parties of a transaction have varying degrees of product knowledge (Chiappori and Salanie 2000; Berger et al. 2011). For example, for real estate companies, consumer purchase intention may be reduced as a result of not knowing the construction quality of houses, quality of after-sales services, bank assessments of the houses, taxes, adjacent environment, and traffic conditions. Through providing informatised services during the display and sale of a house, consumers attain more adequate information, which closes the information gap between them and sellers, enhances service quality, and creates a favourable company image (de Wit and van der Klaauw 2013; Chiappori and Salanié 2013; Li 2014).

Much related research on systematic approaches to developing new services has been conducted in the field of service science (Trkman 2010; Cramer and Hipp 2012). For example, Johnson et al. (2000) proposed the new service development (NSD) theory, which divides service development into four stages: design, analysis, development, and full launch. The design stage involves formulating new service objectives and strategies, generating and screening ideas, and developing and testing service concepts. The analysis stage entails business analyses and project authorisation. The development stage involves service designs and testing, process and system designs and testing, personnel training, service testing and pilot runs, and test marketing. The full launch stage entails full-scale launches and post-launch reviews (Zomerdijk and Voss 2011).

For real estate companies, the concept of service design primarily involves devising strategic plans and novel ideas to manage service operations according to the unique features of the companies and their operational objectives (Hamilton and Selen 2004; Steen et al. 2011). However, development of novel IS services remains lacking in the NSD process. During the early stages of innovative information service (IIS) development, real estate companies must consider aspects such as the design of service systems employed by customers and the innovative application of IT (Linden et al. 2010). To investigate the demands of users and their service expe-

rience, the American design company, IDEO, integrated the different viewpoints held by experts of various disciplines by using a service experience blueprint and scenario-oriented design (Brown 2009; Martin 2009; Zomerdijk and Voss 2010; Tingvall and Karpaty 2011).

The aforementioned NSD-related theories show that prior to planning service designs, real estate companies should first propose innovative service philosophies and strategies as a starting point of service design development (Sawhney 2011). During the design stage, these companies should engage in decision-making and invest resources for design and development of concepts with potential. During the analysis stage, the companies should analyse the commercial values and market potential of these concepts. During the development stage, the companies should review the newly proposed concepts and ideas and perform feasibility tests on those that possess success potential. During the development stage, the companies should select appropriate service systems for the respective services and products and perform field tests and result verifications. During the final full launch stage, the companies should release the new services that have been thoroughly tested (Fitzsimmons and Fitzsimmons 2013).

The present study investigated companies' use of IT to provide new online real-time interactive services and how companies authorise IT to customers and users (i.e., "IT empowerment") to enable them to assume new, independent, and active roles during the self-service process. For the real estate company examined in this study, IIS embodied two additional meanings, namely "the provision of unprecedented information and communication technology" and "information use for developing an innovative service delivery system for existing services" (Glushko 2010; Fitzsimmons and Fitzsimmons 2013).

However, during the process of designing the IIS system and discussing relevant literature, this study determined deficiencies in current theories and tools; that is, a service design tool that enables communication between design teams as well as real estate companies and that incorporates the concept of service science as well as the features of ISs remains missing. However, the service design tools are thus more technology-oriented and complex, which frequently hinders communication between design teams and vendors or senior managers.

The objective of this study was to introduce a service design tool that could be used to develop an IIS system to enable design teams to communicate, discuss, and provide descriptions to vendors regarding the topics of developing a service interface for customers and developing an innovative IT system. The service design tool had the following functions: (a) it could be integrated into the development cycle of the new services and contribute to effective IIS development and deployment; (b) it described the service philosophy and design logic in a clear and concise manner, which included all operations and decision-making-related content during service procedures, interactions among associated individuals, and order of services

provided; (c) it provided a complete description of the IT design to be used and systematically discussed how to develop service encounters within the system as well as the innovative applications of the IT; and (d) it reviewed whether the IIS design tool could effectively and efficiently design, develop, and launch house display and sales services by using the Hihouse case as example.

Research Frameworks and Literature Review

Design methods of service science

The methods applied for service science and ISs can be divided into three types according to structure and scope of the service design, namely process-, stakeholder-network-, and ecology-based methods (Maglio et al. 2009; Spohrer and Maglio 2010; Salvendy and Karwowski 2010; Maglio and Spohrer 2013).

Among process-based service design methods, the service blueprint method is the most representative (Shostack 1984; Bitner et al. 2008; Patrício et al. 2008). Although the service blueprint method is an excellent tool that enables service design planning, performance management, and internal and external communication, it regards technology as a mere supporting element of service design and thus cannot systematically investigate the innovative IT applied in service designs.

The stakeholder-network-based service design method includes the network mapping (Svendsen and Laberge 2007; Spohrer and Maglio 2010) and value-net (Hallikas et al. 2008; Allee 2009) methods. According to the objective of the service system and analyses of the demands of stakeholders, system engineers perform back-chaining and dependency analyses to create cross-function, cross-department, and cross-region service systems to help related parties connect. However, the stakeholder-network-based design method focuses on the connections among related parties (or stakeholders), such as business partners and corporate customers, whereas individual customer-related concerns are often disregarded.

Ecology-based design methods state that the ecology of service systems encompasses all of the "items/entities" involved with the service system, such as resources, the actual service system, stakeholders, government mechanisms, and service system network. However, current ecology-based design methods are immature and under development (Spohrer and Maglio 2010; Spohrer et al. 2014).

Design methods for information systems

The system development life cycle (SDLC) method is the most commonly used service design method for ISs. The SDLC can be applied to describe and define system development procedures and provide developers with a systematic procedure that helps them successfully develop software and services demanded by users (Nurmuliani et al. 2004). The SDLC features four stages: planning, analysis, design, and implementation. The tasks for each stage of development must be independently completed prior

to progressing to the next stage. Because this method requires that stages be completed individually, it ensures favourable system quality (Boehm 1988). As the system development demands and development methods evolve, the SDLC method is currently used for various system development models. These models include the waterfall, (Nurmuliani et al. 2004; Kazman and Chen 2009), rapid prototype (Zhang et al. 2013), spiral (Boehm 1988; Ruparelia 2010), and incremental models (Ruparelia 2010).

This discussion on service-science and IS-related literature revealed the deficiencies of current service design methods demonstrated that adjustments must be made to develop a service design development tool for IISs to meet customer demands, be incorporated into business strategies, and provide detailed and complete information system analyses.

Hihouse service system

The objective of the Hihouse service was to provide house display and sale services. The vision set by the service provider was to "improve the living environment and create new values in life." The strategies adopted by the service provider was an interactive video channel in which videos themed on houses and residential architecture concepts were uploaded online to increase consumers' attention to residential quality of living. To the real estate company examined in this study (hereafter referred to as "the case company"), Hihouse was a customer-oriented innovative service featuring a service quality that was suitable for promoting the brand image of the case company. By examining their service strategies, concepts and guidelines, design of the interface and service delivery systems for users, and information and communication technologies, the services offered by Hihouse were induced: an online marketing and interactive platform, video-stream multicasting, video-on-demand, and information retrieval. These services provided users with a superior browsing experience because the videos were aesthetically pleasing, rich in culture, intellectual, and creative. Hihouse was required to deliver a high-quality brand image for the case company and to maintain high-quality video broadcasting stability and video continuity. Moreover, the system was required to manage high peak demand from multiple areas. In the back-end server, cloud-related technology, peer-to-peer networking technology, and multi-task and distributed systems were applied. To enable users to enjoy views of houses and experience aesthetic pleasure, culture, smart technology, and innovation in this browsing experience, a metaphoric graphical user interface was used to create an impression that embodied contemporary culture and classic elegance. The architectural concept of the Hihouse service system is shown in Figure 1.

Figure 1. indicates that the Hihouse service system featured numerous services, subsystems, and platforms. To design and communicate on these subsystems, platforms, and diverse and complex services required a service design tool that could enable design teams and vendors to discuss service philosophies and design logic in a clear and

concise manner. These philosophies and design logic included all operations and decision-making-related content during the service procedure, interactions among associated individuals, and order of service. The required tool had to comprehensively describe the design for IT application, systematically discuss the service encounter to be provided by the service system, and disclose the innovative application of IT.

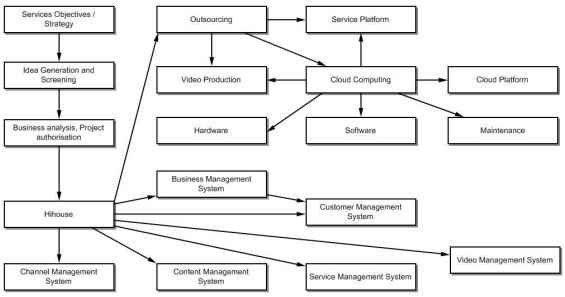

Figure 1. The Hihouse service system employed by the case company (partial image)

Innovative information blueprint

To comprehensively illustrate the application of IT by the Hihouse service using graphics, this study applied the service blueprint method to modify the IIS blueprint (IISB) method. The IISB was incorporated into the NSD cycle and assisted the design team in clearly and concisely displaying the application of IT by the service system. In addition, the IISB enabled the case company to review and determine whether its service strategies, service concepts, philosophies, and guidelines were properly executed prior to making final decisions regarding the information and communication services. Moreover, the IISB enabled the case company to analyse potential failure points and identify opportunities to create favourable impressions on users, improving the problem-solving and creative thinking abilities of the case company. Figure 2 illustrates a segment of the architectural diagram of the Hihouse service that applied IISB to design its communication. The IISB enabled the creation of a flow chart that showed every application of IT by the service delivery system. The IISB, similar to the general service blueprint method, enables IT design-related communication between design teams and vendors.

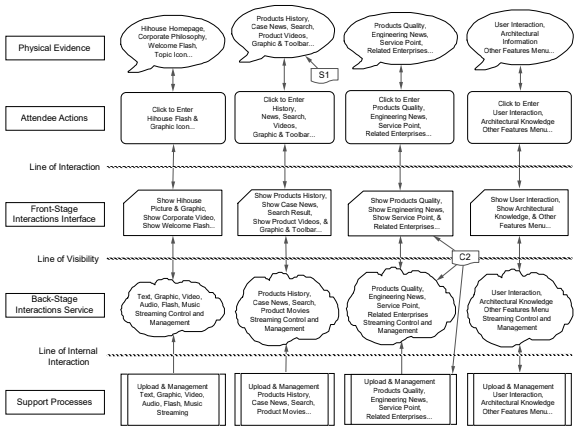

Figure 2. The use of IISB by Hihouse to design communication (partial image)

Physical evidence: The top of the diagram shows physical evidence that users were expected to see, such as overall style, business philosophy, welcome videos, product description, architectural knowledge, search, user interaction, and other function menus. The IISB facilitated communication between the design team and the case company. To assess the effectiveness of the IISB, the follow-

ing questions were asked: "Did the system style match the image of the case company?"…

Audience action: Users operated and interacted with the service system. Audience action signified the operations and selections made by users as well as actions that they performed when viewing videos and making service assessments. The IISB facilitated communication between the design team and the case company. To improve and assess the effectiveness of the IISB, the following questions were asked: "Should the background music play continuously?"; "What type of sensory feedback should the system provide users to maintain consistency of system operation?"…

Line of interaction: Line of interaction was below audience actions, which denoted the operations and selections made by users, services that they experienced, and actions that they performed when making service assessments. Below the line of interaction, content and item information between users and the service system during direct service encounters were featured.

Front-stage interaction interface: The front-stage interaction interface displayed video information that could be perceived by users, such as the service system interface, video information, searchable information, message fields, and interactive animations. The IISB facilitated communication between the design team and the case company. To assess the effectiveness of the IISB, the following questions were asked: "Was the system image quality satisfactory?"; "Was the system video quality satisfactory?"; "Was the system music quality satisfactory?"; and "Was the system content quality satisfactory?"

Line of visibility: Line of visibility denoted users' level of involvement during the service delivery process. Items above the line of visibility were things that users were able to see, namely items displayed on the front-stage interaction interface such as the service interface, images, videos, and various types of function menus. Items below the line of visibility were things that users were unable to see, namely items displayed on the back-stage interaction service such as text, videos, and audio, as well as commands messages generated by audience action.

Back-stage interaction service: Back-stage interaction service performed commands and messages generated by audience action and provided appropriate response screens, videos, and music requested by users. The IISB facilitated communication between the design team and the case company, considered various possible user behaviours, and enabled stable system operations. Questions that were asked included "How can services be deployed to achieve optimal service efficiency and reduce the probability of service delays?"; "How can services be deployed to facilitate the most secure system backup?"…

Line of internal interaction: The line of internal interaction and the support processes below it enabled the design team to determine whether the information system was properly planned by the management of the case company to effectively support the back-stage

interaction services. The Hihouse support procedure involved using a management system for uploading images, text, and videos as well as updating advertisements. These support procedures were not seen by users but were essential for the stable provision of services.

Service touch list

The objective of developing the service touch list (STL) was to enable users to easily understand the service procedures during the service process and to facilitate sufficient communication between the designers and the case company to meet service philosophies and guidelines. The STL proposed in this study comprised the following information: number, name, encounter interaction, user experience design, and art work design. All service functions that users may encounter were listed and subsequently verified, as shown in Table 2.

The product history (S1) from Figure 2. is used as an example. Table 2 presents the names of all the services provided by S1 as well as user experiences beginning from the start of encounter interaction to the operations performed during the encounter interaction and then to the end of encounter interaction. For S11, the system displayed the menu select screen "Start: Show product history" at the start of the service before proceeding to "Action: Play history video." At the end of the video, users were returned to the menu select screen "End: Back to product history interface." In addition, the STL recorded the names of the electronic files containing the art designs as well as the art graphics, images, animations, and background images of each encounter interaction to facilitate subsequent revisions, updates, and review. Therefore, the STL became a tool for the case company to communicate with systems analysts and programmers of the design team. For the case company, which considered the innovative services that external users and customers required from the perspective of these external users and customers, the IT services were highly convenient and

Table 2. Service touch list for S1 (partial list)

No. S1	Name	Encounter interaction	User experience design	Art work design
S11	Product History	Start: Show products history, Action: Play history video End: Back to product history interface	Follow up enterprise image, product style, user experience, and homepage & graphic aesthetics	Product history icon & toolbar graphic, Animation, file item check list
S12	Case News	Start: Case news icon Action: Play flash, Election End: Show news content, Back to case news interface	Follow up enterprise image, texts style, user experience, and web aesthetics	Case news icon & toolbar graphic, file item check list
S13	Product Video	Start: Show products video Action: Play product video End: Back to product video interface	Follow up enterprise image, frame style, user experience, and web aesthetics	Product video icon & toolbar graphic, Animation, file item check list

could be used by users and customers at any time, meeting their demands. In addition, the STL can be used at expert user conferences, at which ideas expressed by external user and customer representatives can be incorporated in discussions to facilitate integrating opinions in the design stage. In addition, the STL can adopt an open approach in which all members of the design team can edit and revise the STL, enabling them to confirm each other's ideas.

The STL considered the perspectives of external customers during the initial stage of service design and incorporated the concept of NSD life cycle, enabling conceptual guidelines and service features to be transformed into actual interfaces and functional designs, which improved the case company's level of acceptance of the design format. The STL featured a concise and easy-to-read format in which external users and customers could add their opinions. These opinions were subsequently used as a communication reference for the case company, systems analysts, and programmers.

Service exchange script

In the IISB, operations performed by each external user and customer triggered a task, which initiated a service exchange process between the front-stage interaction interface, back-stage interaction services, and support processes. This service exchange process was found across the service system, functional departments in organizations or cross-organizations, and in the line of visibility and line of internal interaction processes. By using the service exchange script (SES), the systems analysts and programmers could start from the IISB and trace operations performed by all users and external customers that triggered the front-stage interaction interface, back-stage interaction service, and support processes.

In addition, the SES was used to describe the designs of the operational procedures of the front-stage interaction interface and back-stage interaction service. Subsequently, the SES and IISB were employed to draw the STL and front- and back-stage operating procedures, which enabled the case company to learn whether the service interfaces were operating smoothly and how to appropriately deploy the ISs, and to conduct information exchanges between servers. Designers were reminded to incorporate service concepts, philosophies, and guidelines into each back-stage operating procedure. The SES design described the process and structure of the related algorithms by using multiple natural languages, which enabled programmers skilled at different programming languages to become aware of the functions that each program block possessed during the operating procedure.

The product service point search (SPS) provided by the Hihouse service system in Figure 2 (marked as "C2") is used as an example. When external users or customers performed searches on personal computers, tablet computers, and mobile phones, SESs were created for the front- and back-stage operating procedures. An example of the SES procedure is presented as follows:

{1} External user or customer entered into the Hihouse service system by using a web browser;

{2} Requests for SPSs were made in the browser, which activated the SPS URL address, and a service point search request was submitted;

{3} The SPS sent back the message "play the service point Flash animation to the user's browser" to the main database server;

{4} The main database server returned an SPS service interface to the user, after which the Flash program was activated and the Flash animation was played;

{5} At the end of the Flash animation, the URL for the SPS service interface was resent to the user; and

{6}The SPS returned the information selected by the user. Subsequently, relevant information in the main database server was sent back to the user's browser in the form of images and text.

By describing the user or customer's SESs in sequence, details concerning the front- and back-stage operating procedures as a user or customer performed operations could be known. Furthermore, the SES enabled the case company and the systems analysts and programmers to comprehensively understand the service generation process, allowing them to communicate with each other about design display.

Figure 3. The Hihouse service system interface (partial image)

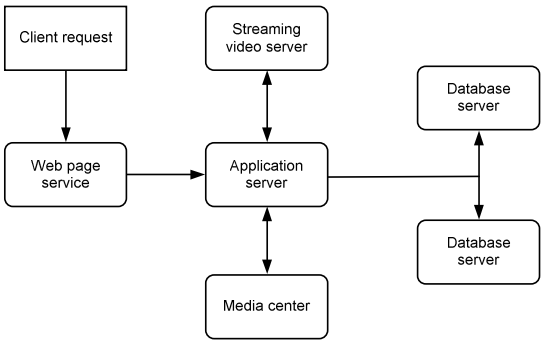

Figure 4. Segment "S1" of the Hihouse service system architecture (partial image)

The Hihouse service system interface was designed through communication and discussion, and part of the interface content i shown in Figure 3. By examining the SES procedure, systems analysts deduced the corresponding front- and back-stage operating procedures and the system architecture, as shown in Figure 4.

Conclusion and Management Meanings

In an era in which service innovation is emphasized, businesses use IT to transform traditional house sale services that feature asymmetric information to house sales services that focus on informatisation, innovation, and customer-orientation. By providing sufficient information, gaps between transaction parties caused by information asymmetry are filled, enabling the provision of superior services. In this study, literature data were examined and a case study was conducted to integrate service science and information system methodologies and technologies to develop three service design tools, which were subsequently employed to create an IIS system. In this case study, the infor-

mation system used by a real estate company for the display and sale of houses was examined. The service design tools were adopted to facilitate communication between a design team and the case company as well as to examine the demands of external users and customers. The IIS service design tool set comprised numerous components, which are listed as follows.

An innovative information service blueprint (IISB): A design blueprint that demonstrated the application of IT in the IIS system. IISB, similar to conventional service blueprints, enabled IT design-related communication between the design team and the case company. In addition, the IISB enabled the creation of a flow chart that showed every application of IT by the service delivery system. Furthermore, the IISB was incorporated into the NSD cycle and assisted the design team to clearly and concisely display the application of IT by the service system. The IISB enabled the case company to review and determine whether their service strategies, service concepts, philosophies, and guidelines were properly executed prior to making final decisions regarding information and communication services.

A service touch list (STL): A list that showed the use of IT in a system to design and plan service encounters. The STL enabled the case company to clearly understand the planning of the service system's interactive interfaces. In addition, the case company compared the STL with the IISB to understand functions provided by each interface, such as icon buttons, so that the company could rapidly visualize the style used on each interface. The STL considered the perspectives of customers during the initial stage of service design and incorporated the concept of NSD life cycle, enabling conceptual guidelines and service features to be transformed into actual interfaces and functional designs, which improved the case company's level of acceptance of the design format.

A service exchange script (SES): A script that illustrated the process in which service information was exchanged between front-stage interaction interfaces, back-stage interactions services, and support processes. By narrating using natural languages, the case company's level of acceptance of the front- and back-stage operating procedures was enhanced, which facilitated smooth and efficient communication during the design stage. By examining the SES procedure, systems analysts deduced the corresponding front- and back-stage operating procedures and the system architecture. In addition, systems analyst integrated all front- and back-stage operating procedure designs to obtain graphics of these procedures as well as the system architecture of a service system.

These three components of the tool set can improve communication on the topic of IT application, which is consistent with the current informatised service situation in which companies authorise IT to customers as well as how front- and back-stage operating procedures are informatised within organisations and between organisations. The design of IT applications must be able to fulfil service goals; the tool set introduced in this study were able to satisfy

customer demands, incorporate business strategies, and provide detailed and complete information system analyses.

By using the tool set for the Hihouse services, the design team confirmed that the concepts and influences of information and communication technology described in informatised service blueprints could be macroscopically integrated into the IISB service blueprint. For every service encounter for informatised services, the designers used the STL to accurately describe design philosophies that provide radical service experiences by employing icon buttons, content, effects, and background pictures. Regarding the operating procedures and the corresponding system management procedures for cross-information systems and interorganisational front-stage interaction interfaces, back-stage interaction services, and support processes, the design teams used the SES to provide an unofficial and easy-to-understand communication channel for the case company and the system engineers. The three aforementioned service tools facilitated favorable communication between the designers and the case company and produced an effective Hihouse system. Hihouse garnered positive feedback from the case company and received praise from customers and users. In the future, these three service design tools can be integrated with company business models to enable companies to expand the scope of their strategies. In addition, these tools can be used jointly with innovative design tools or methods to create more innovative tools for design teams.

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A STUDY ON REUSING CONSTRUCTION-SUSPENDED BUILDINGS IN TAICHUNG CITY OF TAIWAN

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Abstract

According to "Annual Report of Urban Planning in Taichung", the growth of population to million and the urban social/economic indicators have shown an increasing tendency towards urbanization in Taichung city. There have been numerous construction-suspended buildings in Taichung city due to the construction rush and bubble economy in Taiwan earlier on. These buildings are large-scaled, which consequently have been extended into dirtiness and untidiness. However, there was no study on the risks derived from construction-suspended buildings in construction management yet. This study takes the construction-suspended buildings of those not obtaining the building usage permits in Taichung city as the case studies. The feasible mode for the reuse of Construction-suspended building proposed for case study of the phenomenon and substantial recommendations as a way to minimize risks during construction would help activating local economy.

Keywords: Reuse of Construction-suspended building (mainly buildings with completed construction, incomplete construction without being granted an occupancy license.)

Background of the study

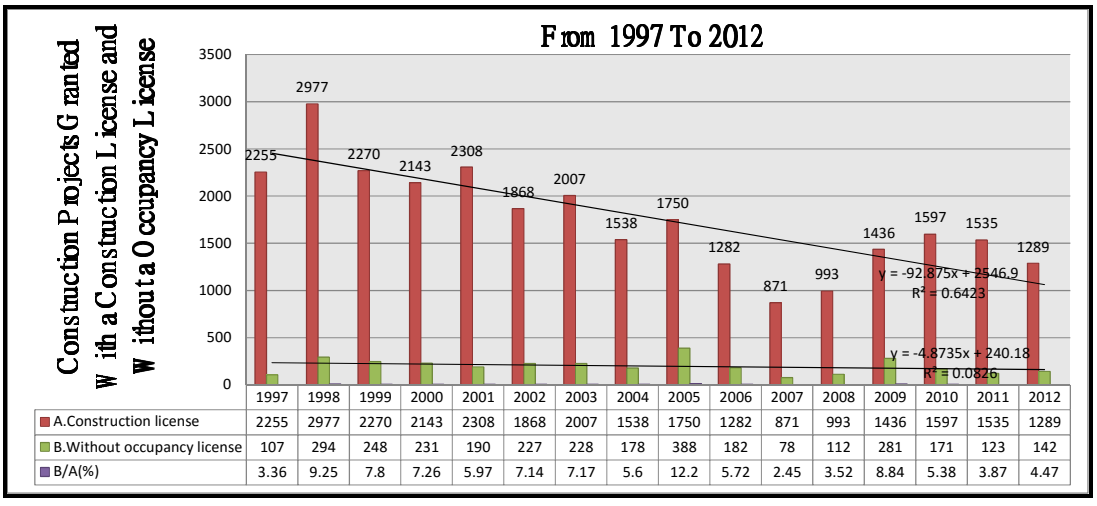
The preliminary survey conducted for this research suggests that 3 rushing construction waves have taken place in Taiwan, where the first one occurred in the early 1975s as result of the ban on construction projects in urban areas and builders turned to sub urbs instead. The second wave came in the late 1975s and early 1985s, when non-urban lands began being redesignated based on current use, a move that led to the rush in non-urban areas. The third one took place between early the mid 1995s (until 2000), when the volumetric rate was implemented in areas subject to urbanization planning. The practice invited a total

construction area of 70,000,000M^2 in application for construction licenses each year between 1997 and 2000, equaling the number of applications for construction license of 2 to 3 years combined in the 1985s.

A preliminary statistics made for the research in question suggests, (as shown in Table 1), 28,119 construction cases in Taichung City were granted with a construction license between 1997 and 2012 and 3,180 cases failed to see their occupancy licenses issued; in another word, of all the cases granted with a construction license, 11.31% failed to see their occupancy licenses granted. Again, of the number of construction licenses granted in Taichung City, a little more than 5% would be suspended of construction work and in 2005, the rate went up to 12.20% and average rate goes between 2.45% and 12.20%.

As Taichung City keeps on seeing Construction-suspended building, the issue has created environmental, security and economic impacts. In construction codes, Construction - suspended building may be defined as buildings issued with a construction license, but not an occupancy license. A thorough breakdown of internal factors (business administration, fund raising and others) or external factors (political, economic and seismic movements among others) of a feasible reuse model for a building that eventually becomes suspended of construction work would help solve economic, calamity prevention and environmental resources among other problems a city may have to deal with as result of Construction-suspended building, and the practice may be applicable to like cases in other cities and eventually help Taiwan see its economy activated.

Table 1. Taichung City With Construction Projects Granted With a Construction License and Without a Occupancy License From 1997 To 2012



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
A.Construction license	2255	2977	2270	2143	2308	1868	2007	1538	1750	1282	871	993	1436	1597	1535	1289
B.Without occupancy license	107	294	248	231	190	227	228	178	388	182	78	112	281	171	123	142
B/A(%)	3.36	9.25	7.8	7.26	5.97	7.14	7.17	5.6	12.2	5.72	2.45	3.52	8.84	5.38	3.87	4.47

A. Construction license Linear trendline formula

$y = -92.875x + 2546.9$;

R-squared value of linear trend line

$R^2 = 0.6423$

B. Without occupancy license Linear trendline formula

$y = -4.8735x + 240.18$;

R-squared value of linear trend line

$R^2 = 0.0826$

With the housing market resuscitated over the years and the market turns expectative with regard to property values, in addition to new projects or growing amounts, many Construction-suspended building turn available as new offers. Next, as lands turn increasingly hard to get, builders see no options but turning to these Construction-suspended building being auctioned by the bank over troubled finance. In contrast to the un believably high prices of state properties in auction, inaccessibility and time- consuming effort in getting new urban lands, buildings of suspended construction work being auctioned with the land usually remain lower than the market value, making it attractive to builders, though management and reuse of idle space remain issues worth paying attention to.

Purposes

There has been no similar research of the risk concerning with the construction-suspended buildings in the field of construction management. In order to identify and solve the problem, the cases of those not obtaining the usage permits in Taichung city were taken to discuss the risks came from these buildings and recommended strategies by applying the risk management.

Hence, the main purposes of this study are as below.

(1) Discuss the risks came from construction-suspended buildings by applying risk management.
(2) Recommend the strategy for solving the construction-suspended building problems.

The researching objects of the cases of having only the construction permit, but not obtaining the usage permits are defined as the construction-suspended building. That is, the building has obtained construction permit in the plan and design phases, and some problems occurred during the construction, and resulting the building of not obtaining the usage permit. According to the preliminary analysis, the construction-suspended buildings occurred in Taichung city are mainly private projects.

Business indicator cycle

Construction works are different from other commodities because of the longer timing of production that keeps the builder from adjusting the pace of production based on market demand and business situation. On the other hand, the construction firms in Taiwan vary in terms of scale of fund; firms with solid fund are capable of taking impacts created by market fluctuation and other unknown risks while builders of poor finance could be put out of business or postpone the project repeatedly when the market turns against them of in case of other risks, leading to Construction-suspended building. Therefore, we like to first point out the business causes to delays in construction works (real estate).

Fully aware that Taiwan's real estate market is vulnerable to changes in the real estate market, international political situations and other political-economic factors, we must say that

inappropriate implementation of volumetric rate is the No. 1 cause of the rush construction wave that produced the large number of Construction-suspended building. (As shown in Fig.1), we have a cause-effect diagram of delayed or idle construction works in Taichung City because of low business cycle.

