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MODERN INDUSTRIAL PRODUCT DEVELOPMENT AND ORGANIZATIONAL IMPACT

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Abstract

The design of an industrial product is nowadays strictly integrated into the whole process of development and production of the item and there is no longer a sequential distinction between the different phases of concept, design and manufacture, as was common in the past.

This paper intends to describe the different phases and techniques of the process of development of an industrial product, highlighting the implications of this modern approach in the organization of a manufacturing enterprise, in particular in terms of the personnel involved. The target is to assess how coordinated activities, use of proper IT-enabled technology and good integration between the staff dedicated to the design, to the production and to other related actions needed to develop any industrial product, are fundamental for its success and for the competitiveness of the related manufacturing enterprise.

Key Words: Industrial Product, Design, Production, Organization, Integration.

Introduction	any object a synthesis of these two cultures is realized and its design in-
Introduction Design is both a scientific- nnical and a humanistic activity. In	volves, beyond all the functional con-
Design is both a scientific-	tent, all the aspects of communication
technical and a humanistic activity. In	and language. Reasonable doubt arises

concerning the fact that design can be realized through a method that faces different aspects in a systematic way by dividing a complex task into a series of simpler ones or, on the other hand, design can have a holistic value [Freddi, 2004].

"There are machines or mechanisms that function wonderfully well if they are carefully designed and constructed with high quality parts, assembled with care and subject to regular, effective maintenance. The relationship between a supplier of goods and services with its design consultants resembles the concept expressed above."

These are the words of one of the most famous contemporary car designers Giorgetto Giugaro, summarizing the principle that the success of any product mainly depends on the grade of integration between the design and the phases of production [Giugiaro G., Giugiaro F., Molineri G].

The main phases of the development of any industrial product are: concept, design (development and validation) and production. In the '50s, during the spread of mass production based on the Fordist model, these phases were considered sequential: once the concept of the product is finished, a detailed design follows to define the technical features and characteristics of the item. These technical requirements concerning structure, shape and materials as well as technologies and processes were transferred to production in order to manufacture the product. This traditional approach had huge limits: only when the first prototype of the product was made - already in an advanced phase of the development process - it was feasible to become aware of possible design errors. Therefore, to correct any problems it was necessary to redesign the product or some parts of it, which was often a significant waste of time and money. The communication and interaction between people working in the design office and in the production plant were limited and often ineffective: each team was working without any comparison or discussion and the effects of this lack of integration on the final cost of the product were extremely high.

Thus the conventional product development process employs a design-build-test philosophy.

The sequentially executed product development process often results in a prolonged lead-time and an elevated product cost [Chang, 2015].

New Organization and Personnel Patterns For An Effective And Efficient Design

To improve the effectiveness and efficiency of the design process, the sequential approach has evolved into a more integrated and simultaneous one, where the different phases are not separated any more and the first product concept can be modified and improved through briefings and feedbacks in every stage of the process.

To this aim, the organization of manufacturing companies has changed in particular in terms of employed technology and human-resource management.

IT-enabled technology, such as computer-aided design, engineering and manufacturing (CAD/CAE/CAM) tools as well as advanced prototyping technology to support product design from concept to detailed designs and ultimately manufacturing have been developed, and are presently used in most enterprises fabricating industrial products. The e-Design approach employs virtual prototyping (VP) technology to support a cross-functional team in analysing product performance, reliability, manufacturing costs early in the product development stage and in conducting quantitative tradeoffs for design decision-making. Physical prototypes of the product design are then produced using rapid prototyping (RP) techniques mainly for design verification. The e-Design approach holds potential for shortening the overall product development cycle, improving product quality, and reducing product cost [Chang, 2015].

Concerning human resources, a closer collaboration and integration between employees and computeraided systems at different offices and departments is fundamental to the new approach. In particular designers, production technicians and planners must work together to guarantee the success of the product, achieving a correct balance between the product quality, its performance and the cost. The design can be developed inside the company or subcontracted to an external studio, in both cases the communication and sharing of the involved personnel is strategic to the final aim of producing a commodity that is convenient and works efficiently.

The figure of the designer has also evolved over the last few decades. Not long ago designers were eclectic generalists. They studied art, science, and religion in order to understand the basic workings of nature, and then applied what they learned to solve the problems of the day. Over time, the quantity and complexity of accumulated knowledge led to increased specialization among designers [Lidwell W., Holden K., Butler J, 2003], but still a good general culture is fundamental in particular to get new ideas from art, nature, cinema and to increase the ability of proposing beautiful and innovative products. A requirement to fabricate with success is the domain of several points of view and experiences, which in part are outside the out-andout construction activity: "Who wants to build, must first look and think!" [Niemann, Winter, Höhn, 2005].

Today, design is a recognized field of cultural history. Knowledge of the classics of modern design, meanwhile has almost become common cultural property, like art and design objects are similar presented [Hauffe, 1998]. Designers need first of all to get a deep knowledge of what has already been produced by their colleagues, before starting a new project.

The Development of the Industrial Product

The following key points in the development of an industrial product (Figure 1) can be considered:

- 1. First Briefing
- 2. Style concept
- 3. Concept tuning
- 4. Virtual reality
- 5. Style feasibility study

- 6. Mock up
- 7. Reverse Engineering
- 8. Technical feasibility study
- 9. CAD Drawings
- 10. Prototyping
- 11. Communication
- 12. Promotion



Figure 1. Key points in the development of an industrial product.

1. First Briefing

The first step to start a new project is to make an in-depth analysis concerning the product the company wants to develop and the target market. It is fundamental to the designers to deeply understand the motivations, the habits and the social and psychological behaviour of the consumers who will use the product. In the two cases: an external design studio acting as a consultant or a design office internal to the enterprise, it is essential that the designers understand the company, its history, mission and corporate culture.

An analysis of substitute products and competitors to well define the company position in the market and to be able to plan some real innovation, if required, is preliminary to the whole product development process. Where does the company want to position itself? Which are the customers who will use the product? Why will they choose it instead of another similar one?

The staff involved in this first briefing phase does not only include designers, but also marketing and sale operators, production planners and technology experts. It is crucial that all these people actively participate in order to collect ideas and be able to start the definition of the product in the most effective way. From the organizational point of view, this means the implementation of good communication and the planning of meetings involving different company areas.

2. Style concept

The briefing suggests some hints to give shape to ideas that can be materialized in the concept. Designers generate the first sketches and outline drawings and the use of paper and pencil (Figure 2) is supported by computer technology for a two or threedimensional visualization of the object. By using these tools it is possible to produce various models that allow a first assessment of the aesthetic and functional impact of the design. Some alternatives (generally three or four) are then submitted to the attention of product decision makers who will select the final one.

In this phase the owner and the Board of Directors of the company have the last word concerning the idea to be developed. It is a crucial moment to which of course also the designers can contribute to the decision with advice and suggestions.

3. Concept tuning

The proposal selected amongst the different alternatives is further finetuned and perfected to the definitive version that will be realized. In this phase the styling is refined and colour rendering and 2D and 3D illustrations are modified and improved according to the target of the project. It is the moment in which innovation can be introduced to differentiate the product from the previous aesthetic standard.

The engineering and modelling staff also take part in this stage to guarantee the industrial feasibility of the product, in terms of materials, technologies and production costs. This integration of the divisions is a focal point: the product should be ready for industrialization directly at the end of the first study phase to avoid radical modifications during the industrialization phase, reducing costs and production times and pursuing "time to market" objectives.

4. Virtual reality

This relatively new technique allows to virtually view and implement a styling concept in order to understand how the product appears. A full-scale model can be obtained allowing styling research in a short time, achieving reliable results in just a few weeks. Most advanced companies and design studios are provided with specific equipment to virtually represent the product. From this 3D model the engineering phase in terms of technical feasibility



Figure 2. Style concept: sketches from "Transportable Bicycle" project work by K. Chang, Y. Kojima, N. Nishimura, S. Peng, Z. Sun, Italian Design Summer School, University of Bologna, 2012.

studies and construction of functioning prototypes can start.

Designers, engineers and company directors are generally involved in this virtual reality representation of the product as it is the first effective way to understand how the product will look and any consideration of changes can still be made without strongly affecting the final cost and time of production.

5. Style feasibility study

The style feasibility study on the definite design solution selected is

necessary before the construction of a full or reduced-scale model. The consistency of the model with ergonomics and the check of legal aspects related to the product to ensure the respect of international regulations are also objectives of this phase. The design feasibility study is fundamental to check various aspects such as: assembly of various components, versatility of internal layout, analysis of the composition and manufacturability of the parts.

The engineering division, working in close cooperation with the designers, indicates and agrees on any stylistic changes to be made to the model in the processing phase so that the result complies with the original design and product.

6. Mock up

Despite the fact that rendering techniques are extremely helpful in visualizing the product and improving the project, still in some cases the possibility to construct a real-dimensions model can make the difference in allowing effective aesthetics checks on the selected concept solution. The aim is to verify the aesthetics of the model designed in the initial Style Concept phase, to implement possible improvements on the virtual model that can be "re-plotted" through mathematical values via reverse engineering or directly on the finished product.



Figure 3. A clay-modelled mock up: study for a perfume bottle by S. Ishikawa, Italian Design Summer School, University of Bologna, 2014.

Expert craftsmen, using NC milling machines and manual techniques (Figure 3), are able to forge different types of materials (wood, resin, plastic, etc.) to obtain a perfect mock-up of the real model. Not always will these skills exist within the company, in most cases it is necessary to sub-contract them.

7. Reverse Engineering

This is a structural method used in industrial processes, able to analyse features and details of industrial products and to generate information and parameters useful to re-engineer the entire project. The selected concept model is scanned through optical or laser technologies from which, after suitable smoothing processes, the 3D virtual model can be further modified and improved.

Through these technology artisan skills are integrated in quality design. Experts in using reverse engineering techniques and related instruments are usual members of any design office or studio and are essential in the movement towards the final definition of the product.

8. Technical Feasibility Study

Costs, materials and technologies are fundamental to define the feasibility of a successful concept.

Evaluations concerning these aspects with an analysis of investment costs and of the unitary costs of the individual parts at the end of the production cycle are carried out in this phase. At the end of these studies an effective industrialization study of the product can be developed in terms of the definition of materials and production technology, the dimensional parameters, the kind of installation of the components, the assembly procedures and of the cycle of the parts developed. A technical bill of materials is finally prepared.

Die-makers and suppliers are involved in this phase, design review sessions are scheduled in order to share and approve the solutions proposed.

9. CAD Drawings

The 3D and 2D drawings complete the technical engineering and feasibility process of the concept model and are fundamental in the prototyping phase and then in manufacturing the finished product (Figure 4). The drawings report the main dimensions and permitted tolerances in the entire project.

These files are shared with diemakers and die-designers who supply the components.

10. Prototyping

The prototype can be defined as the original matrix from which the series product is manufactured. It represents the synthesis of the designer activity. At this point the initial decision regarding the style concept is definitive and the prototype anticipates the production of an infinitive quantity of equal standard products. The final assessment of the product is possible through this full-scale functioning example. The prototypes are of huge value in this stage, prior to the construction of expensive series of production tools. The focus then shifts from the design of each component to the construction of the dies and the instruments necessary to create the prototypes. Finally, the prototype is tested with a real simulation.

A co-design approach is desired. Product designers, die-makers and production engineers jointly work to achieve the best result in a short time.



Figure 4. A CAD Drawing: "Parking Barrier" project work by Y. Izumi, L. Pu, P. Lin, W. Di, Y. Zhao, Italian Design Summer School, University of Bologna, 2013.

11. Communication

Products are recognizable according to graphic design or packaging, the value of both is important to the product's success. According to the marketing mix and to the graphic and coordinative image of the company, a set of material proposals coherent with the corporate image and with the distinctive features of the product can be released, adding to the product the so called "intangible value". Inner employees of the company or external consultants can take care of these aspects, sharing the designer's vision and considering the constructional characteristics attributed to the product from the production engineers.

12. Promotion

The product launch and presentation to the market is a crucial moment of the whole development process. This is an important phase to reach success in sales. Different communications activities are planned: press releases, brochures, videos, interviews and participation in trade fairs. The choice depends on the kind of commodity and on the target market in which to effectively promote the product.

Possible expert consultants in communication and promotion can be involved working together with the marketing and sales offices of the company.

Conclusion

The traditional sequentially executed product development process has been outdone and the present most used and successful approach is the one that integrates phases and functions.

An e-Design paradigm can be defined in terms of IT-enabledtechnology supporting the operators working for the product design and fabrication, who must closing collaborate towards the common aim. Then, beyond the use of new technology tools, human resources must be managed in an innovative way, which implies a constant comparison between alternatives and an ongoing discussion on decisions regarding the product.

Twelve steps can be identified in the development process of an industrial product. Each one is strictly connected to the others and involves staff who also participate in the other phases of the process. The company personnel dedicated to the development of products together with suppliers and consultants must be constantly aware of the final target and of all the activities involved to reach it. This collaborative awareness is essential in order to create good teamwork, to share ideas and information, so reducing costs, time to market and therefore increasing the competitive advantage of the enterprise.

Further research is needed to better define new organizational patterns that can improve the efficiency and the effectiveness of manufacturing companies, better integrating human resources planning and the use of advanced technology to develop industrial products.

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INNOVATION: THE INFLUENCE OF DIVERSITY AND *IT* COMPETENCE OF BOARDS OF DIRECTORS AND EXECUTIVE MANAGEMENT

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Abstract

Prior studies show that innovation and information technology (IT) affect firm growth; IT is a key driver of innovation; boards of directors as well as executive management can lead innovation strategies; diversity of knowledge and expertise influence innovation; and IT/business knowledge sharing is an asset. To our knowledge, however, no research has looked at diversity and IT competence together as potential determinants of innovation or board members and executive managers together as leaders of innovation. Using information in public filings, this research examines the influence of diversity and IT competence of boards of directors and executive management on innovation. Results suggest that executive IT competence and diversity of industry background influence product and process innovation respectively, while diversity in board tenure and firm size affect both types of innovation.

Key Words: Board of Directors, Executive Management, Diversity, IT Competence, Innovation.

Introduction

The Organization for Economic Development and Co-operation (OECD) periodically examines growth performance in OECD European, North American and Asian countries (e.g., OECD, 2003a, 2003b, 2004, 2013). These efforts have identified innovation and the use of information and communication technologies (ICT, hereinafter IT) in the production process as major drivers of productivity growth (Pilat, 2005). Nicholson (2009) concluded that innovation, directly or indirectly, is the primary driver of productivity growth, while Rao et al. (2008) indicated that IT investments contribute significantly to labour productivity in some OECD countries. For instance, the IT production and use has strengthened U.S. productivity growth since the mid-90s (Nicholson, 2009).

Similarly, innovation and IT also contribute to growth at the firm level. To survive in a global market, all industries are increasingly emphasizing innovation (Santamaria et al., 2009) and innovation is essential to organizations seeking to gain a strategic advantage (Gonzales and Chacon, 2014). IT is becoming more central to business performance (Wilkin and Chenhall, 2010) and is a key driver of technological innovation and organizational change (Liang et al., 2010). It can contribute to innovation by helping organizations increase coordination and collaboration (Dewett and Jones, 2001), reduce capital and labour inefficiencies, increase market share, broaden product ranges, customize services and react better to

client demands (Pilat, 2005). For instance, IT has transformed marketing methods in the fashion industry (Gonzalez and Chacon, 2014).

Boards of directors¹ and executive management² can have an impact on innovation strategies (CCA, 2009). In fact, "Boards of directors can significantly influence the degree to which a corporation pursues innovation by fostering a context that facilitates and supports executives' pursuit of innovation" (Zona et al., 2013, p. 302). Moreover, given that executive management decides on the allocation of resources across innovation projects (Talke et al., 2011), their support contributes to effective new product development (McDonough, 2000; Chen et al., 2010) and is key to successful innovation (CE-FRIO, 2011). Chief Executive Officers (CEOs) surveyed around the world are "taking personal responsibility for directing and inspiring innovation as it becomes an even more vital element of business survival and success" (PwC, 2013, p. 3). In light of the fact that the promotion of an innovation culture sig-

¹ Boards of directors contribute to strategic decision making, as they monitor, advise and counsel management (Amar et al., 2013).

² Prior studies refer to the group of individuals involved in strategic decision making at the upper echelons / highest level of an organization as the "top management team" (Bantel and Jackson, 1989; Hambrick and Mason, 1984; Simons et al., 1999; MacCurtain et al., 2010; Talke et al., 2010; Boerner et al., 2011; Wu, 2011), the "senior leadership" (Armstrong and Sambamurthy, 1999) or the "executive management team" (^{Turel} and Bart, ²⁰¹⁴⁾. In this study, we use the expression "executive management" when we refer to the group of individuals that includes the CEO, the CIO, and other senior executives.

nificantly influences innovation (Gunday et al., 2011; CEFRIO, 2012), tools have been suggested to help senior executives assess the prominence of innovation in their corporate culture (Rao and Weintraub, 2013). A culture that fosters and supports innovation, coupled with strong, visionary business leadership, is one of the most significant ingredients for successful innovation in firms (PwC, 2013). Hence, leadership has a major impact on innovation, and leaders of innovation must have the knowledge and expertise to define a vision and provide creative people with direction, support and feedback (Byrne et al., 2009). Senior executives who pool and share knowledge generally influence innovation (MacCurtain et al., 2010). Innovation strategy is fostered by board of director diversity in areas such as education/knowledge and experience (Zahra and Pierce, 1989). Further, R&D investment intensity (which can be used as a proxy for innovation) is influenced by the interaction between outsider-rich boards of directors and executive management characteristics (Kor, 2006).

Additionally, IT competence in boards of directors and executive management is an asset for leading innovation strategies. For example, in an e-government innovation environment that enables governments to provide information and services to citizens through websites, leaders typically provide direction, encourage knowledge sharing and rally resources (Prybutok et al., 2008). Further, increased emphasis on IT innovation through shared IT business understanding is fundamental to IT-based value and competitive advantage (Ray et al., 2007). Chief Information Officers (CIOs) have become executive-level IT innovation leaders (Chun and Mooney, 2009) who can contribute to a firm's competitive advantage (Lim et al., 2012). Given that leadership on the part of IT and non-IT executives such as CEOs, Chief Operating Officers (COOs), Chief Financial Officers (CFOs) and board members is a condition for identifying strategic opportunities, officers should be able to understand the "IT technical details for a given business issue" (Subirana, 2004, p. 19). CIO and CEO mutual understanding of the role of IT leads to the strategic alignment of IT with business and thereby enhances IT's contribution to business performance (Johnson and Lederer, 2010).

Based on the foregoing, it can be concluded that innovation and IT affect firm growth; IT is a key driver of innovation; boards of directors and executive management can lead innovation strategies; diversity of knowledge and expertise influences innovation; and IT/business knowledge sharing is an asset. Although diversity and IT competence of boards of directors and executive management appear to collectively favour innovation, to our knowledge no study has so far considered diversity and IT competence together as potential determinants of innovation, or looked at boards and executive management together as leaders of innovation.