Regulations for the reuse of Construction-suspended building

The Regulations on Reuse of Idle Spaces announced by Council for Cultural Affairs, the Executive Yuan define the term of idle spaces as those including antiques, historical buildings or unspecified old idle buildings or spaces, which are specified as type for reuse and type [1)]. In this research, the term Construction-suspended building is defined as buildings granted with a construction license yet without an occupancy license and the buildings remain in the life cycle of the same. These buildings had been approved by competent authorities for construction license and the failure to be granted of the occupancy license as the buildings undergo expected difficulties during construction that make them with completed construction works and incomplete construction works. (As shown in Table 2), we have a comparison of the reuse of idle spaces and the reuse of Construction-suspended building given in this research.

Table 2. Reuse of idle spaces and Construction-suspended building

Similarity	1. Possibility of reuse. 2. New life to the building		
Difference	Different definitions	Reuse of idle spaces	Antiques, historical buildings or unspecified old idle buildings or spaces
		Reuse of Construction-suspended building	Mainly completely built, incomplete construction without an occupancy license.
	Different types of reuse	Reuse of idle spaces	Mainly antiques, historical buildings
		Reuse of Construction-suspended building	Mainly private buildings
	Different types of reuse	Reuse of idle spaces	Reuse by transferring the use of idle spaces
		Reuse of Construction-suspended building	To propose countermeasures for possible reuses of the building.

To analyze the internal and external factors with impacts on Construction-suspended building, it is paramount to compare relevant construction management codes, abandoned houses after seismic movements, houses on pre-construction sale and engineering disputes among other limitations and a feasible reuse model would only be successful with case analysis. The limitations are given as follows:

Construction management code

Based on Construction Code, the basic structure of construction management features permits, delimitation, construction, use and demolition of buildings as key elements of life cycle behavior plus the rights and obligations of all parties involved and eventually, it defines duties and responsibilities of the competent authorities. The construction technical codes are to specify design, construction, structure and equipment as technical issues involved in buildings and Construction Technical Rule is set as the basic technical specification, where the regulations governing applications for construction or occupancy of buildings are given in (As shown in Fig.2).

Besides, Art. 53 of Construction Code reads: "For approval of terms of construction (effective date of start of construction), 3 months for each story is set as base and in case of application for additional days for special structure, difficult work, demanding engineering work or special cases, the application shall be granted." Measured by Construction Code, a maximum extension of days for construction works between date of receipt of the construction license and date of completion may go as long as more than 2 years; details are given as follows:

(1). Example: (Article 41 of Construction Code, 3 months) + (Article 54 of Construction Code, 9 months) + (Article 53 of Construction Code, 12 months) = 24 months.

(2). Major changes were introduced in 1999 when, as result of business cycle, the buffering period for volumetric rate and the September 21 1999 earthquake, 3 situations may appear from the perspective of the construction license before 2001:

(A). All valid construction licenses before January 1 1999 shall be automatically renewed for 2 years (The Executive Yuan notice No. 8984958)

(B). All valid construction licenses before December 31 2000 shall be renewed for 2 years by application (The Executive Yuan notice No. 27211)

(C). All valid construction licenses before November 30 2000 shall be renewed for 3 years by application (The Executive Yuan notice No. 9067067) and it is specified in Notice No. 9067067 that, if a construction license remains valid, a joint application for renewal for 5 years may be filed together with a construction case approved for another 3 years for construction as referred in the Executive Yuan notice 27211 regarding the reinforcing measures for real estate market.

Except for the issue of engineering survey, the above remarks reflect a rigid construction code. In the event of troubled buildings, such as a house on pre-construction sale, of which the builder extends the construction period intentionally, the uncertainty created on the consumer could become more severe, as the builder might turn speculative with the extended construction period and, in such a case, it would be paramount that the government reviews the policy of extension of construction period based on the interaction between Construction Code and reinforcement of the real estate market.

Abandoned Houses by Seismic Movements

When it comes to safety of abandoned houses by seismic movements, in the research of JIN Wensen (2003),

2 observations [3] are proposed as follows:

(1). Owner responsible for aftermath: For the abandoned building of which the owner is not willing to make further investment in restarting the work because of economic recession and no others are interested in taking the work over, for the sake of local population and safe traffic, the owner is asked to seek solutions on an amicable basis by at least being responsible for the demolition or repair of damaged structures.

(2). Government involvement: For owners of close-up businesses, it is proposed that the government engages per construction code by asking for demolition of buildings in danger or taking over all debts, collecting the property and title of the buildings with repairs of damaged structures and even restoration for service.

Houses on Pre-construction Sale

As houses on pre-construction sale may invite disputes over transactions on contracts signed without any physical house, we are seeing a large number of payment warranty agents that secure the interests of the buyer, known as service bond. Businesses offering such a service are construction agencies, brokers, banks and insurance companies, a practice that does minimize property deal risks. In case of houses on pre-construction sale that cannot be completed, the security bank may ask its own construction agency to take care of impose punitive measures. At this time, the construction agency would first make evaluations before raising fund, awarding contracts until completing the construction and delivery the work. In the event of force majeure that should keep the construction from becoming successful through delivery, the deposit paid by the buyer would then be refunded plus the interest [4].

Engineering disputes

During construction of average housing, disputes over property right, damage to neighboring houses or economic recession, construction works may become suspended and the construction work would then be postponed and solutions should be sorted out for disputes.

Case analysis

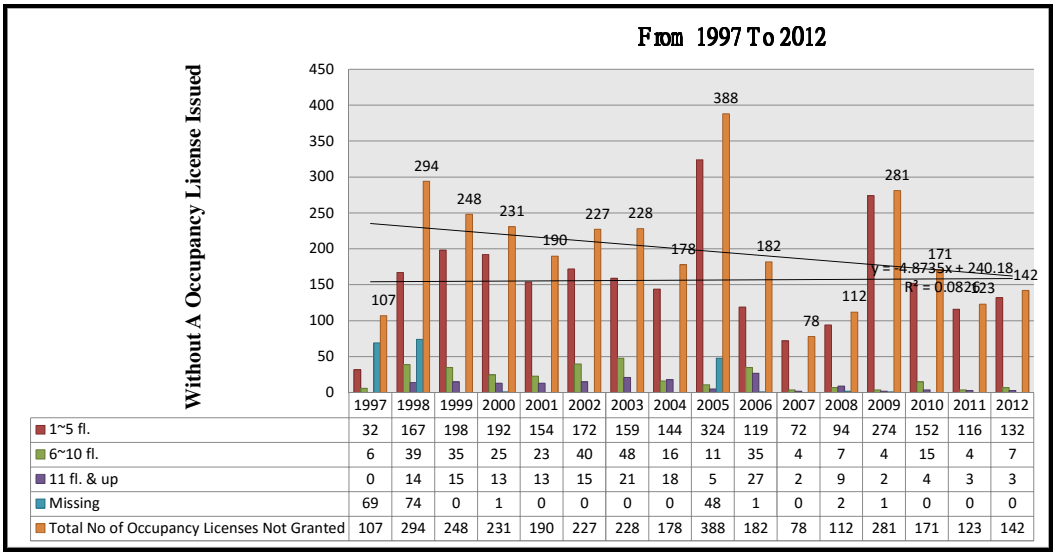
The surveys conducted for this research indicate that, between 1997 and 2012, more than 3,000 construction projects in Taichung City ended up unfinished , quite a large number. Understaffed, the construction agency in Taichung City Government is unable to keep all cases under control and only a few of large cases were kept under control for solutions in 2008. A major city, Taichung City has a large population, booming manufacturing industry and potential acquisitive power, an Construction-suspended building in the city would create significant negative impacts to the city itself [5].

Basic case study

The basic survey conducted for the research in question suggests, of the projects with a construction license granted between 1997 and 2012, there are projects not having been granted an occupancy license and in application and without an application for suspension of construction work. (As shown in Table 3.), Construction-suspended building: (1) mean huge impacts on the concerned parties.(2) Jeopardizes the city landscape. (3) When it comes to the population in the neighborhood, the

engineering structure and public engineering safety would mean potential hazards, unless demolished, the buildings might create other problems, such as collapse causing unnecessary casualties. (4) Homeless people or others may hide in Construction-suspended building creating security concerns in the neighborhood.

Table 3. Construction Projects in Taichung City Without A Occupancy License Issued From 1997 To 2012



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1~5 fl.	32	167	198	192	154	172	159	144	324	119	72	94	274	152	116	132
6~10 fl.	6	39	35	25	23	40	48	16	11	35	4	7	4	15	4	7
11 fl. & up	0	14	15	13	13	15	21	18	5	27	2	9	2	4	3	3
Missing	69	74	0	1	0	0	0	0	48	1	0	2	1	0	0	0
Total No of Occupancy Licenses Not Granted	107	294	248	231	190	227	228	178	388	182	78	112	281	171	123	142

Total No of Occupancy Licenses Not Granted result Linear trendline formula

$y = -4.8735x + 240.18$;

R-squared value of linear trend line

$R^2 = 0.0826$

Construction-suspended building in case analysis

Case analysis is used in this research to sort out both internal and external issues involved in idle buildings before proposing feasible models for reuse of the same.

(1). Case A: Construction License No. 2001-1971, in which the major difference between the details of the data and reconstruction of Construction-suspended building remains (as shown in Table 4).

(2). Case B: Construction License No. 1999-1218, in which the original plan was for a 32-story office building with small suites. In 1998, for poor revolving fund, the project was pronounced closed up and another construction company took over and changed the design. The new design is for households and small suites. The major difference between the details of the data and reconstruction of Construction-suspended building remains (as shown in Table 5).

Table 4. Case A of Reuse of Construction-suspended building

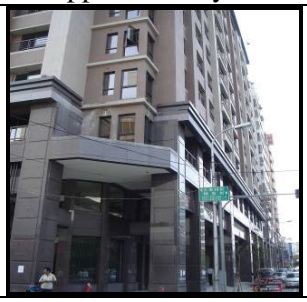
Construction license No.	2001-1971			
Location	Nantun Dist., Taichung City			
Purpose	Residential area			
Type of structure	1 RC building of 78 apartments of 3 levels underground d and 14 on ground			
Base area	Arcades	318.22 m^2	Arcade area	240.53 m^2
	Others	1226.78 m^2	Total flooring	13845.78 m^2
	Total	1545 m^2	Building coverage	45.77%
Cost	NT$129,382,000 approximately			
	  			
Major difference in restored construction work	(1) To demolish part of the original building, safety co-efficient in the second construction shall be taken into consideration as additional load shall be added and, as RC used in the second construction may hurt the beams and columns, welded reinforced bars while increasing load that would all jeopardize the engineering structure creating problems to the structure of the building. (2) Previous evaluation and construction plan.			

Table 5. Case B Reuse of Construction-suspended building 4

Construction license No.	1999-1218			
Location	Taichung City South District			
Purpose	Residential area			
Type of structure	3 RC buildings of 609 apartments of 4 levels underground d and 32 on ground			
Base area	Arcades	○m_2	Arcade area	○m_2
	Others	3312.12m_2	Total flooring	○m_2
	Total	3312.12 m_2	Building coverage	58.22%
Cost	NT$623,584,000 approximately			
  				
Major difference in restored construction work	In this case, the change of design and the demolished part of the building are the major problems. As its façade and part of the facilities do not meet the governing market trend, to assure that the case is attractive to the consumer, the building is to stop for remedies in this regard.			

Using case study on Construction-suspended building in Taichung City, the internal and external causes to Construction-suspended building can be successfully sorted out. On the other hand, a successful case study of reuse of Construction-suspended building may be systematically sorted out with proposal of feasible solutions. (As shown in Table 6), an initial study made for this project based on Case A and Case B for potential cases to Construction-suspended building, such as low business that could be the result of business cycle and end up in the lack of transaction, poor purchase rate of houses on pre-construction sale and lack of fund to keep on with the construction among others. Follow-up studies shall be conducted based on reference literature review, field survey, case analysis plus result revision plus detailing both internal and external causes to Construction-suspended building and eventually proposing feasible models for the reuse of Construction-suspended building.

Conclusions and Suggestions

(1) This research is conducted on the situation in Taichung City, where as many as 3,180 construction projects fail to see the occupancy license is sued over the past 15 years. The real

estate market has long been jeopardized by the international situation and business cycle as well as other political and economic factors, a delayed or suspended construction work can mean major harm to the city and the competent authority needs to be concerned.

(2) A successful reuse of Construction-suspended building is closely associated with the law and proposals are to be made as follows:
A).Revision or adding of decrees for the solution of Construction-suspended building.
B).Establishment of a construction disputes deliberation committee for Construction-suspended building Cases. C).Establishment of Public Environment Preservation Fund for hazards created by Construction-suspended building.

(3) Compulsory insurance for houses on pre-construction sale (such as transaction amount service bond, real estate transaction service bond, housing transaction security system, transaction amount service bond and completed-house transaction insurance among others) plus real estate transaction security trust or real estate securitization to minimize the potential risks during construction as a way to avoid Construction-suspended building because of lack of revolving fund or low business.

Acknowledgments

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Table 6. Causes to Construction-suspended building

Type	Description	Remarks
Economic /Financial /Business	Change in cost of raw material	The rise of labor salary, equipment and machinery, construction materials or land cost, construction costs go up and the construction work is forced to delay.
	Significant change in interest rate/ Construction load interest rate/Credit amount/ Financial deflation measures	1. Bank unable to offer substantial credits 2. Gone a booming economy with sudden financial deflation 3. Deflated politics and economy: (1). Raised deposit reserve rate (2).Raised rediscount rate (3). Government offering securities (4). Reduction of currency supply. 4. Deflated politics and economy: (1). Deflated government expenditure (2). Increase of duties, taxes or reduced taxation point (3). Reduced public investments (4). Reduced effective demand and others.
	Recessed market	1. Low stock market, growing unemployment rate and private sector consumption terns conservative. 2. Houses on pre-construction sale meeting no buyers making the project unable to continue
	Unbalanced supply and demand	Reduced market demand drives the profit down or products in slump
Law	Land law restrictions and changes	Land law restrictions and changes (IVA on land)
	Construction law restrictions and changes	Construction law restrictions and changes (Volumetric rate, coverage rate, indefinite extension of construction terms)
	Renewed urbanization plans	Slow renewed urbanization plans making builders inactive.

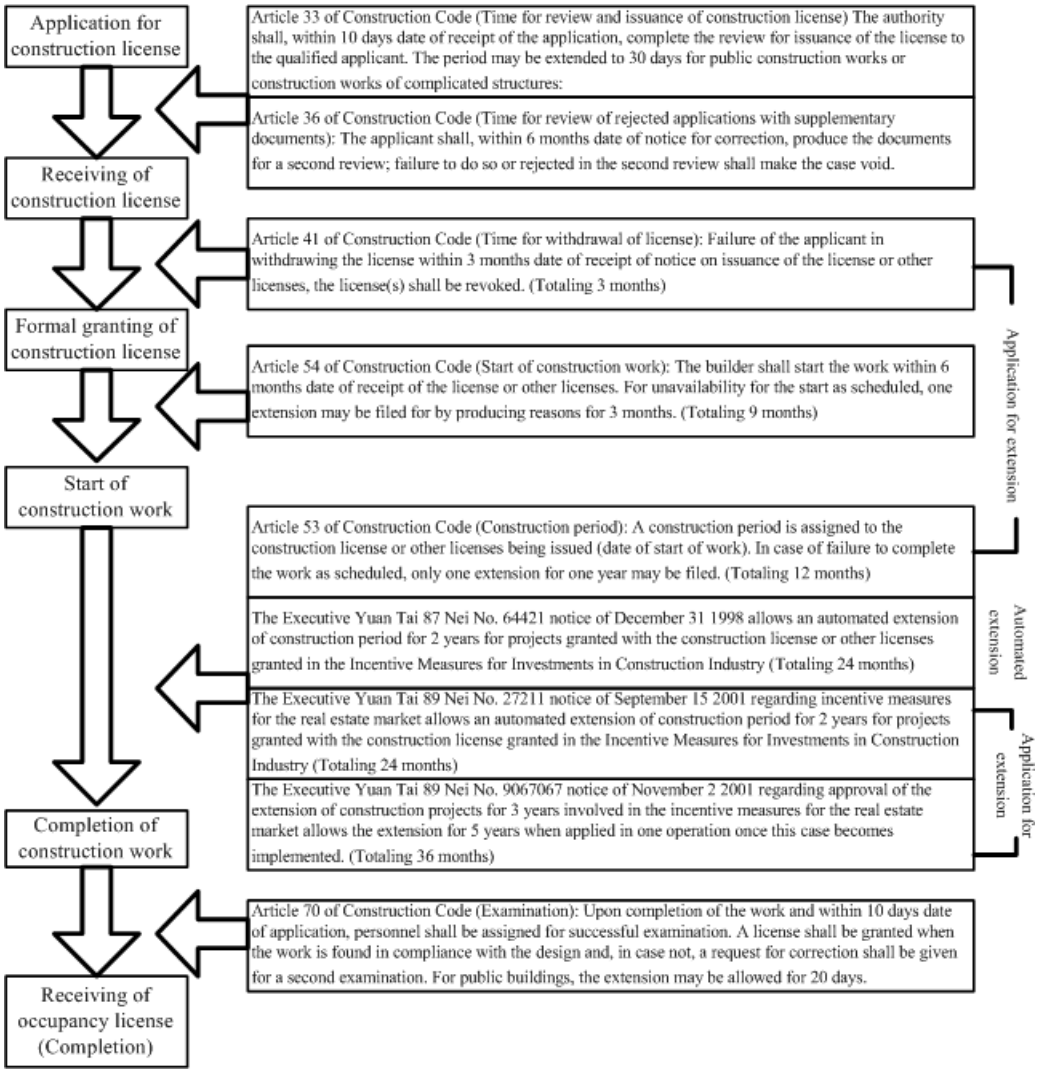

Figure. 2 Flow Chart for Terms of Construction in Different Stages [2)]

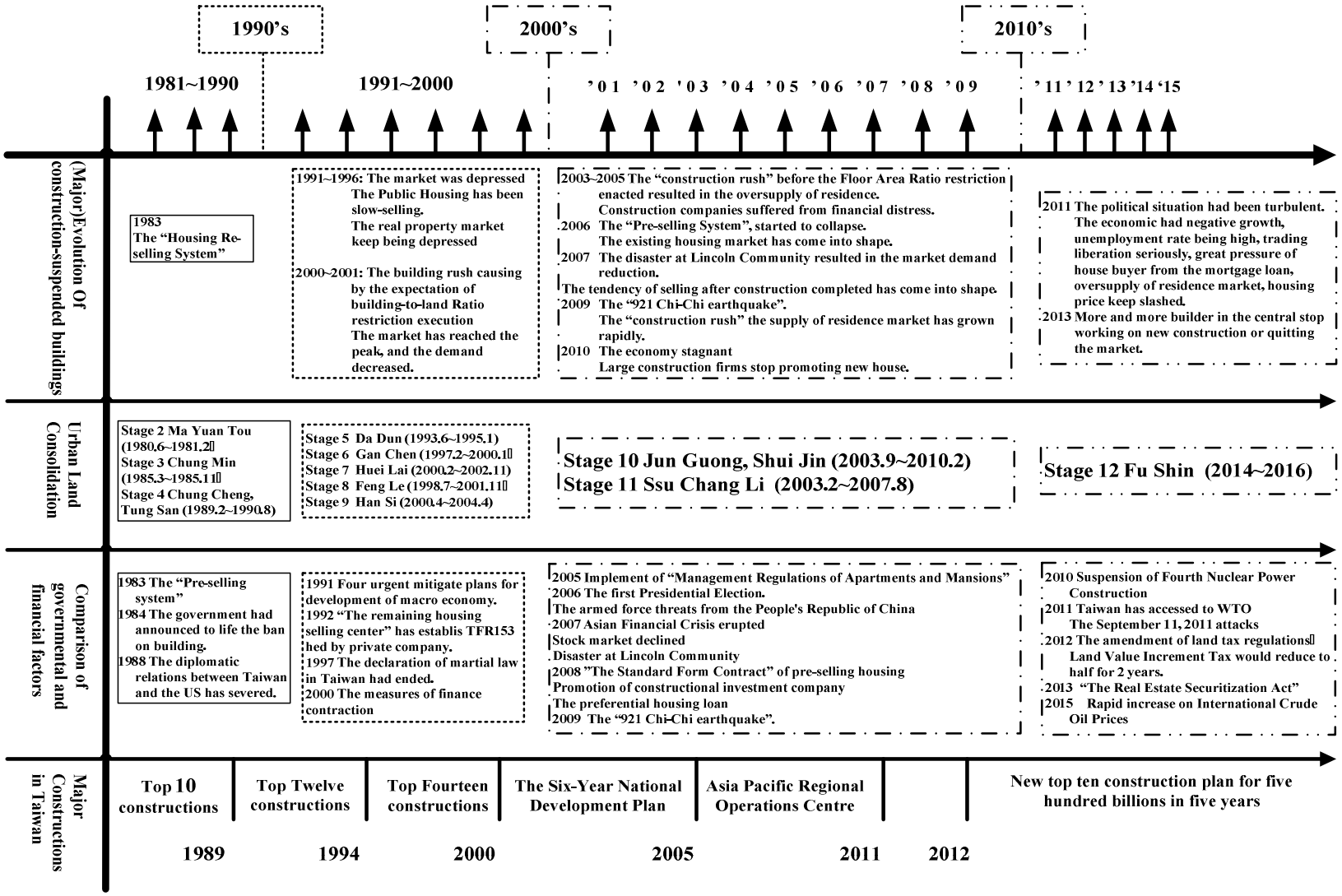

Fig. 1 Evolution of Construction-suspended building

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THE STUDY ON THE SERVICE QUALITY AND SATISFACTION OF PUBLIC HOT SPRING HOTELS

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Abstract

This paper is backed up with a solid empirical object- Jingguang Hotel, given PZB model as method, combined with the characteristics of Hot Springs industry as well as bathing facilities with a view to conducting customers' service quality gap analysis between expectation and perception. The result indicated that state-run hot spring hotels underlay higher effects on customer service satisfaction by their service tangibles and assurance, which further bear more striking strength in prices, hot springs quality as well as the service in the sense of security and hygiene, it also presents where the interior design and its affiliated facilities were all tangibles for poor satisfaction. Upon PZB service quality gap analysis, each dimension and item came to light, which suggested that actual experienced perception was lower than expectation, especially lower in actually using acceptance, by which this study formed the angle of reflection and improvement for relevant authorities and operators.

Key Words: Public hot springs hotels, PZB model, Service quality

Introduction

Tourism and leisure industry has become one of the most important industries in twenty-first century. Increasing income and living quality from rapid economic growth in Taiwan with two-day weekend fad are key factors enhancing higher willingness to engage leisure activities. Taiwan has a rich history of utilizing its hot springs water resources for conducting fundamental industry development. With a fad of weekly holiday, hot spring has become essential natural and tourism resource in Taiwan.

Taiwan Hot Springs Gourmet Festival, was guided by Tourism Bureau, MOTC and organized by ROC Onsen Tourist Association, was held concurrently in seventeen hot spring areas, was taken the general by storm. Thus, Hot spring travel has gradually laid the foundation of "Hot Spring Fad".Taiwan hot springs hotels and SPA resorts have sprung up all over the places.

However, the past abroad and domestic literature of Onsen are solely either focused on water quality-related research (Pentecost et al., 2003) or research of business management in Springs and SPA, very few studies of correlation between service quality and customer satisfaction in hot spring area released. Meanwhile, the study based on particular hot spring area or hotels have started off, most of them are for private hotels with little for state-run ones since government promoted the hot spring tourism in 1999.

Additionally, "Comprehensive Program to Improve Service Quality" implemented by Executive Yuan in 1996 has been more than 10 years. The participants ranged from Executive Yuan authorities at all levels to its municipal, city at all levels, with a view to covering public hot spring hotels and Onsen management units. Public hot spring hotels deserve certain level of service quality to avoid outsourcing.

It is essential to go further study on how service quality of hotels are, hence the research is necessary for giving service quality measuring model, mustering service characteristics from hot spring hotels, making SURVQUAL more effective and explore service quality in various industries.

Design Theory and Literature Review

During the period of being colonized by Japan, police sanatoriums were built as the hot spring outcrops were found by Japanese. After retrocession of Taiwan, those facilities became Police hostels which eventually evolved into Jingguang Hotel nowadays. Therefore, there is historical linkage between public hot spring hotels and hot spring therapy.

Spas and Health

The world's hot spring treatment started from Roman Empire. During European Industrial Revolution (19th century), hot spring application with mechanical principles began to diversify and spread among nations. Hot spring spas not only remained the traditional bathing, showering, steaming and drinking, but also created sauna, Turkish bath, Egyptian bath, Russian bath, French Vichy bath and Germany Kneipp bath therapy (Chang, 2012).

Hot Spring spas gradually prevailed among other areas. German physician Bälz introduced the European spa therapy into Japan in 1875, which set the cornerstone of thriving Japanese bath culture. Japan, the country of obsession with Onsen culture, enacted the world's first hot spring law, developed Onsen hospitals and created the certification system for Onsen doctors, which has enabled Onsen therapy engaged with modern medicine.

The development of hot springs in Taiwan at earlier time, merely four major hot springs (Beitou, Yang ming shan, Guanziling, Sihjhongsi hot springs), the exploitation wasn't overhasty but only a few simple or open-air bath places were built right after the hot spring was discovered by police or aborigines.

Onsen application could be traced back to the Japanese colonial period, it was the time at which Japan developed a large number of hot springs in Taiwan, and built police sanatoriums around hot springs outcrops in order to treat wounded soldiers. After the retrocession of Taiwan, those were called police hostels and eventually evolved into Jingguang Hotel nowadays.

Hot Spring Hotels in Taiwan

The development of hot spring hotel could be traced back to as early as in 1896, by a Japanese named Hirata Gengo who treated his leg with hot spring in Peitou and later founded the first hot spring hotel called "Tengu Om" , which officially started the ryokan history in Taiwan. After Japanese occupied Taiwan, they found that Taiwan has rich hot spring resources, thus followed by another development in Beitou, Yangmingshan, Jiaosi, Chihpen and other places setting up public baths for the Japanese to run business of Ryokan by developing mountain for hot spring resources. After the retrocession of Taiwan, in the 70's, with the economic growth, the provincial government in 1990 selected Chiao Hsi, Guanziling, Sihj-hongsi, Chihpen and other 14 hot springs also two cold springs in Suao and Beipu as the hot spring scenic development focus. Besides, the implementation of two-day weekend has made hot spring hotels transform or convert into hot spring villas, spa pools or even luxurious five-star spa resorts intending to cater customers various needs. To sum up, the spa trend is created.

Currently, the use of hot spring resources is merely one of many business topics on leisure hotels. According to the definition mentioned by some scholars" As long as the stay pattern for the purpose of leisure and tourism and combined with hot spring resources called "ryokan-hot spring hotel". According to Hot Spring Law, Act 18, the hot spring utilization business using hot spring as the purpose of leisure and tourism, ought to provide water sample to the institute accredited by central tourism bureau agency for water condition testing, meanwhile, apply to municipal tourism agency for "Hot Spring Certificate" before conducting business. Hot spring certificate ensure customers water meeting its standard and quality. There are 333 hot spring hotels in Taiwan acquired hot spring certificate as of 2015, July.

Service quality scale in hot spring industry (Lee and Chen, 2006) consisted mainly of three factors: "Environmental equipment factors", "hot spring

water quality factors" and "transportation convenience factors", water quality of which included ingredients of spring quality, quality of spring water, temperature, texture, color, turbidity, hygiene, freshness, purity and usage. Yang (2012) established the evaluation index checklist on hot spring premises; the study showed that the various agencies and organizations, experts and scholars have attached considerable importance to the evaluation of hot spring water hygiene and safety facilities.

Public Hot Spring Hotels

The days when the privatization and Build-Operate-Transfer mode hadn't been popular, made public tourism industry so prevailing. The phenomenon had made either state-run or state-won hot springs hotels scatter all over hot spring areas. The public ryokans are Tangwei spa, Nhon Trach spa, Turtle Island Spa in Yilan County; Wufeng spa in Hsinchu County, Tai'an Jingguang Hotel in Miaoli County; Guguan Jingguang Hotel in Taichung; Lushan Jingguang Hotel, Tonpo Jingguang Hotel and Auwanta spa in Nantou County; Guangziling Jingguang Hotel, Toong Mao Hot Spring Hotel in Tainan City; Sihjhongsi public hot springs in Pingtung County; Chihpen Jingguang Hotel, Tamali spa, Jinfeng Springs, Hongye Hot Springs , Green island spa in Taitung County...etc. Among those, Jingguang Hotel is the largest by scale.

Jingguang Hotel, was derived from Japanese colonial period, later the retrocession of Taiwan called police hostels and eventually evolved into Jingguang Hotel nowadays. Early age, those places were to heal thus many of which were built around where the hot spring outcrops located and remained the Japanese-styled architecture. The ones featured spring quality are Tai'an , Lushan, Dongpu , Guanziling , Chihpen , Gu guan ,while the others are located in the general tourism areas such as Taipei ,Kenting, Alishan Mountain, Penghu police , Riley , Kinmen, Hualien , Southern Cross Litao. Although the national police employees, relatives (including retirees) are the service target, some villas are also open to the general interest.

Due to the escalating demands from customers, customer relationship and service quality is the key to success. State-run business owned the impression of less care in service quality, which brought about the changes in privatization and BOT business model. Face lifting state-run business by means of privatization has been promoting since 1989, part of businesses are able to conduct privatization on their own, while the others are burdened with particular restrictions on policy, in need of better enterprise transformation to enhance the condition privatization. Public hotels and bathing pools also faced the operational issues, which either outsourcing such as Toong Mao hot spring hotels in Tainan or retrieving after outsourcing such as Chin Chuan tribe in HsinChu.

Customer Satisfaction

Customer Satisfaction is a customer judgment (or result) after consuming a product provided the level of pleasure or disappointment. The earliest theory of customer satisfaction could be traced back to "An Experimental Study of Customer Effort, Ex-

pectation, and Satisfaction" by Cardozo (1965). Reisinger and Turner (2003), said that satisfaction is related to expectations and travel experience, with comparison of the experience and expectations, feeling of satisfaction, the customer is satisfied; the other hand, the resulting discontent, and vice versa. As for the possibility of revisiting, is relevant with overall customer satisfaction.

When performances are below expectations, the disconfirmation is negative, which means customers are dissatisfied; when performances equal to expectations, customers are satisfied; when performances outperform expectations, the disconfirmation is positive, and customers are particularly satisfied. Therefore, the influences of satisfaction primarily are cognitive performance, expectations, and disconfirmation, but other factors are still many.

PZB Service Quality Model

Among the relevant literature on discussion of service quality, scholars define service quality as results between customer expectations for service and comparison after service performance. Sasser et al. (1978) stated that the service standards and service quality is similar to the concept of customer service, which is the level and degree of internal and external benefits for customers, can be divided into expected service levels and cognitive service levels. Churchill and Suprenant (1982) proposed that service quality is the customer satisfaction with the services, depending on the differences between actual service and original expectations.

Parasuraman et al. (1985) proposed "service quality gap model (Gap model)", is widely adopted related service quality models , it is posited that the service quality is determined by gap between customer expectations beforehand and afterwards cognitive impact. The influential factors are external communication, personal needs, reputation and past experience and others. As for customer awareness after receiving the service, is affected by the service provider, impact of the service delivery process and marketing. Investigating managers and customers in credit cards, securities business, banking, product maintenance by using depth interviews, discovered the existence of a gap between customer expectations and actual experience of service, the study resulted in the famous "PZB service quality model", as shown in Figure 1.

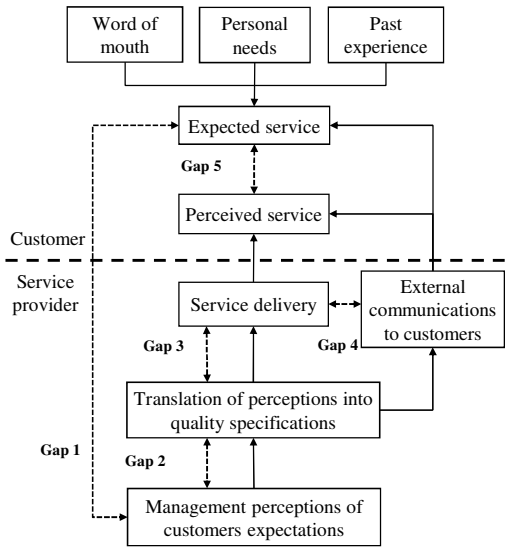

Figure 1. PZB Service Quality Model

It's main concept is customers are decision makers of service quality, enterprises should meet the needs of customers, which is necessary to

smooth five notches. Meanwhile, it also summed up ten dimensions measured the service quality (a total of 97 questions), including reliability, responsiveness, competence, access, courtesy, communication, credibility, security, knowing the customer and tangibles.

Gap 1: between customer expectation and manager perception, and when companies don't understand the customer's expectations, it cannot provide customer satisfaction.

Gap 2: between management perception and service quality specification, the companies may be limited by resource constraints and market conditions, and fail reach the standardization of services, resulting in gaps in the quality of management.

Gap 3: between service quality specification and service delivery, the employees are incapable or lacking of training, it will affect customer perception of service quality.

Gap 4: between service delivery and external communication, such as exaggerated advertising, resulting in customer over expectation, when actual service is not as good as expected, will reduce its perception of service quality.

Gap 5: between expected service and experienced service, refers to the gap between the perceptions of the customer after receiving the service, only is this gap determined size by the customer.

PZB the scholars refined the 10 determinants in 1988 according to the proposed service quality in 1985 into five factors, as "SERVQUAL" scale.

1. Tangibles: The appearance of physical facilities, tools and equipment, personnel

2. Reliability: The ability to perform promised service reliably and correctly.

3. Responsiveness: The willingness to help customers and provide prompt service.

4. Assurance: The knowledge and courtesy of employees and be able to convey trust and confidence.

5. Empathy: Provision of care, individualized attention to customers.

Based on the results of the academic research shows that the merits and drawbacks of using service quality assessment model is remained, even with the same pattern, the results are different as business sector and situation is different. The subject for the study is on service quality of domestic public hot-spring hotels, which with a view of understanding whether SERVQUAL scale adapted to the research of service quality with the domestic quality of service as basis, coupled with the hot spring characteristics for further research.

Method

This study aimed to explore the application of PZB model in ryokan public service quality gap and satisfaction.

Service Quality Model

Study and integrate "service quality SERVQUAL scale" and "customer satisfaction", the construction of this research model (Figure. 2), including accommodation customer background variables, service quality gap as well as the overall service satisfaction, pattern instructions and theory deconstruction.

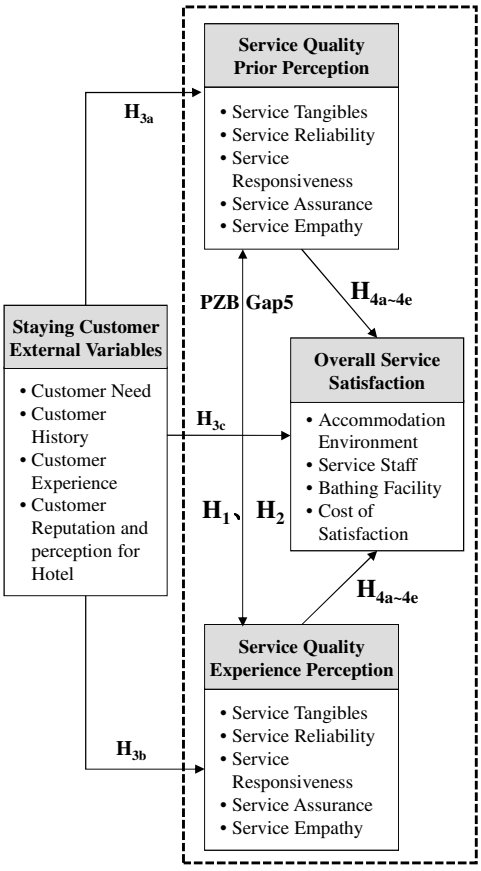

Figure 2. Research Model

Research Hypothesis

Hypothesis 1: Dimensions of SERVQUAL scale account for independent positions in IPA.

Hypothesis 2: The desired perception of service quality and customer experienced perception cause significant differences.

Hypothesis 3a~c: Various customers' backgrounds variables, is making expectation of service quality, perception of performed service as well as the customer satisfaction a significant difference.

Hypothesis 4a~e: Service quality SERVQUAL scale factors not only have positive impact on the overall customer service satisfaction but also cause significance.

Questionnaires Design

A. Questionnaires Framework

The design approached to structured questionnaires, which composed of three parts: General customer background information as part 1; Desired perception and experienced perception as part 2; and the part 3 is customer satisfaction.

B. Encoded Scoring of Scale

Perceptions research model conducted by Five –Level Likert Scale, + 1 ~ + 5 points were measured, coded scoring scale, as shown in Table 1.

C. Pre-test Questionnaires and Reliability Test

This pilot research survey was conducted in October 2014 at Jingguang Hotel that has acquired hot spring certificate.

According to Wu (2009), pointed out that the number of samples for

questionnaires should be taken 3-5 times the maximum "subscale" items as principle. This questionnaires consisted of 20 questions, was expected to collect at least 60 copies. 70 questionnaires were distributed to the tourists of spa hotel, the collected sample came to 65, the collected rate was 92.85%, excluding invalid 2 copies, valid questionnaires rate came to 90%.

Table 1. Encoded Scoring Scale

Variables	**Scoring**
Desired Perception	Unimportant ~ Very Important (+1~+5)
Experienced Perception	Strongly disagree ~ Strongly agree (+1~+5)
Customer Satisfaction	Very poor ~ Very good (+1~+5)

(a) Data Analysis

Service quality perception scale and customer satisfaction scale are significant at more than 0.30 on the same basis of coefficient; extreme scale test questions of the group are considered as significant level, consequently, all questions are reserved.

(b) Exploratory Factor Analysis

KMO value is 0.923 (> 0.6), and the significant level of Bartle former test (P <0.005), shown the research questionnaire data suitable for factor analysis. Using exploratory factor analysis simplify the perception of service quality scale items with method-Principle Component Analysis), extracted the common factors, coped with varimax for orthogonal axis, wherein the loaded factor was greater than 0.5 enabled its significance. Total four factors extracted explained 66.191% of the total variance. This 4 factors are in line with the theoretical framework of the perception of service quality scale, were named as service tangibles , service assurance, service responsiveness, service empathy, 20 questions in total (Table 2).

(c) Reliability Analysis

Through reliability analysis in model scale found dimensional scales Cronbach's α coefficients were 0.705 and 0.733 respectively.

Cronbach's α coefficient in satisfaction scale was .828, showed all with a well-reliability.

D. Operation and Object for Formal Questionnaires

Questionnaires were completed by over-night travelers. In this study, questionnaires are taken by research survey rather than a random sample of convenience. In terms of the amount of sample extraction, under the assumption of sampling error is less than 5% to reliability of 95%, the number of samples collected at least 385 copies. The number of samples derived from the formula was 385 copies, taking the effective rate of pre-trial questionnaire survey of 90% into consideration; distributed formal questionnaires 424 copies were required.

Result and Discussion

The impact on overall service satisfaction analysis

A. Service Identity Difference of External Variables

Table 2. Descriptive Statistics of Prior and Experienced Perception of Service Quality

Fact	Number	Item	Service Quality (Mean)			T Test	IPA	Reliability
			Before (A)	After (B)	Gap (A-B)	P Value	Quadrant	
Service tangibility	T_1	Hotel architecture exterior Design	3.55	3.05	-0.50	0.000***	3	0.854
	T_2	Hotel interior design and facility	3.65	2.85	-0.80	0.000***	3	
	T_3	Price of accommodation, rest	4.20	4.05	-0.15	0.168	1	
	T_4	Hotel hot spring quality and temperature	4.04	4.15	0.11	0.215	1	
	T_5	Hotel hot spring bathing facility	3.20	2.95	-0.25	0.055	3	
	T_6	hotel spa ancillary facilities (bathing products and areas for dressing, shower, rest)	3.10	2.75	-0.35	0.000***	3	
	T_7	Appearance and outfit of employees.	3.75	3.60	-0.15	0.355	2	
		Average	3.62	3.34	-0.28	0.048*	3	
Service assurance	R_1	Staff performs promise in time	3.95	3.68	-0.27	0.187	2	0.721
	R_2	Staff completes service correctly	3.88	3.75	-0.13	0.074	2	
	R_3	Staff is polite with decent manner	3.88	4.05	0.17	0.246	1	
	R_4	Staff acquired professional knowledge	3.45	2.88	-0.57	0.000***	3	
	R_5	Service makes customers feel secure	3.85	4.25	0.40	0.008**	1	
	R_6	Service makes customers feel sense of hygiene	4.05	3.52	-0.53	0.000***	2	
		Average	3.84	3.69	-0.16	0.198	2	
Service responsiveness	A_1	Staff provides essential service in time	3.55	3.52	-0.03	0.498	3	0.698
	A_2	Staff is willing to assist customers	3.69	3.05	-0.64	0.000***	3	
	A_3	Staff can deal with complaint immediately	3.28	3.55	0.27	0.085	3	
	A_4	Staff responses promptly in case of public safety	3.87	3.85	-0.02	0.458	2	
		Average	3.60	3.49	-0.10	0.002**	3	
Service empathy	E_1	Value customer's right	4.03	3.85	-0.18	0.215	2	0.644
	E_2	Provide service or help various customers	3.69	2.85	-0.84	0.000***	3	
	E_3	Provide prompt help to group with special needs.	3.20	2.70	-0.50	0.005**	3	
		Average	3.64	3.13	-0.50	0.012*	3	

The purpose is to identify significant differences on accommodation customer characteristics variables and various facets of models. One-way analysis of variance (One-Way ANOVA) statistical methods is applied for testing. The operational procedures have to be performed by "homogeneity test" on each set of variables to determine whether analysis of variance data shall be carried out on the digital conversion process. The empirical results are as follows:

(a) "Occupational part" variables in the "service quality" acceptance, "overall service satisfaction" acceptance both share significant difference, "police staff and relatives (including retirees)," are significantly higher than other variables.

(b) "Factors of choosing public hotel accommodation" variables in the "service quality" acceptance, "overall service satisfaction" acceptance both share significant difference, "cheap" are significantly higher than other variables.

(c) "The frequency of the public hostel accommodation?" variables in the "service quality" acceptance, "overall service satisfaction" acceptance both share significant difference, " the first (1 time)" are significantly lower than other variables.

(d) "Have you ever stayed in this hot spring area other private hotel for accommodation?" Variables in the "service quality" acceptance, "overall service satisfaction" acceptance both share significant difference,"Yes" are significantly lower than "No" variables.

(e) "Customer for reputation and perception of the public hotels" variables in the "service quality" acceptance, "overall service satisfaction" acceptance both share significant difference, "negative comments" are significantly lower than other variables.

B. Service Quality Influence on the Overall Satisfaction of Service

Multiple regression analysis is to verify the hypothesis that service quality affects overall service satisfaction analysis, and test whether the presence of problems on self-related variables, and model collinearity exist issues. The empirical result showed that F test is at significant level, and "service tangibles", "service assurance" and " service responsiveness " are all positively affected " overall service satisfaction " and of significant (Table 3), which identified the hypothesis 4a~d . The coefficients to "service tangibles" β coefficient (0.472), "the service assurance" β coefficient (0.235) were higher, showing the influence of overall customer satisfaction mainly produced from " service tangibles ", "service assurance". Furthermore, regression model explanatory power reference value R2 is greater than 0.4, reaching acceptable levels. At last, knowing from VIF values and Durbin-Watson value, there is no obvious pattern variables collinearity and self-related phenomena.

PZB Service Quality Analysis of the Gap 5

Importance-Performance Analysis (IPA) proposed by Martilla and James (1977), has been widely used in decision-making process among businesses. By using important - performance level

analysis (IPA) to explore public policy decision-making basis of the hotel service quality improvement, divided into keeping the advantage (I), improve immediately (II), the relative weaknesses (III), excessive attention (IV) four categories. "Importance" in this study refers to the prior customer perception; "performance level" is the customer experienced perception.

(1) Comparison between service quality prior perception and experienced perception

The study conducted acceptance comparison between prior perception and service quality experienced perception of service quality with four factors, are all "experienced perception," less than " prior perception" and almost all passed by the significant test, indicated that the quality of public hot spring services have room to grow. In particular, service empathy (-0.50*) observed the biggest gap, which deserves the attention for relevant units and operators.

On each question item, merely the "service will make customers feel secure" (0.4**) as a minority of "experienced perception" is greater than "prior perception" acceptance, showing customers have money-worth feeling. Other facets are existing issues of "experienced perception" less than "prior perception" of acceptance.

Among them, the " Provide service or help various customers " (-0.84***), " Hotel interior design and facility " (-0.8***), " Staff is willing to assist customers " (-0.64 ***), " Staff acquired professional knowledge " (-0.57***), " Service makes customers feel sense of hygiene " (-0.53***) reached the maximum gap over 0.50. This is implying that consumers spending in these areas have greater expectations gap, also shows that these items are disadvantages for public ryokan operating.

(2) Service Quality Gap 5 in IPA Analysis

Empirical results shown in Figure 3, respectively falls on the first to the third quadrant, the fourth quadrant did not have any questions of factors fallen.

"Keeping the advantages (I)" type of customers is most concerned and in fact has reached satisfaction of the service from the public spa hotels, which worked as service quality advantages; the future should maintain the advantages and more progress. In empirical results, only in "hot spring water quality", "price of accommodation"..4 indicator items fall on this quadrant.

"Immediate improvement (II)" type of customers is most concerned and in reality has not yet reached satisfied with the service, authorities employees should give this type priority in order to improve. From empirical results, the "service assurance, "will value customer's right, "service will make customers feel a sense of hygiene", "staff responses promptly in case of public safety ". 6 indicators fall on this quadrant. The empirical sites are public hotels with hot spring certificate, should be with emphasis on hygiene quality and bathing public security.

Table 3. Model Multiple Regression Analysis and Result

Dependent Variable (factor)	Independent Variable (sub-factor)	*B*	*t*	Sig. (*p*)	R^2	*VIF*	*DW*
Multiple Regression Model: Overall service satisfaction	Constant	—	1.174	0.242	.470	—	1.933
	Service tangibles	0.472	8.431	0.000 ***		2.812	
	Service assurance	0.235	6.493	0.000 ***		1.625	
	Service responsiveness	0.112	2.387	0.018 *		2.778	
	Service empathy	0.131	1.278	0.256		2.167	

Note：

1. *indicate significance，*p<.05 **p<.01 ***p<.001
2. Shaded for “the highest coefficients independent variables in the regression model”

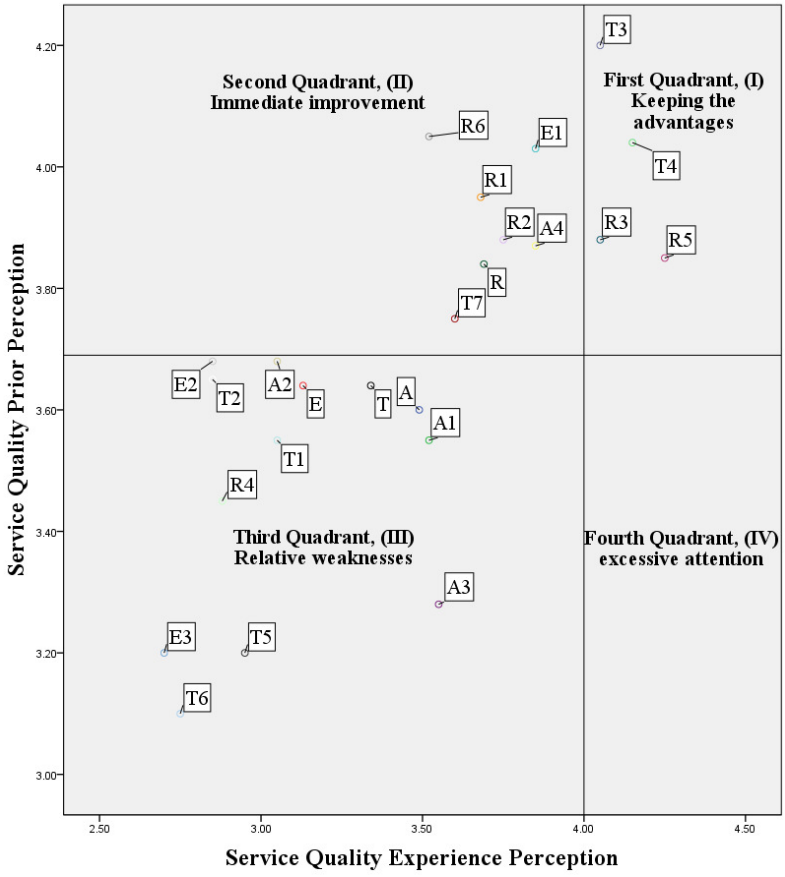

Figure 3. Service Quality Gap 5 in IPA Analysis

"Relative weaknesses (III)" type of customers is less than satisfactory on both prior perception and experienced perception. Therefore, never disregard importance of prior perception from customers, such as physical facilities and ancillary facilities of hot springs hotels, and the indicator of service empathy, are all in urgent need of investing resources to improve their service quality.

Conclusion

Service quality is defined by the customer's perception and formed the gap between customer expectation and experienced perception, so the public spa hoteliers intended to improve service quality should get started by understanding what customers expect. Results from this study found that, although a small part of the customer actual experienced perception are higher than prior expected perception, most customers experienced perception are lower than prior expectation, which can be seen, the service quality of public spa hotel, still have room to improvement.

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E-BUSINESS OF ELECTRONIC SALES ON CV "XYZ" COMPANY

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Abstract

Information and communication technology is growing rapidly and supports technology and increasingly sophisticated gadgets that have an impact on various forms of business. The speed and ease of consumers to obtain information about the main driver of the development of a business or company. A company or any other business that has the speed and ease of service will attract more consumers, without prejudice of the qualities of the company. The need for ease in getting information and service companies en-courage their service is no longer dependent on the place but need to be supported by an interactive website and smartphone role.

Increased use of ICT in the company to be a request for marketing needs. Research collaboration with CV "XYZ", a company engaged in the sale of electronics. The method used is observation, systems analysis, design and implementation of e-business electronic sales. This application is built using Java, Eclipse, XML, PHP with MySQL as database and JSON connector as well. This application supports the company packaged in an application-based smartphone with android operating system. Features in this application provides convenience services such as sales and product information, order products and transaction information. The results showed that the application of E-Business applications based on Android CV "XYZ" into one of the services that can inc
rease sales turnover by 29.27%.

Keywords : e-business, sales, application, android

Introduction

The development of a dynamic community needs to get direct services and are willing to get the information quickly transformed many businesses and corporate services. For example, in the sale of airline tickets, 2 years ago, people have come to airline ticketing or institution. However, in accordance with the development of information technology, airline ticket purchase can be done in retail have access connections even ticket purchases can be made via the internet at home.

Currently, the rapid development of information technology gives a lot of influence on aspects of business activity. The development of information technology brought some significant changes in the business, so that demand speed and responsiveness in the business or company in varying scale and form of service to be repaired immediately to respond to the changing needs of society. The rapid development of information technology is supported by communication technology that have a significant development in line with the development of human needs become more complex. Where communication technology here is in the form of smartphone hardware with many operating systems that are easy to obtain and purchased by people in a variety of sizes and prices. People at any level have become accustomed and even tends to depend on smartphone communication where users have a reason to facilitate access to information and their communication to other users. Access to information such as news, social media, health news, and other information into the current trend. On access to communications, today, people are facilitated by many data communication services connected to the internet, such as; WhatsApp, Line, Blackberry Messenger, Facebook Messenger and other data communication services that are easy and free to be applied in smartphones.

E-Business depict businesses that operate online. The definition of e-business, according to some sources: according Chaffey (2007), e-business is the exchange of information electronically mediated in the organization and external stakeholders to support business processes.

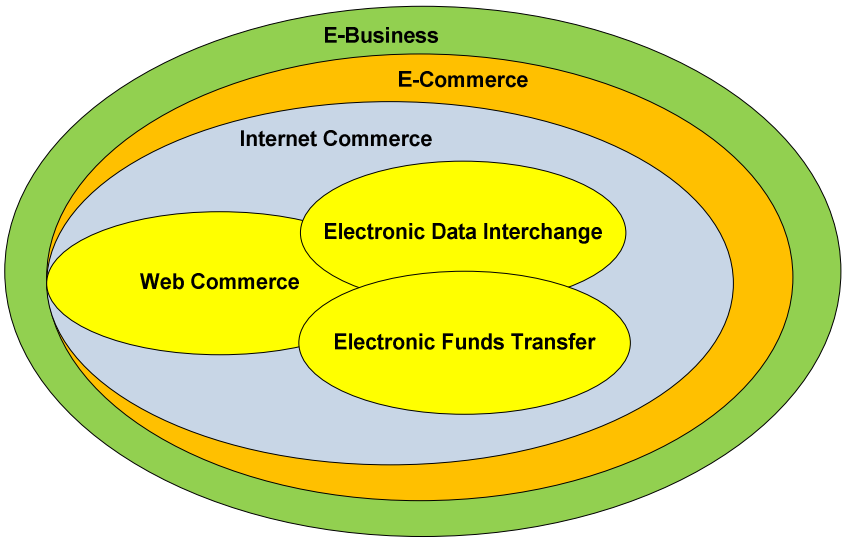
According to O'Brien (2005) explains that e-business is the use of the Internet and other information technologies and networks to support e-commerce, communication and collaboration company, and the various processes that run through the web, both in the corporate network and in our customers and partners business.

Further O'Brien explained that today many companies that have moved from mainframe-based legacy systems into application client / server cross-func-tional, involving the installation of software enterprise resource planning, supply chain management, or customer relationship management of SAP America, PeopleSoft, Oracle, and other companies.

According to Sawhney, Mohan (2001) understanding of e-business is "The use of electronic networks and associated technologies to enable, improve, enhance, transform, or invent a

process or business system to create superior value for current or potential customers".

So e-business is the use of electronic networks and associated with technology, to improve, modify, or create a business process or system that creates superior value to current and potential customers. If these conditions can be achieved then the company's goals more easily achieved. The term e-business is often equated with e-com-merce, e-business but actually has a much broader sense than the e-com-merce. E-commerce is part of e-business. According to Huff et al (2000) quote from the Orion Group illustrates the difference between e-Business, e-Commerce, Internet commerce, electronic web commerce, EDI and fund transfer (EFT) as shown below:



The relationship between E-Business, E-Commerce and others

E-Business has the advantage that: Efficiency (reduce total operating costs); Effectiveness (customers can be in touch with the company at any time); Reach (able to expand the company's reach and space for expansion with ease); Structure (change the behavior of firms in the business approach); and Opportunity Efficiency (innovation to create products or services that are new).

Of much of the information needed by the user, especially for a company or business, is the utilization of access to information about its business products. Access to the product include product information, product quality, product availability, purchase transactions of products, and other matters relating to the business transaction. A company should make a breakthrough in seizing opportunities in developing information and communication technologies, so companies must develop support information system that has a function to support business processes with the aim to optimize the input, process and output of the company to produce a process that

is profitable and sustainable. Many companies or businesses are still using a system based sales and promotion of products without utilizing information technology media, so customers should visit the place of sale. Sales system with information technology is still con-strained by several things, such as data connections, lack of knowledge on the features of information technology in the utilization of information and com-munication technology, and the limited application of information systems to support business services in the community.

Use of the Internet for E-Business has spread widely in small, medium and large. Researchers conducted a literature review of several other studies regarding the use of the Internet for E-Business, E-Commerce, the impact to the crime in cyberspace (cybercrime). Dijkman, et.al (2015) describes the use of the Internet for business models so as to increase the company's revenue. Rahimi, et.al (2015) also describes the management of information technology (IT) to the business process, including the role of IT within it. While Weiwei (2015) and Brzozowska (2015) conducted a study of business through E-Business and E-Commerce in the modern economy for the company's product sales transaction activity there by increasing the amount of sales of products and services. But Hu (2014) describes the impact of the sale on the Internet with the results of the analysis showed a 15% sales decline due to the effects of tax cuts for various products.

Business impact of online sales is also explained by the researcher Apăvăloaie (2014) and Balakrishnan, et.al (2014) which describes the impact of product marketing through social media on the generation Y with the results of the analysis that attract the younger generation of consumers easier and faster for the products offered.

Another study done research on E-Business and E-Commerce, such as Wu et.al (2014) to measure the quality of service of E-Commerce in social media. Furthermore, researchers Dinu et.al (2014) highlights how internet users E-Commerce services to the ministry in doing online sales.

In online sales transactions can not be separated by the cybercrime so consumers should be careful. Researchers Hille, et.al (2015) conducted a study regarding the scale of cybercrime in using the E-Commerce services. From various studies above, the development of internet usage has grown rapidly, but researchers still do research on E-Business for the company CV "XYZ" which aims to increase the number of sales of the company's products. This study differs from previous studies because it chose Android platforms as a medium for online sales. The operating system used widely in this Android smartphone. This system is one smartphone platform used in many levels is highly supported by Google. Based on the basis of application development (software), at this time, Android was developed quickly. Therefore, the Android-based appli-cation that was developed to meet the needs of users of smartphones that have Android operating system. The programming language used in the development of this application is Java, the Eclipse compiler, and addons ADT.

The aim of this study is to bring together and develop information technology facilities-based smartphone that will be implemented in the company CV "XYZ" located in Sleman, Yogyakarta, to process business transactions, mainly to support the sales of electronics companies. CV "XYZ" company operating in the electronics and information technology, which has several selling products, such as smartphones, PCs, laptops, computer networking devices, and accessories. CV "XYZ" requires software (program / application) and the hardware that supports business pro-cesses to optimize sales and marketing processes for the company based on the needs of information and technology in society.