Indeed, the relationship between executive management diversity and firm performance has been widely discussed in the strategy literature, but these studies have had mixed results (Certo et al., 2006; Diaz-Fernandez et al., 2014). There are comparatively few studies on the influence of executive management diversity on innovation (e.g., Talke et al., 2011; Mihalache et al., 2012; Qian et al., 2013), and empirical evidence is not altogether consistent (Qian et al., 2013). Moreover, we know little about the impact of board diversity (e.g., Wu, 2008) or the influence of board and executive management characteristics together (e.g., Kor, 2006) on innovation. Further, so far, there is no study on the relationship between board and executive management IT competence and innovation. With this in mind, we examined the association between board and executive management diversity and IT competence, and innovation.

Results show that executive IT competence and diversity of industry background are associated with product and process innovation respectively, while diversity in board tenure and firm size are related to both types of innovation. Differences among industries are also apparent, particularly as regards management innovation.

Our contribution is threefold. First, given that boards of directors and executive management collectively influence the pursuit of innovation strategies, we are the first to document whether a mix of specific characteristics in both groups affects innovation in organizations. Second, by examining the influence of IT competence, a factor that appears critical to innovation, we complement the governance, innovation and IT literature. Lastly, the significant determinants identified and empirical insights gained are useful in guiding further research on understanding the factors that enhance innovation in organizations.

Background and Hypotheses

The literature discussed above indicates that boards of directors and executive management collectively contribute to innovation. In this section, we develop a framework based on insights from innovation, governance and IT studies and conduct our investigation from a resource-based perspective. As shown in Figure 1, diversity and board of directors and executive management IT competence are expected to be associated with innovation.

Innovation refers to "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD/European Communities, 2005, p. 46).

In regard to the board of directors' strategic role (see the following section on the influence of diversity and IT competence), 'diversity' refers to i) *demographic diversity* (gender, cultures, and tenure, as in Ben-Amar et al., 2013); ii) *diversity in boards* (gender, age, ethnicity, experience, and tenure, as in Hafsi and Turgut, 2013); or iii) *board diversity* (one single factor loading functional backgrounds, industry backgrounds, education, age, as well as personality



Figure 1. The Conceptual Model

and values, as in Zona et al., 2013).

Executive management diversity refers to the range of executives' knowledge, skills and abilities (Oian et al., 2013). It is a multidimensional concept that encompasses, for example, educational background, organizational tenure and age (Wu et al., 2011). Some dimensions of diversity such as age or gender are less relevant to strategic decision making than experience and tenure (Simons et al., 1999). Some studies adopted a broad definition of diversity, considering it to be one single construct comprised of many dimensions (e.g., Talke et al., 2010: Bear et al., 2010: Zona et al., 2013). Other authors conversely examined these dimensions as separate constructs (e.g., Bantel and Jackson, 1989; MacCurtain et al., 2010; Wu et al., 2011). Given the relevance of experience and tenure to strategic decision (Simons et al., 1999), we considered board of directors and executive management diversity in terms of three separate dimensions of heterogeneity: functional background, industry background and tenure.

Functional background is described as all the categories in which a board member or an executive has functional experience (e.g., finance/accounting, production/operations, research/ development, information systems/IT). Industry background reflects all the categories in which they have industry experience (e.g., financial services/insurance, manufacturing, telecommunications/ IT/ media). Executive management *tenure* is defined as the number of years each executive has been assigned to the executive team, while board of director tenure refers to the number of years each board member has been assigned to the board.

Competence derives from knowledge and experience. *IT competence* consists of managerial or technical IT skills (Mata et al., 1995) and IT experience (Basselier et al., 2003). Managerial IT skills are a source of competitive advantage (Dehning and Stratopoulos, 2003). They include the ability to conceive, develop, and harness IT applications to support and enhance other business functions, while technical IT skills refers to the know-how needed to build IT applications from the available technology and using these applications to make products or provide services (Mata

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et al., 1995). The development of managerial or technical IT skills can benefit from hands-on IT experience such as working on and managing IT projects (Basselier et al., 2003).

Influence of Diversity and IT Competence on Innovation

Board of Directors

From a resource-based perspective, boards of directors "help the firm interface with its general and competitive environments" (Zahra and Pierce, 1989, p. 297). Boards are viewed as providers of key resources with collective experience and expertise (Bear et al., 2010) that contributes to strategic decision making and the ability to counsel management (Ben-Amar et al., 2013) with their own analyses or suggestions (Zahra and Pierce, 1989).

The board's ability to carry out its strategic role requires rich knowledge and experience to ensure that management is proactive in finding appropriate alternatives and being creative when opportunities emerge (Shimizu and Hitt, 2004). Functional diversity in the board is an asset in this regard and can help provide such skills (Bear et al., 2010). In other words, the advisory/strategic role of board members requires diversity (e.g., experiences) (Ben-Amar et al., 2013) and specific skills and abilities (Zahra and Pierce (1989). According to Wu (2008), the collective competence (knowledge, experience, and commitment) of board members is positively associated with product innovation. When board members have more industry-wide and

company-specific knowledge and experience and invest additional time and energy in their role, innovation in the form of new product introduction rises (Wu, 2008).

Board of director IT competence has a positive influence on the board's level of involvement in IT strategic decision making and oversight (Jewer and McKay, 2012). Conversely, lack of IT knowledge on the part of board members can limit their assessment of IT-based strategy (Huff et al., 2006; Bart and Turel, 2010). Given that board IT competence has an impact on IT-based strategy and considering the increasing and crucial importance of IT to innovation and growth (Pilat, 2005; Gonzalez and Chacon, 2014), board IT competence is expected to be related to innovation.

This discussion leads to the following hypotheses:

H1a: Innovation is positively associated with board of director diversity.

H1b: Innovation is positively associated with board of director IT competence.

Executive Management

From a resource-based perspective, executive management provide valuable resources for innovation (Yap et al., 2005; Boerner et al., 2011), as boards of directors do. Executive management diversity has often been considered a key driver of innovation (Qian et al., 2013). Indeed, diversity increases executive management ability to handle strategic

change (Hambrick and Mason, 1984), has a significant positive impact on organizations' strategic choice to emphasize innovation (Talke et al., 2010), and increases a firm's strategic innovation orientation (market orientation and technology orientation) (Talke et al., 2011). More specifically, diversity in functional backgrounds can help executive management generate alternative solutions and innovation (Bantel and Jackson, 1989). Wider differences in educational, functional, industry, and organizational background as well as in executive tenure lead to greater focus on innovation fields³ (Talke et al., 2010). In addition, the knowledge ossification effect (Berman et al., 2002; Tsun-Huang et al., 2005; Yin and Bao, 2006) can be moderated "by combining the experience and knowledge of the company that long tenured top management team members have with new knowledge and fresh insights lesser tenured individuals may bring to the organization, [as] new knowledge may emerge" (MacCurtain et al., 2010, p. 224).

Enhanced IT competence on the part of business managers leads to stronger IT leadership from business people (Basselier et al., 2003). IT skills are correlated to a commitment to technological innovation (Hulland et al., 2007), whereas lack of formal IT training results in lower comprehension of IT application possibilities (CCA, 2009). Therefore, executives with considerable IT knowledge/skills and experience can be reasonably expected to display greater competence in leading the IT strategy by articulating and communicating their vision about the role of IT in innovation strategies.

The following hypotheses derive from the above discussion:

H2a: Innovation is positively associated with executive management diversity.

H2b: Innovation is positively associated with executive management IT competence.

In summary, from a resource-based perspective, boards of directors and executive management with different and complementary functional and industry backgrounds are more likely to lead an organization to innovate, as are those with various years of experience among members. When board and executive management have IT competence, the firm is more likely to use IT in its innovation endeavours.

Methodology

Sample

The entire roster of firms found in the S&P/TSX composite index on February 26, 2012, was selected on account of the large size of these organizations and the fact that they represented about 95% of the market capitalization of all Canadian-based companies listed on the Toronto Stock Exchange. Of the 253 sample firms, foreign-based firms, development-stage companies, subsidiaries of a parent company already in the sample, and firms with missing data were

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³ Innovation fields consist of multiple innovation projects that relate to a common theme (Talke et al., 2010).

removed, resulting in a final sample of 163 firms.

Approach and Data Source

Archival data collection was performed using information available from databases or other sources, including annual reports, proxy statements, and annual information forms obtained from the SEDAR database.⁴ Firm websites provided complementary information when needed.

In light of the conceptual framework, two data collection tables were developed and tested respectively for innovation and board/executive characteristics. One of the researchers developed an initial version of the tables, which a research assistant tested on about 30 sample firms. After discussions with the research assistant, both researchers refined the tables and agreed on a set of written instructions for two research assistants in charge of collecting data (one for each table). Data on the firms' 2011 fiscal year were collected in the summer and fall of 2012. The researchers subsequently performed reliability checks on the data for each of the main constructs and computed the diversity and IT competence measures as detailed below

Measurements

Innovation

Prior literature often used R&D expenses as a proxy for innovation (Hyland

et al., 2006; Zona et al., 2013). In this study, we used three measures of innovation, product, process, and management. Eight items were used to measure product innovation; five to measure process innovation; and four to measure management innovation (items and their source are presented in the appendix). Depending on the type of item, some were coded according to the number of corresponding innovations described in the annual report or the annual information form, or else were given the value of 0. Other items were coded 1 if present, 0 otherwise.⁵ Formative composite indexes were computed for product innovation (sum of eight items), process innovation (sum of five items), and management innovation (sum of four items). Higher scores indicate a higher level of innovation. The inter-item correlation Cronbach alpha for the indexes was 0.15 for product innovation, 0.01 for process innovation and 0.06 for management innovation. These inter-item correlations are low, which is appropriate for formative indexes in which items make distinct and cumulative contributions to the variable (Diamantopoulos and Winklhofer, 2001).

Diversity and IT competence

To measure *diversity*, we first collected data on the functional and industry backgrounds of board members and executives and used the annual information form or proxy statement to find out the number of years each individual had been appointed to the board or the

⁴ All firms listed on the TSX file the documents required by regulation at http://www.sedar.com/.

⁵ The measure obtained for each item is conservative since most organizations describe their innovations in qualitative rather than quantitative terms.

executive team. In light of Talke et al. (2010), Wu et al. (2011), and Boerner et al. (2011), we computed executive management heterogeneity in terms of functional and industry backgrounds, based on Blau's (1977) formula.⁶ We subsequently measured executive management heterogeneity in terms of tenure, based on Allison's (1978)⁷ coefficient of variation (standard deviation/mean). The same operations were performed to calculate diversity across boards of directors. Functional background categories consisted of finance/accounting, marketing, human resources, production/operations, research/ development, information systems/IT, legal/general counsel, management, politics, communications/ investor relations, strategy/ development, and others. Industry background categories were financial services/ insurance, manufacturing, mining, oil & gas, retail/wholesale, telecommunications/ IT/media, services, and utilities. Higher scores in terms of functional and industry backgrounds and tenure were considered to indicate greater diversity in the board or executive management.

To measure IT competence across boards of directors, we first used a dichotomous variable for each board member (1 if the board member had managerial or technical IT skills or IT experience; 0 otherwise). We then computed an IT competence score totalling the number of board members with IT competence, divided by the total number of board members. This gave us the proportion of board members with IT competence within a firm. We applied the same steps to measure IT competence across executive management. Higher scores indicate a greater proportion of individuals with IT competence on the board of directors or in executive management.

Control Variables

Some studies demonstrated that firm size, either directly or indirectly, can significantly influence innovation (Acs and Audretsch, 1988; Askarany and Smith, 2008; CEFRIO, 2012; Damanpour, 2010; Lee and Sung, 2005; Van Dijk et al., 1997; Yap et al., 2005; Zona et al., 2013). Indeed, larger firms have sufficient resources to cope with the risks of failure and the cost of innovation (Damanpour, 2010). Small firms (with fewer than 100 employees), conversely, are less likely than mediumlarge firms to produce any form of innovation (CEFRIO, 2012). While it has been claimed that size moderates the impact of intrapersonal functional diversity on innovation in SMEs (Yap et al., 2005), other studies demonstrated that size has no effect (Audretsch and Acs. 1991; Mueller et al., 2009). Nevertheless, going back to the idea that size can

⁶ Blau's formula is the most commonly used measure of diversity-as-variety (Harrison and Klein, 2007, in Bear et al., 2010). Blau's (1977, p. 9) formula is $1 - [\sum x_i^2/(\sum x_i)^2]$, where x_i is the number of persons in each group, and the sum is taken over all groups. For functional backgrounds, a group corresponds to a function, For example an operations manager. For industry backgrounds, a group corresponds to an industry, for example manufacturing. The closer the result of the calculation is to 1, the greater the heterogeneity.

⁷ Since the coefficient of variation is a scale invariant measure, it is more appropriate than standard deviation or variance for interval scaled variables (Allison, 1978, in Boerner et al., 2011, p. 335).

affect innovation, we controlled for its influence, measuring *firm size* through the natural logarithm of total assets, a method that alleviates the problems caused by nonnormal distribution (Hair et al., 1998).

As innovation may differ by industry (Acs and Audretsch, 1988; Audretsch and Acs, 1991; Eirez et al., 2013; Jimenez-Zarco et al., 2012), we controlled for industry by using three dummy variables for firms belonging to the following groups: oil & gas and mining industries, financial services/ insurance and telecommunications/ IT/media, and retail/wholesale, services and utilities. The manufacturing sector is the comparative basis as it is absent from the regression.

Data Analysis

Given that the dependent variables (product, process, and management innovation) exhibited considerable skewness and kurtosis, we used the natural logarithm of the measures (Hair et al., 1998). As values of the dependent variables are contained in a limited range, we used right- and left-censored Tobit regression analyses to assess the relationship between board of directors and executive management characteristics and innovation. All the variance inflation factors were below 1.84 for continuous variables and below 3.73 for dummy industry variables (not tabulated). For condition indexes above 15, the regression coefficient decomposition matrix shows that no condition indexes account for variance proportions above 90 percent for two or more coefficients. According to Hair et al. (1998), this indicates that multicollinearity is not a problem.

Results

Descriptive Data

Table 1 presents descriptive data on the sample firms. Product innovation accounts for the highest proportion of innovations (mean = 4.01), followed by process innovation (mean = 2.11). However, process innovation displays great variability (std dev. = 11.00) and has a median of only 1. Management innovation is the smallest innovation category. A number of firms have zero innovation (n = 12, not tabulated). Boards of directors and executive management are quite heterogeneous in terms of functional background (mean = 0.720 and 0.784respectively), but boards are more heterogeneous than the latter in terms of industry background (mean = 0.687 and 0.466 respectively). Tenure is similar for boards and executive management with mean dispersions of 0.634 and 0.682 respectively. IT competence is low for boards and executive management (5.4% and 6.9% respectively). Table 2 presents the correlation matrix.

Tests of Hypotheses

As shown in Table 3, the separate regressions of the control variables and each independent variable related to board and executive management diversity and IT competence on product innovation (Model 2 to Model 9) indicates that diversity in executive industry background and executive IT competence, as well as firm size, favour

Panel A: Firm si	ze and	performance,	, and board a	and executi	ve size						
Variables	Ν	Mean	Median	Std De	ev. M	in.	Max.				
Firm size											
Revenues ^a	163	5,241,226	1,387,293	9,103	,349 ()	49,679,000				
Assets ^a	163	34,845,440	3,084,982	111,999	,472 238,	,998 ′	751,702,000				
Market value ^a	163	7,758,034	2,766,304	12,387	,743 391,	,111	69,940,940				
Performance											
Net income ^a	163	529,075	148,445	1,050	,873 -562	,808	5,889,000				
Board size	163	9.79	9.00	2.92	. 4	1	19				
Executive size	163	8.38	8.00	3.77	2	2	26				
Panel B: Organi	zation	main industry	v (n = 163)								
Industry			Ν	Industry			N				
Financial Service	s/Insura	ance	25	Retail/W	holesale		7				
Manufacturing			14	Services			22				
Mining			28	Telecommunications/Media/IT 11							
Oil & Gas			48	Utilities							
Panel C: Depend	lent an	d independen	t variables (1	n = 163)							
Variables			Mean	Median	Std Dev.	Min.	Max.				
Dependent variał	oles										
Product innovat	tion		4.01	2	6.74	0	70				
Process innovat	ion		2.11	1 11.00		0	140				
Management in	novatio	on	0.31	0	0.62	0	3				
Independent varie	ables										
Board functiona	al back	ground ^b	0.720	0.746	0.098	0.235	0.844				
Board industry	backgr	ound ^b	0.687	0.724	0.141	0.219	0.901				
Board tenure ^c			0.634	0.650	0.258	0.000	1.339				
Board IT compo	etence ^d		0.054	0.000	0.123	0.000	0.900				
Executive funct	ional b	ackground ^b	0.784	0.802	0.091	0.278	1.000				
Executive indus	stry bac	kground ^b	0.466	0.500	0.234	0.000	0.853				
Executive tenur	re ^c		0.682	0.677	0.372	0.000	1.890				
Executive IT co	mpeter	nce ^d	0.069	0.000	0.138	0.000	0.800				
Firm size (ln as	sets)		15.338	14.942	1.748	12.38	20.44				

 Table 1. Sample Firm Characteristics and Research Variable Descriptive Data

 • Firm size and performance, and beard and executive size

^a Numbers are in thousands of Canadian dollars.
 ^b Heterogeneity, according to Blau (1977).
 ^c Coefficient of variation (Std Dev./Mean).
 ^d Percentage of board members or executives with IT competence.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1.0														
2	.03	1.0													
2	10	12	1.0												
5	.17	.12	1.0												
4	06	.09	.03	1.0											
5	.12	.13	.17	.31	1.0										
6	.16	07	.05	.06	.13	1.0									
7	.06	06	.16	.03	.16	.01	1.0								
8	.00	.02	.02	.24	.15	08	.05	1.0							
9	.07	.11	.09	.16	.35	.09	.14	.19	1.0						
10	01	.08	.06	.17	.07	.42	02	.12	.08	1.0					
11	.16	02	.14	.02	.23	.07	.62	.14	.21	.02	1.0				
12	.23	.20	.24	01	.29	.22	.06	08	.03	.13	.01	1.0			
13	.24	08	.35	.03	.21	.16	.31	03	.01	05	.30	.48	1.0		
14	17	09	05	04	.05	.03	.06	07	.20	.13	01	05	29	1.0	
15	14	.16	39	.01	29	18	30	.11	17	06	27	30	50	51	1.0
16	.14	02	.24	.02	.15	.05	02	05	.00	00	.04	09	16	17	29
												11 /			
1	Depe	endent i	variabl	es (1)				0	Ind	epende	nt vari	ables (c	cont.)	. 1	
1	Pr(Dr(Juuci II	inovati	on (ln)				9 10	E	xecutiv	/e indu	stry dat	ckgroui	10	
2	M	nagem	ent inn	on (iii) ovatior	n (1n)			10	E	vecutiv		omnete	nce		
5	Inde	n <i>enden</i>	t varial	hles	I (III)			12	E	irm siz	e (ln as	sets)	lice		
4	nue _l R∩	ard fun	ctional	hacko	round			13	F	inancia	l servi	ces/insi	irance	and tele	<u>-</u>
•	DU	uru run	letionu	oueng	ound			15	c	ommur	ication	is/IT/m	edia		
5	Во	ard ind	lustry b	ackgro	und			14	R	letail/w	holesa	le, serv	ices and	d utiliti	es
6	Во	ard ten	ure					15	C)il & ga	as and 1	nining			
7	Bo	ard IT	compe	tence				16	Ν	lanufac	cturing				
8	Ex	ecutive	functi	onal ba	ckgrou	nd									

Table 2. Pearson Correlations (n=163)

Note: Correlation greater than .19 is **significant** at the 0.01 level (two-tailed); Correlation greater than .15 is **significant** at the 0.05 level (two-tailed).

product innovation ($p \le 0.10$). The retail/wholesale, services, and utilities industries and the oil & gas and mining industries are less innovative than the manufacturing sector ($p \le 0.05$ and $p \le$ 0.10 respectively). When considering all variables (Model 10), board tenure is associated with product innovation. In fact, in a model with only the four board variables and the controls (not tabulated), board functional background and board tenure are related to product innovation (p = 0.088 and 0.091 respectively). Executive industry background is no longer significant in the overall model while executive IT competence is significant in both the individual and overall models. Table 4 presents the separate regressions of the control variables and each independent variable related to board and executive management diversity and IT competence on process innovation (Model 2 to Model 9). Diversity in board and executive management industry background as well as firm size are associated with process innovation (p ≤ 0.10). In the overall model (Model 10), executive management industry background remains significant while board industry background is no longer related to process innovation. Instead, diversity in board tenure is associated with process innovation, but, surprisingly, has a negative effect. There are no industry differences relative to process innovation.

For management innovation, variables related to board and executive management diversity and IT competence are not associated with innovation either individually or together. Hence, the regressions are not presented. In fact, the only significant differences pertain to industries. The oil & gas and mining sectors and the retail/wholesale, services, and utilities industries are significantly less innovative than the manufacturing sector ($p \le 0.01$, not tabulated).

Discussion and Conclusion

The objective of this study was to examine the influence of diversity and IT competence of boards of directors and executive management on innovation. We found that some board and executive management characteristics were associated with innovation, and that from a resource-based perspective, greater heterogeneity in board of director tenure and executive IT competence lead to more extensive product innovation. In addition, process innovation is driven positively by diversity in executive industry background. As anticipated, large organizations innovate to a greater extent, and there are differences among industries.

Contrary to the resource-based perspective, process innovation is negatively associated with heterogeneity in board tenure. This negative relationship might be explained by other theoretical frameworks⁸ or the knowledge ossification effect (Berman et al., 2002; Tsun-Huang et al., 2005; Yin and Bao, 2006). Indeed, combining the experience and knowledge that longtenured board members have with the new knowledge and fresh insights of lesser tenured individuals (as Mac-

⁸ For instance, Boerner et al. (2011) suggest that under social identity theory, self-categorization theory and similarity attraction theory, executive management diversity can be negatively associated with organizational performance.

Curtain et al. (2010) suggest for executive management) may be a positive step for process innovation, but only up to a point or in certain circumstances.

Some of our results are similar to Talke et al. (2010), who found that diversity (as a single construct) in executive management is positively associated with innovation. These results suggest that heterogeneity in board tenure is relevant to strategic decisions such as innovation. In fact, tenure enhances firmrelated experience, and a mix of tenured and non-tenured individuals seems to foster product innovation. Further, executive IT competence may lead to the use of IT, a key driver of technological innovation (Liang et al., 2010).

Contrary to Bantel and Jackson (1989), results from the current study suggest that board of director and executive team functional background does not significantly impact on innovation. In more recent studies that used functional background as part of a single, multidimensional construct, diversity in executive management (Talke et al., 2010) and boards of directors (Zona et al., 2013) was positively associated with innovation. Measurement differences might explain these mixed results. Our study describes functional background as all the cate-gories in which a board member or an executive has functional experience, while Bantel and Jackson (1989) define it as the category in which the individual has the most experience. Other studies considered different types of functional background, including the categories studied in Yap et al.'s investigation (2005), which found that intrapersonal function diversity has a positive impact on innovation while dominant function diversity has no significant influence. Lastly, Hambrick and Mason (1984) identified three types of functional track orientation: output (marketing, sales, and product R&D); throughput (production, process engineering, and accounting); and peripheral functions (law and finance). These different types of functional background could be investigated in further research.

As with board and executive management functional background, board industry background and IT competence were not significantly associated with product and process innovation and therefore merit further investigation. Further, as board and executive management diversity and IT competence do not significantly influence management innovation in any degree, it might be relevant to develop a more sophisticated measure of manage-ment innovation. Other board and exec-utive management characteristics could be studied in relation to innovation, including educational background, a topic that has yielded mixed results (Henneke and Lüthje, 2007; Wu et al., 2011). Moreover, considering the importance of the innovation measure used (Hemphälä and Magnusson, 2012), it may be relevant to distinguish between incremental and radical innovations. Interactions among product, process, marketing, and organizational innovations could be investigated in a future study on antecedents of innovation. Further research could analyze enterprise governance of IT and its relationship with board members' and executive managers' individual and group characteristics in order to provide an in-

depth understanding of factors that enhance synergy between IT and business. This analysis could help build a theory about the relationships among factors that enhance IT-business synergy and their influence on innovation strategy. To sum up, this study is the first to consider IT competence along with specific dimensions of diversity in boards of directors and executive management as potential determinants of innovation. It also relates these determinants to three measures of innovation, product, process, and management. Using a direct measure of innovation instead of a proxy such as R&D, this study opens up a new perspective on the topic. By examining the influence of IT competence of board of directors and executive management, it contributes to the governance, IT, and innovation literatures. Further, by identifying significant characteristics of the board of directors and executive management that influence innovation, the results provide empirical insights for later research into factors that enhance innovation.

Recent global surveys indicate that CEOs around the world are taking responsibility for leading innovation, (PwC, 2013), and that board members (more specifically, audit committee members) report that the information they receive about "the company's growth and innovation needs improvement" (KPMG, 2014, p. 1). These findings highlight the interest of senior executives and board members in innovation. From that perspective, our overall results have practical implications. They provide firms with new information that may be used to enhance the synergy and complementarities of board and executive team members, in view of their role as leaders of innovation. Indeed, maintaining a greater mix of board tenure and recruiting IT-competent senior executives with different industry backgrounds may favour innovation. If firms want to improve product innovation specifically, a mix of tenures on the board and a greater proportion of executives with IT competence could be considered. An executive team that includes senior members with different industry backgrounds may enhance process innovation. A blend of characteristics in both bodies can foster synergy and complementarities and favour innovation by combining substantial knowledge of the firm and its competitive environment, new knowledge and fresh insights from experiences in prior organizations, and an IT perspective.

Despite its contributions, this study has limitations. Dependent and independent variables were measured on the basis of the researchers' assessment of data/qualitative descriptions presented in public documents. For strategic or other reasons, the description of innovations may not have been exhaustive, particularly in relation to management innovation, for which board and executive management determinants were not significant, possibly due to their low occurrence. Conversely, some firms could have overestimated their innovation efforts in an effort to burnish their image. Diversity and IT competence measures may have been underestimated as a result of abridged reporting in public documents, leading to a less accurate measure of the independent variables. Overall, however, our measures are probably more on the conservative side, which

		Table 3: R	legression l	Results - Pr	roduct Inno	vation ^a				
Variables/Model	1	2	3	4	5	6	7	8	9	10
Board functional background		-0.787								-0.846
		(0.120)								(0.106)
Board industry background			-0.027							-0.241
			(0.479)							(0.337)
Board tenure				0.367						0.451
				(0.102)						(0.095)
Board IT competence					0.118					-0.535
-					(0.426)					(0.230)
Executive functional background						0.209				0.300
2						(0.393)				(0.348)
Executive industry background							0.379			0.361
							(0.098)			(0.116)
Executive tenure								-0.047		-0.176
								(0.426)		(0.279)
Executive IT competence									0.816	0.977
Ĩ									(0.086)	(0.075)
Firm size (Ln assets)	0.089	0.088	0.090	0.080	0.091	0.090	0.089	0.091	0.102	0.098
	(0.034)	(0.036)	(0.048)	(0.065)	(0.037)	(0.031)	(0.035)	(0.042)	(0.018)	(0.043)
Financial services/insurance,	-0.196	-0.195	-0.198	-0.189	-0.208	-0.200	-0.196	-0.203	-0.271	-0.265
telecommunications/IT/media	(0.578)	(0.580)	(0.582)	(0.593)	(0.563)	(0.569)	(0.581)	(0.575)	(0.454)	(0.491)
Retail/wholesale, services and	-0.850	-0.861	-0.852	-0.837	-0.853	-0.851	-0.884	-0.848	-0.838	-0.855
utilities	(0.018)	(0.018)	(0.020)	(0.020)	(0.018)	(0.018)	(0.014)	(0.019)	(0.019)	(0.023)
Oil & gas and mining	-0.514	-0.520	-0.517	-0.482	-0.510	-0.520	-0.498	-0.516	-0.467	-0.465
	(0.070)	(0.070)	(0.080)	(0.091)	(0.074)	(0.067)	(0.084)	(0.074)	(0.101)	(0.141)
F (p)	4.55	3.91	3.71	3.84	3.65	3.77	4.59	3.66	4.32	2.71
~	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)	(0.003)	(0.001)	(0.004)	(0.001)	(0.002)
Pseudo R ²	0.038	0.041	0.038	0.041	0.038	0.039	0.041	0.039	0.042	0.053

^a Probability tests, in parentheses, are one-sided except for Ln assets and industries. The tests of significance are corrected for heteroscedasticity. The manufacturing sector is the comparative basis as it is absent from the regression. The intercept is not presented.

Variables/Model	1	2	3	4	5	6	7	8	9	10
Board functional background		1.010								0.585
		(0.133)								(0.268)
Board industry background			1.028							0.631
			(0.092)							(0.212)
Board tenure				-0.321						-0.590
				(0.237)						(0.092)
Board IT competence					-0.073					-0.877
					(0.469)					(0.186)
Executive functional background						0.015				-0.887
						(0.494)				(0.159)
Executive industry background							0.677			0.559
							(0.047)			(0.086)
Executive tenure								0.132		0.269
								(0.328)		(0.182)
Executive IT competence									0.651	0.789
									(0.164)	(0.166)
Firm size (Ln assets)	0.213	0.214	0.190	0.222	0.212	0.213	0.210	0.208	0.223	0.202
	(0.002)	(0.002)	(0.005)	(0.004)	(0.003)	(0.003)	(0.002)	(0.006)	(0.002)	(0.011)
Financial services/insurance,	-0.572	-0.575	-0.514	-0.572	-0.565	-0.572	-0.565	-0.552	-0.628	-0.471
telecommunications/IT/media	(0.203)	(0.195)	(0.263)	(0.200)	(0.224)	(0.205)	(0.204)	(0.213)	(0.169)	(0.300)
Retail/wholesale, services and	-0.140	-0.123	-0.089	-0.151	-0.139	-0.140	-0.196	-0.141	-0.126	-0.137
utilities	(0.725)	(0.751)	(0.828)	(0.702)	(0.728)	(0.725)	(0.622)	(0.719)	(0.748)	(0.725)
Oil & gas and mining	0.291	0.296	0.396	0.265	0.289	0.291	0.318	0.296	0.332	0.384
··· –	(0.449)	(0.430)	(0.339)	(0.480)	(0.454)	(0.452)	(0.403)	(0.428)	(0.387)	(0.313)
F (p)	2.64	2.21	2.26	2.40	2.18	2.22	2.55	2.71	2.16	1.61
-	(0.036)	(0.056)	(0.052)	(0.040)	(0.059)	(0.055)	(0.030)	(0.022)	(0.062)	(0.095)
Pseudo R ²	0.040	0.043	0.046	0.042	0.040	0.040	0.048	0.041	0.042	0.059

Table 4: Regression Results - Process Innovation^a

^a Probability tests, in parentheses, are one-sided, except for Ln assets and industries. The tests of significance are corrected for heteroscedasticity. The manufacturing sector is the comparative basis as it is absent from the regression. The intercept is not presented.

limits the likelihood of obtaining significant results. Lastly, a larger sample could have strengthened the significance of the regression coefficients.

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Appendix. Measures of Innovation

Items	Source	Coding
<i>Product innovation</i> Development of products new to the firm	Fitzgerald et al. (2008)	1 if yes; 0 otherwise
New product introduction / launch	Nieto and Santamaria (2010)	1 if yes; 0 otherwise
Line extensions (minor modification of an existing product) or "me-too" prod- ucts (imitation of competitors' products already on the market)	Radas and Bozic (2009) Wu (2008)	number of innova- tions
Major innovation	Radas and Bozic (2009) Wu (2008)	number of innova- tions
Use of new technology that enables quantum leaps in product performance	Talke et al. (2010)	number of innova- tions
Use of technologies that impact or cause significant changes to the whole indus- try	Talke et al. (2010)	number of innova- tions
Product testing / tests / feasibility study / exploration	Orens et al. (2010)	1 if yes; 0 otherwise
Awards for products	Orens et al. (2010)	number of awards
Process innovation		
Introduction of new machines / fixed assets in a broad sense	Nieto and Santamaria (2010)	number of innova- tions
Introduction of new methods of organization	Nieto and Santamaria (2010)	number of innova- tions
Use of new technology that enables quantum leaps in process performance	Adapted from Talke et al. (2010)	number of innova- tions
Use of technologies that impact or cause significant changes to the whole indus- try	Adapted from Talke et al. (2010)	number of innova- tions
Awards for processes	Adapted from Orens et al. (2010)	number of awards
Management innovation		
Implementation of new or significantly changed corporate strategies (e.g., mis- sion statement)	Mol and Birkinshaw (2009)	number of innova- tions
Implementation of new or significantly changed marketing strategies (e.g.,	Mol and Birkinshaw (2009)	number of innova- tions

leading to increased market share)

Implementation of advanced manage-
ment techniques within the firm (e.g.,
knowledge management, quality cir-
cles)

Implementation of new or significantly changed organizational structure (e.g., people, diversification activities)

Mol and Birkinshaw (2009)	number of innova- tions
Mol and Birkinshaw (2009)	number of innova- tions



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INNOVATIVE RESOLUTION OF OUTSOURCING CONFLICT: A CASE STUDY OF AN ELECTRICAL COMPONENT MANUFACTURER IN CHINA

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Abstract

This case study explores the better solutions to resolving conflict caused by manufacturers when implementing outsourcing. Actually, the practice of outsourcing in China tends to be commonplace; thereby, one company named as "B", was an early mover in outsourcing beginning in 1997 and is the subject of this study. Besides incurring probable dilemma, the outsourcing provider will face the severe problem of even losing their contract, especially when the buyer tries to improve the efficiency by means of production automation. In 2013, Company B utilized the win-win strategy (presented in most textbooks of Business Administration course) to solve the conflict between outsourcing buyer and provider. As a result, both parties no matter buyer or provider fulfill mutual requirements without harming each other's benefits.

Key Words: outsourcing, automation, win-win strategy

Introduction

Research Background

A number of researchers focus on the issue of outsourcing. They propose many aspects from the reasons of outsourcing, how to evaluate and management, and so forth. However, in practical side, manufactures face some problems while the implement outsourcing. But, researchers seldom provide the resolutions.

Nowadays, China is not only a world manufacturing factory, but also an important market nowadays.

This study intends to sketch a whole picture of how an electrical component manufacture apply outsourcing and solve the conflicts with a smart strategy in China.

Objectives

First, the research reviewed the current relative literatures on outsourcing and found the gaps between academic and practical sides. Second, it tried to use a manufacturer for studying in order to explain its outsourcing strategy. Then, the real problems which outsourcing company and supplier face were presented. Finally, this study figured out how to solve conflicts raised from outsourcing implementation

Literature Review

Definition of Outsourcing

A number of literatures had studied outsourcing. They can be categorized into four subjects including the definition of outsourcing, importance of outsourcing, evaluation of outsourcing performance, cooperation between outsourcing company and supplier.

The term 'outsourcing' was coined in the late 1980s for the subcontracting of information systems. (Tomas F. & Victor, 2006) After that, different definitions of outsourcing were proposed by Harrigan (1985), Loh & Venkatraman (1992), and Quinn & Hilmer(1994).

Importance of Outsourcing

Since the 1990s outsourcing has become a widespread phenomenon (Quinn & Hilmer, 1994; Rodriguez & Robaina, 2006). The growing body of research on outsourcing focuses on the outsourcing company and analyses such issues as its "make or buy" decisions selection of suppliers. (Araujo & Spring, 2006; Kumar, Kundu, & Pedersen, 2010).

"Make, Buy or Ally?" always disturbs decision makers. Thus, the study of theoretical perspectives on knowledge process outsourcing through alliances had completed by Susan & Stephen in 2010.

Especially, outsourcing deals now entail "value-based outsourcing, equity based outsourcing, e-Business outsourcing, and business process outsourcing" emphasizing the evolution that has taken place in the outsourcing arena (Dibbern et al., 2004).

Evaluation of Outsourcing Performance

In 2002, the work of Gilley and Rasheed focused on the analysis of the impact of outsourcing on organizational performance using the competitive strategy as moderating variable, and concludes that the impact is positive in the case of cost leadership strategy and negative in that of a differentiation strategy.

Likewise, the concept of RBV is important to the study of outsourcing, as superior performance achieved in organizational activities relative to competitors would explain why such activities are internalized with organization (Gainey and Klaas, 2003; Roy and Aubert, 2002).

Cooperation between Outsourcing Company and Supplier

Outsourcing proponents cite several reasons for choosing outside vendors. There are vendor expertise and sophistication, improved quality of delivery, increased focus on core competencies, cost reduction, and balance sheet improvement. (Yvonne Lederer Antonucci et. al., 1998) In fact, outsourcing does not create value simply by externalizing activities, but the supplier and the outsourcing company jointly co-create value via increased activity coordination. (Enrico et al. 2014). We also differentiate strategic outsourcing from strategic alliances. Strategic alliance represent collaborative arrangements that firms establish to achieve common goals in which benefits are ultimately shared by alliance partners. (Inkpen, 2001). The scholars, Chen et al. in 2004 and Murray and Kotabe in 1999, drew a distinction between strategic outsourcing and strategic purchasing. Strategic purchasing refers to the ongoing process of soliciting, negotiating, and contracting for delivery of goods and services from suppliers. In a different way, <u>s</u>trategic outsourcing is the process of engaging the services of a provider to manage essential tasks that would otherwise be managed by in-house personnel.

Methodology

The methodology adopted for this study was an interpretive case study (Klein & Myers, 1999; Walsham, 1995). Data were collected from multiple sources, including semi-structured interview, documentary materials, and notes from field observation. Then, in semi-structured interviews the interviewees were from different range of managerial staffs covering the areas of factory operation, financial management, auditing, and human resource department.