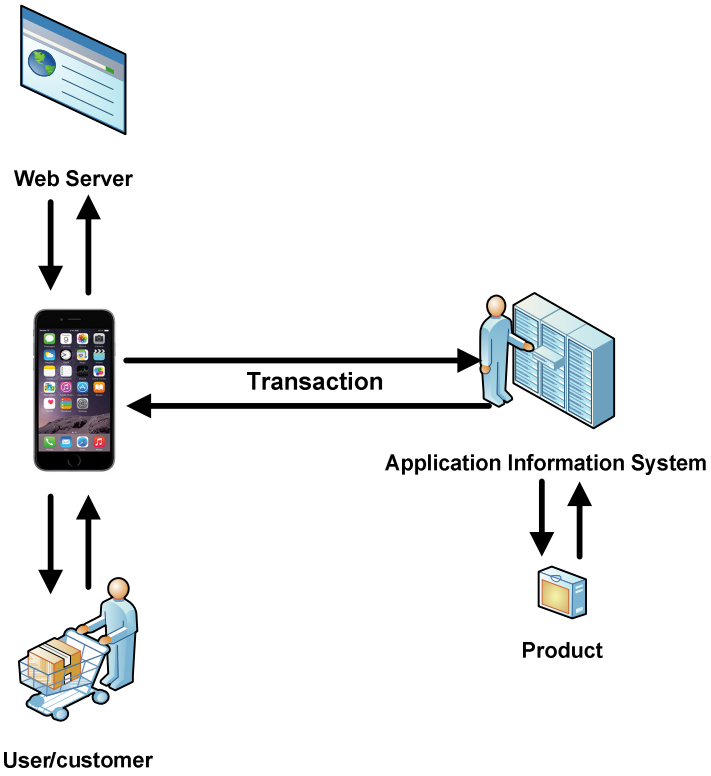


Figure 1. The Application E-Business of Electronic Sales

Limitations of the problem in this research is the application of a specially developed sales in the product order service activities, sales information, product information available and the financial transactions of sales in the CV "XYZ". This is an Android system-based application that supports it easy for buyers or customers in ordering products that are available, and special application just to see identification, specification, and price of the products to the buyer or customer.

Research Method

E-Business research is done in CV "XYZ" which is located protruding, Sar-

iharjo, Ngaglik, Sleman, Yogyakarta. This research was conducted in January 2015 and ended in November 2015. Data and information collected through observations help to design and analyze systems, including interviews with owners and technicians, and a review of relevant literature.

The materials and tools needed in this research include software such as Eclipse, Java, PHP, MySQL, Photoshop while the hardware required is a modem, mobile phones and smartphones.

Observations made to mngetahui how the system runs. After the design, engineering and wake up the system there to tryout system implementation, simulation and implementation and evaluation to improve the system to make it better.

Result And Discussion

The first step before making the system interface design system for interactive applications become. E-business process flow of electronic sales in CV "XYZ" should know and need a transaction documents that aim to help in the design application. Furthermore, designing a system of e-business electronic interactive sales so easy to use.

Based on data obtained from the CV "XYZ" is still applying the manual for data processing circulation of goods, so that data processing is less effective and efficient, these reports are not updated at all times and no sales information systems that support information technology. To help process business transactions in CV "XYZ" developed an e-business applications with Smartphone-based electronic sales using the Android operating system. Android has several advantages such as portability (smartphone) so that through communication of data, users can get information fast, ease of uploading or downloading data or files, applications that can be integrated with Google and the user can install it from Google Play.

After implementing e-business electronic sales in the CV "XYZ" is finished and has been tested (tryout) and then publish it on Google Play so that customers CV "XYZ" can install applications and use with ease.

Customers or buyers to access the system in the purchase of electronic products from CV "XYZ", must install e-business applications in Google Play.

E-business applications of electronic sales CV "XYZ" has a menu: "PRODUCT", contains information from electronic products (product name, price products and stock products); "ACCOUNT", contains accounts for cust-omer / buyer; "ABOUT", contains information about the company CV "XYZ"; and "HELP", contains support facilities if there are problems related to the application penggunana. Customer / buyer must have an account that first enroll in the "ACCOUNT". After having an account, the customer / buyer can make a purchase electronics products.

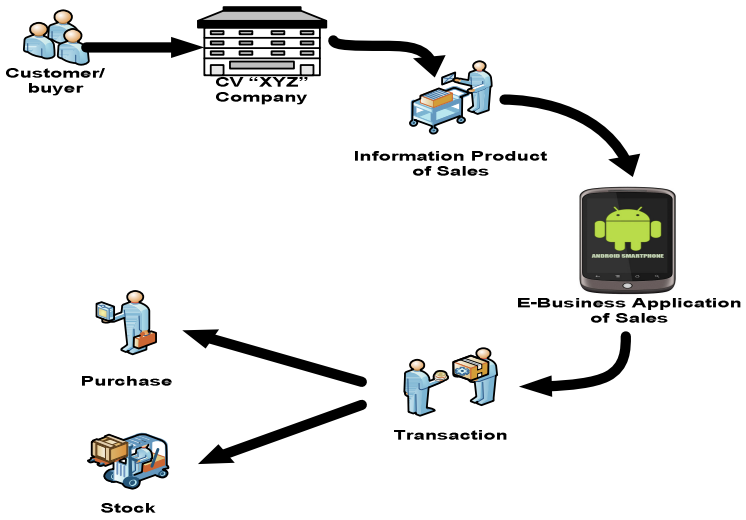


Figure 2. Flowchart Application of E-Business

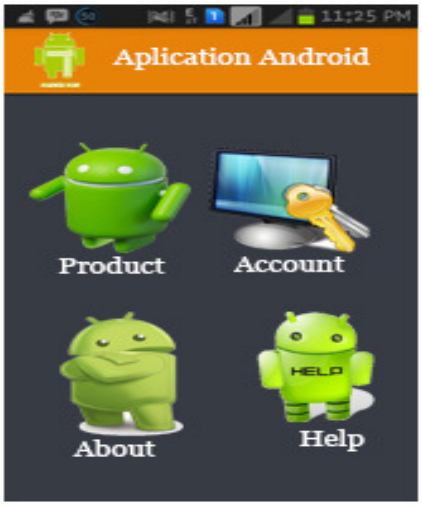


Figure 3. Menu on Application System

Figure 4. List Product of Application E-Business

from CV "XYZ", then comes the next menu to complete the purchase of a product called the transaction.

Figure 5 is a recapitulation of sales of electronic products in CV "XYZ" for 11 months in 2014 before using E-Business applications. Whereas in Figure 6 shows the results of the recapitulation of sales of electronic products in CV "XYZ" for 11 months in 2015 after using the E-Business applications.

Based on the results of the sales summary electronically on CV "XYZ" in 2015 increased sales of electronics products than in 2014. The percentage increase in sales of electronic products in CV "XYZ" after using the application of E-Business at 29.27%.

Research results with e-business electronic sales in the CV "XYZ" has a system that is interactive and easy to use so as to provide convenience for the customer / buyer. If there is a wrong data input, the system will provide feedback to the user in the form of dialog messages. With the application of e-busines can help CV "XYZ" promote, increase the sales of electronic products, and provide convenience for the customer.

Conclusions

From the research that has been done can be concluded that with the

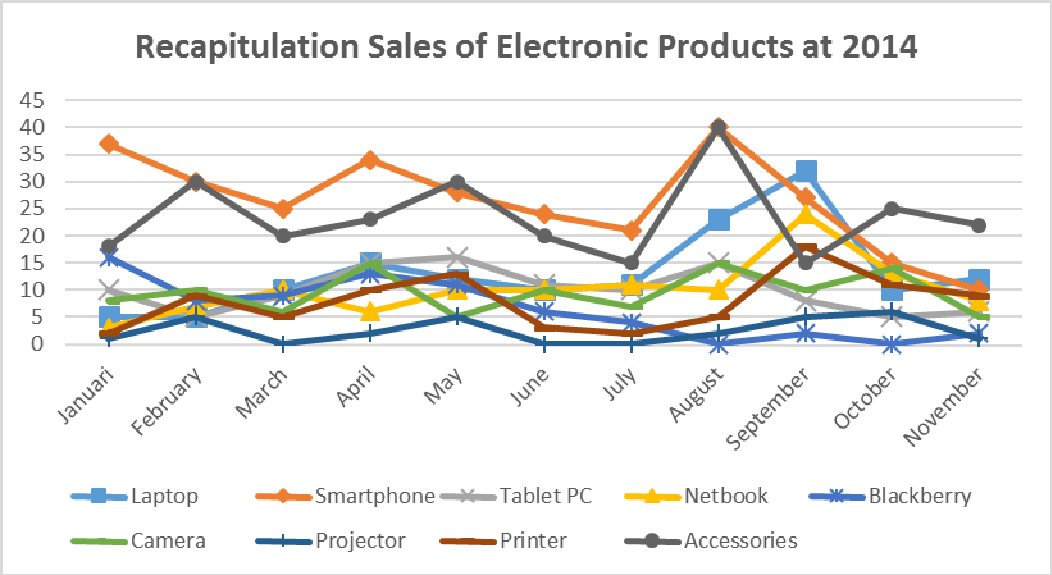


Figure 5. Recapitulation Sales of Electronic Products for 11 Months at 2014

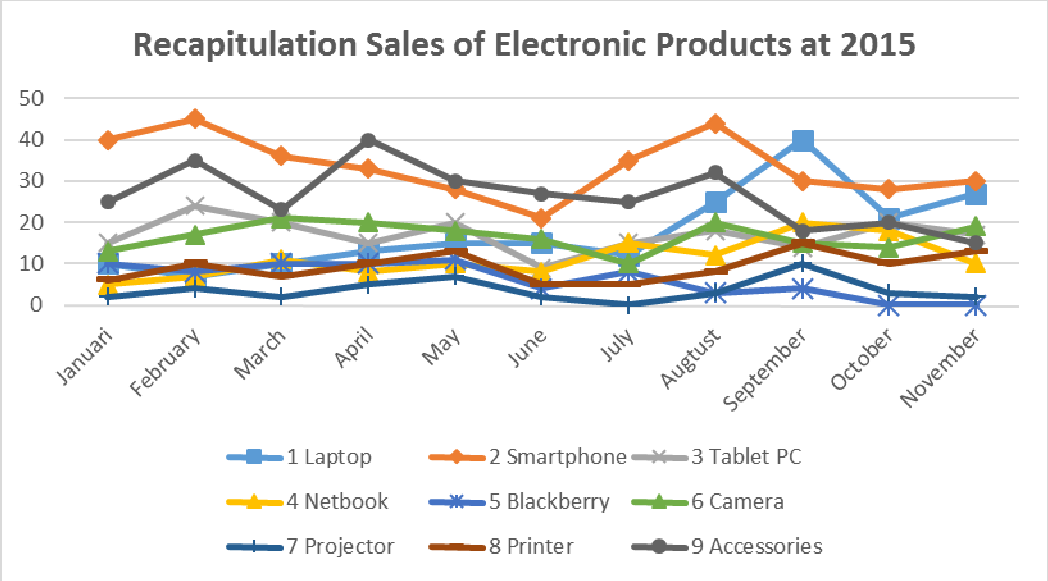


Figure 6. Recapitulation Sales of Electronic Products for 11 Months at 2015

system of e-business applications of electronic sales in the CV " XYZ " to provide convenience for the customer / buyer and sales is becoming more increased by 29.27 % . However , for the future of e -business applications in the customer verification process must be further improved so that the system be-comes more powerful. We recom-mend that there should be a system backup data automatically in any period of time so as to minimize the loss of data.

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THE DEVELOPMENT PRIORITY OF TECHNOLOGY COMPETENCE OR MARKET COMPETENCE: CASE STUDY OF TAIWAN FLAT PANEL DISPLAY

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Abstract

Previous studies have illustrated that corporate competence types should be developed sequentially (e.g. technologies promote markets, TPM); however, few studies have clearly indicated which type of competence a firm with limited resources should first develop to facilitate attaining other follow-up competence types. In practice, we observe contradiction that the international enterprises adopt the market competence to transfer external firm's technologies (MPT). It is an interesting phenomenon that motives to resolve the gap between the theoretical argument and practice. This study explored whether a firm with limited resources should first develop technology or market competence. By longitudinally tracking two Taiwan FPD equipment manufacturers for 8 years and using the extended case method (ECM), the ideal competence development route for manufacturers was determined: to first exploit technology competence or to first explore market competence. This study indicated that corporate competence development was determined by resource characteristics, learning mechanisms, and development routes. We found if firms possess improvement resources (IR) or social resources (SR), then they should apply an inside-out or outside-in routes; in other words, these firms should first exploit technology competence or explore market competence, and then apply the intra- or inter-OL mechanisms to facilitate attaining other competence.

Keywords: technology competence, market competence, resource-based theory, organizational learning theory, Small-Sized Firm

Introduction

In a dynamic environment, developing new types of corporate competence to maintain corporate survival is a critical topic (Helfat and Winter, 2011; McGrath, 2001). For example, Wernerfelt (1984, 2011) proposed that the key factor influencing corporate diversification and growth is the resource development sequence rather than product development sequence. Danneels (2002) recommended that firms first attain technological competence and subsequently apply it to develop new products, thereby attracting new customers, creating novel markets, and harnessing customer competence. Levinthal and March (1993) reported that firms should first exploit their existing resources because doing so is more time- and cost- efficient than developing new resources. Thus, developing resources sequentially is critical for firms. Danneels (2002) briefly mentioned the sequence of developing technological and customer competence; however, most scholars have failed to illustrate competence development sequences.

Past research explored the development of firm competence mostly stressed on large organizations (Nonaka, Chia, Holt, and Peltokorpi, 2014; Wernerfelt, 2014). However, they do not give enough attention to small-sized firms constrained on the situation of limited resources, not to develop several competences simultaneously, and think how small-sized firms use previously competence to facilitate follow-up competence . Which competence shall prioritize to develop so as to build another competence for small-sized firm, accordingly, needs further study. Particularly, few empirical studies have focused on small-sized firms prioritize to develop necessary competence, promote another competence, and consider the strategic thinking over the characteristics, mechanism, and routes of interaction of small-sized firm.

The purpose of this study was to explore how small-sized firms utilize firm's limited resources, learning mechanism, routes, and prioritize to develop necessary competence for firm's survival. The research problem of this study is that small-sized firm constrained on the situation of limited resources, not to develop several competences simultaneously, and think how small-sized firm using previously competence to facilitate follow-up competence. And what thinking should be used for small-sized firms to choice of the fitness learning mechanism and routes.

This research by longitudinally tracking two Taiwan Flat Panel Display (FPD) equipment manufacturers for 8 years and using the extended case method (ECM) compared dichotic successful route of competence development. We found that Neda (disguised name) possessing the characteristics of improvement resources (IR), develop technology competence first, and apply intra-organizational learning (intra-OL) mechanism and inside-out routes (IOR) to promote market competence (Technology Promote Market, TPM). Conversely, ARET (disguised name) has the characteristics of social resources (SR) (Alcacer and Oxley, 2014; Chittoor,

Kale, and Puranam, 2014), develop market competence first, and execute inter-organizational learning (inter-OL) mechanism and outside-in routes (OIR) to promote technology competence (Market Promote Technology, MPT). The article concludes with noting the academic and practical application. Research limit and future research direction is offered as well.

Literature Review

Definition of the resource-based view

Penrose (1959) stated that only resources with unique characteristics can assist firms in generating profits. Additionally, Mahoney and Pandian (1992) reported that both tangible and intangible resources are corporate assets. Furthermore, Wernerfelt (1984, 2014) indicated that resources are the key to developing resource position barriers because they can assist firms in gaining relatively advantageous positions. Moreover, Barney (1991) asserted that corporate resources should possess the following characteristics to enable firms to generate sustained competitive advantages: value, rareness, inimitability, and non-substitutability. These scholars have emphasized that resource heterogeneity facilitates building a corporate competitive advantage. Regarding resource types, Noda and Bower (1996) proposed the concept of universal resources and indicated that their high adaptability and alternatively assist firms in continuously modularizing resources for competence development. Tsai and Ghoshal (1998) as well as Nahapiet and Ghoshal (1998) proposed the concept of social resources, which can produce social connectivity with external and internal organizational relationships to enable collaborations and generate opportunities.

Relationship between resources and competence

Scholars following the RBV have varying opinions regarding methods of using resources to develop competence. Wernerfelt (2014) stated that firms should leverage their existing resources to establish resource position barriers, thereby developing new types of competence, placing firms in advantageous positions, and generating corporate competitive advantages. Danneels (2002) reported that applying existing corporate resources to develop new types of competence involves resource exploitation and greatly influences corporate competence development; Danneels (2007) also emphasized leveraging internal corporate resources to develop new types of competence; and March (1991) asserted that two types of resource exploitation and resource exploration, namely, internal and external resource configuration, are involved in exploiting corporate resources to develop competence. Internal resource exploitation is more beneficial to corporate competence development because less time and fewer resources are used for internal resource exploitation than for external resource exploration. Helfat and Peteraf (2003) emphasized a dynamic resource-based view and indicated that corporate competence development should focus on the evolving dynamic essence of resources over time and that the evolution of internal resources determines the direction of corporate competence development.

Teece, Pisano, and Shuen (1997) reported that, to respond to external and internal environmental changes, firms should achieve business prosperity by creating, integrating, combining, and allocating resources. These scholors have stressed that developing internal and existing corporate resources is the key to developing corporate competence, thereby suggesting that the RBV is critical to the development of corporate competence.

Competence development

According to the concept of developing competence through re-sources, previous studies have mostly focused on applying existing comp-etence types to develop new competence types. For example, McGrath (2001) reported that a firm should increase its existing competence to enrich its cor-porate resource database and develop new competence types, thereby enhancing the firm's survival in a dynamic environment. Danneels (2002) emphasized that a firm should apply its existing internal resources to develop first-order competence, which can facilitate attaining second-order competence. Henderson and Cockburn (1994) divided competence into two levels: (1) component competence, which is generated by applying and combining existing competence types and (2) architectural competence, which further modularizes component com-petence to a higher level, thereby gradually developing corporate competence.

Learning mechanism and competence development

Sinkula (1994) as well as Slater and Narver (1995) emphasized the three steps of organizational learning: information acquisition, information dissemination, and information-shared interpretation. Specifically, information acquisition refers to the process by which knowledge is obtained; information dissemination refers to the process by which information from different sources is shared, thereby leading to new information or understanding for organizations; and information-shared interpretation refers to the process by which one or more types of knowledge or applications are generated after more commonly understood concepts.

Regarding the question of how to apply existing corporate resources to develop new types of corporate competence, scholars following OLT have proposed numerous benefits of organizational learning for corporate competence development. March (1991) emphasized exploitative learning, a concept that focuses on the reuse of existing and internal corporate resources and competence. Additionally, Danneels (2007) concluded that underused and existing corporate resources should be applied for executing exploitative learning to develop corporate competence. Furthermore, Barney (1991) indicated that efficient and effective corporate competence can be produced when firms apply controllable resources and competence to develop new types of competence.

These scholars have emphasized that firms should execute organizational learning and develop corporate competence by using their existing corporate resources. However, numerous other

scholars adhering to OLT have indicated that learning is not restricted to internal corporate learning; instead, external resources can be integrated to achieve inter-OL. For example, Yannopoulos, Auh, and Menguc (2012) emphasized applying various learning types to improve and expand existing resources for corporate competence development. Exploration learning is an innovative and entrepreneurial perspective and approach that challenges corporate conventions (March, 1991). Inkpen and Dinur (1998) proposed that firms should effectively employ inter-OL from external corporate channels to explore innovation options. Additionally, Holmqvist (2003) reported that firms should no longer apply their internal corporate experience and knowledge as sources for learning; instead, firms should learn according to new approaches and concepts that are external to corporations. The aforementioned scholars have stressed using innovative approaches to explore learning opportunities as well as applying external corporate resources to engage in inter-OL and develop corporate competence.

Methodology

This study employed the extended case method (ECM) for qualitative research to conduct in-depth interviews, observations, and a practical literature review of Taiwan panel equipment manufacturers. The two cases that served as dichotic samples facilitated conducting comparative analyses and extensive theoretical development (Glaser and Strauss, 1967; Strauss and Corbin, 1990). Additionally, the processes of corporate competence development were longitudinally tracked for 8 years to explore how this type of development was influenced by corporate resource characteristics, learning mechanisms, and development routes. This case study involving long-term comparative analyses offered abundant and detailed survey results and findings (Rouse and Daellenbach, 1999).

Brief introduction of the case company

Neda Company (assumed name) is a panel equipment manufacturer located in the Central Taiwan Science Park. Established in 1978, Neda, which has 587 employees and earned a revenue of approximately NT$561 million in 2013, provides automation devices for integrated circuit, semiconductor, flat panel display, and solar energy industries. Neda's automation technology is widely applied in equipment shipping and manufacturing in the photovoltaic and semiconductor industries. The key technology developed by Neda in recent years has been applicable to the research, development, and manufacturing of automation equipment in the high-tech industry; the details are provided in Table 1.

ARET is a company that offers machine automation and maintenance for cathode ray tubes (CRTs), SCs, ARET is a company that offers machine automation and maintenance for cathode ray tubes (CRTs), SCs, thin-film transistor liquid crystal displays (TFT-LCDs), and solar cell industries. ARET was founded in 1982, and had approximately 489 employees and $424 million (in 2013) in annual sales at the time this study was conducted. In many ways, ARET has been a successful company. Its automa-

tion equipment, especially micro-drills, the entire factory equipment and pack/unpacking system, have been adopted extensively by leading optoelectronics firms in material moving and manufacturing.

Table 1. Case Company

Company	Service Items	Time of Establishment	Number of Employees/annual sales in $ million NT dollars	Research period
Neda	Robot design, robot application, automation skill, moving system, pocessing machinery, clean room equipment design, and control system application	Since 1978 32years	577/5.4	3rd, Mar, 2006 to 30th, Apr, 2014
ARET Company	Automation equipment, micro-drill the entire factory equipment, micro-drill, robot design, and pack/unpack system	Since 1982 28years	489/4.25	

Interview data

The present study employed the extended case method (Burawoy, 1991, 2014). Danneels (2002) asserted that adopting this method for collecting empirical data facilitates integrating, reconceptualizing, and extending theories, rather than creating theories. Burawoy (2014) also indicated that, because the extended case study method is used to compare theories and inter-view data and subsequently to compare concepts and theories, the two-cycle exchanges and intensive analyses thereby enhance data interpretation. The interview period of the present study was 8 years (from March 3, 2006 to April 30, 2014), during which 47 interviews were conducted. The presented interview information was retrieved from the interviews with those in charge of the company; the interviewed executives were from different departments (such as, departments of quality control, design, materials, and management), and various entities and people were also interviewed (authorities, research institutes, and clients). The interview lasted from approximately 45 minutes to 2 hours; numerous interviewees consented to the interviews being recorded, and those who provided key information were subsequently invited to confirm the correctness of the relevant interview information (Miller, Cardinal, and Glick, 1997). Jick (1979) reported that the restrictions of employing only one research method can be

overcome by adopting various approaches to collecting different types of data. Thus, in addition to the interview data, corporate documents and files also served as abundant and diverse bases for theoretical development.

Findings

In accordance with the research purpose, the research findings were classified into four parts: (a) technology competence and market competence, (b) the development priority of technology competence and intra-OL, and (c) resource characteristics and selection of a competence development route. Each is discussed below.

Technology competence and market competence

To theoretically interpret the technology and market competence of the research case companies, we extended the concepts of component and architectural competence proposed by Henderson and Cockburn (1994) and defined competence as a competence group formed by resources that can be continuously exploited or developed, in which a layer called composite com- petence is incorporated. The first layer, called component competence, refers to existing corporate competence. Addi- tionally, the second layer, composite competence, is a group's unique composite competence developed by applying and combining existing types of corporate competence. Moreover, the third layer, architectural competence, refers to high-end architectural com-petence formed by further modularizing different types of composite competence. Thus, technology competence can be divided into three layers. The first layer, component competence, refers to existing corporate manufacturing skills and know-how (T_1) (Wu, Wan, and Levinthal, 2014; Danneels, 2002). Furthermore, the second layer, com-posite competence, represents the research and designs (T_2) (Walsh and Ungson, 1991) executed by applying and combining the various types of existing corporate manufacturing skills. Finally, the third layer, architectural competence, refers to the radical innovations in the processes and materials (T_3) (Obloj and Zemsky, 2014) formed by further modularizing the research and designs derived from composite competence.

Market competence can also be divided into three layers of competence. The first layer, i.e., component competence, refers to personal (employees) relationship connections (M_1) (Eggers, 2012, 2014), which indicate the existing and external social connections possessed by corporate executives. Additionally, the second layer, composite competence, refers to competitor relationships (M_2) (Park, Srivastava, and Gnyawali, 2014; Kleinbaum and Stuart, 2014) formed by combining the existing and external social connections possessed by corporate executives in order to establish collaborative relationships with competitors. Finally, the third layer, architectural competence, refers to customer relationships (M_3) (Engerman, and Rosenberg, 2014), which modularize the various competitor relationships into connections that extend beyond competitors to crucial clients. The distinction between technology competence and market competence is listed in Table 2.

Table 2. Technology competence and market competence

patterns	Technology competence	Market competence
Architectural competence	Manufacturing and material radical innovation(**T_3**)	Relationship with customers(**M_3**)
Composite competence	Research and Design(**T_2**)	Relationship with competitor(**M_2**)
Basic competence	Manufacturing know-how(**T_1**)	Relationship with employees(**M_1**)

The Development Priority of Technology Competence and Intra-OL

This section demonstrates the interplay of resource characteristic impacts on firm's competence development, as well as the historical progress of the critical resource development. Based on the interview and the historical progress of Neda's existing resource, we found that Neda has the characteristics of improvement resources (IR) and exploitation resource (March, 1991). They obtain advanced knowledge from intra-firm interaction by continuing to improve

their existing resources. In other words, small-sized firms have historically progressed by exploiting improvement resources, and tend to prioritize developing technology competence, and then to promote market competence (TPM) (Nyberg, Moliterno, Hale, and Lepak, 2014).

T_1 to M_1.

The key for T_1 to enhance M_1 is the intra-OL atmosphere and mechanism within the company, in which intradepartmental, interdepartmental, and personal knowledge should be employed to distribute technological knowledge to other departments, including the department of sales (Harvey, Palmer, and Speier, 1998). The aim was to employ the concept of exploitative learning to transfer the existing and internal corporate technological skills to the professionals and executives of all departments (information acquisition), thereby enabling these personnel to learn to provide in-depth services to clients (information interpretation). The learning network at Neda involved weekly formal departmental meetings, monthly cross- departmental meetings, intradepartmental apprenticeships, informal chats during meal times, and activities held during voluntary overtime working periods. Employees were encouraged to participate in these diverse meetings and activities to transfer interdepartmental professional technological knowledge (information dissemination). Subsequently, the knowledge could be transferred to clients outside the company, and the professional executive–client relationship could also be established. The executives' personal technological competence was sufficient to enable them to professionally interact with the technology licensors from the major foreign companies; specifically, professional technological competence was crucial for clients in engaging in long- term collaboration with the company. Director Tsai of the liquid crystal display group

division (September 14, 2009) indicated the following:

> *"We are all trained as electromechanical technicians. Our boss guided us in learning the series connection and structural alignment of electromechanical devices; even the staff of the Department of Sales had to have these skills. We removed and reinstalled the devices when they failed to meet our expectations and standards. For example, magnetic traction is used to manufacture the patent rollers used in cleanrooms, thereby preventing dust from forming on the roller caused by the mutual contact between the roller and the surface required for cleaning. We think ahead, and thus our clients naturally become more dependent on us."*

T_2 to M_2.

When the manufacturing skills supported the corporate competence in research and design, competitors naturally pursued a horizontal alliance and collaboration, thereby engaging in coopetition with the market competitors (Badaracco, 1991). In Taiwan, the common method applied for research and design (T_2) to enhance competitor relationships (M_2) is using strategic alliances derived from joint research and development (R&D) or capacity sharing. The premise of strategic alliances in joint R&D is that firms are required to possess design, research, and development competence to integrate various systems (Wernerfelt, 2011), thereby enabling further social interaction with competitors and facilitating competitor relationships. Manager Chi of the Department of Management (June 1, 2010) indicated the following:

> *"When we integrated the methods we were familiar with, the product manufacturing processes sometimes became very smooth. For example, PIM [plastic injection molding] is developed through an integration of PMM [precision mold manufacturing] and IM [injection molding]. This integration achieved favorable effects and also drew the attention of our Japanese competitor, Shibaura Mechatronics Corporation, and we subsequently collaborated to develop sealing machines."*

The following is a classic example of an intra-OL mechanism in which T_2 enhance M_2: The department of precision machinery at Neda Company transferred relevant knowledge on injection molding and laser marking technology to the departments of integrated circuit and precision machinery (information acquisition), and the technical staff members at different levels from these departments jointly developed various types of systems (e.g., plastic injection mold components, automated semiconductor punching machines, and automated semiconductor laser marking machines) through the following interaction and joint learning channels (information dissemination): weekly meetings, monthly meetings, gatherings after work, and during free time when socializing with clients. These types of technology involved in new R&D (information-shared interpretation) attracted the attention of Neda's Japanese competitor Shibaura

Mechatronics Corporation, which invited Neda to jointly develop new products. Director Zheng of the semiconductor department (February 20, 2014) reported the following:

> *"Among our 600 employees, 300 are involved in R&D, amounting to the largest number of employees involved in R&D in the LCD industry in Taiwan. Discussions and interactions take place during regular meetings and in private. For example, once during our free time when we were socializing with our clients, we discussed how to assemble structures and develop precise systems and machines; subsequently, we returned to our office at midnight to draw the layouts. Because of our efforts and devotion, our competitors who previously did not hold us in high regard are now more likely to pay attention to us."*

T_3 to M_3.

Taiwanese equipment suppliers must be cost-effective and innovative in manufacturing processes and materials to be recognized in the global equipment supply chain, a process that may require a long-term commitment (Lin, Chen, Sher, and Mei, 2010). Using the strategy of applying breakthrough process and material innovations (T_3) to facilitate forming customer relationships (M_3), Neda satisfied its customers and reduced costs through modular innovations in manufacturing processes and materials (Danneels, 2002), thereby developing connections with its crucial customers. Deputy Director Huang of the department of sales development (June 24, 2008) addressed the following regarding strategies for using T_3 to enhance M_3:

> *"Our innovation in the plastic materials used for cleanrooms substantially elevated the dust-proof capability and cleanness of the coating machines, and that is why we are able to enter into and collaborate with the major clients of the panel and IC (integrated circuit) industries with favorable prices for our products."*

General Manager Tsai (June 1, 2008) indicated the following:

> *"When I was at a lecture given by Shin-I Lin in 2005, Kun-Yao Lee phoned me, hoping that our company could merge with Gallant Precision Machining Co., Ltd. to manufacture equipment supplied to local companies. Subsequently, we became the only company capable of offering services to the touch panel company TurnKey Linux, and the process equipment services we provided involved glass cutting, chamfer milling, adhesive residue scraping, washing, patching, lighting inspection, and packaging and shipping…."*

To create an intra-OL mechanism in which T_3 enhances M_3, Neda management led innovative learning sessions. This innovative learning was developed on the basis of the existing LCD manufacturing technology as well as the hardware and software control technology (information acquisition). Specifically, General Manager Tsai, who is an innovator, led the departments of LCD,

electromechanical engineering, and materials in person to encourage brainstorming among the staff in these departments (information dissemination), and the corporate war room gradually developed diverse process innovations such as the automatic optical and automatic test equipment (information-shared interpretation). For example, Neda Company collaborated with major companies such as Statinc Company.

> *"With regard to our internal QDTCS spirit, our equipment quality and technology are weaker than those of the major international companies; however, we have advantages in product delivery and cost. We aim to use the existing materials (technology) in an attempt to try out different cooking methods (modules) and then offer new dishes (equipment) to our customers. Working overtime with the boss is stressful, and executing process improvements at midnight is tiring, but only by doing so can we accept red orders (accept orders at a loss), deliver black orders (profit from delivered orders), and collaborate with the major clients." (Deputy Director Huang of the department of equipment, March 23, 2011)*

Resource characteristics and selection of a competence development route

When addressing the influence of resource characteristics on the selection of a competence development route, scholars following the RBV have all emphasized applying static resources to develop dynamic competence (Wernerfelt, 1984; Danneels, 2002; Helfat, 2000). The key to competence development is to first examine the existing resource characteristics and subsequently select the routes for corporate competence development. The corporate culture of Neda Company is focused on technological research, development, and innovation; in addition, its improvement resources can serve as a basis for developing an inside-out route (IOR) for corporate competence development. Through intra-OL and exchange, various levels of technological competence can be attained and subsequently applied to facilitate developing different levels of market competence. Director Shi of the automation business division (January 31, 2012) stated the following:

> *"The founder of our company developed the first robot in Taiwan, and thus we can say that engineering is in our company's DNA. The reason why our company is able to continuously develop to this day is greatly related to our initial mission: to compete with Japanese companies in automation technology!"*

Through the cases, we identified the sequence and mechanism for competence development. The priority for corporate competence development was determined by corporate resource characteristics. If a firm possesses improvement resources (IR), then it should follow inside-out route (IOR) of internal to external development. Specifically, technological competence should first be attained and then elevated through the intra-OL mechanism to create innovative products and new product markets,

thereby driving the development of corporate market competence. If a firm possesses social resources (SR), then it should follow outside-in route (OIR) of external to internal development. Particularly, market competence should first be attained and then enhanced through an inter-OL mechanism to develop innovative resources and new types of product technology, thereby facilitating attaining corporate technological competence.

Academic Application

Scholars following the RBV have emphasized examining the course of corporate growth from a resource-based rather than a competence-based perspective. On this basis, the present study offered a new perspective for research in the field of strategic selection that can especially benefit companies with limited resources. The concept of sequentially developing resources forwarded in this study was similar to the concept of resource allocation proposed in previous studies. Similarly, this study can serve as a reference for firms during corporate strategic development. When existing types of competence are applied to sequentially develop other competence types, including advanced competence, (Danneels, 2002), decision-makers can select various routes and mechanisms for corporate competence development on the basis of the different routes derived from organizational learning mechanisms.

Scholars adhering to the RBV have indicated that, in general, corporate resources are not fully utilized (Penrose, 1959). The present study investigated an approach to maximizing the use of corporate resources: viewing corporate competence as a surplus for developing other types of competence. However, this approach has not been seriously considered in previous studies, and, by using the routes of competence development, the present study was the first to evaluate this approach. Statements from a few other studies (Wernerfelt, 1984; Danneel, 2002, 2007; Noda and Collis, 2001) related to the present study found a correlation among different types of competence development; nevertheless, the development mechanisms indicated in these previous studies have never been explored in detail. We integrated the RBV and OLT to investigate the corporate experience value derived from the various mechanisms on which different routes of competence development ultimately depend. Moreover, the RBV and OLT are correlated regarding resource allocation and competence transfer; specifically, a lack of basic resources may restrict competence development. Critical mechanisms and influences are also involved in the processes of resource allocation and competence transfer.

We also indicated the lack of literature on the mechanisms of competence development. The concept of resource allocation, which includes a transition from general resources to specific types of competence, was addressed to explore cases involving competence development. We supported the OLT-proposed concept of internal and external learning because only an appropriate information learning route can facilitate competence development, and the research results corresponded with those

of March (1991). In addition to this concept, we also emphasized the importance of the mechanism for competence development, for which the connection between resources and competence was not necessary but sufficient and for which the relevant mechanism was necessary and sufficient. In addition, competence was not completely developed on the basis of endogenous variables; numerous routes required external environmental stimuli. With regard to information management, this study also revealed the segmentation between information exploration and application. To address the importance of knowledge management in strategy studies, future researchers should consider viewing a firm as a bundle of capabilities or knowledge as a critical perspective for developing the following, all of which are crucial for corporate growth: cross-departmental or cross-organizational strategic knowledge management, competence development groups, and interdisciplinary platforms for compe- tence and knowledge enhancement.

Firms possessing improvement resources should employ the route from internal to external development; specifically, these firms should first develop intrafirm technological competence to promote the continuous exploitation of internal corporate resources and development of new types of competence, thereby facilitating the attainment of external market competence (TPM). Leonard-Barton (1995) and Conner (1991) reached similar conclusions, emphasizing that a firm should first develop its existing corporate technological resources and then develop its new product markets; in other words, a firm should develop sequentially: It should first invest technological resources to attain market resources and then follow an inside-out corporate development route. Danneels (2002) indicated that a firm should employ its existing technology competence to service its new customers and markets, a process that symbolizes the following: internal to external development, sequential competence development from technological to customer competence, and application of technological competence to facilitate attaining customer competence. Roth- aermel and Deeds (2004) reported that a firm with superior technology competence should commit to exploiting its manufacturing and marketing resources to benefit its promotion of commercialized products and new market development. This finding is similar to that proposed in the present study: technology competence should be applied to facilitate market competence development.

Danneels (2002, 2007) regarded using corporate resources as critical for attaining corporate competence. The present study concluded that leveraging and utilizing internal corporate resources are the key to corporate competence development and indicated that connecting external corporate resources is another option for developing corporate competence.

Limitations and Future Research

Researchers and firms intending to apply the results of this study should note that the resources were only divided into two categories according to the characteristics of the cases and that the research on competence route develop-

ment merely explored technology and market competence. The relationships among other types of resource competence as well as other development routes and mechanisms can be discussed in follow-up research. Future studies can also consider extending the research on firm competence development to corporate alliances (Lane and Lubatkin, 1998) as well as to corporate mergers and acquisitions (Eisenhardt and Martin, 2000; Karim and Mitchell, 2000). To date, the confirmable research on corporate growth suggests that the key to this growth is balanced development and connections between existing and new competence types (Floyd and Lane, 2000; Holmqvist, 2003). This study constitutes preliminary research in the strategic research domain, and follow-up studies can conduct in-depth investigations on the applicability of different competence development routes and correlations among resources. Identifying existing competence types (resources) is an unpredictable process. In addition, various types of situational constraints are involved in the routes and mechanisms of competence development, and implementing relevant systems and coordinating organizational structures and cultures are challenging: all of these problems merit investigation in futrue research.

The results of this study were limited by the strong intuitive and conceptual ideas involved in the cases; thus, future researchers may consider employing quantitative methods to verify the research results.

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APPLICATION OF ACTIVITY- BASED COSTING ON REINFORCING STEEL BAR MANUFACTURER

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Abstract

Reinforcing steel bar manufacturers are important upstream material suppliers for the construction industry. While indirect costs account for a relatively low proportion of overall manufacturer costs for steel products, incorrect cost apportioning methods result in miscalculated indirect manufacturing costs, and this cost calculation issue is worth investigating. This study analyzes the traditional cost systems used by certain steel manufacturers, and subsequently introduces Activity-Based Costing (ABC) to compare the effectiveness gap of the two approaches. Results showed that companies using ABC to implement cost controls have greater clarity of the relationship between resources, operations and costs, clearly showing the consumption status of each cost, and depicting the apportionment of production costs. ABC entails complex operating procedures. For the construction industry to use ABC as a cost control system, a holistic approach should be taken to carefully assess organizational and project relevance.

Keywords: Reinforcing Steel Bar Manufacturer, Cost Control, Activity-Based Costing, Construction Industry, Construction Company

Introduction

In response to significant challenges facing the overall construction industry, many companies are cutting staff or introducing other cost control measures in an attempt to reduce project operating costs. Compared to other industries, construction companies and their up and downstream material suppliers mostly rely on traditional cost control methods which can distort actual indirect costs, resulting in incorrect apportionment of indirect costs and leading to the loss of opportunity to further improve cost control effectiveness. Traditional cost accounting is mainly assessed based on distribution, with manufacturing costs distributed to each operation. However, today direct labor is no longer a key cost and basing the distribution of indirect manufacturing costs on man-hours, machine-hours or direct labor costs will inevitably result in distorted product costs.

In the 1980s, ABC was proposed as an improved method for indirect cost accounting for the manufacturing and service industries, specifically to resolve distorted estimates of manufacturing costs. ABC first divides the manufacturing process into a series of operations each accounting for a share of manufacturing costs. Finally, a share of consumption is attributed to each product for each operation for direct distribution of operation costs to the product. This not only improves the product's cost attribution, but also better reflects resource consumption, thus providing more accurate cost calculations.

Taiwan's reinforcing steel bar industry faces increasing challenges due primarily to China's increased steel production capacity. Currently, many steel companies, especially small and medium-sized firms, are experiencing the following cost management issues:

1. Unsound fundamentals, such as inaccurate statistical measurements resulting in significant resource wastage.
2. Failure to implement competitive procurement price management and inability to effectively control prices for bulk procurement of raw materials and fuel, thus increasing procurement costs.
3. Imprecise cost accounting and lack of timely feedback on production costs, resulting in information delays which adversely affect management decisions.

This study examines the reinforcing steel bar industry, using ABC cost calculation principles to determine indirect costs in a case company's actual production costs and to provide a comparison with indirect product costs as determined by traditional cost systems.

Previous Study

Traditional cost management

Extensive use of computerized automated factory equipment and software has resulted in a major production restructuring, making possible the rapid production and customization of high-quality products. This replacement of human labor by automation has greatly reduced the proportion of direct labor costs, Whereas

direct labor costs originally accounted for 40~50% of product costs, today that proportion has dropped to less than 10%, while production related indirect labor costs have gradually risen.

Traditional costing (TC) can obtain more accurate product cost information in mass production and labor-intensive industries (Gilligan, 1990), but rapid changes and the business environment and fierce international competition have gradually reduced the importance of such industries and replaced them with a large number of small volume, high diversity and capital intensive business patterns.

TC directly attributes direct material and labor costs to product costs. Distribution of manufacturing costs is conducted in two stages. First, assign costs to according to unit organization function or operating characteristics to the corresponding cost center, and then use Volume-related Level to distribute average manufacturing costs to all products (Cooper and Kaplan, 1988). In addition, Cooper and Kaplan (1991) suggested that product cost systems should simultaneously focus on inventory valuation, emphasize operational and cost controls, and weigh product cost and profitability. Cooper and Kaplan (1988) and Kaplan (1988) pointed out that, in the perception of cost habits, TC assumes a variety of costs are short term or within a fixed range, divided into fixed and variable costs according to changes in production or work volume.

Activity-Based Cost

Activity-Based Cost first analyzes a firm's total production and support operation activities, taking operation activity centers as the unit for accumulated costs ("cost pools"). It then analyzes the cost drivers to serve as the basis for cost distribution, calculating the cost distribution rate for each job activity. It then finally distributes operation activity costs to each product (Kaplan, 1984). ABC is used to measure product cost, operational performance, resource consumption and costs. It was originally used to the distribution of manufacturing costs, but the management model was later found to be suitable for the sales and service industries (Johnson, 1998).

Mantera and Vara (2008) view ABC as a costing system that recognizes the cause-effect relationship existing between cost drivers and cost activities by quantifying the cost and performance of process-related activities and cost objects. ABC is used as to supplement rather than to replace a company's usual costing system (Garrison, et al. 2008). ABC provides better profitability measurements and better-informed strategic decisions about pricing; product lines and market segments (Blocher, et al. 2008).Pedro et al. (2011) implemented the ABC cost system in a Portuguese manufacturer of metallic structures to assess the real advantages and disadvantages of the ABC approach. Rasiah (2011) states that "the companies that implement it run the risk of spending too much time, effort and even money on gathering and going over the data." He further noted that managers often overlook some activities and costs associated with its implementation.

Montes, et al. (2014) introduced a new comprehensive estimate model (the

POP model) for the construction industry, based on the principles of the ABC methodology and in tune with the innovative PBC approach.

In addition, Hsu, et al. (2011) presented a case study to analyze how ABC can be integrated into an ERP system to resolve cost problems related to of stainless rolling steel loss and repeated procedures in stainless steel manufacturing. Meng et al. (2007) proposed an integrative production cost management method to provide accurate accounting and efficient control of product costs in iron and steel manufacturing. The integrative mode based on ABC and ERP/MES is presented for cost management, which satisfies information integration centering on cost and integrates the flow of logistics, funds and information. This approach improves cost management, reduces product costs and improves firm market position.

Models based on the ABC methodology seem to provide improved accuracy because such models allocate all overhead costs to their corresponding activities. In particular, in the construction industry ABC identifies and classifies of all activities and operations required to produce each construction work unit by analyzing all the factors that influence its cost (Montes, et al. 2014). Advance knowledge of these cost factors provides construction companies with an essential tool to control and manage their economic investment on construction sites (Sánchez and Morales, 2002; Sánchez, 2005) and to analyze costs and benefits at the level in which processes are arranged.

Research Methodology

Designing an ABC system requires many different kinds of data, as explained below:

1. Construct required information for ABC

Each company should provide a list of its production process operations, corporate organization chart, and staff headcount by department, detailed manufacturing and marketing expenses, work skill set, and employee salary data.

2. Data collection methods

Turney (1991) recommends collecting information through the following methods:

(1) Observation: observe work activities in practice.

(2) Record: record the amount of time required to complete each job or task.

(3) Survey: obtain required data.

(4) Interview: interview personnel to understand company operations, preferably combined with observation.

3. Data sources

The above data is collected from the following sources: (1) Accounting department: data related to accounting, such as amounts, budgets, costs, manufacturing costs and marketing costs. (2) Worksite or operations staff: activity drivers, processes and procedures. (3) Information systems: order volume, operating hours, machine hours, etc.

ABC uses multiple elements in a cost assignment view, a model designed according to the cost attribution model proposed by Turney (1991) to define relevant factors. The constituent elements of ABC are defined as follows (see Figure 1):

Resource: All costs required for job implementation.

Activity: A combination of tasks performed within the enterprise or organization.

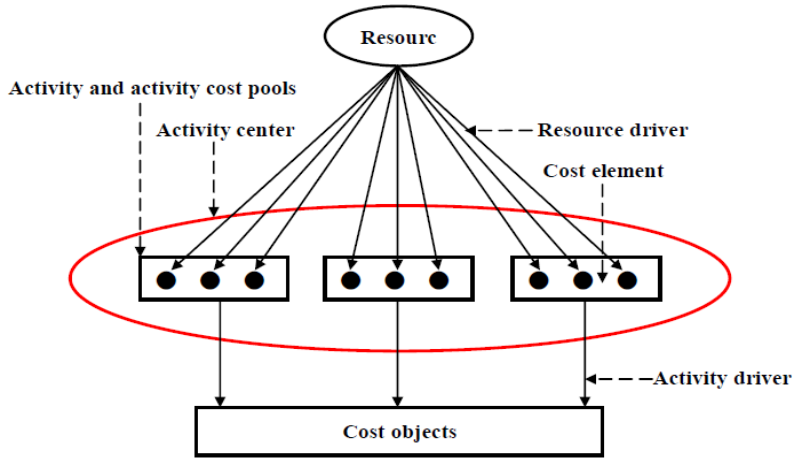
Activity Center: A collection of related tasks divided according to function or procedure.

Cost Element: Post-task distribution of resource expenditures as cost components in a database.

Cost Objects: Cost attribution pools, which may be products, service items or projects.

Resource Driver: Links between resources and tasks, which indicate the resources consumed by the task.

Activity Driver: Intensity and frequency measurement factors underlying the cost of the corresponding task.



With the definition of each operation, the following principles are used to identify, confirm and establish all resources, operations and costs for the task:

1. Identify all operation activities
Identify operation activities in terms of the level of detail required for the task, usually to improve performance for tasks requiring more precise work. For the purposes of calculating the underlying product cost, this can be merged with task driver level operations for the same task.

2. Confirm resources (reconstructing the general ledger)
General operation costs are taken from the general ledger, but because these are generally classified and aggregated according to line expenditure (salaries, rent, etc.), general ledger cost items must be re-attributed to the operations center to facilitate the distribution of operating costs.

3. Confirm underlying costs

Underlying costs are the endpoint of ABC cost attribution, and this information is the basis for management decision making. The selection of underlying costs is tied to the management strategic objectives, and costs can be calculated as expenditures for customers, products, services and contracts.

4. Establish operating centers

To be able to use a more structure method to express operating information, operation-specific procedures are collected together as operating centers.

After establishing the main component factors, one can select a distribution method. Costs are generally distributed using three methods (Copper, 1992):

(1) Direct classification: Best method for resource costs attributable to the product (e.g., direct materials, direct labor and other direct product costs) if not directly included, then select on the basis of cost driver.

(2) Cost driver distribution method: Operation cost drivers are treated as linked factors for resources, operations and underlying costs. The selection of cost driver should consider the optimal combination of cost size and reasonable cost reflection. Cost drivers are generally divided into resource drivers and activity drivers.

(3) Arbitrary distribution method: When drivers cannot be determined, arbitrary distribution avoids the waste of resources.

Following these steps completes all actions to achieve ABC model settings. Manufacturing costs are redistributed according to the essence of the ABC system to establish a reasonable method of manufacturing cost distribution, and to produce a cost attribution model (Figure 1).

Case Study

Background of the sample company

The case study company (CSC) mainly produces Deformed Steel Bar (six specifications from D13~D32). The CSC is organized into six departments (QA, production, operations, finance, management and processing). Production and manufacturing costs are distributed among the production, QA and finance departments. This study primarily uses data provided by these three departments. The CSC mainly produces deformed steel bars, requiring the purchase of small billets as raw materials for the production of rolled steel and then deformed steel bars.

The CSC primarily uses job costing to calculate costs, with manufacturing costs mainly divided into raw material costs, labor costs and manufacturing costs for calculation on a monthly basis as follows:

1. Raw materials costs: Material costs are directly calculated for each product based on existing running accounts and billet consumption statistics.

2. Labor costs: Direct production costs for the production of each bar size are calculated according to actual monthly production volume. Dividing labor

costs for the month y total production hours obtains direct labor cost assessed rates/hour.

3. Manufacturing costs: The manufacturing cost for each bar size are calculated by dividing manufacturing cost (usually referring to manufacturing costs for the previous month) by total production hours (equals the manufacturing cost allocation rate).

Cost data from the case study firm shows that raw material costs account for 93~95% of total costs, as opposed to 4~5% for manufacturing costs, while labor accounts for only 0.3% of total costs. Due to the characteristics of the manufactured product, there is a greater emphasis on the distribution of manufacturing costs to prevent the continued use of incorrect cost calculations and incorrect product pricing. Currently, manufacturing and labor costs are distributed on a "work-hour" basis, and cost distribution operations for each department are conducted using the same approach, which can easily result in cost distortions.

This study conducted interviews with managers in the firm's finance and production departments, and considers relevant cost-related information to determine the firm's cost calculations suffer from the following issues and oversights:

1. Among D13~D32 (excluding D29), D13 and D16 are small-diameter products, while D19, D22, D25 and D32 are large-diameter products. Different diameter sizes are used to manufacture various products, which are produced in different units of time-production volume. Labor costs are distributed based on "time-hours", which is more favorable for large-diameter products, but distort the production costs of small-diameter products.

2. Manufacturing of large-diameter products require greater consumption of electricity and fuel, thus using identical criteria for cost distribution would result in cost distortions.

3. Combined product characteristics and parameters entail the use of different production dies, power consumption, fuel consumption and unit-time production volume. However, product prices are kept uniform, making it impossible to distinguish actual labor and resource consumption for each type of product, and product pricing should be determined by the cost of actual production inputs.

Interviews conducted at the case study company indicate that current cost aggregation methods could easily result in cost distortions.

Building the ABC framework

The following sequence defines the CSC's resources, operations, operating centers, and underlying costs. Resource categories for CSC are summarized in Table 1.

1. Resources: All economic factors used in executing operations (e.g., materials, labor, technology, equipment, etc.). This study is primarily concerned with indirect costs (such as indirect labor,

Table 1. Resource Categories of Case Study Company

Fixed costs	Indirect labor	Overtime	Pensions	Meals
	Clothing	Labor insurance	Healthcare	Equipment depreciation
	Miscellaneous	Repairs	Insurance	Consumables
	Processing expenses	Transport	Other	Amortization
Variable costs	Fuel	Plant utilities		

utilities, plant depreciation expenses, amortization expenses, etc.), rather than directly traceable resources.

2. Operations, operating centers: Production processes entail the execution of a collection of actions. The production flow includes: Billet analysis, reheating furnace, roughing, and intermediate rolling and finish rolling, cooling, cutting, and bulk packing. As shown in Figure 2, the flow also includes secondary processes attributed to each department. Each department is either a primary operating center or a secondary production process.

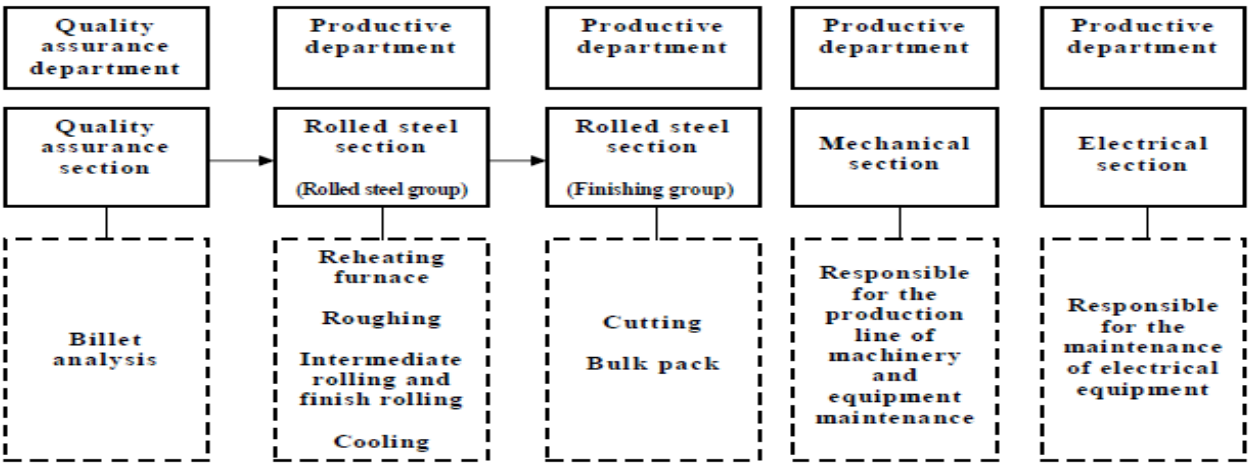


Figure 2. Case Study Company Processes and Operating Center

2. Underlying costs: This refers to the need for any final cost calculation related to customers, products, medical services, contracts, etc. The case study firm's products are not particularly distinctive, thus this study suggests that costs should be calculated according to the output product– reinforcing steel bars.

Once the main operations are established, we then follow the ABC implementation process to distribute related resources by cost driver according to di-

rect classification, cost driver distribution, and arbitrary distribution. Table 2 shows resources and resource attribution ratios for each indirect cost. This study uses the ABC system cost distribution concept to redistribute manufacturing costs and establish a reasonable manufacturing cost distribution model according to a cause-and-effect relational structure. Ratio of operations assigned to direct Dept. from indirect Dept. is shown in Table 3.

Analysis and Discussion

The total cost for the QA, Mechanical and Electrical Divisions is multiplied by each distribution ratio to obtain the indirect and direct department distribution costs. The total amount and fixed cost subtotal for the Rolling and Finishing Groups are summed to obtain the indirect and indirect total department costs. Figure 3 shows ABC cost distribution structure of the CSC.

Table 2. Resource Use Attribution Ratios

Resource	Resource driver	Department				
		QA Div.	Rolling Group	Finishing Group	Mechanical Div.	Electrical Div.
Indirect labor	Direct attribution※	0.09	0	0.25	0.43	0.23
Overtime	Direct attribution※	0.14	0	0	0.84	0.02
Pensions	Direct attribution※	0.09	0	0.25	0.43	0.23
Meals	Direct attribution *	0.13	0	0.13	0.47	0.27
Clothing	Direct attribution *	0.13	0	0.13	0.47	0.27
Labor insurance	Direct attribution #	0.09	0	0.25	0.43	0.23
Healthcare	Direct attribution #	0.09	0	0.25	0.43	0.23
Equipment depreciation	Asset content monthly depreciation ratio	0.03	0.67	0.04	0.04	0.22
Miscellaneous	Directly attributed to each operation center	0	0.58	0.04	0.16	0.22
Maintenance	Distributed by number of service calls for each operation center	0.1	0.3	0.25	0.25	0.1
Insurance	Plant monthly depreciation ratio	0.03	0.67	0.04	0.04	0.22
Consumables	Use by each operation center (average consumption ratio)	0.3	0.05	0.4	0.1	0.15
Processing	Rolling Group	0	1	0	0	0
Transport	Fuel consumption (mileage)	0	0.55	0.2	0.25	0
Other	Average distribution for each department	0.2	0.2	0.2	0.2	0.2
Amortization	Monthly amortization for each account (average distribution ratio)	0.03	0.67	0.04	0.04	0.22

※: Calculated as ratio of salaries; * : Calculated as ratio of total personnel; # : Salary disbursements/month

Table 3. Ratio of Operations Assigned to Direct Dept. from Indirect Dept.