The authors also visited all factories of the sample company, Bothhand, in China and observed their work flow processes in order to acquire the real information.

Finding and Discussion

Company profile

Bothhand Enterprise Inc. named as "BH" group was founded in 1992. It has established an irreplaceable position in Ethernet Component & DC/DC Converter market. The sales amount was around USD\$80 million in 2014. The maximum amount of employee was around 5000 in 2006. However, there are less than 1000 employee in 2015. The headquarter is located in Tainan Taiwan. Three major factories are Guangzhou, Kaiping, and Deyang in China. The Changzhou factory was restructured as a sales center in 2010. Then it has been responsible for customer service all around China. Its major customers include Asus, Foxconn, Panasonic, D-Link, Samsung, LG, and so on.

Overall Finding

BH group was geographically divided into three parts as Taiwan, Overseas, and China with their different functions. There are three whollyowned factories in China. (Guangzhou, Kaiping, Deyang) This company has implemented outsourcing since 1998 at the beginning of labor shortage along the coastal cities in China.

First, the quality and date of delivery are harder to control sometimes even though the winding process is not so professional with knowledge. The outsourcing suppliers could not attain the contract requirement at the beginning. Managers said that we have to spend lots of time to teach them. Occasionally the venders ignore the production S.O.P. with intent in order to save its cost. In addition, poor mutual understanding of the contract and loss of key talent and/or knowledge transfer inefficiently like Shawn McCray proposed that the Top 10 Problems with Outsourcing Implementation in 2008.

Second, as a result, finding a proper supplier is vital for BH group.

Parts of the outsourcing suppliers are owned by previous BH employee. Basically, they learned the coiling skills before leaving ompany and becoming as the suppliers. However, the problem of security was happened like supplier selling the semi-finished products to BH's competitors.

So, Bothhand Group also faced difficulties in terms of security and privacy, service delivery, and reduced quality of service. Their challenges include the irreversibility of the outsourcing decision, loss of control, hidden costs, challenge associated with the vendor, and a loss of skills/ knowledge/ expertise. Those situations had been presented by Apte et al. in 1997, Aubert, Rivard, & Patry in 2001, and Quelin & Duhamel in 2003.

Third, no matter what type of product they make, all manufacturers walk the same fine line and face many of the same burdens. For example management often must make a critical decision: go left and invest in assembly automation technology, or go right and outsource production. (Austin, 2006) BH group decided to develop production automation step by step in 2008 in order to gain the competitive advantage.

Few years later, they decided to change the production process with most labor-loaded into automation by applying winding machine. At the same time, it caused the current outsourcing suppliers losing their jobs. They had tried to find a solution in order to help their outsourcing suppliers without losing their jobs. Nowadays, there are still some semi-automation processes operating in BH own factories. But the automation improvement will be implemented permanently.

Resolutions of Problems

Outsourcing Supplier Selection.

Every factory indeed is a single company just like a business unit in BH group. So, they may manage their vendors and contract with themselves individually. Since there is a competitive phenomenon within factories, each factory try to find the best supplier in order to make a better profit.

Quality Control.

BH group reorganized a new department for handling all major raw materials to improve quality-control. That prevented the outsourcing suppliers buying the cheaper materials with the worse quality. As well, the economic scale of material purchasing will gain a better price.

A manager in BH said "Our vendors has been provided the service of coiling for more than ten yearsthey trust BH which can offer the great deal and help them to grow ..." So, trust is another important factor for obtaining a stable and superior quality.

Win-win Strategy.

To find a cheaper labor is not the unique means in China. Automation could be another choice to fight competitors. So, how to decrease the harm for outsourcing suppliers while implementing automation became an important subject.

BH had invited few major outsourcing suppliers investing a new company, Shi-Shan, which execute the production process automation. The purpose is to share the profits with them and appreciate their help in the early stage of outsourcing support.

Long-term and Future Cooperation.

Based on the long-term cooperation, outsourcing suppliers have provided suggestions and opinions to Shi-Shan for improving the machine efficiency. Since the "relationship" is important factor for doing business especially in China, keeping a good relationship with those suppliers may facilitate the domestic sales in the future.

Conclusion

First, "BH" group invited its outsourcing providers to join the project of automation development and co-organize a new joint-venture company. The "Shi-Shan" J-V Co. is an example. As a result, both parties no matter buyer or provider fulfill mutual requirements without harming each other's benefits.

Second, organization restructuring is a good approach to solve the problems or conflicts caused by outsourcing. In this case, this company reorganized a new department in order to implement common-procurement. It has sustained the competitive advantage not only on cost-down but also on better quality-control.

Moreover, the factor of "trust" in the outsourcing process has been emphasized again in this study. As Holcomb & Hitt said in 2007 that previous cooperation, defined in terms of both the length and quality of exchange relationship, fosters a climate of trust, openness and confidence. Repeated interactions or "cycles of exchange" between parties strengthen their willingness to trust each other and to expand the boundaries of the relationship.

The study done by Ursula in 2012 showed that the past decade has seen a significant growth in organizational restructuring, and in particular, the use of outsourcing. The resulting fragmentation has created a complex set of challenges for existing employment relations frameworks. The BH group and its outsourcing suppliers also experienced the same situation.

Therefore, the future research could be extended to explore the consequence of outsourcing about employee's rights after pursuing automation by manufacturer. And, the meaning of the term "quanxi" is a similar word to "trust" but more important in China. It might be an exciting issue for further discussion, too.

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INNOVATION CAPABILITY OF TAIWAN SEMICONDUCTOR INDUS-TRY: NETWORK ANALYSIS OF DIRECTORS AND SUPERVISORS

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Abstract

By the network of directors and supervisors exists in Taiwan semiconductor industry to explore high-tech firms' innovation capability. The empirical study presents an exploratory research for evaluating network analysis of appointed directors and supervisors among the fifty-five listed Taiwan semiconductor firms, which offers the indicators of degree and betweenness centrality with corresponding network characteristics of visibility and strategic position. Moreover, the network characteristics of the high-tech firms are examined for interactive relationships with the firms' innovation capability by Pearson correlation. Finally, the empirical results and conclusions can provide the insights and implications for network relationships of directors and supervisors in the semiconductor industry.

Key Words: Innovation capability, Taiwan Semiconductor Industry, Network Analysis, Directors and Supervisors

Introduction

Increasingly competitive business environment, thriving and robust firms are forced to find a way as obtaining external knowledge to secure valuable advantages through numerous relationships. Only a few examples of more permanent avenues for knowledge acquisition are alliances, foreign direct investment (FDI), co-investment, mergers and acquisitions (M&A). In contrast, communications with suppliers and buyers, start-ups by individuals belonging to another firm, staff movement, and interlocking directorate transfer knowledge are less permanent (O'Hagan and Green, 2004). However, interlocking directorate research indicates that the sharing of board members is a means of both influencing business decisions external to the firm and gathering strategic business information (Pfeffer and Salancik, 1978; Carroll and Carson, 2003). Some studies of interlocked directors demonstrate that interlocks can provide firms with a source of information on business practices (Useem, 1984; Davis, 1991; Haunschild, 1993). Du Plessis and Saenger (2007) propose the supervisory board and the firm as a whole are able to make well-informed decisions on the firm's well-being or fate. Therefore, this paper attempts to concern with one avenue of knowledge transfer and innovation capability, namely a wide variety of information and information flow control, through network analysis of directors and supervisors.

The main purpose of this paper examines whether a network pattern of appointed directors and supervisors' activities exists among the Taiwan high-tech semiconductor industry and the primary strategies of coordination and control are occurred through network relationships of directors and supervisors, by network analysis. A high-tech firm's wide variety of information and information flow control are developed by network characteristics of visibility and strategic position, moreover, it explores to demonstrate that a high-tech firm's network characteristics (i.e. visibility and strategic position) should interact with a firm itself innovation capability.

In the empirical study, it presents an exploratory research for evaluating network analysis of appointed directors and supervisors among the fifty-five listed Taiwan semiconductor firms, which offers the indicators of degree and betweenness centrality with corresponding network characteristics of visibility and strategic position. The network characteristics of the firm itself are examined for interactive relationships with the firm itself innovation capability by Pearson correlation. Finally, the empirical results and conclusions can provide insights and implications for network relationships of directors and supervisors in the semiconductor industry.

Literature Review

Impact of Interlocks

An interlocking directorate exists "when one person affiliated with one organization sits on the board of directors of another organization" (Mizruchi, 1996: 271); interlocks between competing firms are called direct interlocks. Interlocking directorates occur regularly across industries and have often been praised, since they mobilize a scarce resource: the expertise of senior managers and directors of large corporations (Ecclesm, 1981; Mizruchi, 1996; Core at al., 1999; Heracleous and Murray, 2001; Hermalin and Weisbach, 2001; Fich and White, 2005). According to previous studies, there are four well-known views are mentioned on the origin and effect of interlocks for an extensive review (Mizruchi, 1996). Firstly, interlocks are a way for firms to co-opt and/or monitor each other (Dooley, 1969; Mizruchi and Stearns, 1994). Secondly, interlocks provide firms with information on business practice (Davis, 1991). Thirdly, interlocks merely reflect upper-class cohesion (Useem, 1984). Fourthly, it recently puts forward busyness hypothesis of Ferris et al. (2003) states that multiple directorships place an excessive burden on directors (Fich and Shivdasani, 2006).

Knowledge Transfer

Generally, the rationale has moved from interlocked directors as a controlling mechanism to interlocked directors as a transfer mechanism. Researchers (Useem, 1984; Lorsch and MacIver, 1989; Haunschild and Beckman, 1998; Carpenter and Westphal, 2001) argue that interlocks are an avenue for leaders to exchange knowledge and strategy between firms. This concept belongs to resource dependency theory (Pfeffer and Salancik, 1978); viewing interlocks as a mechanism for reducing uncertainty by increasing the knowledge of top management decision-makers. Thus, interlocking directorates provide a unique avenue to examine the transfer of external knowledge between firms. Especially, interlocked directors can play a critical role in the development of the hightech industry given the nature of technology and knowledge and the interdependence between product design and process technology from different firms.

Network Analysis

Research on interlocked directors is based on a type of network analysis that relates individuals with particular events. This type of network is commonly referred to as an affiliation network (Wasserman and Faust, 1994). Additionally, Everard and Henry (2002) address an exploratory research utilizes social network analysis to investigate relationships between organizations as captured by interlocked directorates.

Accordingly, this paper will attempt to observe the network structure of appointed directors and supervisors and the primary objectives of coordination and control are occurred among Taiwan semiconductor firms for the high-tech industrial insight, using network analysis. Moreover, the empirical results demonstrate that a high-tech firm has a wider variety of information and control the flow of information by network characteristics of visibility and strategic position; and provide insights and implications for network relationships of appointed directors and supervisors among the semiconductor firms

for enriching the existing literature on interlocking directorates.

Methodology

Data Collection

The network sample consists of the fifty-five listed Taiwan semiconductor firms from Company Financial Quarterly Reports, and directors and supervisors' linkages are analyzed by coding Taiwan semiconductor interindustry appointed activities that occur from April to December, 2007 and from January to September, 2008. Additionally, innovation capability can be evaluated by the number of patents held by the listed Taiwan semiconductor firms according to the United States Patent and Trademark Office (USPTO) and Taiwan Intellectual Property Office (TIPO) databases. Therefore, two limitations of this paper should be recognized. The first is this paper consists of data for an 18-month period, it focuses on distribution of phenomena over a limited period. Secondly, no indepth case studies are performed in individual firms.

Network analysis represents a network pattern of directors and supervisors' linkages among firms and displays the primary objectives of coordination and control by network relationships of directors and supervisors. This paper is done for the appointed directors and supervisors between firms and creates a square matrix showing the linkages between firms. Subsequent analyses use the firms×firms network, making the firms for which centrality measures are calculated. Both measures of degree and betweeness centrality are calculated and both results are given in UCINET (Borgatti, Everett and Freeman, 2002) output.

Degree Centrality

Degree centrality is a measure of the number of adjacent actors in the network to a particular actor. It can be considered the simplest of the centrality measure since it directly measures activity. Nieminen (1974) has introduced a simple, natural and perfectly general measure of centrality based upon degree. Calculations for degree centrality are computed using the following formula for nondirectional relations:

$$C_D(a_k) = \sum_{i=1}^n a(a_i, a_k)$$

In directional networks, degree centrality of each actor can distinguish between in-degree and out-degree to receptively measure its in-degree and out-degree centrality (Knoke and Burt, 1983). The in-degree centrality $(C_{D,in}(a_i))$ and out-degree centrality $(C_{D,out}(a_i))$ of a given actor are formally defined as:

$$C_{D,in}(a_i) = \sum_{j=1}^k r_{ij,in} \; ; \; C_{D,out}(a_i) = \sum_{j=1}^k r_{ij,out}$$

Both measures of in-degree and out-degree are corresponding to the investigation of network attributes of actors' linkages as inward and outward connections, respectively. Comparing the two measures of in-degree and outdegree of a given actor can display the initiative visibility or the passive visibility role among actors.

Betweeness Centrality

For the view of betweenness centrality takes an extremely competitive business environment view, since some actors can act as 'gatekeeper' controlling the flow of information between other actors. Betweeness centrality for actor k is measured by calculating the probability that any path between any two actors i and j will have to go through k. When all possible paths are equally likely, Freeman (1977) calculates overall centrality of actor a_k is determined by summing the partial betweenness values for all unordered pairs of actors as follows:

$$C_B(a_k) = \sum_{j=1}^{n} \sum_{k=1}^{n} b_{ij}(a_k)$$

Applying the indicator to the network characteristics of the actors' linkages indicates whether the central actor can more or less completely control information and occupy strategic position between pairs of other actors.

Pearson Correlation

This paper further explores and observes the indicators of network analysis, including degree centrality (i.e. visibility) and betweeness centrality (i.e. strategic position), as it exists relatively correspondence with the firm's innovation capability by Pearson correlation. According to Kung and Lin (2003) reviewed the number of patents obtained by Taiwan between 1998 and 2002 to study the innovative potential of the country and to project trends, this paper considers the number of output patents to represent their innovation capability in the high-tech firms. To develop a suitable global patent strategy and to maximize both intellectual property rights and returns on innovation and R&D investment in the global marketplace of today, we adopt the patent databases based on United States Patent and Trademark Office (USPTO) and Taiwan Intellectual Property Office (TIPO) in the fifty-five Taiwan semiconductor firms.

Empirical Analysis

Analyses and Discussion

Firm appoints a director or supervisor in the fifty-five listed semiconductor firms is indicated by a '1', and absence of investment activity is indicated by '0'. Consequently, the binary-matrix is intended to enable network analysis of the fifty-five listed Taiwan semiconductor firms. Table 1 shows network indicators, degree centrality and betweenness centrality, and the corresponding network characteristics of visibility and strategic position by the fifty-five listed Taiwan semiconductor firms, which are all calculated by UCINET. Additionally, Table 1 also shows each firm's innovation capability in the fifty-five listed Taiwan semiconductor firms through the number of patents.

Furthermore, this paper examines the network characteristics of the firm itself, including visibility and strategic position, interacts with itself innovation capability (USPTO and TIPO), by Pearson correlation. Table 2 shows network characteristics indeed interact with the firm innovation capability by Pearson correlation. The values in parenthesis show p value (*p<0.05, **p<0.01, ***p<0.001) by Pearson correlation analysis.

Firm		Visibility		Strategic Position	Innovation Capability (The number of patents)		
		Degree Centrality		Patwaanaaa	TIDO	USDTO	
N.	Cala Nama	Out-	In-	Centrality	(Affair)	(Affair)	
INO.	Code Name	degree	degree	Centrality	(Allall)	(Allall)	
F1	PTI	1	1	0.00	181	47	
F2	ASE Inc.	0	0	0.00	2,873	487	
F3	FST	2	2	0.00	0	0	
F4	TMC	1	1	0.00	0	0	
F5	MVI	1	2	2.00	823	420	
F6	TSMC	1	0	0.00	7,090	4,865	
F7	Ralink	1	1	0.00	273	68	
F8	PPt	1	1	0.00	740	75	
F9	Tong Hsing	3	3	6.00	24	4	
F10	Orise Tech	1	2	15.00	4	1	
F11	KYEC	0	0	0.00	85	4	
F12	MXIO	2	2	0.00	2,208	1,145	
F13	SONIX	0	0	0.00	21	19	
F14	SPIL	1	1	0.00	824	316	
F15	Sigurd	1	1	0.00	24	3	
F16	SiS	2	2	40.00	510	294	
F17	Sitronix	0	0	0.00	39	2	
F18	PQI	0	0	0.00	116	15	
F19	Nanya	3	3	4.00	1,168	396	
F20	VIĂ	0	0	0.00	2,881	946	
F21	SpringSoft	3	2	28.00	17	15	
F22	IST	3	3	6.00	106	0	
F23	SUNPLUS	1	1	0.00	627	137	
F24	Weltrend	0	0	0.00	99	9	
F25	PanJit	0	0	0.00	23	2	
F26	HOLTEK	3	4	58.00	180	88	
F27	MOSPEC	0	0	0.00	0	0	
F28	Transcend	2	2	0.00	36	1	
F29	GUC	1	1	2.00	4	3	
F30	ALi	1	2	26.00	224	38	
F31	ESMT	1	1	0.00	72	39	
F32	KINSUS	1	1	0.00	76	5	
F33	FARADAY	1	1	0.00	418	204	
F34	Winbond	2	2	0.00	1,458	983	

Table 1. Network characteristics and innovation capability of each firm

F35	Inotera	1	1	0.00	1,226	0
F36	Walton Chaintech	2	2	0.00	0	0
F37	Walton Advanced	3	3	4.00	55	6
F38	OSE	0	0	0.00	73	17
F39	LPI	0	0	0.00	67	4
F40	GREATEK	1	2	13.00	3	1
F41	SDI	0	0	0.00	47	11
F42	GTM	0	0	0.00	4	0
F43	Realtek	1	0	0.00	1,132	275
F44	ELAN	0	0	0.00	321	30
F45	Richtek	0	0	0.00	20	13
F46	Precision	1	1	0.00	7	0
F47	FATC	2	2	0.00	1	1
F48	GET	2	1	14.00	1	1
F49	DAVICOM	1	1	0.00	3	2
F50	MediaTek	3	3	47.00	1,660	506
F51	UMC	7	5	131.00	5,259	3,010
F52	NOVATEK	3	3	36.00	512	95
F53	ITE	2	3	18.00	67	6
F54	KB	0	0	0.00	18	6
F55	Rectron	0	0	0.00	0	0
	Mean	1.25	1.25	8.18.00	617.73	256.73

Table 2. Network characteristics interact with the firm innovation capability

Pearson Correlation (N=55)	Visibility	Initiative visibility	Passive visibility	Strategic position
Visibility	1			
Initiative visibility	0.981*	1		
Passive visibility	0.978*	0.920*	1	
Strategic position	0.732**	0.754**	0.677**	1
TIPO	0.223	0.309*	0.123	0.372*
USPTO	0.232	0.318*	0.132	0.358*

Note: *p<0.05; **p<0.01; ***p<0.001

Network Characteristics vs. Innovation

Comparing in-degree and outdegree measures of a given firm can show whether the focal firm is an outbound or inbound firm among a group of firms. The initiative visibility firms are, in order of out-degree score, F51UMC, F9-Tong Hsing, F19-Nanya, F22-IST, F26-HOLTEX, F37-Walton Advanced, F50-Media Tek, F52-NOVATEK to display Taiwan semiconductor outbound appointed directors and supervisors listed firms, since in-degree is relatively lower than outdegree in these firms. In contrast, the passive visibility firms are, in order of in-degree score, F51-UMC, F26-HOLTEX, F9-Tong Hsing, F19-Nanya, F22-IST, F37-Walton Advanced, F50-Media Tek, F52-NOVATEK, F53-ITE to present Taiwan semiconductor inbound appointed directors and supervisors listed firms, since in-degree is relatively higher than out-degree in these firms. Consequently, we find that the firms of higher degree score are as similar to the firms of higher outdegree and in-degree score.