	Operation	Usage Ratio	Direct Department (Operating Center)	
			Rolling Group	Finishing Group
			0.58	0.42
QA Div.	Billet analysis	0.15	0.087	0.063
	Inspection	0.25	0.145	0.105
	Production testing	0.6	0.348	0.252
Mechanical Div.	Equipment maintenance	0.7	0.406	0.294
	Die maintenance	0.2	0.116	0.084
	Miscellaneous equipment maintenance	0.1	0.058	0.042
Electrical Div.	Automatic control system maintenance	0.5	0.29	0.21
	Power equipment maintenance	0.3	0.174	0.126
	Fixed lift (crane) maintenance	0.2	0.116	0.084

Completion of the aforementioned steps for cost attribution obtains unit production volume statistics for November 2014. Final cost attribution to products is divided into four parts: labor costs, material costs, and fixed and variable redistributed manufacturing costs to arrive at the final product unit price. Because two of the products feature two different categories, thus costs are calculated for a total of eight products. Ration of indirect to direct department operation distribution and the unit cost calculation for each product are shown in Tables 4 and 5, respectively.

Product costs calculated using the ABC system and current cost system found that raw materials accounted for 93~95% of total manufacturing costs, thus material costs will be removed prior to comparison to clarify the discrepancy of manufacturing cost distribution. Table 6 summarizes the results of two methods (product unit cost discrepancy, and product unit cost discrepancy without material costs). Table 7 summarizes the comparison results of unit cost b for ABC and current System.

Table 8 shows that unit cost b without material cost (that is, the sum of labor and manufacturing costs) provides a clearer picture of resources used in product manufacturing and highlights a larger discrepancy. Compared to traditional methods, ABC calculations of the unit cost b for products A_1 and B_1 respectively show a reduction of 14.147% and an increase of 27.554% (Figure 4). This indicates that the CSC has been using an incorrect distribution method, and more resources and manufacturing costs should be apportioned to product A_1, while the amount of manufacturing costs apportioned to product B_1 should be reduced. The product cost variance between the existing costing system and the ABC system is calculated to show that manufacturing costs are indeed incorrect.

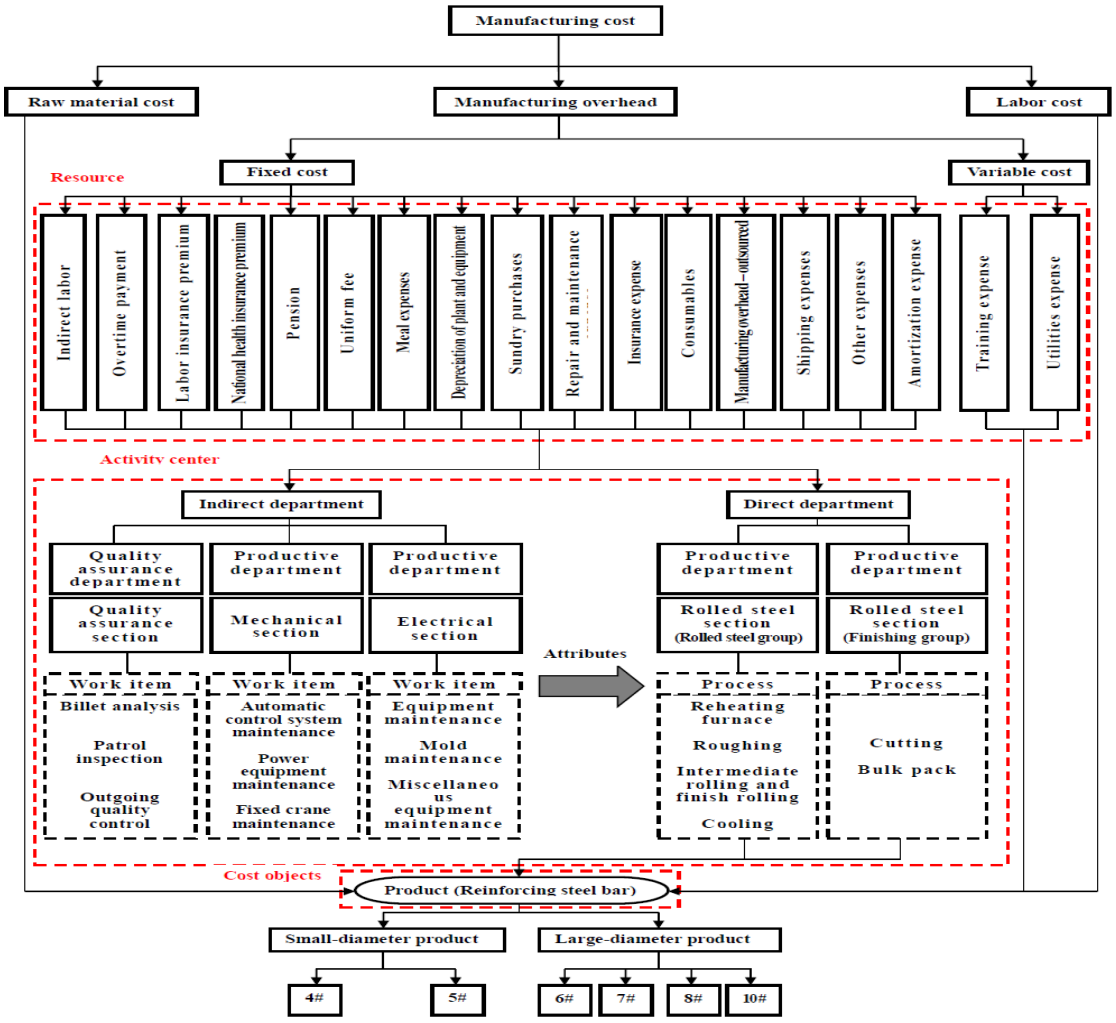


Figure 3. ABC Cost Distribution Structure for Case Study Company

Table 4. Ration of Indirect to Direct Department Operation Distribution

Resource	ABC distribution amount	QA Div.	Rolling Div. (Rolling Group)	Rolling Div. (Finishing Group)	Mechanical Div.	Electrical Div.
Fixed cost	8,807,765	520,029	4,500,728	951,411	1,110,997	1,724,600
Indirect to direct department distribution	-	-	1,946,263	1,409,363	-	-
Manufacturing subtotal	8,807,765	-	6,446,991	2,360,774	-	-

Table 5. Unit Cost Calculation for Each Product

Type	Labor cost (ton) (1)	Material cost (ton) (2)	Fixed manufacturing cost (ton) (3)	Variable electrical cost (ton) (4)	Variable fuel (ton) (5)	Total manufacturing expense (6)= (3)+(4)+(5)	ABC manufacturing cost (ton) (7)=(1)+(2)+(3)+(4)+(5)
A_1	73.29	26,019.91	646.50	192.69	486.68	1325.86	27,419.06
A_2	149.24	20,328.75	1316.48	283.01	774.96	2374.45	22,852.43
B_1	111.75	26,517.65	985.76	131.10	288.86	1405.73	27,656.88
B_2	93.83	20,224.19	827.70	415.20	1002.03	2244.93	22,362.41
C_1	68.87	26,385.15	607.52	182.12	479.53	1269.18	27,698.87
D_1	71.09	26,119.34	627.15	170.48	490.19	1287.82	27,397.54
E_1	66.11	26,309.17	583.20	148.15	503.30	1234.65	27,026.73
F_1	61.94	26,321.47	546.44	134.39	484.25	1165.08	27,002.05

Table 6. Comparison of Unit Prices Using ABC and Current System

Type	Labor (hr)	Unit production (kg)	(1) ABC unit cost a	(2) Current system unit cost a	(3)=(1)-(2) Difference a	(4)=(3)/(1) Unit cost difference (%)
A_1	380	1,275,835	27,419	27,617	-198	-0.722
A_2	284	468,254	22,852	22,558	294	1.288
B_1	425	935,823	27,656	27,617	40	0.144
B_2	206	540,221	22,362	22,558	-196	-0.875
C_1	406.6	1,452,712	27,698	27,617	82	0.296
D_1	400	1,384,393	27,397	27,617	-219	-0.801
E_1	800	2,977,467	27,026	27,617	-590	-2.184
F_1	1156.18	4,592,589	27,002	27,617	-615	-2.277

Table 7. Comparison of Unit Cost b for ABC and Current System

Type	(1) Labor cost (ton)	(2) Material cost (ton)	(3) Fixed manufacturing expenses (ton)	(4) Variable electricity cost (ton)	(5) Variable fuel cost (ton)	(6) Total manufacturing expense (ton)	(7) ABC unit cost b	(8) Current system unit cost a	(9) Current system unit cost b
A_1	73.29	26,019.91	646.50	192.69	486.68	1325.86	1,399.15	27617	1597.09
A_2	149.24	20,328.75	1316.48	283.01	774.96	2374.45	2,523.68	22558	2229.25
B_1	111.75	26,517.65	985.76	131.10	288.86	1405.73	1,517.47	27617	1099.35
B_2	93.83	20,224.19	827.70	415.20	1002.03	2244.93	2,338.76	22558	2333.81
C_1	68.87	26,385.15	607.53	182.12	479.53	1269.18	1,338.05	27617	1231.85
D_1	71.09	26,119.34	627.16	170.48	490.19	1287.82	1,358.92	27617	1497.66

E_1	66.11	26,309.17	583.20	148.15	503.30	1234.65	1,300.76	27617	1307.83
F_1	61.94	26,321.47	546.44	134.39	484.25	1165.08	1,227.03	27617	1295.53

Notes: (6)=(3)+(4)+(5); (7)=(1)+(6); (9)=(8)-(2)

Table 8. Comparison of ABC and Current System Manufacturing Cost b

Type	Labor (hr)	Unit production (kg)	ABC unit cost a (1)	Current system unit cost a (2)	Difference a (3)=(1)-(2)	Unit cost difference (%) (4)=(3)/(1)
A_1	380	1,275,835	1,399.15	1597.09	-197.94	-14.147
A_2	284	468,254	2,523.68	2229.25	294.43	11.667
B_1	425	935,823	1,517.47	1099.35	418.12	27.554
B_2	206	540,221	2,338.76	2333.81	4.95	0.212
C_1	406.6	1,452,712	1,338.05	1231.85	106.20	7.937
D_1	400	1,384,393	1,358.92	1497.66	-138.75	-10.210
E_1	800	2,977,467	1,300.76	1307.83	-7.07	-0.544
F_1	1156.18	4,592,589	1,227.03	1295.53	-68.50	-5.583

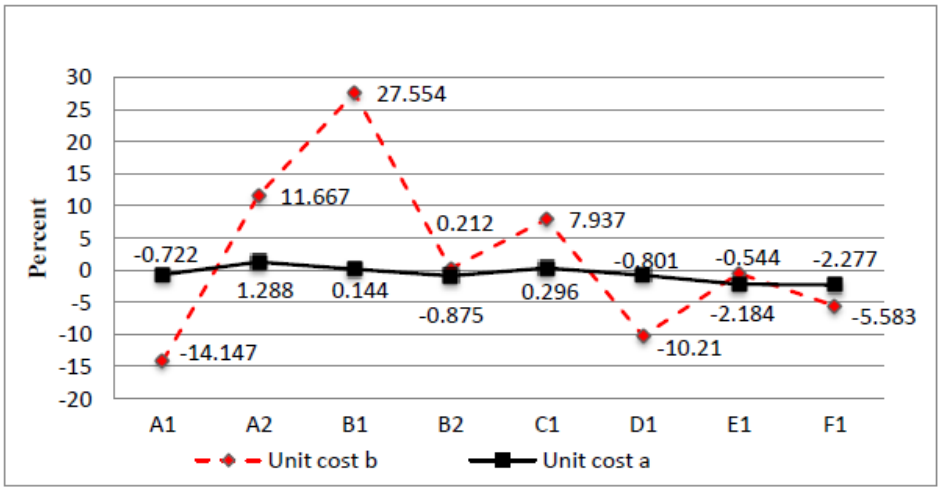


Figure 4: Comparison of Unit Cost a and Unit Cost b

Conclusions

The work first analyzes the costs control of rebar manufacturers. ABC cost methods are then introduced to compare the effectiveness of ABC with traditional cost systems. Some key findings are summarized as follows:

1. Issues related to current cost system

The case study company uses single drivers (direct labor work-hours) as the basis for distributing manufacturing costs, which does not take into account the causal relationship between resources and operations, thus distorting manufacturing costs. This incorrect cost distribution results in price discrepancies of -2.2%~ 1.2%, with a variance of -14.1% to 27.5% of manufacturing costs for each product. Due to the special characteristics of the products made, the cost distribution of the existing cost system results in lower manufacturing costs being attributed to high-volume products, and additional costs being attributed to low-volume products.

2. Calculating unit costs without material costs clarifies cost distribution

For the case study company, material costs account for 93%~95% of total manufacturing costs. Thus removing material costs from unit manufacturing costs can more clearly presenting the cost distribution discrepancy. This cost distribution is relatively small and is unlikely to highlight the correct distribution of manufacturing costs, unit capacity and labor work-hours. This study proposes unit cost a as the basis for pricing, while unit price b can provide a clearer distribution of manufacturing costs.

3. Challenging the suitability of ABC in traditional manufacturing

In traditional manufacturing, manufacturing costs make up a relatively low proportion of total costs, thus raising a challenge to the appropriateness of applying ABC. Using ABC to calculate product costs for the case study company, this study finds a price discrepancy of -2.2%~ 1.2%. Although this discrepancy is small, it highlights the miscalculation of manufacturing costs. This is a key consideration in determining whether the case study company should adopt ABC.

4. ABC system disadvantages

Complex cost calculations require partitioning and software requires customization to meet client requirements. Executing manufacturing process tasks entails expending manpower and work-hours, and such resource consumption must be recorded in detail. When analyzing work flows, excess forms and information will result in over- complicated cost calculations, thus increasing the difficulty of implementing ABC. In addition to partitioning, this requires restructuring of the general ledger, followed by the analysis of large amounts of cost data, which will be difficult to implement without the support of computerized systems. Additionally, current ABC software packages are incompatible with the characteristics of various industries, requiring companies to engage in extensive software customization.

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THE MODEL OF DYNAMIC CAPABILITY IN SUPPLY CHAIN

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Abstract

Supply chain plays an important role in the impact on business competitiveness. However, the process in between is just like a black box. Although there were some scholars noticed that supply chain relationship would influence dynamic capability, very few of them investigated the dynamic capability from the angle of interactive intensity in supply chain, and the understanding of the important intermediate factors toward the dynamic capability model in supply chain was insufficient. For this reason, the research had the manufacturing industry in Taiwan as the research subject and adopted two intermediate influential factors, which were relationship trust and relationship commitment, to explore the influence between interactive intensity and dynamic capability in supply chain in depth. The research structure and proposed hypotheses were verified and tested with structural equation modeling. The research revealed that interactive intensity in supply chain had a positive influence on the dynamic capability of an organization through the intermediate variables: relationship quality - relationship trust and relationship commitment.

Keywords: Supply Chain, Interactive Intensity, Relationship Quality, Dynamic Capability

Introduction

From the past researches on supply chain relationship, it can be found that many relation variables were relationship qualities which are very important to the establishment and maintenance of a long-term relationship, such as trust or commitment. Many scholars also mentioned trust or commitment would influence the relationship behavior of supply chain (Lee, 2016; Firouzi, et al., 2016; Luzzini, et al., 2015; Brinkhoff, et al., 2015); that was, the higher of the trust and commitment among supply chain partners could reduce more uncertainty for future cooperation and increase the compatibility of one another. It could also generate interactive behaviors which was favorable to a long-term relationship.

However, the past researches on dynamic capability in supply chain were rarely based on "interactive intensity" and were also short of integrated dynamic capability models in supply chain to explore the impact of interactive intensity and relationship quality among supply chain organizations on dynamic capability. For this reason, the research set off from the angle of interactive intensity in supply chain. The relationship quality (trust and commitment) was used as the intermediate variable according to the view of social exchange theory and the integrated model based on relationship was established for the investigation of the dynamic capability generated from inter-organizational interaction.

In summary, the research was expected to further explore the impact of interactive intensity among supply chain organizations on the development of future relationship quality as well as on dynamic capability through relevant literature review concerning relationship management among organizations. Therefore, the purposes of this study are as follows:

1. To develop a supply chain dynamic capability model based on relationship.

2. To explore the interactive intensity among supply chain organizations and the impact on dynamic capability through relationship quality (trust and commitment).

Theory and Hypotheses

The interaction among supply chain organizations is a kind of social exchange activity (Wu, et al., 2014; Tanskanen, 2015). The circulation of knowledge or resources is generated by the interactive behavior while new knowledge or resource is exactly what

needed for dynamic capability. In fact, the social exchange among supply chain members is similar as the goods exchange in economics and the difference is the reward or return of social exchange might not be money or tangible material. In view of this, the research was based on the theory of social exchange with the input of two intermediate variables, "trust" and "commitment", to explore the impact between interactive intensity in supply chain and dynamic capability in depth.

After the literature review, it is believed that the interactive intensity of supply chain partners would influence the establishment of relationship quality, and it would have a further impact on dynamic capability through the medium of relationship quality (trust and commitment). The research model was established according to this, as shown on Figure 2-1.

Prior research pointed the quality of the interaction in between would be higher when both interactive parties opened their mind to each other and provided the needed information to the other party (Mirkovski, et al., 2016; Cavusoglu, et al., 2012). For example, when information users provided more background details to information providers, users would be able to receive more, wider, more precise and more time-effective information of their target demand relatively. Kellogg and Chase (1995) made interactive theory and operation definition complete when exploring the topic related to the relationship between interaction and service quality, and they also developed three dimensions relevant to interaction measurement: communication time, information richness and level of intimacy. When the ratio of the percentage of time that supply chain partners actually appeared during the whole transaction behavior is higher, it means higher level of interaction between both parties of transaction; in other words, the interaction among supply chain partners should be focused on the times engaged with interaction.

Interactive intensity refers to direct face-to-face or indirect contact frequency between sales representatives and customers in order to achieve the goal of their own or for the enterprise (Puccinelli, et al., 2015; Ramaseshan, et al., 2013). Williamson (1983) indicated that interactive intensity reflected the various efforts done by sales representatives in order to keep an open and communicative

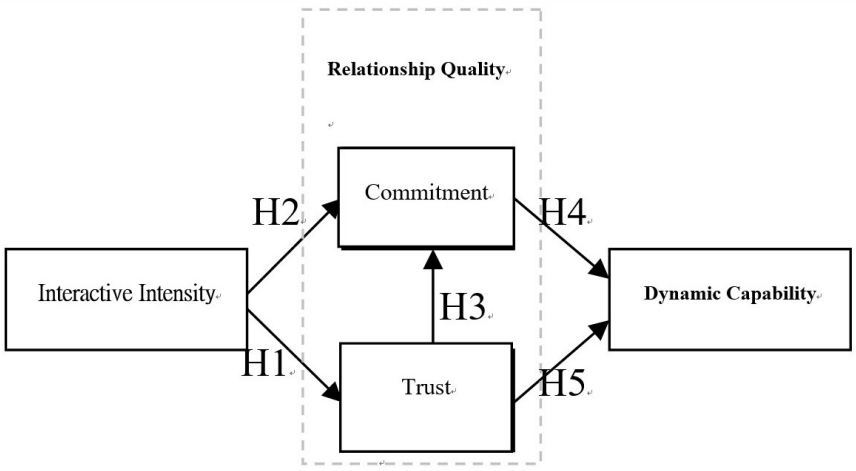


Figure 2-1 Research Mode

with customers, and it also represented a kind of commitment for the relationship between each other. Prior research suggested that high interactive intensity could improve the flexibility of negotiation between both parties (Mohr & Nevin, 1990; Peters & Fletcher, 2004). It can be known from the idea that interactive intensity emphasized the process of interaction; that was, the interaction recognition of buyers toward the sellers, the service providers. In addition, Grönroos (2004) mentioned that interaction process is the core of relationship marketing, and there is a series of act, episode, sequence and relationship included during the whole process. Two individuals interact with each other in the same event, and the result will be generated during the process; different results shape out different relationship. In other words, events are the foundation for relationship establishment, and the interactive intensity developed from it is not only an interactive concept but the foundation for supply chain partners to establish and maintain their relationship. To sum up, the research defined "interactive intensity" from the recognized interaction level on the customer's side, meaning the interactive frequency with another party sensed by an organization in supply chain.

Prior research expressed that interactive intensity was also the key variable which influence whether the relationship between both buying and selling parties would be maintained in long term (Crosby, et al., 1990; Chia & Dibb, 2014). Customers' expectation

toward the guarantee and responsibility of sales representatives would be gradually fulfilled through interaction, and the relationship between both parties would be further strengthened (Krishnamurthy & Kumar, 2015; Sweeney, et al., 2016). Williamson (1983) believed interactive intensity also represented a commitment to the relationship between both parties other than reflected the efforts done by both supply chain partners in order to maintain an open and communicative channel. Interactive intensity has positive influence on emotional development or social links among supply chain partners. As a result, supply chain partners should provide the other party a cozy feeling just like at home and develop good social relationship in order to make the relationship stronger, longer with the quality improved. To sum up, the following hypotheses were proposed:

H1: The higher the interactive intensity among supply chain organizations is, the higher level of relationship trust between supply chain organizations is.

H2: The higher the interactive intensity among supply chain organizations is, the higher level of relationship commitment between supply chain organizations is.

Prior research pointed that the establishment of trust was the important factor on the process of social exchange (Ertürk & Vurgun, 2015; Schoenherr, et al., 2015). Social exchange theory assumed the exchange process would develop as time goes by, and both the exchanging parties would show their dependability for this exchange relationship by the approach of relationship commitment (Birtch, et al., 2016). Furthermore, trust is the significant factor to improve knowledge sharing efficiency of both sides, and it could increase positive delivery of the knowledge (Ozlati, 2015; Olander, et al., 2015). According to the explanation on social exchange theory in relation to the relationship between trust and commitment, the consequence of mistrust would result in the decrease of commitment to the exchange relationship between both sides and turned the original long-term exchange relationship into a short-term transaction relationship (Paillé, et al., 2015; Tanskanen, 2015). Furthermore, prior research highlighted trust was the crucial factor to determine a commitment relationship (Altinay, et al., 2014). It is believed trust would bring high value to the partnership, and therefore the participants from both parties would like to make commitments to the relationship between each other (Søderberg, et al., 2013). Based on the

reasons mentioned above, it is assumed that the trust level among supply chain organizations would influence the relationship commitment among the organizations. Thus, the hypothesis H3 of the research was proposed as follows:

H3: The higher the trust level among supply chain organizations is, the stronger relationship commitment among supply chain organizations is.

Prior research suggested that dynamic capability was a set of regulations or processes that guided resource allocation (Pettus, 2015; Macpherson, et al., 2015). The support of resources or capabilities from partners could be retrieved through a strengthened supply chain partnership. With key complementary resources, following abilities in resource integration, allocation, distribution, renew, learning and response of an organization can be improved. Furthermore, enterprises enhanced their relationship between one another through supply chain networks and strategic alliances so as to increase the competitiveness of suppliers, and the higher quality level of supply chain relationship is, the more positive influence on dynamic capability it may cause (Jin & Edmunds, 2015; Scholten & Schilder, 2015; Pereira & Vilà, 2016). Therefore, hypothesis H4a was proposed as follows:

H4a: The higher the level of "relationship quality" among supply chain organizations is, the stronger the "dynamic capability" of an organization is.

Based on the perspective of social exchange theory, prior research suggested that relationship commitment and trust can be used as the main variables when shaping the concept of relationship quality, and this elaborated that the maintenance of relationship was very crucial (Tsai & Hung, 2016; Ferro, et al., 2016). It meant the belief in which partners would like to maintain the relationship and would fulfill short-term sacrifice to achieve long-term profits. In addition, relationship trust and relationship commitment are adopted as dimensions for relationship quality in supply chain researches (Ferro et al., 2016; Ponder, et al., 2016; Dedahanov & Rhee, 2015). Therefore, the hypothesis H4a can be further divided into hypothesis H4 and hypothesis H5.

H4: The higher level of "relationship commitment" among supply chain organizations is, the more the "dynamic capability" of the organization will be enhanced.

H5: The higher level of "relationship

trust" among supply chain organizations is, the more the "dynamic capability" of the organization will be enhanced.

Research Method

Measurement of research variables

All of the observation variables in the research were based on relevant literatures plus the reference of the advanced opinions from three scholars and four industrial experts for the adjustment and modification of some of the content and wordings with the expectation of being able to meet the context and theoretical foundation of the research. All latent variables were measured by several observation variables. Subjects answered their level of agreement toward each observation variable according to the questions. The adopted scale for the measurement was Likert 7-point scale (1: totally disagree; 7: totally agree). The operational definitions and the sources of reference of the variables in the research are sorted as in the following Table 1.

Questionnaire design and sampling

The pretesting of the questionnaire was conducted in order to modify its content and avoid unclear sentences and inappropriate questions so that the content validity of the questionnaire could be increased (Churchill, 1979). The modification of questions in the questionnaire has been conducted by four industrial experts and three scholars. 30 vendors were randomly sampled from the research population of the top 1000 manufacturers in Taiwan. Each of the vendors was given a questionnaire for pretesting for the modification of wordings in order to eliminate semantic obstacles.

A self-report scale was adopted as the measurement tool in the research. Podsakoff and Organ (1986) believed the problem of common method variance would possibly occur when using a single questionnaire to collect data from the same group of subjects for data analysis considering the data included independent and dependent variables at the same time. Therefore, the research took the opinion of Podsakoff, MacKenzie and Lee (2003) as the reference and adopted precautions in advance in order to avoid this kind of problem. For example, (1) Respondent's information concealment: the research used anonymous approach and respondent's questionnaire was put into envelopes and sealed before collecting it back in order to earn the trust of the respondents and increase the authenticity of the questionnaire re-

sponded; (2) Separation approach of data collecting: the research applied psychological isolation, and it was marked on the questionnaire that each question was independent to avoid answer deviation when respondent answering each question; (3) "Negative worded design": the research used negative worded items on the questions for the dimension of "trust"; (4) "Item context arrangement": used simple, clear and easy items for understanding and avoid asking two questions or using two negative items in the same question.

Table 1. Operational definitions and sources of reference of the variables in the research

Research Variable	Operational Definition	Items	Reference
Interactive intensity	Whether supply chain organizations feel getting constant interaction with the other party.	4 questions	Crosby et al. (1990)
Relationship trust	Supply chain organizations have positive expectation toward the behavior of the other side and have the mental status of willing to undertake risk actively.	4 questions	Bettencourt (1997), Crosby et al. (1990), Doney and Cannon (1997), Morgan and Hunt (1994)
Relationship commitment	Supply chain organizations have psychological attachment toward relationship and are willing to exchange relationship maintenance with temporary sacrifice.	4 questions	Bettencourt (1997), Crosby et al. (1990), Doney and Cannon (1997), Morgan and Hunt (1994)
Dynamic capability	Our company's integration on internal and external resource, the efficiency and effectiveness of the resource application, and the ability to respond external changing environment rapidly.	3 questions	Teece et al. (1997), Prahalad and Krishnan (2008)

The research population was the top 1,000 manufacturers in Taiwan surveyed by CommonWealth Maga-zine in 2013, and the investi-

gated units were the relationships between manufacturers and their suppliers while the respondents were set to be senior managers or senior procurement specialists who were in charge of related business with suppliers. For the benefits of follow-up research and analysis, each of the participated enterprises were requested to select one most crucial supplier (with highest purchasing amount or with highest interactive frequency) as the respondent of questionnaire. The research randomly selected 1/2 of them, 500 enterprises, as the samples; the questionnaire was mailed or delivered by staff in person to the accountable person (President or General Manager) of the enterprise to forward to the manager in purchasing department who was in charge of contacting the supplier or to the senior specialist who was responsible for purchase execution for the response according to the experience of working with most crucial supplier in terms of business. The questionnaires were provided on August 15th, 2015 and 127 valid copies of questionnaire were retrieved after the questionnaires were mailed or delivered and three times of follow-up with the effective response rate of 25.4%. It was close to the response rate of 28% in the research in the same category in Taiwan by Liu (2010) in "Chiao Ta Management Review". Therefore, we surmised that the response rate of the research was reasonable and acceptable. In order to review the potential non-response bias and the representativeness of samples, the suggestion of Armstrong and Overton (1977) was followed, and the early-response samples (64 copies) and late-response samples (63 copies) from the 127 effective questionnaires were examined based on employee number, annual revenue of the enterprise and years of establishment with Chi-square test. The test result revealed there was no significant difference between the two batches of the response samples, and it was assumed that non-response questionnaire would not cause much deviation to the research result. Among the effective responded samples, over 88.3% of the respondents occupied important positions in the company with the titles of CEO (4.5%), vice president (10.8%), assistant general manager (23.4%), manager (38.9%) and senior procurement specialist (10.7%).

Measurement model

Goodness-of-fit of the model and theoretical model were verified and

tested with LISEREL8.3 in the research. The default maximum likelihood method (MLE) was used to estimate parameters when conducting data analysis. In terms of applying MLE data, the assumption of multi-variate normal distribution must be met and the sample size should not be too small; 100-150 must be requested for proper use (Ding, et al., 1995). After eliminating invalid samples, there were 127 valid samples, and Q-plot distribution slope of standardized residuals didn't violate normal assumption; it met the above requirement. The main purpose of measurement model analysis was to confirm two things: (1) verifying whether each measuring variable in the model was able to measure potential variables correctly under the consideration of whole model; (2) examining whether it was loaded with complicated measuring variables in different factors (Anderson & Gerbing, 1988). That was to test the two important construct validities in the model: the convergent validity - it referred to measure variables from relevant variables with different approaches for measurement, and the relevance between each other must be high, which meant the measurement result should be the same when measuring the same thing; Discriminant validity - measure two different concepts, no matter it was done by the same approach or different approaches, and conduct correlation analysis on the measurement. The relevance should be low. In accordance with the suggestion of Baozzi and Yi (1988), the research selected four most indicative indicators to evaluate the measurement model. The detailed description was as follows:

(1) Reliability of individual question items: this indicator was to evaluate the factor loadings from measuring variables to the potential variable and test statistical significance of each variable loadings. In factor loadings analysis, significance test was done by t-test; the greater the t value was, the stronger the intensity was. It would be seen as significant if the absolute value of t was over 1.96. Table 2 showed the standardized factor loadings for all the individual variable were above 0.5 with the t value greater than 1.96, and it revealed the measuring quality of the whole measuring questionnaire was good; the relevance among the questions was very high.

(2) Composite reliability of latent variables: the composite reliability of latent variables was the composition of reliability of all the measuring variables, and it represented internal consistency of construct indicator; A higher reliability revealed higher internal consistency of these indicators. The

suggested value by Fornell and Larcker (1981) was over 0.6. Table 2 showed the composite reliability of each variable in the measurement model was above 0.6. The composite value of the research was between 0.87 and 0.91, and it represented good internal consistency in the research model.

(3) Average variance extracted of latent variables: average variance extracted was the calculation of average

Table 2. Analysis results of the measurement model

Dimension	Question order on the questionnaire	Factor Loadings	Standard Error	T value	Composite Reliability	Variance Extracted
Interactive Intensity (I)	I1：Supply chain partners visited or concerned each other regularly or irregularly	0.61	0.17	12.4	0.87	0.72
	I2：Supply chain partners provided continuing long-term after-sales service	0.61	0.19	9.9		
	I3：Supply chain partners cared about each other and provided assistance when encountering problems	0.63	0.22	11.9		
	I4：Supply chain partners coordinated with each other and went through different time together	0.60	0.19	10.3		
Trust (T)	T1：Happy to assist supply chain members	0.66	0.12	15.3	0.91	0.76
	T2：Treated supply chain members sincerely	0.72	0.10	14.1		
	T3：Actively assisted supply chain members for problems	0.67	0.12	16.2		
	T4：Would not do anything harm to supply chain members	0.61	0.25	12.2		
Commitment (C)	C1：Able to provide our company proper knowledge feedback	0.77	0.16	8.9	0.89	0.83
	C2：Able to fulfill the knowledge of our company	0.68	0.17	13.1		
	C3：Able to provide the information that our company wants	0.75	0.14	15.5		
	C4：Able to offer a stage for company to devote knowledge	0.70	0.18	17.4		
Dynamic Capability (DC)	DC1：Our company is very efficient in integrating and applying both internal and external resources	0.73	0.14	15.8	0.90	0.74
	DC2：Our company is very effective in integrating and applying both internal and external resources	0.72	0.209	14.3		
	DC3：Our company has a rapid responding ability to the external environment change	0.68	0.19	11.4		
	χ^2/d.f.=1.82; AGFI=0.80; NFI=0.90; NNFI=0.91; CFI=0.92; RFI=0.91; RMSEA=0.073					

explanatory from each measuring variables of latent variables to the variance of the latent variable. If the average variance extracted was higher, then it showed higher reliability and convergent validity of the latent variable. Fornell and Larcker (1981) suggested the standard value must be greater than 0.5. According to Table 2, the variance extracted value of each variable in measurement model was all greater than standard value of 0.5 (0.72-0.83), and it represented good reliability and convergent validity of the latent varia-

bles in the research.

(4) Discriminant validity: discriminant validity referred to the different measuring question items used to measure different dimensions. According to Fornell and Larcker (1981), the method used to measure discriminant validity was that the average variance extracted of each dimension should be greater than the squared value of the correlation coefficient between the dimension and other dimensions. Table 3 showed the value met the evaluation standard above and was with good discriminant validity. The minimum dynamic capability (AVE value = 0.56) of average variance extracted was used as an example, and the maximum squared value of correlation coefficient between dynamic capability and other dimensions was 0.18, which was less than 0.56, meeting the evaluation standard.

Table 3. Variance extracted and squared value of correlation coefficient

Dimension	Interactive intensity	Trust	Commitment	Dynamic Capability
Interactive intensity	0.64			
Trust	0.12	0.78		
Commitment	0.22	0.17	0.65	
Dynamic capability	0.06	0.17	0.18	0.56

Note: The diagonal shows the average variance extracted of the dimension and non-diagonal was the squared value of correlation coefficient of each dimension.

The Structural Model

Table 4. Each indicator goodness-of-fit of structural model

Goodness-of-fit index	Suggest value	Source of reference of the suggested value	Measurement Model	Structural Model
χ^2/d.f.	≦ 3.00	Bagozzi and Yi (1988) ; Hair et al. (2005)	1.82	2.46
AGFI	≧ 0.80	Hair et al. (2005)	0.80	0.80
NFI	≧ 0.90	Hair et al. (2005)	0.90	0.90
NNFI	≧ 0.90	Bentler (1990) ; Hair et al. (2005)	0.91	0.91
CFI	≧ 0.90	Bentler (1990) ; Hair et al. (2005)	0.92	0.92
RFI	≧ 0.90	Bentler (1990) ; Hair et al. (2005)	0.91	0.92
RMSEA	≦ 0.08	Hair et al. (2005)	0.073	0.077

Structural model analysis included the goodness-of-fit analysis of the research model and the explanatory of the whole research model. The paper referred to the opinions of Bagozzi and Yi (1988) and Hair et al. (2005) and selected 7 indicators for the goodness-of-fit evaluation for the whole model including Chi-square test and its degree of freedom (χ^2/d.f.), goodness-of-fit index after adjustment (AGFI), NFI, NNFI, comparative fit index (CFI), RFI and root mean square error approximation (RMSEA). The result was summarized as in Table 4. Bagozzi and Yi (1988) suggested the value of Chi-square test and its degree of freedom (χ^2/d.f.) should not be greater than 3 (Hair, et al., 2005). The value of Chi-square test and the degree of freedom (χ^2/d.f.) of the research was 2.46, which was smaller than the suggested value, 3, and it revealed that it was an acceptable model while other indexes all met the suggested values of most researches of AGFI $\geqq$ 0.80 (0.80), NFI $\geqq$0.90 (0.90), NNFI $\geqq$ 0.90 (0.91), CFI $\geqq$ 0.90 (0.92), RFI $\geqq$ 0.90 (0.92), RMSEA $\leqq$ 0.08 (0.077). Overall, the research model and observation data of the research had excellent goodness of fit.

Table 5 and Figure 2 showed the path relationship among each dimension estimated through SEM. Its path value followed the standardized coefficient and verified the five hypotheses in the research model. All of them achieved the significant level of α=0.01.

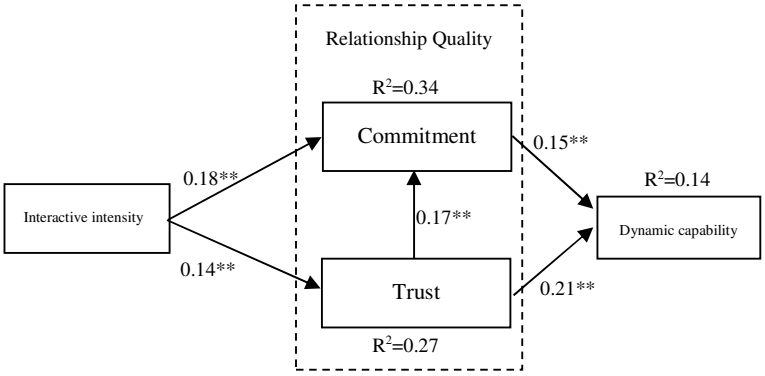
Conclusion and Recommendations

With the thoughts concerning supply chain rising, enterprises no longer only focus on the dynamic capability inside the enterprise but expand themselves to the external sources of dynamic capability among supply chain members. The research followed the fundamental spirit of social exchange theory and used commitment and trust of relationship quality as the intermediate variables to investigate the influence of interactive intensity among supply chain members on the dynamic capability of the organization. Through SEM test, the five hypotheses proposed in the research were all supported by empirical data. The research results showed the higher the interactive intensity among supply chain organizations was, the higher the relationship trust level and relationship commitment between the supply chain organizations were; the higher the trust level among supply chain organizations was, the stronger the relationship

commitment between supply chain organization was. Higher relationship commitment among supply chain organizations would enhance the dynamic capability of the organization.

Table 5. Verification of research hypotheses

	Hypothesis	Path Coefficient	T Value
H1	The higher the interactive intensity among supply chain organization, the higher the relationship trust level between supply chain organizations is.	0.14**	6.96
H2	The higher the interactive intensity among supply chain organizations, the higher the relationship commitment level between supply chain organizations is.	0.18**	7.17
H3	The higher the trust level among supply chain organizations, the stronger the relationship commitment between supply chain organizations is.	0.17**	8.64
H4	Higher the relationship commitment among supply chain organizations would enhance dynamic capability of the organization.	0.15**	4.17
H5	Higher the trust level among supply chain organizations would enhance dynamic capability of the organization.	0.21**	9.32



*: p < 0.05，**: P < 0.01

Figure 2. Hypothesis verification result

Higher trust level among supply chain organizations would enhance the dynamic capability of the organization.

The empirical research results could help enterprises to understand how interactive intensity in supply chain influences the dynamic cap- ability of supply chain members and enhances relationship commitment and trust among supply chain members by controlling interactive intensity in sup-

ply chain from different sources or degrees as well as further increase dynamic capability of supply chain members. Based on the research results, enterprises may find that the interactive intensity among supply chain members seems to be the important source of external dynamic capability among supply chain members. For many enterprises, the finding should be a very important inspiration. In other words, the interactive intensity among supply chain members seemed to have effectiveness of significant enhancement toward the generation of external dynamic capability of supply chain members.

The research took the top 1,000 manufacturers in Taiwan as the empirical subjects, and it would need further empirical research to gain generalized results for other industries or small-medium enterprises to refer. Besides, the research belongs to the category of cross-sectional study, and it should not be used to discuss the longitudinal effectiveness between supply chain interactive intensity and the generation of dynamic capability. It is expected that continuing efforts would be made by scholars for following researches in future.

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SHEAR BANDING INDUCED SEISMIC BUILDING TILTING FAILURE AND ITS CONTROL

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Abstract

Building tilting failure is often caused by the reduction in foundation bearing capacity during an earthquake. However all the seismic design specifications for buildings are focused only on the vibration resistance of upper structural elements, such as columns, girders, plates and walls. Thus new buildings with improved seismic resistance still suffer tilting failure during an earthquake even with magnitude smaller than the design one. Based on the above-mentioned finding, the authors of this article point out that seismic design of buildings should emphasize the ground modification for foundation soil. An easier way to achieve this is to replace inferior foundation soil with graded gravel, and to carry out verification tests with respect to selected materials.

Keywords: seismic building tilting failure, shear banding, ground modification.

Introduction

It is generally noticed that when ductile solids such as rocks, overly consolidated clays, granular materials, polymers, and structural metals are deformed sufficiently far into the plastic range, a smoothly and continuously varying deformation pattern gives way to highly localized deformations in the form of shear bands (Rice, 1977) as shown in Figure 1. Such a phenomenon can be understood as the instability in the macroscopic constitutive description of inelastic deformation of the material. Specifically, instability is

understood in the sense that the constitutive relations may allow the homogeneous deformation of an initially uniform material to lead to a bifurcation point, at which nonuniform deformation can be incipient in a planar band under conditions of continuing equilibrium and continuing homogeneous deformation outside the zone of localization (Rudnicki and Rice, 1975).

Figure 1. Shear banding occurred during earthquake (Zhushan, Taiwan)

When sliding occurs within a shear band, the alternate occurrence of slip-stick phenomenon (as shown in Figure 2) will cause ground to vibrate (as shown in Figure 3). In other words,

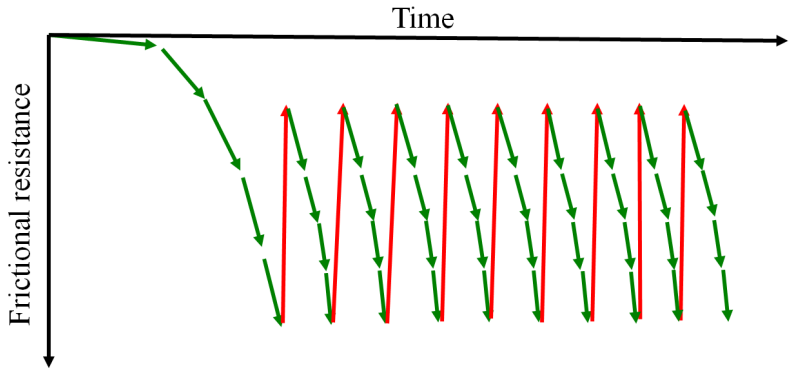


Figure 2. Stick-slip type of starting and kinetic friction (Reproduced from Lambe and Whitman, 1969)

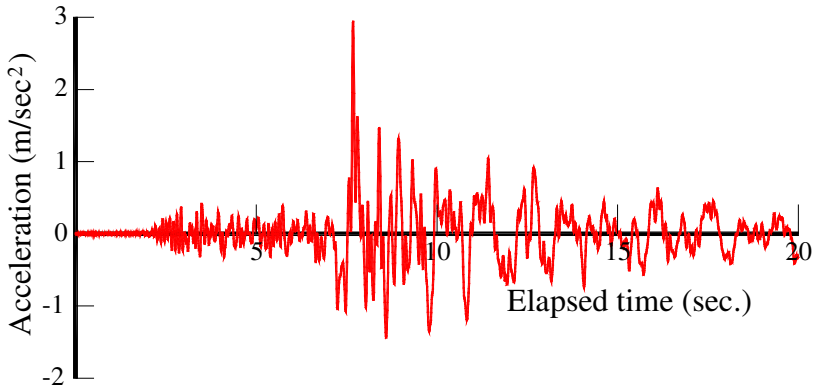


Figure 3. Illustration of ground acceleration duration curve related to ground vibration

the actual earthquake effects include localized shear banding and comprehensive ground vibration.

On September 21, 1999, the Chi-Chi earthquake measuring 7.3 on Richter scale took place in Taiwan. The tilting failure of school buildings of Kwangfu Junior High School in Taichung City are as shown in Figure 4; due to the severity of such a failure, this campus has been preserved as the 921 Earthquake Education Park.

(a) front side view

(b) rear side view (cited from Peggy, 2013)

Figure 4. Localized tilting failure of school buildings in Kwangfu Junior High School after the Chi-Chi Earthquake

Currently most structural engineers believe that the cause of failures for school buildings is excessive ground vibration. As a result, most efforts after the Chi-Chi earthquake are focused only on improvement of vibration resistance for upper structural elements. However, if the cause of tilting failures for school buildings is excessive ground vibration, theoretically that should happen to all school buildings because they were all suffering from excessive vibration during the earthquake. Yet the fact is proven otherwise. It is shown in Figure 4 that tilting failure of school building took place locally at the severely fractured hanging wall along the side of thrust fault scarp due to shear banding rather than the unfractured foot wall on the other side without shear banding. Therefore, the investigation of actual cause of school building tilting failure becomes rather important for the purposes of earthquake education and damage mitigation.

Applicability Of Structural Analysis Models

Building structural analysis models are all in simplified forms so far. The physical model of school building as shown in Figure 5a includes foundation soils, foundations, columns, girders, plates and walls; however, the structural analysis model does not include foundation soils and foundations, which are replaced by spring simulated foundation soils (Note: this simulation could be neglected), and the boundary

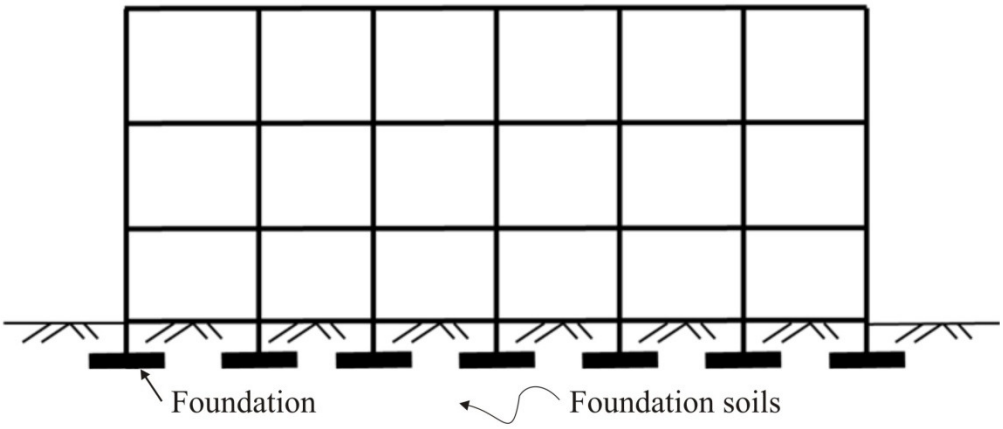


Figure 5a.
Illustration of physical model

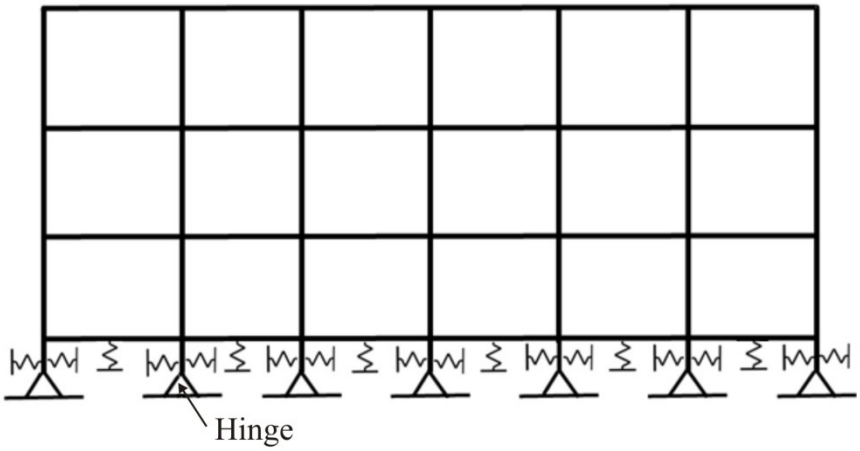


Figure 5b.
Illustration of structural analysis model (bottom of column set as hinge)

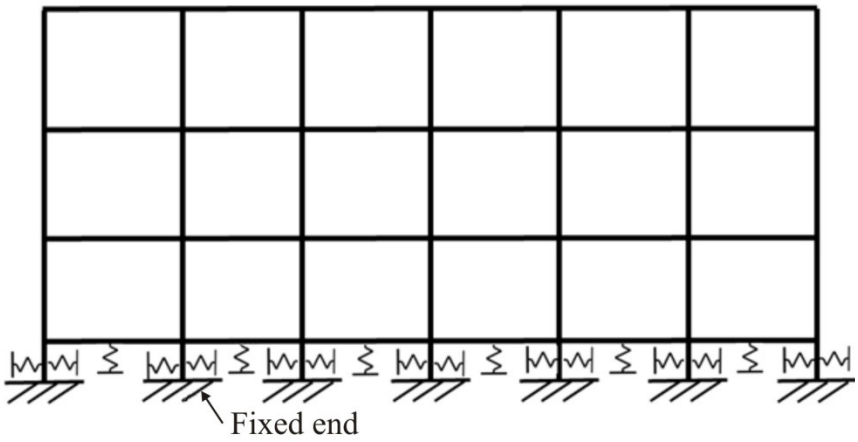


Figure 5c.
Illustration of structural analysis model (bottom of column set as fixed end)

Figure 5. Comparison between physical building model and structural analysis model

condition at the bottom of column is set as hinge (as shown in Figure 5b) or fixed end (as shown in Figure 5c).

Under the action of external forces, when the bottom of column is set as hinge, the structural analysis model as shown in Figure 6b is only applicable to the simulation in which there is no displacement at the bottom of column; when the bottom of column is set as fixed end, the structural analysis model as shown in Figure 6c is only applicable to the simulation in which there is no displacement nor rotation at the bottom of column.

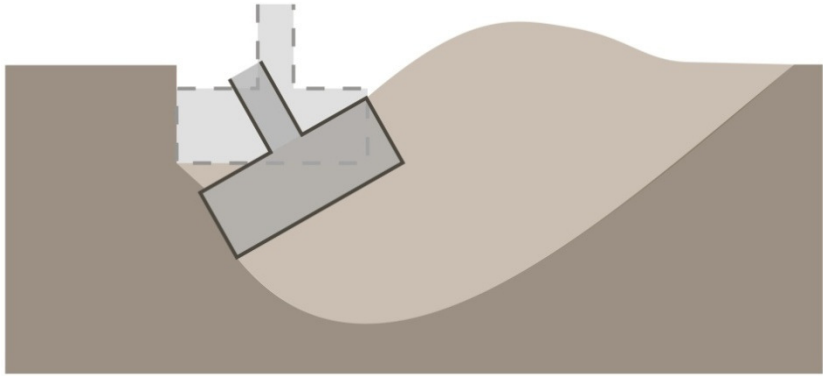
In order to ensure that the conditions set in structural analysis of physical building will not be changed under the action of external forces, the design of upper structural elements must meet building earthquake-resistant design specifications (Construction and Planning Agency, Ministry of the Interior of Taiwan, 2011); and the design of lower structural elements (including foundation soils and foundations) must also meet building foundation design specifications (Construction and Planning Agency, Ministry of the Interior of Taiwan, 2001), which requires the safety factor of ordinary foundation bearing capacity to be greater than 3.0, and the safety factor of seismic foundation bearing capacity to be greater than 1.2.

The Impact Of Foundation Shear Failure On Overall Structural System

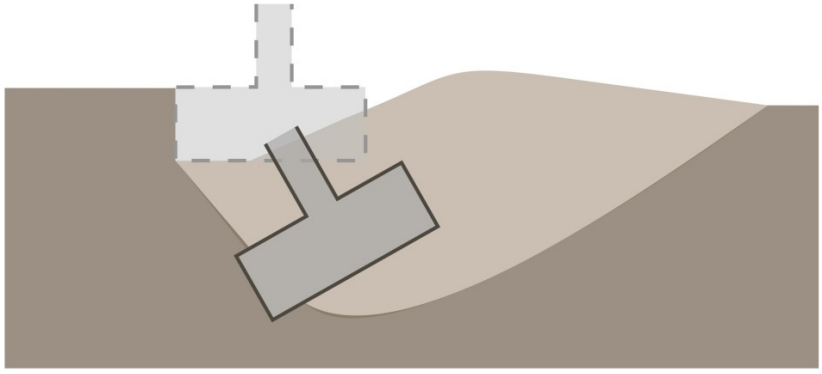
Currently it is the structural engineer who is responsible for the building structural analysis and design, while the geotechnical engineer is only responsible for the soil properties and ordinary foundation bearing capacity; in such analysis and design model, the structural designs of all buildings did not take into consideration the change

of soil properties during an earthquake and the impact resulted from greatly reduce foundation bearing capacity.

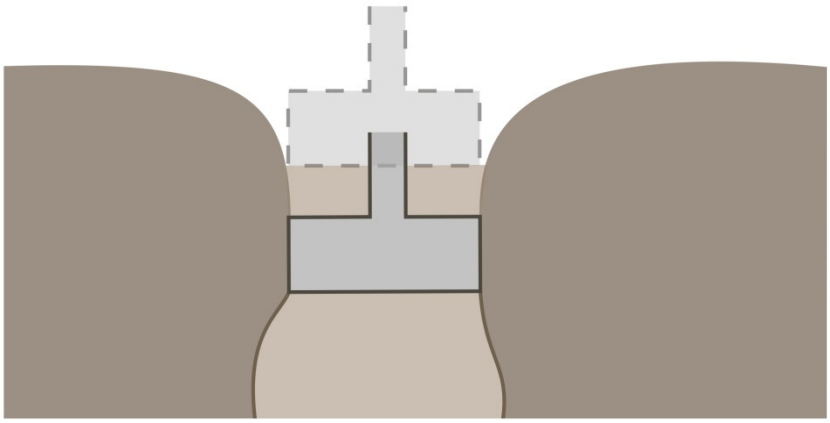
After the Chi-Chi earthquake, even though it is proven that the safety factor of foundation seismic bearing capacity less than 1.0 has led to tilting failure of building along with the foundation shear failure (as shown in Figure 6), most structural engineers still believe that the cause of such damage is the insufficient vibration resistance of the upper structures. With such focus on the enhancement of vibration resistance of upper structural elements, the impacts of significant displacement and rotation of foundations on overall building structural behavior have not be considered at all.



(a) general shear failure



(b) local shear failure



(c) punching shear failure

Figure 6. Various types of foundation shear failures

As for buildings currently in compliance with new seismic design specifications, theoretically there should not be any tilting failure during an earthquake measuring less than 7.3 on Richter Scale with the vibration resistance of all upper structural elements greatly improved. However, there were indeed quite a few new buildings suffering from tilting failure during the Meinong Earthquake measuring 6.4 on Richter Scale took place on February 6th, 2016, which includes a new building with the construction of main structure completed just six months earlier (as shown in Figure 7).

When one side of a building subsides along with a sinking foundation, the cause of tilting failure is definitely related to the shear failure of foundation soils; any loosening, softening, or liquefaction of soil during earthquake could induce shear failure of foundation soils, and the position of bottom of column will be changed along with displacement or rotation of foundation. Under such circumstance, the structural analysis model as shown in Figure 5b or Figure 5c cannot be used to simulate this kind of structural failure behavior. Therefore, when the structural analysis model as shown in Figure 5b or Figure 5c is used by structural engineers, they must meet the specifications of foundation seismic capacity safety factor in building foundation design specifications (Construction and Planning Agency, Ministry of the Interior of Taiwan, 2001) in addition to meeting the specification of building seismic design specifications (Construction and Planning Agency, Ministry of the Interior of Taiwan, 2011).

(a) Before earthquake (cited from Google Earth, 2016)

(b) After earthquake

Figure 7. Newly decorated building which was severely damaged during Meinong Earthquake

Case Analysis

Analysis conditions

In this paper the safety factors of seismic bearing capacity of school building foundation as shown in Figure 4 have been analyzed, in which the soil properties and strength parameters come from the test result based on on-site sampling (as shown in Table 1).

Table 1. Test result of soil properties and strength parameters

Test item	Test result
Wet unit weight γ_{wet}	18.2kN/m^3
Peak cohesion c_p	3.2kPa
Peal angle of internal friction ϕ_p	32°
Residual cohesion c_r	$0kPa$
Residual angle of internal friction ϕ_r	29°

As for the foundation of that school building, the width B is 2m, and the foundation depth D_f is 1.5m. The difference between the properties of hanging wall soil and foot wall soil is resulted from shear banding. Residual cohesion c_r and residual angle of internal friction ϕ_r must be used for hanging wall soil due to the effect of shear banding, while peak cohesion c_p and peak angle of internal friction ϕ_p must be used for foot wall soil due to no effect of shear banding. The horizontal seismic coefficient k_h is 0.237, and the vertical seismic coefficient k_v is 0.1185; the seismic coefficient k_v is 0.1185; the seismic coefficient is derived from the correlation (as shown in Table 2) between the actual measurement (as shown in Table 3) of Wufeng Elementary School Seismic Station No. TCU065 during 921 Earthquake and the PGA and seismic coefficient provided by Water Resources Agency of MOEA. Under various load combinations, the adopted design load capacity q_{design} is 300kN/m^2.

Analytical method

As for square foundation, equation 1 can be used to calculate the ultimate seismic bearing capacity of foundation $q_{ult,E}$:

$$q_{ult,E} = c\,N_{cs}s_c e_c + qN_{qs}s_q e_q + \frac{1}{2}B\gamma N_{\gamma s}\,s_\gamma e_\gamma \quad \text{..... (1)}$$

Where c represents cohesion, q represents pressure of cover soil above bottom surface of foundation, γ represents unit weight of soil, N_{cs}, N_{qs} and $N_{\gamma s}$ represent the static soil bearing capacity parameters of elongated foundation proposed by Meyerhof (1951, 1963); s_c, s_q and s_γ are the shape correction factors proposed by Hansen (1970); and the seismic correction factors e_c, e_q and e_γ proposed by Budhu and Al-Karni (1993) are:

$$e_c = exp\left(-4.3k_h^{1+D}\right) \quad \cdots\cdots\cdots\cdots \quad (2)$$

$$e_q = (1-k_v)\exp\left[-\left(\frac{5.3k_h^{1.2}}{1-k_v}\right)\right] \quad \cdots\cdots \quad (3)$$

$$e_\gamma = (1-\frac{2}{3}k_v)\exp\left[-\left(\frac{9k_h^{1.1}}{1-k_v}\right)\right] \quad \cdots\cdots \quad (4)$$

In three aforementioned equations, $D = C/(\gamma H)$, and H is the depth of sliding failure surface from ground surface. When the foundation burial depth is known as D_f, H can be calculated as:

$$H = D_f + \frac{0.5B}{\cos\left(\frac{\pi}{4}+\frac{\phi}{2}\right)}\exp\left(\frac{\pi}{2}\tan\phi\right) \quad \cdots \quad (5)$$

Table 2. Correlation between horizontal PGA and horizontal seismic coefficient k_h (cited from Water Resources Agency of MOEA, 2008)

Horizontal PGA	k_h
<0.12g	0.10
0.12g~0.18g	0.10~0.12
0.18g~0.50g	0.12~0.16
0.50g~0.80g	0.16~0.24
>0.80g	0.24
Note: $k_v = k_h \times R$, $R \geq 0.5$.	