Moreover, the correlation between visibility and innovation capability, the result is not a significant positive correlation with both USPTO and TIPO, however, analysis of the correlation between initiative visibility and innovation capability reveals that initiative visibility is significantly and positively (r=0.318*, r=0.309*) correlated with both USPTO and TIPO; thus, a high initiative visibility indicates strong innovation capability. Nevertheless, passive visibility is not significantly and positively correlated with innovation capability.

In addition, the correlation between initiative visibility and passive visibility is a highly significant positive correlation (r=0.920**), which indicates that firms with high initiative visibility have high passive visibility. Consequently, firms with both of high initiative visibility and passive visibility have high overlapping in the semiconductor inter-industry directors and supervisors' network.

Betweenness centrality ranges from 0 to 131, and mean betweenness cen-

trality is 8.18. Ten firms that exceed the mean are, in order of betweeness centrality score, F51-UMC, F26-HOLTEK, F50-Media Tek, F16-SiS, F52-NOVATEK, F21-SpringSoft, F30-ALi, F53-ITE, F10-Orise Tech and F40-GREATEK to more control flow of information degree between pairs of other firms.

A firm with high betweenness centrality is a critical intermediary between pairs of other firms since most directors or supervisors stop at this firm when making appointed activities involving other firms. F51-UMC has the highest strategic position in the fifty-five listed Taiwan semiconductor firms with the highest betweenness centrality. Furthermore, the analysis of correlation between strategic position and innovation capability reveals a highly significant positive correlation $(r=0.358^{**}, r=0.372^{**})$ between strategic position and USPTO and TIPO. Thus, a higher strategic position can increase itself innovation capability.

In addition, the correlation between visibility and strategic position is a highly significant positive correlation $(r=0.732^{**})$, which indicates that firms with high visibility have high strategic position. Additionally, the correlation between initiative visibility and strategic position is significant and positive $(r=0.754^{**})$, and the correlation between passive visibility and strategic position is significant and positive $(r=0.677^{**})$.

Conclusion

This paper is to examine whether a network pattern of appointed directors and supervisors of the fiftyfive listed Taiwan semiconductor firms exists through network analysis. The purpose of this paper is to respectively evaluate a firm's measure of degree centrality and betweeness centrality mirrors its measure of visibility and strategic position, as determined by appointed directors and supervisors' activities within the network of the fifty-five listed Taiwan semiconductor firms. In addition, we observe the correlation between network initiative visibility (i.e. out-degree) and passive visibility (i.e. in-degree); and seek the correlation between network visibility (i.e. degree) and strategic position (i.e. betweeness). The results indicate that network initiative visibility is significantly and positively correlated with network passive visibility, including F51-UMC, F9-Tong Hsing, F19-Nanya, F22-IST, F26-HOLTEX, F37-Walton Advanced, F50-Media Tek, F52-NOVATEK. These firms can play the roles of strategic implications for appointed directors and supervisors' network such as information exchange, uncertainty reduce, decision making. Additionally, between network visibility and strategic position are significant positive correlation, the four firms, namely F51-UMC, F26-HOLTEK, F50-Media Tek and F52-NOVATEK especially possess a conspicuous strategic position by appointed directors and supervisors' network for information flow control and knowledge acquisition among the fifty-five listed Taiwan semiconductor firms.

Furthermore, we are interested in whether the visibility and strategic position of directors and supervisors' network may individually interact with the firm's innovation capability. The results show that both network characteristics of initiative visibility (i.e. outdegree) and strategic position (i.e. betweeness) are significantly and positively correlated with innovation capability (USPTO and TIPO) by appointed directors and supervisors' activities within the network of the fifty-five listed Taiwan semiconductor firms, especially F51-UMC and F50- MediaTek. Consequently, the valuation effect of innovation capability indeed fits in with the emergent investment of Chesbrough (2002) corporate VC investments framework, that is, high-tech firms can allow exploration of potential new opportunities and businesses for experimenting with new capabilities, developing a backup technology or exploring strategic whitespace. Another angle of view, the firms with outstanding innovation capability, especially F2-ASE Inc.(0), F6-TSMC(1), F20-VIA(0), F35-Inotera(2) and F43-Realtek(1), unexpectedly below average of 2.51 degree centrality score and all gain zero betweeness centrality score within the inter-industry directors and supervisors' network. One of rational though may explain that these firms focus business strategy on crossindustry rather than inter-industry.

Thus, a future research agenda should include quantitative analysis of other high-tech industries. Quantitative research is confirmatory and deductive in the industry nature. Moreover, individual firms that are high in specific network characteristics, such as visibility and strategic position, can be analyzed separately by case study and interviews to obtain a generalized conclusion about strategies used by specific firms.

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INNOVATION AND COMPETITIVE EDGE: EFFECTIVE DESIGNER MANAGEMENT IN CHINESE SMEs

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Abstract

In the recent changing environment, companies must be able to respond quickly to change. Such ability to respond regularly depends upon the quality of enterprise personnel. This study used a questionnaire to ask both the design managers of manufacturing companies and the managers of design companies regarding the methods and criteria used to recruit new industrial designers, as well as surveying their consummation with the job performance of afresh recruited industrial designers in Chinese SMEs. The relationship between the method used to recruit new industrial designers and manager consummation with the job performance of afresh recruited industrial designers was also explored. The vital findings of the study are: a) All the companies use interviews in the recruitment of industrial designers, 97% companies use portfolio, 38% adopt written test of aptitude test and English, and 16% adopt the right on the spot test of project design. The companies adopt written tests are the manufacturing companies of which the test is required to every newly recruited employee while only design companies have the right on the spot test to check the ability of the applicant in sketching and computer-aided design. b) The top five criteria in the recruitment of new industrial designers are creativity, product form design ability, design quality, awareness of design trend, and sense of aesthetics; the lowest five criteria are having certificates of design skill, having award winning records, other specialties, knowledge of marketing strategy, and educational background. There exist significant differences of selection criteria among managers with different backgrounds, firm scales and business types. c) The three performance items of newly recruited industrial designers that managers satisfy the most are schedule control ability, sense of aesthetics, and computer aided design software manipulating ability; the three

worst items are free hand sketch, knowledge of engineering & manufacturing, and product planning abilities. There exist important differences in the manager's satisfaction toward newly recruited industrial designers' job performance among different ways of recruitment.

Key Words: Industrial Designer, Product Design, Design Management, Design Performance

Introduction

In the current changing environment, companies must be able to respond rapidly to change. Such capability to reply regularly depends upon the quality of enterprise personnel. One of the key subjects for managerial staffs to select the best personnel from numerous job applicants. Therefore, the competitiveness of modern companies almost equals the competitiveness of enterprise personnel (Werther and Davis, 1993; Chang, 2013). Excellent personnel perform tasks well and will significantly impact team effectiveness (Drucker, 1964). New product design and development requires integrating the elite in a company but it is difficult to find suitable R&D personnel. However, it is important to recruit such personnel if possible. It is unwise to stifle talented personnel (Ulrich and Eppinger, 2012). Industrial designers play a key role during the new product design and development stages of companies, and are a key human resource. In implementing product development strategy, Baxter (1995) claimed that suitable personnel should be placed in a suitable position at a suitable time. Otherwise, all of the efforts expended in planning, equipment, and investment will be in vain (Crawford and Benedetto, 2014; Hsu, 2013).

A survey conducted by CEPD demonstrated that numbers of industrial designers will be unable to meet demand during the coming eight years (CEPD, 2013). Furthermore, according to CIDA (2013), the annual demand for industrial designers in the Taiwan market is about 600~800. Currently, more than 1300 industrial design graduates leave college every year. On the surface it thus seems that the supply should exceed the demand, but companies still claim to have difficulty in finding proper personnel (Weng, 2003). Wang (2003), creativity superintendent at BenQ, claimed that Taiwan probably produces fewer than 50 graduates per year who are qualified to take charge of practical projects. This demonstrates that despite numerous college graduates entering the job market, companies still have difficulty recruiting suitable industrial design personnel. On the other hand, when recruiting design personnel, managers should effectively judge the suitability of the interviewer; otherwise, managers will suffer considerable trouble when no suitable personnel can be hired (Ulrich and Eppinger, 2012).

Few studies have examined the recruitment and job performance assessment of industrial designers. However, appropriate recruitment methods

are essential to designer selection and may influence product designer job performance. This study interviewed managers of industrial design departments in local companies and managers of design houses to study the methods and criteria used for recruiting new industrial designers and their satisfaction with the job performance of the newly recruited industrial designers. The relationship between the method used to recruit new industrial designers and manager satisfaction with the job performance of newly recruited industrial designers was also studied. The analytical results can provide a reference for the relevant managers in selecting appropriate new industrial designers and for use in education design to create suitable curriculum and teaching contents to equip novice designers for the requirements of the job.

Literature Review

Recruitment is a process through which an enterprise attracts individuals with suitable job knowledge and ability. Therefore, whether an enterprise can recruit high quality personnel depends on proper recruitment procedures (Werther and Davis, 1993). Appropriate and prudent recruitment will also improve enterprise image by giving the interviewers a feel of the severe attitude in hiring new personnel. De-Cenzo and Robbins (1994) claimed that the recruitment procedure includes initial interview screening, completing the application form, general interview, background check, job offer, physical check, and permanent employment. Werther and Davis (1993) classified the recruitment methods used by industrial

designers into written tests, interviews, and project design. Lin (2002) noted that the methods available to design houses in Taiwan for recruiting new industrial designers include face-toface interview, portfolio check, and project design. Project design indicates tests that require interviewers to use computers, drawing sketches, rapidly process designs, and other similar tasks. Consequently, this study divided the recruitment methods used by industrial designers into four classes: written tests, face-to-face interviews, portfolio checks, and project design (Ulrich and Eppinger, 2012.

Additionally, during stages of product development, industrial designers should not only possess prior a detailed knowledge of design related skills but should also possess knowledge regarding marketing decisions, production, and integration and communication ability (Lin, 2002). He (1996) claimed that the primary skills for designers are creative thinking, ability to design product form, design presentation, aesthetic sense, evaluation ability and analytical ability. Yeh (2002) further observed that industrial designers should possess the following abilities: problem definition, creativity, product planning, valuation, communication and presentation, CAID skills, and independent problem solving ability. Yeh (2000) also identified the following abilities as important for industrial designers: CAID skills, problem solving, creativity, communication and coordination, knowledge of marketing strategy, international perspectives, product form design skills, mechanical and structural design abilities, ability to develop design ideas, and product planning abilities. Finally, Wang (2001) stressed foreign language abilities and knowledge of human factors for meeting the requirements of internationalization and human factors design (Wu, 2014).

Luh (2004) and Young (2002) identified the abilities that design graduates should possess from both the theoretical and industrial perspectives. Luh and Young divided the dispositions of industrial designers into attitudes and abilities. Industrial designer attitudes can relate to teamwork, design quality, self-confidence, novelty of design, aesthetic sense, patience and perseverance. The abilities of industrial designers include creativity, keen sense of observation, awareness of design trends, idea sketch ability, verbal presentation ability, product analysis and planning ability, ability to work independently, and ability to generate proper product forms, colors and textures. From this perspective, industrial designers in an enterprise should possess numerous dispositions to be effective participants in product design and development activities (Wu, 2014). Consequently, Lin (2002) induced seven criteria for use by design houses in recruiting new industrial designers: enthusiasm, communication, desire to learn, cooperation, sketches ability, creativity, and aesthetic sense. According to the above ideas, the authors grouped the criteria used for recruiting industrial designers into three dimensions (background, professional ability, personal disposition) and 27 items (see Table 1).

 Table 1. Dimensions and criteria for the recruitment of industrial designers

Dimensions	Criteria of selection
Background	(1) educational background, (2) work experience, (3) specialties, (4) certificates of design
	skills, (5) foreign language, (6) awards received
Professional ability	(7) idea sketch ability, (8) product form design skills, (9) product analysis and planning
	ability, (10) presentation ability, (11) ergonomic knowledge, (12) 2D software ability, (13)
	3D software ability, (14) machining and manufacturing knowledge, (15) knowledge of
	marketing, (16) problem solving ability, (17) awareness of design trends, (18) creativity
Personal disposition	(19) team work, (20) quality of design work, (21) self-confidence, (22) novelty to things,
	(23) aesthetic sense, (24) optimistic and ambitious, (25) work enthusiasm, (26) desire of
	learning, (27) patience and perseverance

Job performance means a person can demonstrate their abilities when performing physical or mental activities (Gerhart and Milkovich, 1990). Moreover, job performance assessment describes how enterprise management record the job performance of subordinates and other related situations, and grade overall personnel performance following a certain period (Jac, 1995). Because industrial design is a highly specialized activity, it is difficult to establish standard evaluation criteria (Ulrich and Eppinger, 2012). For example, Chang and Chen (2000) claimed that in dealing with job performance assessment, the characteristics of new product development should be carefully considered and should not be processed in the same manner as production or business departments. Additionally, Cheng (1998) observed that in Taiwanese companies and design houses, monitoring of designer performance stresses design project output; that is primarily a sort of target management (Wu, 2014). As far as the evaluation of industrial designer's job performance is concerned, Wang (2001) mentioned seven items of job performance criteria for junior industrial designers, including product form, free hand sketching ability, personal disposition, product planning

ability, knowledge of engineering and manufacturing, ability to use design software, and ergonomic knowledge. Furthermore, Lin (1997) argued that the assessment of the job performance of industrial designers relies on continuous management assessment of the job quality, efficiency, and control of the design objectives of new designers. Emphasis should be placed upon whether the newly entered designers can cooperate with other team members, their enthusiasm for work, aesthetic sense, analytical ability and creativity in solving design problems, and execution ability (Crawford and Benedetto, 2014). Based upon Wang's seven criteria regarding the professional ability of junior industrial designers and Lin's evaluation methods for industrial designer job performance, ten criteria were selected for evaluating the job performance of new industrial designers, as listed in Table 2.

Item	Description
Product form	The ability in dealing with the product form, color, and texture related to the func- tion.
Free hand sketching ability	The ability to present ideas with sketches quickly, clearly, and fluently.
Creativity	Define and solve the problem with creative thinking, an overall creative perfor- mance.
Personal disposition	Be aggressive and optimistic and curious about things; be able to work together as a team for design project.
Aesthetic sense	Be sensitive to arts, humanities, fashion, and design trends.
Product planning ability	Be able to solve the problem in a systematic and reasonable way.
Knowledge of engineering and	Be able to process the engineering drawing for final form and model and possess
manufacturing	knowledge of manufacturing procedure and material machining.
Ability to use design software	Be able to use computers for 2D graphics and layout and construct the 3D models covering product form, color, and texture.
Human factors knowledge	The ability to deal with 2D and 3D interface of product; be able to integrate the relations between anthropometrical data and dimensions of the product.
Schedule control ability	Be able to control job and schedule.

Table 2. Criteria for evaluating the job performance of industrial designer

Research Methods

This study used a questionnaire to explore the recruitment and job performance of new industrial designers. The primary phases of this study include literature review, questionnaire format design, survey, results analysis, and discussion. Earlier sections demonstrate that literature review covers the recruitment and criteria for selecting industrial designers and criteria for evaluating the job performance of industrial designers.

Based on the literature review, the questionnaire is designed to comprise four parts. The first part deals with business types and the recruitment of industrial designers in companies, scale of organization, and methods used for recent recruitment of industrial designers. The second part demonstrates the importance of the criteria companies use for recruiting new industrial designers. Three dimensions are considered: background, professional abilities, and personal disposition, each of which contains several detailed questions, for a total of 27 questions. Subjects are required to provide scores of 1, 2, 3, 4, 5 to indicate "not important at all", "not important", "fairly important", "very important", and "extremely important" in response to every question. The third part considers manager satisfaction with the job performance of new industrial designers. Ten items for evaluating job performance are product form, free hand sketch, creativity, personal disposition, aesthetic sense, product planning abilities, knowledge of engineering and manufacturing, ability to use design

software, human factors knowledge, and scheduling ability. The subjects were asked to respond with the numbers 1, 2, 3, 4, 5 to indicate whether they were "not satisfied at all", "not very satisfied", "fairly satisfied", "very satisfied", or "extremely satisfied" with the job performance of newly hired industrial designers. Finally, the subjects were asked to provide basic demographic data about themselves, including gender, age group, educational degree, and title. To ensure the validity of the questionnaire format, a pilot study was performed, and portions of the text of the survey were revised accordingly (Crawford and Benedetto, 2014).

The survey was conducted from February to March, 2014 by mail. 91 design houses registered in CEPD and 200 companies from the 104 employment website (2014) that were seeking industrial designers, as well as 250 companies from the top 1000 manufacturers listed in Common Wealth (2012) that primarily produced consumption goods and information products were selected as the sample population. Managers in product design departments and those who had conducted face-to-face interviews of new industrial designers were interviewed. The newly hired industrial designers are defined as those who had obtained bachelor's degrees, and who had less than two years of work experience. Totally, 450 copies of questionnaires were sent and recalled by telephone and postcard. Finally, 125 copies valid questionnaires (27.8%) were returned. Table 3 lists the background data of the subjects.

Data Analysis and Results

Recruitment Methods

Companies usually use two steps for recruiting industrial designers. Table 4 clearly shows that all companies adopted face-to-face interviews in recruiting designers, while 96.8% of them checked applicant portfolios. Additionally, 40.2% of the companies interviewed further conducted written tests, with attitude and verbal tests being required for all newly recruited employees for the personnel resource sector. Only 20.5% of the companies interviewed adopted on the-spot project design tests for ensuring the ability of newly hired industrial designers to meet the company requirements in the area of design work. About half of design departments in companies (46.9%) adopted written tests, while only some design houses (17.2%) used written test. Only some design houses (51.7%) used on the spot tests to check applicant abilities in sketching and computer-aided design and none of design departments in companies did.

Item	Property	No of persons	0%	Item	Property	No of persons	0%
nem	Male	93	74.4%		Person in charg	33	26.4%
Gender	Female	32	25.6%		Department chief	41	32.8%
	25-30 years	19	15.2%	Title	Creativity superinten- dent	19	15.2%
	31-35 years	25	20.0%		Senior designer	32	25.6%
Age groups	36-40 years	39	31.2%		OEM mainly	29	23.2%
	41-45 years	27	21.6%	Tuma	ODM mainly	41	32.8%
	46-50 years	9	7.2%	Туре	OBM mainly	24	19.2%
	Over 51 years	6	4.8%		Design house	31	24.8%
	High school	12	9.6%		Below 10 persons	64	51.2%
Level of	Junior college	21	16.8%		11-20 persons	45	36.0%
education	College	53	42.4%	Scale	21-30 persons	11	8.8%
	Graduate	39	31.2%		31-40 persons	2	1.6%
					Over 41 persons	3	2.4%

Table 3. Statistics of the subject's background

Criteria for Selecting New Industrial Designers

Table 5 shows that the five main criteria companies use for recruiting new industrial designers are, in decreasing order of importance, creativity, ability to design product form, quality of design work, awareness of design trends, and aesthetic sense; meanwhile, the five least important criteria are cer tificates of design skill, awards received, specialties, knowledge of marketing, and educational background.

From the overall dimension of evaluation criteria, the most important one is personal disposition, which was assigned an average score of 4.53, indicating very important, followed by professional ability in second place, with an average score of 4.33. Mean-

while, the average scores of the criteria of ability to use 2D computer software, knowledge of human factors, and knowledge of marketing fell between 3.9~3.0, indicating that they were fairly important to important. Moreover, the scores of other criteria all exceed 3.54, indicating important. For the dimension of background, the average is 3.54. The only exception was certificates of design skill, with a score of 2.92 that less than 3.00, meaning fairly important to not important, and the average scores of other criteria all fell in the range of fairly important to very important. These figures demonstrate that companies hope to select new industrial designers based on personal disposition, and professional ability, and ability to match project design requirements. The reason for the criteria certificate of design skill being assigned the lowest importance may be due to the lack of useful certificates of design skill for industrial designers. Therefore, the managers place little emphasis on certificates of design skill. This study uses independent sample t test and one-way ANOVA to examine the differences among subject types and the relation between business types and criteria for selecting new industrial designers. *t*-test is used to examine the gender effect and ANOVA is applied to test the effects of age groups, level of

education, title, business types, and organizational scale. The F values and P values demonstrate whether significant differences exist among these criteria. Furthermore, the Scheffé multiple comparison test is applied to different groups to identify the causes for these significant differences (McCall, 1998). Criteria, property of companies, and criteria that reach significant differences are shown in Table 6.

Regarding the titles of interviewed subjects, enterprise department chiefs, creativity managers, and senior designers place greater emphasis on the foreign language competence of new industrial designer than managers in charge of design houses do. This phenomenon demonstrates that design departments in companies place a greater emphasis on internationalization and designing products for global markets than design house managers do. Regarding level of education, managers with higher educational backgrounds are more concerned with about the product form design ability and idea sketch ability, while lower educational backgrounds are concerned with the machining knowledge, meaning that managers with higher educational backgrounds ask more about design skills of the newly hired industrial designers.

Recruitment methods	Design department in compa-	Design house	Total number
	nies	(39 copies)	(125 copies)
	(86 copies)		
Face-to-face interview	86 (100.0%)	39 (100.0%)	125 (100.0%)
Portfolio check	81 (95.3%)	39 (100.0%)	121 (96.8%)
Written test	40 (46.9%)	7 (17.2%)	50 (40.2%)
On the spot tests	10 (11.6%)	20 (51.7%)	26 (20.5%)

Table 4. Recruitment methods in companies interviewed

D: :	Cuitania of estadion	Auguage	1	D /	Dimensions		
Dimensions	Criteria of selection	Average	sa	Kank	Average	sd	Rank
	Educational background	3.71 **	0.68	23			
Background	Work experience	3.71	0.70	21			
	Specialties	3.60 **	0.70	25	3.54	0.34	3
	Certificates of design skill	2.92 **	0.61	27			
	Foreign language	3.71	0.72	22			
	Awards received	3.57 **	0.75	26			
	Idea sketch ability	4.22	0.88	16			
	Product form design skills	4.90 *	0.31	2			
Professional	Product analysis and planning ability	4.23	0.71	15		0.27	
	Presentation ability	4.25	0.64	14	4.33		
	Ergonomic knowledge	3.79	0.67	20			
	2D software ability	3.95	1.00	19			2
ueiiity	3D software ability	4.68	0.63	7			
	Machining and manufacturing knowledge	4.03	0.83	17			
	Knowledge of marketing	3.69 **	0.74	24			
	Problem solving ability	4.57	0.59	10			
	Awareness of design trends	4.78 *	0.43	4			
	Creativity	4.92 *	0.28	1			
	Team work	4.56	0.65	11			
	Quality of design work	4.84 *	0.39	3			
	Self-confidence	4.01	0.75	18			
Personal dispo-	Novelty to things	4.30	0.70	13			
sition	Aesthetic sense	4.74 *	0.49	5	<u>4.53</u>	0.34	1
5 mon	Optimistic and ambitious	4.38	0.62	12			
	Work enthusiasm	4.61	0.58	9			
	Desire of learning	4.70	0.48	6			
	Patience and perseverance	4.61	0.61	8			

Table 5. Importance of the dimensions of criteria for selecting new industrial designers

Note: "*" means importance ranked in top 5 and "**" denotes importance ranked in bottom 5.

ruore of eriteria, property of companies, and eriteria mat reach significant anterenees	Table 6.	Criteria,	property of	companies.	, and c	criteria the	at reach	significant	differences
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Criteria	Property	Average & ANOVA for recruitment methods	F value	p value
Foreign language	Title	Department chief (3.95)>manager in charge of design house (3.28);	3.77	0.016*
		Creativity superintendent (3.71)>Person in charge of design house (3.28);		
		Senior designer (3.62)>Person in charge of design house (3.28)		
Idea sketch ability	Level of education	Graduate school (4.38)>Junior college (3.33); College (4.16)>Junior college (3.33)	4.93	0.003*
	Business types	ODM (4.25)>OEM (3.54); OBM (4.69)>OEM (3.54);	6.64	0.000*
		Design house (4.25)>OEM (3.54)		
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	Organizational scales	11~20 persons (4.47)> below 10 persons (3.79)	5.11	0.003*
Product form design skills	Level of education	Graduate school (4.91)>High school (4.00); College (4.86)>High school (4.00); Junior college (4.93)>High school (4.00)	4.43	0.006*
2D software ability	Age groups	41~45 years (4.53)>26~30 years (3.60); 41~45 years (4.53)>31~35 years (3.71); Over 51 years (3.50)>26~30 years (3.60)	2.47	0.038*
3D software ability	Gender	Male (4.71)>Female (4.27)	2.12	0.037*
Machining knowledge	Level of education	Junior college (4.53)>college (3.91)	2.85	0.042*
Knowledge of mar- keting	Age groups	46~50 years (4.20)>31~35 years (3.29); Over 51years (3.50)>31~35 years (3.29)	2.53	0.034*
Creativity	Gender	Female (5.00)>Male (4.89)	3.16	0.002*
Team work	Business types	Design house (4.79)>OEM (4.25)	3.37	0.022*
	Organizational scales	11~20 persons (4.78)> below 10 persons (4.38)	3.65	0.016*

Notes: "*" represents reaching significance level of 0.05.

Regarding gender, male managers tend to emphasize the 3D software abilities of prospective new designers more than female managers do, while female manages emphasize creativity. It indicates that male managers may focus on design techniques, while female managers focus on creativity when recruiting new designers. In terms of age groups, older managers tend to place a greater emphasis on the 2D software abilities of designers, as well as marketing knowledge, demonstrating that older managers may ask new industrial designers to use 2D graphics for displaying product ideas and are highly concerned with ideas that relate to special marketing strategies. In terms of business types, managers in companies that aggressively design and develop new products, that is, ODM, and OBM business types, and managers in design houses, place greater emphasis on the sketching and team work abilities of new designers than mangers in OEM business types do. It indicates that managers in different types of companies will seek dif

ferent design abilities in newly recruited industrial designers. Regarding organization scale, managers in companies with large numbers of employees place greater emphasis on the sketch ability and team work of new industrial designers, meaning that managers in different sized organizations require different team work abilities from newly hired industrial designers.

Job Performance

Table 7 lists the overall situation of the job performance of newly recruited industrial designers. The overall average job performance score for new industrial designers is 3.66, falling in the range between fairly satisfied and very satisfied. This score indicates that managers are not extremely satisfied with the performance of newly hired industrial designers. Among job performance items, the top three criteria associated with higher levels of manager satisfaction are schedule control ability, aesthetic sense, and computer aided design software manipulating

ability. Meanwhile, the criteria that managers are least satisfied with are free hand sketching, knowledge of engineering and manufacturing, and product planning abilities. This phenomenon exists because industrial designers are good at using computer software to assist in developing project proposals. These tools can reinforce product design efficiency, but may lead newly recruited industrial designers to neglect traditional free hand sketch skills. Additionally, considerable variety exists in the application of product texture and machining techniques. Newly recruited industrial designers should enrich their knowledge of engineering and manufacturing. It is also the case for product planning ability, and thus newly recruited industrial designers should strengthen their product planning ability. Furthermore, Table 8 lists the effects of different recruitment methods on industrial designer job performance. Face-to-face interview is indispensable for all recruitment methods. Therefore, a t-test is conducted to analyze the effects of portfolio check, project design, and written test. The test result demonstrates that portfolio checking significantly influences the performance of new industrial designers in terms of creativity, personal disposition, and schedule control ability. This phenomenon occurs because a portfolio often indicates designers work experience, sketches, and similar information which managers can use as a basis for selecting individuals with better work experience and execution ability. Furthermore, the adoption of project design also leads to significant differences in the performance of new industrial designers in terms of product form skills, product planning abilities, and ability to use design software. In the procedure of the project design test, the manager frequently asks designers to perform practical design tasks such as idea sketches, rapid design, and computer graphics, so that the manager can select designers with better design ability who are better able to cope with work pressure. Finally, the written test also causes significant differences in the personal disposition of industrial designer. This phenomenon occurs because the result of attitude testing will reflect whether the personal disposition or character of the new industrial designer is suitable for product design.

Item of job performance	Average	sd	Rank	
Product form	3.69	0.84	6	
Free hand sketching ability	3.20 **	0.85	10	
Creativity	3.74	0.76	5	
Personal disposition	3.76	0.82	4	
Aesthetic sense	3.92 *	0.77	2	
Product planning ability	3.57 **	0.79	8	
Knowledge of engineering and manufacturing	3.44 **	0.94	9	
Ability to use design software	3.81 *	0.90	3	
Ergonomic knowledge	3.57	0.68	7	
Product form	3.92 *	0.97	1	
Total average	3.66	0.50		

Table 7. I	Descriptive	analysis o	of the	industrial	designers'	job	performance
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Notes: "*" means ranked in top 3 and "**" means ranked in bottom 3.

Conclusion and Management Meanings

This study explored the methods and data used to recruit new industrial designers and their satisfaction with the job performance of newly recruited industrial designers. The relationship between the method used for recruiting new industrial designers and manager satisfaction with the job performance of newly recruited industrial designers was also explored. The survey results can provide a reference for managers, educators, and designers. The author reached the following conclusions.

Table 8. The items of industrial designer's job performance that recruitment methods' effect reaches significant levels

Job performance	ANOVA for recruitment methods	t-value	P value
Product form	project design (3.78) >no project design (3.11)	4.61	0.001*
Creativity	portfolio check $(3.96) >$ no portfolio check (3.69)	2.20	0.028*
Personal disposition	written test $(3.86) > $ no written test (3.62)	2.38	0.018*
	portfolio check (3.98) > no portfolio check (3.71)	2.58	0.040*
Product planning ability	project design (3.62) > no project design (3.22)	2.83	0.005*
Ability to use design software	project design (3.85) > no project design (3.50)	2.22	0.028*
Schedule control ability	portfolio check (4.15) > no portfolio check (3.88)	2.32	0.023*
Average	portfolio check (3.80) > no portfolio check (3.63)	2.90	0.004*
	project design (3.70) > no project design (3.40)	2.72	0.009*

a) Besides the fact that all companies adopted face-to-face interviews in recruiting designers, 98.0% of them checked applicant portfolios. Additionally, 40.2% of the companies interviewed further by conducting written tests, with attitude and verbal tests being required for all newly recruited employees for the personnel resource sector. Only 20.5% of the companies interviewed adopted on the spot project design tests for ensuring the ability of newly hired industrial designers to meet the company requirements in the area of design work. About half of design departments in companies (46.9%) adopted written tests, while only some design houses (17.2%) used a written test. Only some design houses (51.7%) used on the spot tests to check applicant abilities in sketching and computer-aided design, and none of design

departments in companies did. b) The five most important criteria in recruiting new industrial designers are creativity, product form design ability, design quality, awareness of design trends, and aesthetic sense; meanwhile, the five least important criteria are certificates of design skill, awards received, specialties, knowledge of marketing, and educational background. Selection criteria differ significantly among managers with different backgrounds, firm scales and business types. As a result, industrial designers should improve their personal dispositions, such as teamwork, selfconfidence, optimism, aggression, enthusiasm and their professional abilities to meet an enterprise's requirements. c) There exist significant differences in the property of companies and criteria. In terms of the titles of interviewed

subjects: enterprise department chiefs, creativity managers, and senior designers place greater emphasis on the foreign language competence of new industrial designer than do managers in charge of design houses. In terms of level of education, managers with higher educational backgrounds are more concerned about the product form design ability and idea sketch ability, while lower educational backgrounds are concerned with the machining knowledge. In terms of gender, male managers tend to emphasize the 3D software abilities of prospective new designers more than female managers do, while female manages emphasize creativity. In terms of age groups, older managers tend to place a greater emphasis on the 2D software abilities of designers, as well as marketing knowledge. In terms of business types, managers in companies that aggressively design and develop new products, that is ODM and OBM business types, and managers in design houses, place greater emphasis on the sketching and team work abilities of new designers than do mangers in OEM business types. In terms of organization scale, managers in companies with large numbers of employees place greater emphasis on the sketch ability and team work of new industrial designers. d) Enterprise managers are not very satisfied with the job performance of newly hired industrial designers. The three items used to assess the performance of newly recruited industrial designers that managers are most satisfied with are schedule control ability, aesthetic sense, and ability to use design software; meanwhile, the three items that managers are least satisfied

with are free hand sketching, knowledge of engineering and manufacturing, and product planning abilities. The field of design education should focus on these items and organize an appropriate curriculum to cultivate designers that will be more competitive in the human resource market. e) The written test causes significant differences in the personal dispositions of new industrial designer. On the spot design testing causes significant differences in the abilities of new industrial designers in product forming, product planning, and using design software. Consequently, depending on requirements, enterprise managers can adopt specific recruitment methods of combinations of different procedures for more effectively hiring excellent design talents.

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FASHION HOUSE COUTURE OVERVIEW: A BRIEF PERSONAL STORY BASED ON THE W. EDWARDS DEM-ING'S THEORY OF MANAGEMENT

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Abstract

This paper reviews Fashion House Couture, a small fashion design company in New York, NY, using W. Edwards Deming's Organizational Theory. The paper narrates an employee's personal story, makes observations relevant to many similar and non-similar organizations worldwide, and offers recommendations for improvement and change based on Deming's 14 Points for Management, Elliott Jaques' Organizational Theory, and Ivanov's Ideas for New Organizational Theory.

Key Words: W. Edwards Deming, Organizational Theory, 14 Points for Management

Introduction designer for a new and upcoming fashion company in Manhattan, New York. The amazing world of fashion and designing is a fast pace industry. I was lucky enough to land a job as a junior job description included stretching design, pattern making, color coordination and research for upcoming trends. After working for the company for a year, I was asked to do several tasks outside of my job description. I was asked to sweep the designer floors, answer the telephone, and call clients to schedule appointments, portfolio presentations and garment completion.

After a year, I asked my immediate supervisor for a raise because I wanted be compensated fairly for the work I was doing. The supervisor said "the company was not doing well, so, she wouldn't be able to give me any pay increase." However, she wanted me to continue doing the extra work.

The next week a memo was posted of the company's yearly earrings, and it showed the company was making good money with no loss. According to Ivanov (2015), this was a clear case of Double Talk, saying one thing, but meaning another, lying to get want you want without worrying about the person to whom you are lying.

After hearing the news that the company was not making money I, decided to give my supervisor ideas to improve the company. My ideas were dismissed, and the supervisor never forwarded my ideas to the CEO of the company.

According to Deming, the employees do not have any power; all of the power belongs to the CEO/ management. If change is going to occur, the CEO must lead and approve the changes (Deming, 1992, 1993). I learned this first hand when I suggested that the company should hire more local designers. This could have saved the company money. Hiring more local designer instead of experienced high priced designers for a much lower cost to the company, would have saved the company thousands of dollars.

According to Deming, you cannot measure work, so even thou I thought I should have been paid more money, the CEO did not agree. The CEO wanted to keep most of the money for himself.

Deadly Diseases

According to Deming, a major Deadly Disease is Lack of Constancy of Purpose. Deming states that a "Lack of Constancy to plan products and services that will have a market and keep the company in business, and provide jobs" (Deming, 1992, 1993). The evaluation of performance, merit rating, or annual review do nothing for the employees or the company. These diseases cause problems for the employees, such as employee confrontation between lower level employees and management (Deming, 1992, 1993). For example, I was given a yearly evaluation with double-A rating, but with no increase in pay. What I did receive was a certificate for a job well done. I agree with Deming - "what I could do to improve the quality of work in this company?" - absolutely nothing because the CEO has all the power and makes all the decisions for the company.

Lessons Learned

I have learned that the CEO of the Fashion House Couture, where I

worked for a couple of years, controls everything. The CEO is in charge of everything, making all decisions pertaining to the. The life of the company depends on the CEO's decisions and actions.

An example of a Deadly Disease pertains to Fashion House Couture happened in late December of 2012 when the company decided to stop local designers from marketing their garments to overseas buyers. This cost the company to lose money. As a result, the entire introduction level department was eliminated a year later.

At the beginning I noticed the company was buying new machinery, then a year later several employees were laid off. This was clearly not a good business practice or good decision-making on the part of the CEO.

According to Deming the emphasis on short-profits, short-term thinking (just the opposite from constancy of purpose to stay in business), fueled by fear of friendly takeover, and push from bankers and owners for dividends harmed this company.

Recommendations

To improve this company, the CEO could possibly meet monthly with employees to discuss plans and ideas to increase sales and improve relationships with the current buyers.

The CEO could also introduce necessary training to keep up with the changing times in the fashion business. Such could be attending classes at The Fashion Institution in New York. He could also facilitate discounts on fabric from Mood and The Garment District in New York. This would allow the designers to be more creative with less costs to them.