Table 3. Monitoring result of TCU065 seismic station during 921 Earthquake (cited from Central Weather Bereau, 1999)

Monitoring item	PGA
East-West Direction	0.79g
North-South Direction	0.57g
Vertical Direction	0.26g

Analysis result and discussion

The safety factors of seismic bearing capacity of foundations located at hanging wall and foot wall are as shown in Table 4. When the foundation is located at foot wall, the safety factor of seismic foundation bearing capacity is $FS_E = 1.28 > 1.2$, and this analysis result is consistent with the phenomenon of foundation at foot wall remaining safe during earthquake. When the foundation is located at hanging wall, the analysis reveals that the safety factor of seismic foundation bearing capacity is $FS_E = 0.67 << 1.2$, thus leading to shear failure of foundation soil. This could be the main cause of tilting failure for the school building shown in Figure 4 after the Chi-Chi earthquake.

Table 4. Analysis results of safety factors of seismic bearing capacity of foundations located at hanging wall and foot wall

Foundation location	Analysis condition	c (kPa)	ϕ	k_h	k_v	q_{ult} (kPa)	FS_E
Foot wall	Without shear banding	3.2	32°	0.237	0.1185	384	1.28
Hanging wall	With shear banding	0.0	29°	0.237	0.1185	201	0.67

Control Method For Seismic Building Tilting Failure

As for buildings in compliance with building seismic design specifications, in order to prevent buildings from suffering tilting failure due to foundation shear failure, the inferior foundation soil can be replaced by graded gravel within the range of depth H obtained from Equation 5 to ensure that there is no shear failure of foundation.

For verification of suitability of selected graded gravel, a large-scale direct shear test apparatus proposed by the author and a special test method can be used to quickly obtain the shear strength parameters required by this analysis, and then the analysis result of safety factors of foundation seismic bearing capacity can be used to deter-

mine whether or not the selected graded gravel is suitable.

The proposed large direct shear test apparatus

A large direct shear test apparatus proposed by the authors is as shown in Figure 10, in which the cross-sectional area of shear box is 30.5cm x 30.5cm, the maximum height of upper box is 15cm, and the maximum height of lower box is 20cm.

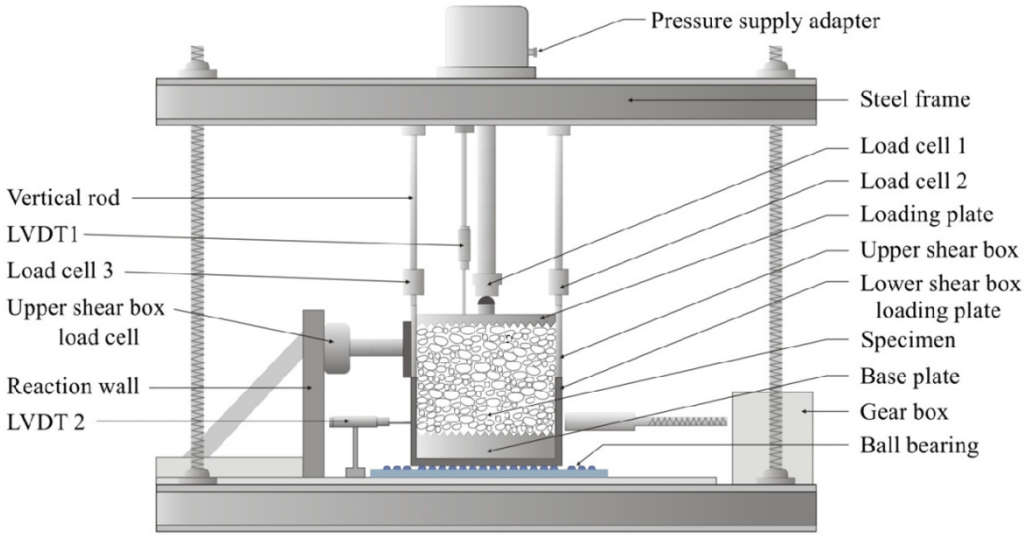


Figure 10. Schematic diagram of the proposed large direct shear test apparatus

The maximum particle size of graded gravel is 2.54cm based on the reliability of test result. The direct shear test apparatus can be used for direct shear test via pushing to the left or pulling to the right. After specimen and measuring instrument are properly installed, the vertical force can be applied to the loading plate via oil pump and pressure supplying rod until the numerical value displayed by load cell 1 reaches the predetermined vertical force. And then the readings of load cell 2, load cell 3, LVDT 1 and LVDT 2 are zeroed. The transmission and gearbox can be used to control the speed of horizontal displacement, and the control valve can be used to control the lower shear box above ball bearing to move to the left or to the right for pushing or pulling shear test.

The upper shear box will be lifted during the application of shear stress; for minimizing such lift, one set of vertical rod and load cell will be installed on both sides of upper shear box; the additional vertical force generated during this test will be displayed by these two load cells; therefore, during the process of applying horizontal displacement, the actual vertical force is the sum of vertical forces displayed by load cell 1 to load cell 3 as shown in

Figure 3 as $\sum_{n-1}^{3} V_n$, and the horizontal force T is the numerical value displayed by the upper shear box load cell installed on the reaction wall. Therefore, with a specific horizontal displacement, the induced angle of internal friction (ϕ_i) of test specimen can be calculated as:

$$\phi_i = \tan^{-1}\left(H \Big/ \sum_{n-1}^{3} V_n \right) \ldots\ldots \quad (6)$$

The special test procedure

Step 1: Carrying out the first pushing shear test with horizontal displacements from 0mm to 36mm (curve number 1).

Step 2: Carrying out the first pushing shear test with horizontal displacements from 36mm to -36mm (curve number 2)

Step 3: Carrying out the second pushing shear test with horizontal displacements from -36mm to 36mm (curve number 3).

Step 4: Carrying out the second pushing shear test with horizontal displacements from 36mm to -36mm (curve number 4)

Step 5: Carrying out the third pushing shear test with horizontal displacements from -36mm to 36mm (curve number 5).

Typical test results

When the large-scale direct shear test apparatus is used for the test, the typical test results of graded gravel are as shown in Figures 11~13; it is worth noting that, instead of being a constant value, the normal stress will vary along with the horizontal displacement; with minimized lift of upper box, this test result will become more and more reasonable and reliable.

Definitions of peak and residual angles of internal friction

1. The peak angle of internal friction ϕ_p:
   In curve number 1, the maximum value of ϕ_i is defined as the peak angle of internal friction ϕ_p.

2. The residual angle of internal friction from pushing shear test $\phi_{r,push}$:
   In curve number 3 and curve number 5, the minimum value of ϕ_i is defined as the residual angle of internal friction of pushing shear test $\phi_{r,push}$ with horizontal displacements greater than 32mm.

3. The residual angle of internal friction from pulling shear test $\phi_{r,pull}$:
   In curve number 2 and curve number 4, the minimum value of ϕ_i is defined as the residual angle of

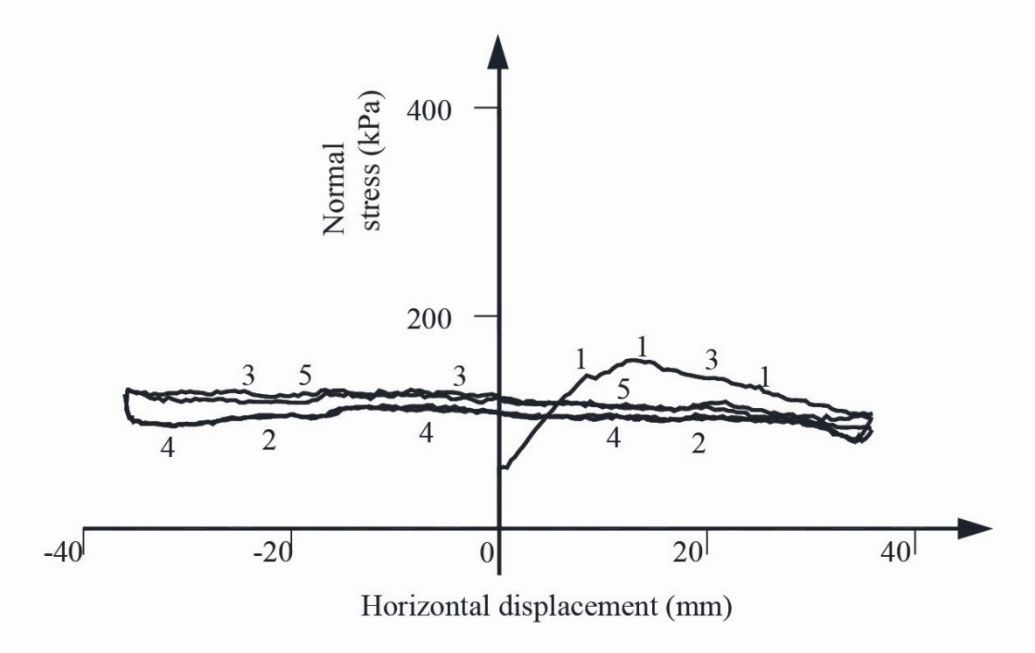


Figure 11. The variations in normal stress with horizontal displacements

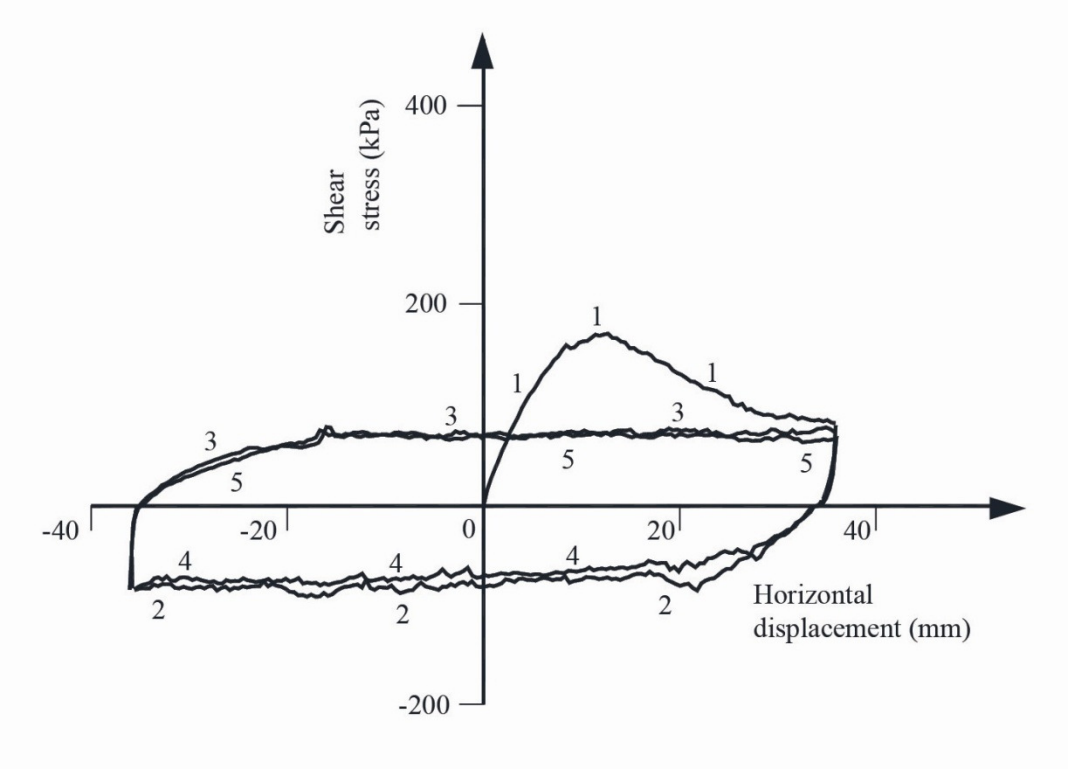


Figure 12. The variations in shear stress with horizontal displacements

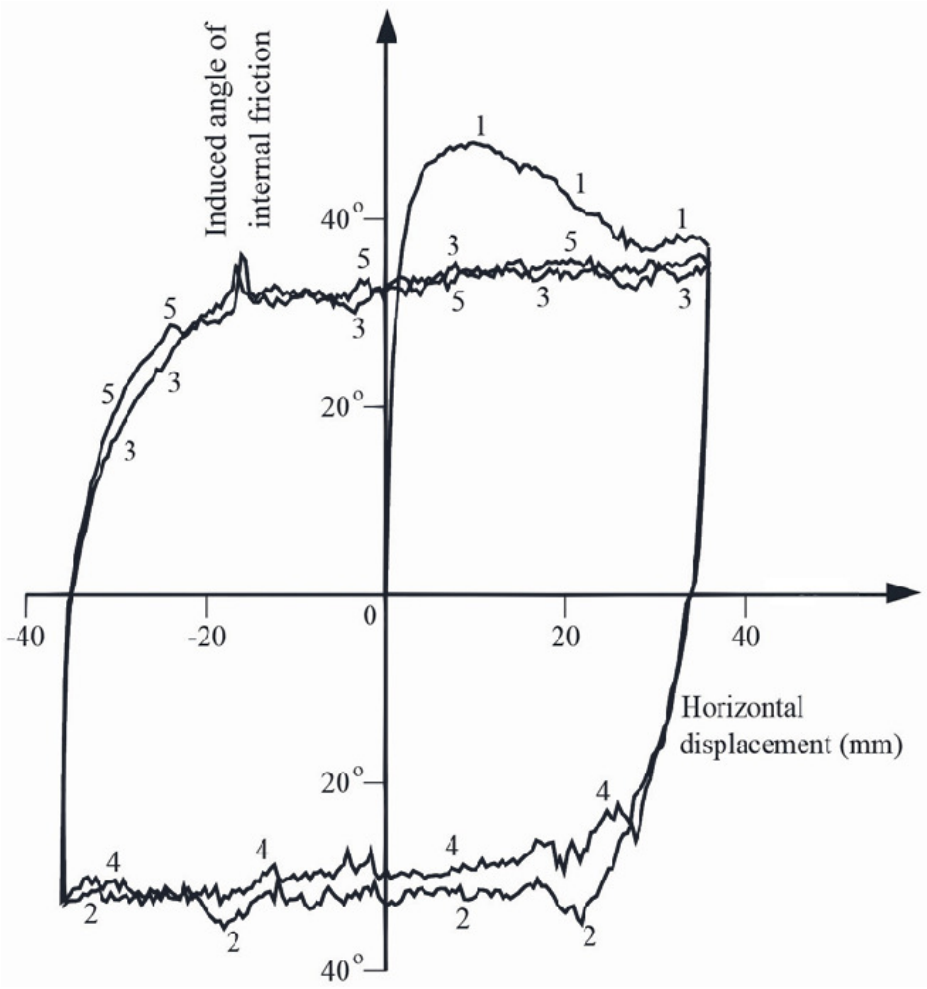


Figure 13. The variations in induced angle of internal friction with horizontal displacements

internal friction of pulling shear test $\phi_{r,pull}$ with horizontal displacements less than -32 mm.

4. The adopted residual angle of internal friction ϕ_r:

$$\phi_r = \text{Min}\,(\phi_{r,push}\,,\ \phi_{r,pull})$$

Selected graded gravel

The particle size distribution curves of three different graded gravels selected, S1, S2 and S3, are as shown in Figure 14. The physical properties and soil classifications of these three different graded gravels are as shown in Table 5. It appears that S1 is with the highest gravel content, and S3 is with the lowest gravel content; and S1 is with the lowest uniformity coefficient, and S3 is with the highest uniformity coefficient.

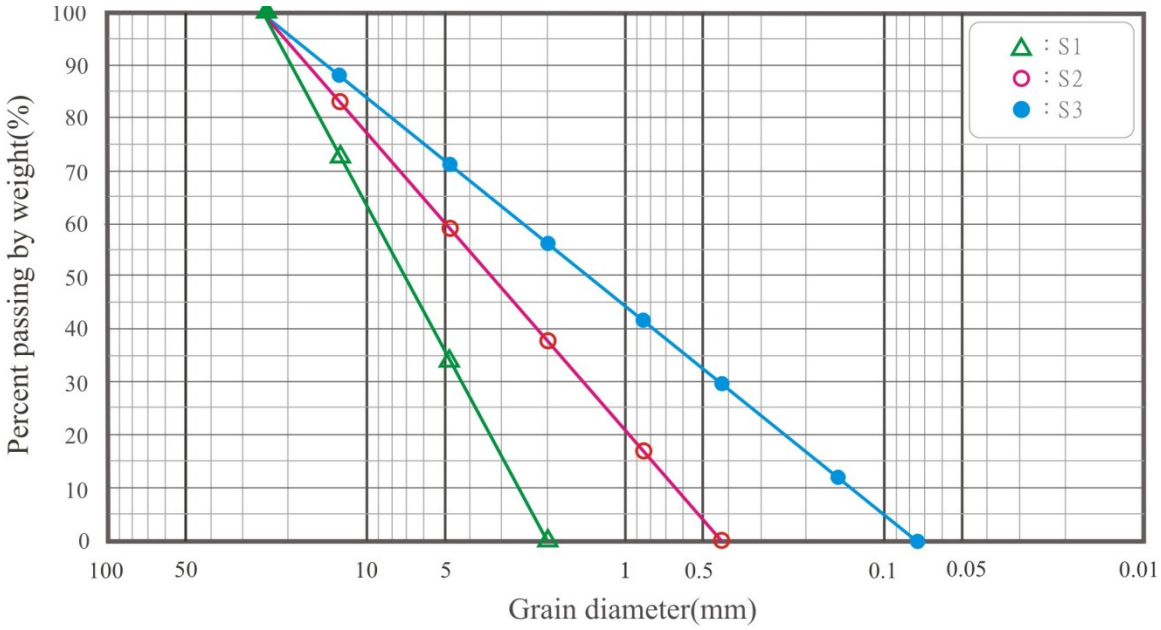


Figure 14. Particle size distribution curves of three different graded gravels

Table 5. Physical properties and soli classifications of three kinds of graded gravels

	Specimen S1	Specimen S2	Specimen S3
Dry unit weight, kN/m^3	17.65	17.75	18.33
Content of gravel (%)	65.96	40.99	28.78
Content of sand (%)	34.04	59.01	71.22
Coefficient of uniformity, C_u	3.56	7.73	18.9

Test result of large-scale direct shear test apparatus

The results of large-scale direct shear test of three different graded gravels are as shown in Table 6; where the peak angle of internal friction of S1, S2 and S3 are 48.1°, 42.7° and 38.8° respectively, while the residual angles of internal friction are 30.0°, 33.2° and 34.5° respectively.

Table 6. Peak and residual internal angles of friction obtained from tests

Specimen number	ϕ_p	$\phi_{r,push}$	$\phi_{r,pull}$	ϕ_r
S1	48.1°	33.4°	30.0°	30.0°
S2	42.7°	33.4°	33.2°	33.2°
S3	38.8°	34.5°	35.4°	34.5°

Suitability verification of three kinds of graded gravels

For the foundation at top wall affected by shear band, the residual angle of internal friction ϕ_r (as shown in Table 6) obtained from the test must be adopted for the foundation seismic bearing capacity analysis.

The safety factor of foundation seismic bearing capacity FS_E obtained from the analysis with the three kinds of selected graded gravel as the foundation soil are as shown in Table 7. It is shown in Table 7 that, except for the safety factor of seismic bearing capacity of S3 being $FS_E > 1.2$, the 之 FS_E of the other two kinds of graded gravel are both less than 1.2, thus proving that only S3 is the suitable foundation soil material.

Table 7. The analysis results of safety factors of seismic bearing capacity with graded gravel as the top wall foundation soil

Foundation soil	Residual angle of internal friction ϕ_r	$q_{ult,E}$ (kPa)	FS_E
S1	30.0°	214	0.71
S2	33.2°	333	1.1
S3	34.5°	415	1.4

Conclusions

Buildings in seismic zone countries will face the direct challenge of earthquake within their service lives. If the cause of building tilting failure obtained from investigation is not in compliance with the fact, these buildings will still suffer from tilting failure during subsequent earthquake even if the seismic resistance of upper structural elements is greatly improved. Therefore, the research results of this paper will support the following four conclusions:

1. Shear banding is resulted from localized deformation, and it will induce ground vibration; therefore, in addition to the effect of ground vibration on upper structural elements, the influence of shear banding on safety factor of seismic foundation bearing capacity should also be taken into consideration.

2. When the safety factor of seismic foundation bearing capacity is less than 1.0, the building will suffer from tilting failure no matter how high the seismic resistance of upper structural elements is. Therefore, the enhancement of seismic foundation bearing capacity must be the emphasis of building seismic design.

3. Using graded gravel as foundation soil can prevent shear banding during an earthquake from inducing foundation shear failure thus avoiding tilting failure of a building.

4. The large-scaled direct shear test apparatus proposed by the author and the special test method can be adopted to quickly obtain the shear strength parameters of graded gravel. Then the resulting safety factor of seismic foundation bearing capacity can be used to confirm the suitability of graded gravel as foundation soil.

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EXAMINING THE MEASUREMENT INVARIANCE ACROSS GENDER FOR THE PART OF RESPONSIVENESS IN *SERVQUAL* SCALE IN RETAIL BUSINESS OF TAIWAN

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Abstract

The purpose of this quantitative study was to examine the measurement invariance across gender for the part of Responsiveness in SERVQUAL Scale for retail chain stores business in Taiwan. The SERVQUAL Scale has been known a successful instrument for measuring service quality in current business studies. However, the issues of measurement invariance across groups in SERVQUA have received very few considerations. Literature also revealed there is the significant relationship between gender and service quality. The population in this research was selected as customers from four retail chain stores in Taiwan, resulting in 200 individual surveys for analysis. The results indicated the Taiwan version of Responsiveness 5-item scale achieved strict measurement invariance across gender. The property of factor loading, structural covariances and measurement residuals across gender were invariant. Fi-

nally, this research generated the recommendations for retail chain stores business in Taiwan and suggested future scholar studies.

Key Words: service quality, SERVQUAL, responsiveness, measurement invariance, retail chain stores, Taiwan

Introduction and Literature Review

Service quality has been described as the critical factor to sustain the proficiency for company development. The most prominent questionnaire for measuring service quality – SERVQUAL Scales was created by Parasuraman, Zeithaml, and Berry (1988). The SERVQUAL Scales provided five dimensions to measure the service quality, such as tangible, responsiveness, reliability, empathy, and assurance. Even though this questionnaire has applied broadly to perform studies for service quality in industries or countries, only some studies have examined the issues of the measurement invariance for SERVQUAL Scale. In addition, numerous researchers (Baird 1976, Blustain 2000, Canary and Hause 1993) have suggested theories for gender difference in numerous facets on psychology and manner, such as social talents, communications, work approaches and so on.

People also pay much attention on the issue of the increasing woman buying power for those years, and the studies for gender differences in consumer behavior have become important topic for current academy researcher and marketing administrators in business. Research by Meyers-Levy and Maheswarm (1991), and Mitchell and Walsh (2004) revealed gender difference will lead to different buyer behavior. Mitchell and Walsh (2004) also claimed gender differences resulted in different decision making process. These theories and studies suggested that there is the significant relationship between gender and service quality.

Therefore, this research expanded previous research and applied SEM approach to evaluate the measurement invariance across gender for the component of Responsiveness in SERVQUAL Scale in retail chain stores business of Taiwan.

Research Purposes and Hypotheses

Based on the previous studies and theories, the purposes and the significance for this research were: (a) to examine the measurement invariance

across gender for the part of Responsiveness in SERVQUAL Scale in retail chain stores business of Taiwan, (b) to have the recommendations for managerial application of retail chain stores business, and (c) to identify areas for future scholarly inquiry. Byrne (2010) suggested the tests for multigroup invariance are: (a) factor loadings, (b) factor covariances, and (c) structural regression paths. Following this concept, the researcher proposed three hypotheses as follows.

Hypothesis 1: Assuming the measurement weights for 5 items is variant across gender.

Hypothesis 2: Assuming the structural covariances for 5 items is variant across gender.

Hypothesis 3: Assuming the measurement residuals for 5 items is variant across gender.

Methodology

The five items of Responsiveness in this research were little modified from the SERVQUAL Scales (Parasuraman et al, 1988). Following Five Likert Scale: strongly disagree, disagree, neutral, agree, strongly agree, the five items were: (a). Service per- sonnel can correctly answer my question., (b). Service personnel provide me kind service., (c). Service personnel provide various service for different customers. (d). Service personnel is polite., and (e). Service personnel handle the problem in on time manner.

Previous studies by Hu (2011, 2012, and 2013) have demonstrated the validity and reliability for this scale are reasonable and acceptable. The customers from four retail chain stores in the Kaohsiung city of south Taiwan attended this research. The pretest was conducted with Item Analysis in 50 samples. The researcher applied the method of random sampling. Each store randomly invited volunteer customers who shopping in stores to participate the questionnaire survey. The total number of valid responses was 200 (not including 15 invalid response), providing an adjusted response rate of 93%.

Analysis of Results

The research unitized Structure Equating Modeling (SEM) by Analysis of Moment Structure (AMOS) software to test the model structure and hypotheses in this study. The factor analysis for five Responsiveness items was showed as Figure 1. The outcomes of multi-sample analysis for the unconstrained and the three constrained models were listed as Table 1. The unconstrained model showed an acceptable baseline model for both male and female. The

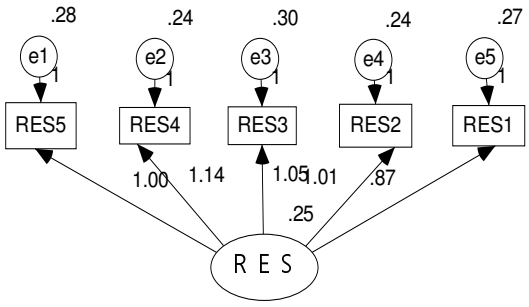

Figure 1. Factor Analysis for Responsiveness Items

Table 1. Model Fit Indexes for Models

Model	χ2	DF	P	x 2/DF	NFI	CFI	RMSEA
Unconstrained	31.247	10	.001	3.125	.913	.937	.104
Measurement weights	33.777	14	.002	2.413	.906	.941	.084
Structural covariances	33.803	15	.004	2.254	.905	.944	.080
Measurement residuals	37.517	20	.010	1.876	.895	.948	.067

Table 2. Nested Model Comparisons

Model	DF	x 2	P
Measurement weights	4	2.530	.639
Structural covariances	1	0.026	.872
Measurement residuals	5	3.715	.591

multi-sample analysis also showed the indexes of model fit for three constrained models (measure, weights, structural covariances, and measurement residuals) across gender, and these indexes indicated the three constrained models were accepted. The test results for nested model comparisons were showed in Table 2. The $\chi 2$ difference test ($\chi 2(4)= 2.530$, $p>.05$) between baseline model and constrained model for measurement weights was not significant, indicating the factor loadings across gender in this

scale were invariant. In addition, the result of the $\chi 2$ difference test between baseline model and constrained model for structural co-variances ($\chi 2(1)=.026$, $p>.05$) was not significant, indicating that, aside from the factor loadings, structural co-variances of this scale was invariant across the gender. Finally, the result of $\chi 2$ difference test for measurement residuals ($\chi 2(5)=3.715$, $p>.05$) was not significant, indicating the measurement residuals across gender in this scale were invariant, too. The findings did not support H1, H2 and H3.

Conclusions and Suggestions

The results indicated this Taiwan version of Responsiveness 5-item scales of SERVQUAL Questionnaire are strict measurement invariance across the gender, including invariance of factor loadings, structural co- variances and measurement residuals. The results did not consist with the views of Meyers-Levy and Maheswarm (1991), and Mitchell and Walsh (2004) suggested gender differences will lead to dissimilar buyer actions. Although this model was fully measurement invariance, Milfont and Fischer (2010) claimed full measurement invariance is questionable to hold in reality. Based on the research by Hu (2014), the part of Tangibles in SERVQUAL Questionnaire is partial measurement invariance across the gender. Those studies revealed the researcher should keep strict manner to conduct research for multiple items in questionnaire for the issues of measurement invariance across group. And this study suggested the effect of measurement invariance across genders is not significant when apply the part of Responsiveness in SERVQUAL Scale for conducting studies, specially exploring the service quality for the retail chain stores business in Taiwan.

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