The CEO could also provide coffee and tea for the office to create a more friendly environment. This would help employee feel the company cares for them. The company should also consider paying their employees fairly (Ivanov, 2011, 2012, 2013, 2014, 2015), (Jaques, 1996, 2002).

According to Jaques and Ivanov, the higher you go up in the hierarchy, the longer the tasks become. It takes time to complete a task. The CEO should create a conducive environment in for longer tasks (Jaques, 1996, 2002), (Ivanov, 2011, 2012, 2013, 2014, 2015).

Additionally, the company should invest into modern software to keep up with changes in technology.

Conclusion

There is nothing that I could do to change or improve this company. The CEO has complete control and makes all of the decisions. The employee is just a pawn in this game. In reality, no changes would be made unless the CEO makes them.

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APPLICATION OF THE TALENT QUALITY-MANAGEMENT SYSTEM TO ASSESS TRAINING EFFECTIVENESS OF ENTERPRISES

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Abstract

This study explored the effectiveness of training activities provided by enterprises to their employees. A total of 158 Taiwanese enterprises assessed in 2013 using the Talent Quality-management System (TTQS) were used as research targets. Comprehensive Metaanalysis 2.0 was used for conducting meta-analyses for determining whether the TTQS assessment indicators significantly influenced the assessment of the training effectiveness of the enterprises in the services and manufacturing sectors. The results revealed that the TTQS assessment indicators significantly influenced the assessment of the enterprises' training effectiveness, indicating the suitability of these assessment indicators as effective assessment tools. Specifically, the TTQS assessment indicators can be used to assess the training effectiveness provided by enterprises. In addition, all TTQS assessment indicators in the various dimensions influenced the overall training effectiveness of the enterprises. Therefore, they were used to determine whether the enterprises effectively undertook training activities at various stages. The results showed consistent training outcomes and assessment results. Therefore, the TTQS was conducive to enterprises, and the mechanisms through which enterprises promoted and undertook training activities were objectively determined.

Key Words: Assessment, Enterprises, Human Capital, Meta-Analysis, Talent Quality-Management System (TTQS)

Introduction

Human capital is a critical factor influencing an enterprise's business operations and is an indispensable asset to an enterprise. Enterprises should link training outcomes with their business goals to ensure their sustainable development and to demonstrate the relevance of training. The American Society for Training and Development (ASTD) defines training as the process of using learning plan to help employees improve their work performance by verifying, evaluating, and assisting their personal development (McLagan, 1983). The Workforce Development Agency, R.O.C. (Taiwan), previously known as the Bureau of Employment and Vocational Training, R.O.C. (Taiwan), developed the Talent Qualitymanagement System (TTQS) involving a plan-design-do-review-outcome cycle to ensure that enterprises provide reliable and appropriate training to their employees. In 2011, the Workforce Development Agency (WDA) provided a follow up report on the effectiveness of the TTQS. The report indicated that this agency provided training courses since 2006; the training courses included basic TTQS

courses, advanced functional analysis, strategic planning, and related courses for internal auditing staff. The number of trainees increased annually.

Furthermore, this agency provided guidance to new divisions annually. To conduct a consistent assessment, the WDA began to formally assess subsidy plans in 2010, indicating the determination the government to promote the TTQS. This implies positive results from the implementation of TTQS could be obtained. In the current study, we used enterprises that introduced TTQS into their organizations as the research targets. Such enterprises were used because they consider training as a type of investment rather than a waste. Currently, the TTQS of the enterprises were individually was assessed. The training processes and quality of enterprises were examined according to assessment indicators. However, the effectiveness of training in enterprises involving a TTQS from the perspective of the industry would require further analysis. The purposes of this study are outlined as follows: (1) To examine the training performance of enterprises applying TTQS. (2) To explore differences in the training effectiveness between various types of enterprises. (3) To provide a reference for enterprises to improve their training effectiveness and to effectively promote TTQS.

Literature Review

Talent Quality-management System

The Ministry of Labor, Executive Yuan, developed the TTQS for enhancing the ability of vocational training divisions to provide training and to stimulate talent development and investment. In other words, the WDA stipulated talent quality management regulations to enhance the ability of enterprises and training institutions to provide training and to improve training quality (Ministry of Labor, 2014). According to the International Organization for Standardization (ISO 10015), Investors in People (IIP), and the Deming cycle (i.e., the plando-check-act (PDCA) cycle), the Ministry of Labor developed the TTQS to assist enterprises and training institutions in assessing training quality. The TTQS comprises a five-step training management cycle (plan, design, do, review, and outcome (PDDRO)) (Chang & Chen, 2013; Chiu, 2012; Hsieh, 2012; Chen, 2010).

Personnel training and development has become a vital strategy for industrial upgrade and development. Enterprises can effectively respond to a rapidly changing economy and society only by implementing vocational training systems that can enhance employee performance continually and systematically (Wang, 2012). Backer (1964) defined human capital as people's wisdom, knowledge, ideas, skills, and health. Although people can be separated from their financial and physical assets, they cannot be separated from their knowledge, skills, health, or values, demonstrating the inseparability of human capital (Wright & McMahan, 2011). Chiu (2012) reported that the TTQS, Deming PDCA cycle, IIP, or ISO 10015 can be used for developing training process and quality improvement indicators and for implementing a systematic thinking and design framework. In a TTOS assessment mechanism, the relationships among various operating procedures must be evaluated when using a TTQS training management cycle to implement a training program; furthermore, enterprises and training institutions should adopt TTQS procedures to ensure that their business goals are achieved. Therefore, each step in the TTQS PDDRO cycle should meet the PDCA requirements. These processes can thus ensure the effective implementation of the TTQS (Huang, 2012). The TTQS is an innovative training mechanism for enterprises and training institutions. Enterprises should apply the TTQS to optimize their service quality, ensure the quality of manpower training, and achieve their business goals, thereby, fulfilling their corporate core values (Chen, 2013). The TTQS can enhance the ability of enterprises and training institutions in providing training and can improve the effectiveness of training programs. In addition, it has been widely applied to preemployment training and on-the-job training and has been used as a tool for identifying suitable training procedures (Workforce Development Agency, 2014).

Training

Both education and training involve imparting knowledge and skills (McGehee & Thayer, 1961; Watson, 1979). The success of a business is dependent on the professional abilities of its employees. Such abilities involve professional knowledge and skills, which can be improved through training (Shu, 2011). Nadhr and Laird (1979) reported that the purpose of training employees is to help them to develop specific abilities or to improve their capabilities in executing work functions and prepare them for their future work responsibilities. This can enable employees who assume new positions to make substantial contributions to their organizations. Employees are primarily trained to improve their work performance or ability and to help them adapt to new work procedures and governance standards. Gilley and Eggland (1989) indicated education and training mutually support and correspond with one another. Employees undergo education to prepare them to assume greater responsibilities and contribute through their performance in future tasks, and undertake training to improve their current work performance. Neumann et al. (1998) categorized employee training into three groups, namely education, training, and development, and are capable of providing employees with basic knowledge, professional knowledge, and advanced knowledge, in addition to job-specific skills and knowledge. Yang and Chen (2012) emphasized that enterprises should not ignore the importance of employee training because employees are crucial capital and assets for enterprises. Enterprises provide training programs to strengthen the overall organizational performance, ensure the adequate use of human resources, and enhance the performance of employees. An organization typically provides training to its employees to enable them to modify their work practices in order to assist them in achieving organizational goals (Michael et al., 2012). Therefore, training is a crucial method for equipping employees with necessary knowledge and skills, enhancing overall organizational performance, and achieving organizational goals (Lin & Wang, 2012). Desimone and Harris (1998) suggested that because demand assessment is a powerful strategic planning method, training requirements must be assessed before executing human capital development and training processes. Before providing training, an enterprise must assess training requirements so that the training program can meet the requirements of the enterprise and its employees. Lee (2003) indicated that training can effectively enhance the employees' professional capabilities. The effectiveness of training must be assessed for understanding training outcomes. The main objectives of assessing the effectiveness of training are presented as follows: (a) to continually improve training processes and effectiveness, and (b) to provide a reference for future training plans. The mechanism associated with assessing the effectiveness of training comprises a cyclic system various dimensions and steps. The additional objectives of assessing training effectiveness are to clearly understand the current situation of employees, to modify work procedures, to

maximize the effectiveness of training activities undertaken by enterprises, and to adequately respond to the changing market (Lee et al., 2013; Wang, 2006).

Meta-Analysis

Glass proposed the term metaanalysis in 1976. In the book The History of Statistics, Stigler (1986) indicated that the principle of least squares suggested by Legendre in 1805 can be used to solve current meta-analysisrelated problems (Cheng, 2013; Hwang & Lin, 2002). Because meta-analysis entails applying quantitative analysis techniques, the errors encountered in numerous previous studies can be eliminated to obtain coherent, useful, and generalizable findings (Tseng et al., 2014; Hwang, 2004; Ying & Chung, 2000; Hunter & Schmidt, 2004). Metaanalysis is a type of quantitative literature review; effect sizes are used to represent the relationship between two variables and can be classified into d family, *r* family, and odds ratio family. Researchers in the education and psychology fields typically adopt d and rfamilies, whereas those in the medical field typically adopt odds ratio. Metaanalysis has become one of the mainstream research methods in the education and psychology fields. Studies involving meta-analysis have been generally published in *Psychological* Bulletin, Review of Educational Research, and Personality and Social Psychology Review (Hsu, 2013). Standardized mean difference developed by Hedges (1981), odds ratio, and correlation coefficient are typically used as an effect size index in the literature related to psychology, medicine, and management, respectively (Hong, 2012).

Methodology

Ascertaining the Sources for Secondary Data Analysis

In Taiwan, products from the agricultural, industrial, and services sectors constitute 1.6%, 56.8%, and 41.6% of the total domestic production, respectively (Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C. (Taiwan), 2015), indicating that the services and manufacturing sectors are the main industries in Taiwan. In this study, enterprises in Taiwan that had been assessed in 2013 served as the research targets. We used this selection criterion because the services and manufacturing industries constituted the main industries in Taiwan.

A statistical analysis revealed that 158 enterprises satisfied the selection criterion. Table 1. shows the distribution of enterprises assessed in 2013, and Table 2 shows classification criteria for TTQS assessment. As shown in Table 1. 54.286% of enterprises in the services industry satisfied the threshold criterion, and 20.000% of the enterprises in this industry were awarded a bronze medal according to the assessment results. These two groups of enterprise constituted 74.286% of the overall enterprises in the services industry. In addition, 43.089% of the enterprises in the manufacturing industry met the threshold criterion; however, 26.016% of the enterprises in this industry did not meet

		Services	industr	<u>y</u>	Manufacturing industry			
Level	Fre-	Percent-	Moon	Standard	Fre-	Percent-	Moon	Standard
	quency	age(%)	Mean	deviation	quency	age(%)	Mean	deviation
Gold	2	5 714	85.7	254	2	2.439	86.1	280
medal	L	5.714	5	.554	5		7	.209
Silver	2	8 571	78.3	2 752	1	2 252	77.6	2 251
medal	5	0.371	3	5.755	4	5.252	3	5.551
Bronze	7	20,000	67.0	2 000	21	25 202	66.8	2 074
medal	/	20.000	0	5.000	51	25.205	2	2.974
Satisfied								
the	10	51 286	55.8	2 161	53	13 080	56.0	2 121
threshold	19	54.200	9	2.404	55	45.009	0	2.424
criterion								
Failed to								
meet the	1	11 / 20	47.3	1 888	32	26.016	46.2	5 261
threshold	4	11.429	8	4.000	52	20.010	2	5.201
criterion								
Overall	35		60.7	10 670	123		57.6	10.095
Overall	55		7	10.079	123		2	

Table 1. Distribution of enterprises assessed in 2013

Data source: This study

Level	Classification crite- ria	Implementation effectiveness
Platinum medal	> 96.5	Enterprises with a platinum medal can serve as model enterprises.
Gold medal	96 - 85.5	Enterprises with a gold medal have effectively im- plemented the TTQS and should continue to improve.
Silver medal	85 - 74.5	Enterprises with a silver medal have adequately im- plemented the TTQS and should make other critical improvements.
Bronze medal	74 - 63.5	Enterprises with a bronze medal have only partially implemented the TTQS and should make a substan- tial improvement.
Threshold	63 - 53.5	Enterprises in this category have not presented effec- tive implementation results.

Table 2. Classification criteria for TTQS assessment

Data source: WDA, Executive Yuan, R.O.C. (Taiwan, 2015)

the services and manufacturing industries were .354 and .289, respectively. the threshold criterion. These two groups of enterprise constituted 69.105% of the overall enterprises in the manufacturing industry. These standard deviations were the smallest among all enterprises, and the services and manufacturing industries attained the gold medal category. This means that training quality was similar among enterprises in the gold category. The enterprises that did not meet the threshold criterion registered the highest standard deviation (4.888 and 5.261), signifying that a large difference existed in the training performance among enterprises that did not meet the threshold criterion.

Assessment Tool

As mentioned, we used enterprises assessed in 2013 as the research targets. An assessment table was used as a TTQS assessment tool for each enterprise. The TTQS assessment tool comprised 5 dimensions and 19 assessment indicators. Table 3 shows the business edition of the TTQS assessment table.

Standardization of Assessment Scores

For the TTQS indicators, the scores for Indicators 1–16, 18, and 19 ranged from 1 to 5. Furthermore, the scores for Indicators 17a and 17b ranged from 0 to 2, whereas those for Indicators 17c and 17d ranged from 0 to 3. To ensure that all TTQS indicator assessment scores were comparable on the same basis, we standardized the scores by using the range method. The

standardized TTQS assessment scores ranged between 0 and 1.

Calculation and Formulae

Meta-analysis is mainly related to the transformation of effect size. An effect size refers to the correlation between variables or mean difference between groups. The correlation coefficient r and standardized mean difference d are the typically employed standardized effect size. The correlation coefficient r and standardized mean difference d are interchangeable, and the only difference between them is the method involved in calculating standard error and error correction (Field, 2001). In this study, effect size was defined as the correlation between two variables. Therefore, the variables explored in this study involved the various types of enterprises in the services and manufacturing sectors, assessment indicators, and correlation between various assessment indicators. The mean effect size was examined using the following expression (Ying & Chung, 2000):

Z test for mean effect size: $Z = \frac{\overline{d'}}{SE_{\overline{d'}}}$ (1) 95% confidence interval (CI): Lower = $\overline{d'}$ -1.96× $SE_{\overline{d'}}$ (2) Upper = $\overline{d'}$ +1.96× $SE_{\overline{d'}}$ (3)

Criteria for Evaluating Mean Effect Size

90

According to Cohen (1988), an effect size of less than .20 is a small effect size, signifying a low correlation between groups; an effect size of less than .50 is a medium effect size, indicating a moderate correlation between groups; and an effect size of .80 is a large effect size, implying a high correlation between groups. Data Analysis and Discussion

Differences in Training Effectiveness Among Enterprises

The study conducted a metaanalysis for determining the differences in the TTQS assessment results among the enterprises in the services industry. As shown in Table 5, after the effect sizes of the 35 enterprises in the services industry were integrated, the independence hypothesis was supported (Q = 45.362, p > .05). Therefore, the fixed effects model was used to examine the mean effect size (d = .542; d >0). The standard error of the average effect size was .022 and the 95% CI ranged between .500 and .584. The TTQS assessment indicators were used to adequately assess the effectiveness of training programs implemented by the enterprises in the services industry; in other words, the assessment results were discriminable. The O statistic for testing the independence hypothesis was 45.362 (df = 34) and was not significant at $\alpha = .05$ (p = .092 for the χ^2 test). Accordingly, the independence hypothesis was accepted. The results revealed that the TTQS assessment indicators were independent of the results obtained from assessing the effectiveness of the training provided by the enterprises in the services industry.

Therefore, the TTQS assessment indicators were useful tools for assessing the effectiveness of the training implemented by the enterprises in the services industry.

We also executed a meta-analysis for determining the differences in TTQS assessment results among the enterprises in the manufacturing industry. As shown in Table 6, after the effect sizes of the 123 enterprises in the manufacturing industry were integrated, the independence hypothesis was supported (Q = 127.239, p > .05). The fixed effects model was thus used to examine the average effect size (d = .488; d > 0). The standard error of the average effect size was .011 and the 95% CI ranged between .466 and .511, indicating the TTQS assessment indicators could effectively assess the effectiveness of training programs provided by the enterprises in the manufacturing industry; specifically, the assessment results were discriminable. The Q statistic for testing the independence hypothesis was 127.239 (df =122) and was not significant at $\alpha = .05$ $(p = .354 \text{ for the } \chi^2 \text{ test})$. Therefore, the independence hypothesis was accepted. According to the results, the TTQS assessment indicators were independent of the results obtained from assessing the effectiveness of the training provided by the enterprises in the manufacturing industry. This thus signifies that the TTQS assessment indicators were adequate tools for assessing the effectiveness of training implemented by the enterprises in the manufacturing industry.

DimensionCod	e Assessment indicator	Dimension	Code	Assessment indicator
Plan Q1	Declaration of organizational vision/mission/ strategies and its objectives and demands	Do	Q12	Realistic training syntax to the plan
Plan Q2	Apparent training policy & objectives and the top man- agement commitment and involvement	Do	Q13	The degree of learning outcome translating or to be applicable into the job activities
Plan Q3	Unabridged PDDRO training system and scrutinized core items for the training	Do	Q14	The systematization of the training arrangement in- formation archives
Plan Q4	Well-structured documenta- tion on the training quality management	Review	Q15	Programs in-process as- sessment reports and peri- odic meta-analysis
Plan Q5	Connectivity with training planning and business aims	Review	Q16	Scrutinized monitoring and instant corrective re- medial measures
Plan Q6	Training capabilities and ob- ligations consigned to the training authorities	Outcomes	Q17	Training outcome assess- ment with diversity meth- ods to the completion
Design Q7	Competency gap analysis to make of the training require- ment	Outcomes	Q18	The top management per- ceptions and recognition to the training
Design Q8	Systematized designs for the training programs	Outcomes	Q19	Total Training Perfor- mance
Design Q9	Stakeholders' participation in the process of training design			
Design Q10	Standardized process and criterions for the procurement of training products or ser- vices			
Design Q11	The integration of trainings into the targeted demand			

Table 3. TTQS Training Quality Assessment – Version for Business Institution

Data source: WDA, Executive Yuan, R.O.C. (Taiwan, 2015)

The meta-analyses executed in this study revealed that for the various enterprise types, the results of the independence test were not significant and the independence hypothesis was thus accepted. This finding indicates that the TTQS assessment indicators were useful tools for assessing the effectiveness of training implemented by the various enterprise types.

Overall enter-	Number of effect sizes	Effect size	Variance	Standard error	95% CI			
prises	158	d	Variance	Std Error	Lower limit	Upper limit	Z value	р
Fixed effects model		.500	.000	.010	.480	.520	50.003	.000
Random effects model		.499	.000	.011	.478	.521	46.283	.000
Independence test	Q-value	df	р					
	177.449	157	.126					

Table 4. Meta-analysis of TTQS in enterprises

Note: An effect size $\leq .2$ is a small effect size; an effect size > .05 is a medium effect size; an effect size $\geq .8$ is a large effect size.

Data source: This study

Services enter-	Number of effect sizes	Effect size	Variance	Standard error	ndard 95% CI rror			
prises	35	d	Variance	Std Error	Lower limit	Upper limit	Z value	р
Fixed effects model		.542	.000	.022	.500	.584	25.176	.000
Random effects model		.537	.001	.026	.487	.587	21.013	.000
Independence test	Q-value	df	р					
	45.362	34	.092					

 Table 5. Meta-analysis of TTQS in services enterprises

Note: An effect size $\leq .2$ is a small effect size; an effect size > .05 is a medium effect size; an effect size $\geq .8$ is a large effect size.

Data source: This study

Table 6. Meta-analysis of TTQS in the enterprises in the manufacturing industry

Manufacturing	The number of effect sizes	Effect size	Variance	Standard error	95% con inte	nfidence rval		
enterprises	123	d	Variance	Std Error	Lower limit	Upper limit	Z value	р

Fixed effects model		.488	.000	.011	.466	.511	43.258	.000
Random effects model		.488	.000	.012	.466	.511	42.106	.000
Independence test	Q-value	df	р					
-	127.239	122	.354					

Note: An effect size $\leq .2$ is a small effect size; an effect size > .05 is a medium effect size; an effect size \geq .8 is a large effect size. Data source: This study

Table 7. Meta-analysis results regarding TTQS in enterprises

		Effect size		Independence test		
_	Fixed effects	Random effects	Difference	Statistic	р	Results
	model	model	ICVCI			
Overall enter- prises	.500***	.499***	Medium	177.449	.126	Independent
Services en- terprises	.542***	.537***	Medium	45.362	.092	Independent
Manufacturing enterprises	.488***	.488***	Small to medium	127.239	.354	Independent

Note: 1. *p < .05, **p < .01, ***p < .001

2. A difference level is indicated by an effect size; an effect size $\leq .2$ is a small effect size; an effect size > .05 is a medium effect size; an effect size $\ge .8$ is a large effect size. Data source: This study

Differences Among the Various Enterprise Types

Table 7 shows the meta-analysis results for the TTQS in the enterprises, indicating that the effect sizes for the various enterprise types are significant. These effect sizes were medium effect sizes, signifying that TTQS assessment indicators can be used to help enterprises effectively plan and undertake training activities and avoid unnecessary time consumption and costs. Consequently, the enterprises can effectively provide training to their employees

to enhance the employees' skills and improve business performance.

Conclusions

In this study, a quantitative meta-analysis was conducted for determining the effectiveness of the training provided by enterprises. The findings are described in the following section.

(1) Enterprises planning to implement training activities should readily improve the quality of the training process workflow and effectiveness of such activities to increase the willingness of enterprises to implement training activities. The analysis results revealed that the TTOS assessment indicators were independent of the results obtained from assessing the effectiveness of the training provided by the various enterprises, indicating that TTQS assessment indicators were adequate tools for assessing the quality and effectiveness of training provided by enterprises. The TTQS assessment indicators comprised five dimensions: plan, design, do, review, and outcome. The plan dimension of the TTQS assessment indicators demonstrated the greatest influence on training effectiveness, signifying that enterprises planned training activities to achieve business goals and formulated relevant training systems accordingly. The review dimension of the TTOS assessment indicators exhibited the secondhighest influence on training effectiveness, indicating that enterprises engaged in training activities effectively monitored training processes and managed unexpected events to ensure that the training outcomes met the expected goals.

(2) Enterprises in the services and manufacturing sectors are distinct. Enterprises in the services industry provide intangible products, whereas those in the manufacturing industry provide tangible products. This study found that the effect sizes of training effectiveness for enterprises in both the services and manufacturing industries were significant; the effect sizes of training effectiveness for the enterprises in the services and manufacturing industries were moderately correlated.

Therefore, the enterprises in both the services and manufacturing sectors demonstrated excellent TTQS performance. Furthermore, the mean effect size for enterprises in the services sector (.542) was superior to that for those in the manufacturing sector (.488). This difference is attributable to the business operation model adopted in these industries. Enterprises in the manufacturing industry mainly manufacture products and thus place considerable emphasis on product quality control and production efficiency improvement. By contrast, those in the services sector mainly provide services (e.g., information services, educational services, healthcare services, and social work services) that are delivered by people. Therefore, compared with enterprises in the manufacturing sector, those in the services sector placed greater emphasis on training.

(3) The TTQS is an assessment tool for evaluating the effectiveness of training activities provided by enterprises and for examining whether such training activities satisfy the enterprise business requirements. Specifically, training programs must be implemented according to enterprises' business philosophies and development strategies and must be linked to business goals. Employees' training performance should be assessed to maximize training effectiveness. Training programs provided by enterprises must facilitate organizational development and enhance employees' work capabilities. Effective training can help enterprises achieve their business goals and increase human capital.

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EXPLORING STRATEGY FIT OF COMPETITION ON FOREIGN ENTERPRISE AND BRAND STRATEGY

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Abstract

Strategy options for competing in world markets exist when competitive conditions across national markets are linked strongly enough to form a true world market. An Multinational Enterprise (MNE) has to know the environmental change to allocate its resource in time in order to survive. The purpose of this research is to understand the present development of Taiwan's MNE in Vietnam and the trend in future. The research also discusses the competitive strategy of MNE and brand strategy while facing considerable amount of stress from a variety of market competition. According to the result of this research, the competitive and brand strategies of Taiwan's MNE should focus on decreasing expense and lowering the cost, improving service technique, quality, differentiation. This will enable the MNE to build cost advantages, differentiation, centralize advantages, management advantages and global positioning. These advantages develop drafts for competitive strategies shorten the time for decisions of policies and responses.

Key Words: Competitive Strategy, Brand Strategy, Brand Extension, MNE's Strategy,

Introduction

A FDI inflow into Vietnam is widely believed to benefit the economy in terms of investment capital, technology transfer, management skills, and job creation. Accordingly, there has been an increasing number of research on the impacts/contribution of FDI to economic growth, poverty reduction, industrial upgrading. Consistent with the fact that the studies on FDI flows are considerably behind the trade literature as pointed out by Blonigen (2005), although there is now a large body of research on the link between trade liberalization and growth and poverty reduction in Vietnam, the determinants of FDI and its impacts on the economy of Vietnam are still under researched.

In this context, this paper is one among several papers written in parallel to provide a systematic study on the determinants of FDI and its potential impacts on the economy of Vietnam. The main purpose of this paper is to collect and review FDI related papers on Vietnam and to provide an updated analysis of the determinants of spatial distribution of FDI across provinces in Vietnam during 1988-2006. In this paper, we go a step further by examining the determinants of FDI spatial distribution by source countries. We expect that the purpose and location consideration of inward FDI from different countries may vary.

Beginning with the application of

branding to products for the purpose of product differentiation, brands have developed and become one of the key success factors in firms achieving competitive advantage though differentiation. The Vietnamese retail market is expected to be one of the most attractive retail markets by 2020 (Vietnam net, 2006). More competition is expected to exist between local and foreign distributors to secure a piece of this big cake (Vietnam net, 2006). The modernization of retailers in Vietnam has occurred rapidly during the last ten years which has contributed approximately 0.5% of total estimated sales by Vietnamese food retailers through the modern super market system with many local and international brand names. Therefore, this study of brand equity from the retailing perspective in the Vietnamese market will significantly contribute to the literature on branding, especially focused on small and independent retailer.

According to the research background and motives, the concrete objectives of this study are as follows:

- (1) Understanding the Foreign Enterprise's Strategies competitive in Vietnam.
- (2) Study the critical success factors of Multinational Enterprise (MNE).
- (3) Provide the suggestion to building the strong branding for Multinational Enterprise (MNE). This chapter is aimed at strategy fit of competition

of foreign enterprise and brand strategy has done with the content of the interview results, to conduct data analysis and discuss the meaning, which is also based on interviews with the subject of three of the papers drawn up future research purposes.

Literature Review

Multinationals Enterprise (MNE), FDI/R&D on the host economy

FDI (Foreign Direct Investment) and foreign-owned Research and Development (R&D) on total factor productivity (TFP) of domestic firms is in Vietnam's high-tech industries. Growth in local firm's TFP is modeled as being dependent on the local firm's distance in technology space to foreign affiliates in the same industry, along with R&D, both foreign-owned and domestic. This model is tested on small-sampled industry-level data for Vietnam, using a within estimator, panel data approach. That openness of an economy towards FDI encourages growth in the host economies has been demonstrated already in the early macro-economic literature (Helpman, 2009).

A Research on Strategy Fit of Competition of Foreign Enterprise

Issues related to multinational enterprises (MNEs) and the internationalization of economic activity have sparked both academic and policy attention in recent years. The current discussion about the sources and consequences of foreign direct investment (FDI) highlights the interrelatedness of technology, innovation and FDI. Large MNEs are identified as the main drivers for the globalization of innovation and of research and development (R&D) activities in the literature.

Competitive strategies

As mentioned previously, Porter's (1990) competitive strategies include cost leadership, differentiation and focus. The cost leadership and differentiation strategies can be considered as the mode of competition, which refers to a firm's decision on the methods of developing competitive advantage. To draw an example from the case studies summarizes the supporting components for each mode of competition that are commonly found in the 12 companies. The focus strategy is related to the scope of competition, which refers to a firm's decision on the breadth of developing competitive advantage (Kale and Arditi, 2002). This scope of competition can vary in three dimensions: market/product, geography and function (Cheah, Kang, and Chew, 2007). In the context of construction, the dimension of market/product would refer to the different types of projects and market segments. Evidence drawn from the case study companies confirms that many have indeed diversified into various market segments and functions, although there is a few that have stayed focused within selected geographical regions.

Brand Strategy

Product branding rules are not always applicable to service branding. Services have distinctive features that define their own success factors (De Chernatony and Segal- Horn, 2003) and they entail the need for adapting the application of traditional strategies (de Chernatony and Dall'Olmo Riley, 1999). The ingredient or component branding strategy is the use of branded ingredient or component on a product by a brand (Norris, 1992). According to Norris (1992) proposed that the ingredient branding strategy result in more efficient promotion easier access to distribution, highly quality product and highly profit margin. More recently, Levin et al (2000, 2010) in the taste test study fond this adding a wellknown branded ingredient improves product evaluations of both unknown and well-known hosts brand more than when an unknown branded ingredient was added.

The account for the simultaneous impacts of each the constitution brands and its characteristic in the evaluating product as suggested by the conceptual combination literature (Hampton, 1987, 1997; Hadjicharalambous, 2013; Osherson and Smith, 1981, 1982). Since the cobranded is the result of combining two brands to name a product when evaluating that product, one has to consider the overall fit between the brand pair and the product.

The brand is not a name, a position or a marketing statement. Instead, it is a promise made by a company to its customers and supported by the same company. In the same line of thought, we agree with Aaker and Keller (1990) definition of a parent brand as the name of the brand that represents the basis for the extension. In an ever more rising competitive environment, brand marketers are looking for ways to expand their portfolios and at the same time decrease the costs of the new products introduced as well as diminish the risk of new product failure (Völckner and Sattler, 2006). One of the most popular ways to achieve this is to put a new product created in another category under the name of an existing brand. This is called brand extension (Swaminathan, Fox, and Reddy, 2001).

All major companies established in the house wares' market have identified structural changes within the market. These include a shift in the relative importance of various channels of distribution; a decline in the traditional and independent outlets; and emergence of multiple retailers in the house wares' market. Many of these "new" house wares' retailers have already established their own brands in other product areas where they have penetrated the market and secured sizeable market shares. This research sets out to identify the strategies of the growth retailers as a basis for developing a proactive approach to brand policies.

Research Methodology

Conceptual Framework

A lot of research has been doing related to this concept, it like that is an important issue to consider for MNCs international market. Therefore we find this relevant for our research topic as well. With this modification we believe that our figure sufficient in order to research our purpose. Based on mentioned key factor we have created a conceptual framework which is summarized in Figure 3.1.

Sampling Design and Data Collection

In this study, the data source with multinational enterprise through the company's business in charge of the indepth interview, their view of business with the company to verify the status of each comparison. In addition, the study data collection is the mining of multiple sources of evidence include

Competition Strategy		Strategy FIT		Competition Strategy	
Cost leadership Strategy Differentiation		strategy	Own Branding	Cost Leadership	Differentiation
				Cost Leadership I Own Branding C	Differentiation wn Branding
Branding Strategy		B B	Extension	Cost Leadership I Branding Extension	Differentiation Branding Extension
Own Branding Branding extension		Brandin	Branding]		

Figure 3.1 Conceptual Framework

documents, files, records, interviews, direct observation. Second data collection data mining based approach supplemented by primary data. In addition, the study data collection is the mining of multiple sources of evidence include documents, files, records, interviews, direct observation. Second data collection data mining based approach supplemented by primary data. The objective of this study is the case for more information in the research findings as the main basic for derivation.

The resource of a case the company's Wedsite, annual reports, newspapers assessment, information magazines, and the internet search vendor of information. Interviews with industry experts, in the observation of experts, data analysis on the secondary impact on Taiwan's list of production industry may be an important factor that made the most important factors in the elements together as a group, into questionnaire.

Cases studies are appropriate for small scale researches that handle few unit in the narrow perspective and where in an in-depth is going to be conducted. One source of this research discusses was used in this thesis: interviews. According to Denscombe (2003) an interview is a guided conversation between two or more people. Furthermore, he states that a semiconducted interview is an interview where the researchers have conducted the interview questions prior to the interview. However, the respondent can speak freely and expand the answers to have a dialogue with the researchers.

According to Jakobsen (1993) there are two kinds of interviews: faceto-face interviews and telephone interviews. We conducted the interview questions prior to the interview, and the interview guide was sent to the respondents in advance. The respondents were given room for reflections and explanations and the respondents were also able to ask questions during the interview. Additionally, supplementary information from three companies was added to the cases.

Research Method

Based on the purpose of analysis of Taiwan's MNE, for three companies within the industry and its current situation, do a preliminary investigation and understanding, so that the three companies know that in the current environment the status of Taiwan; Secondly, to investigate the three companies to understand the history of the past and grasp market trends, and predict the future trend of industrial development; the last inquiry, and MNE to identify foreign market opportunities and provide direction for the development of competitive strategy. Upon completion of the basic MNE analysis, competitive analysis that is entering the stage is among the manufacturers in products, production techniques, manufacturing costs, brand strategy and competitive strategies to discuss several aspects, through expert interviews and a questionnaire survey. Finally, on the critical success factors make MNE competitive strategy and brand strategy.

This study used qualitative (Qualitative) of the descriptive study (Descriptive study) case study method. The purpose of this study to explore strategic competitive advantage, understanding the Foreign Enterprise's Strategies competitive, the study the critical success factors of MNE, provide the suggestion to building the strong branding for MNE, as the industry is changing at any time, for different stages of the competition and the evolution of different changes in the competitiveness of industry cooperation in an interactive state and the impact of the strategy.

Data Analysis

Main Competitive Strategy

Taiwan is currently electronic industry which is a mature stage of industry, each company's competitive strategy to adopt in order to maintain industry profitability and at the same time to each individual to defend the competitive ad- vantage of enterprisebased. Interviews process is still trying to find various properties of electronic industry and company's styles of leadership, strategy and it success formula and branding strategy of MNE Enterprises. In the interview data analysis, we found that most of three companies is also competitive strategy towards the development of these three advantages. To explore the electronic industry, companies are generally the transportation strategy, it is aggregate data will be follows.

Low cost strategy.

As the capacitor is maintain from international sales specially. Taiwan manufacturers turn living space with low profits, need expansion of ownbranding sales channels and competition in order to improve gross margins, lower production cost risk. Compare to these companies, is entirely difference styles under the list of new product and new strategy to attractive customers, the low proportion of discount and sometimes it is the reverse operation to the introduction of high-priced area every other customer market. Clear communication with customers is different from the others high-style features.

Position Strategy.

Chiming company: Avoid the competition, does not make the price war, set about from quality from quality, from serving. Enertech Engineering co.,LTD: Current position is followed, the profit-based strategy will be those who have the most profit. Sonjiu on its market leading position, with the exception of active multi-market expansion strategy Tong Road, the order not to consolidate the existing market strategy. Sonjiu is emphasized its experts and actively involved in other businesses are already operating the specific type of market. The challenges, there is much market share the space.

Differentiations strategy.

Enhance its services and strategic differences, different from the stereotypical MNE Enterprise gives the impression that Chiming company: It is computer control too for quantization not to manage: first let all figure at all quantization, the second constant education and training, improve the professional knowledge, and avoid the risk that is managed MNE stressed the point now is to make the product and customers services, and its interaction with the customer friendly approach in its possession an important factor in the market. Enertech Engineering co.,LTD: Improve the quality and strong financial advantages.

Strategies to increase product innovation.

The development of new products is MNES to do it's utmost in the operation of d, and not only to the introduction of new goods, but also different from other product, but also to raise the threshold obstacle to imitate others. Chiming company: R&D serves customer, so carry on R&D when the customer have the demand. Does not research and develop and sell to the customer well, what the customer needs to grind to the customer again. Various MNE wants to expand through innovative strategies to enhance differentiation to innovative model of goods and services to meet the needs of more consumers, cultivate more loyal customers in the market in order to maintain the advantage of a unique situation.

Strategy Fit

Differentiation-Brand Extension Strategy.

The direct costs of differentiation include higher-quality inputs, bettertrained employees, higher advertising, and better after-sales service. Chiming company: It is computer control too for quantization not to manage: first let all figure at all quantization, the second constant education and training, improve the professional knowledge, and avoid the risk that is managed. Sonjiu Electronic Enterprise. CO., LTD: Major competitors at home and abroad in accordance with the existing analysis can be seen that by grasping the company's competitive advantage, manufacturing capacity powerful, sales of low price, fast delivery, provide a high degree of restrain of the product. Flexible manufacturing systems and just-intime scheduling have increased the versatility of many plants, made model changeovers less costly, and made the goal of an "economic order quantity of one" increasingly realistic. Translation, negotiating and maintaining consistency in a foreign language poses a challenge for most brand owners. Chiming company: Because I just talked about our company made industrial products. Enertech Engineering co.,LTD: Lack of international financial, logistical support difficult, with inexperienced management personal abroad. *Cost Leadership –Own Branding Strategy.*

Low cost relative to competitors becomes the theme running through the entire strategy, though quality, service and other areas cannot be ignored. Sonjiu Electronic Enterprise. CO., LTD: Reduce the human cost and error rate including: online transaction management transactions, reducing costs and staff to deal with human error rate. Chiming company: Function as the budget control of the cost Low cost provides a defense against powerful suppliers by proving more flexibility to cope with input cost increases. The factors that lead to a low-cost position usually also provide substantial entry barriers in terms of scale economies or cost advantages. Chiming company: We can expand economic scale and reduce manufacturing cost basically. And then in the internal systems management, whole information is our cost advantage. Enertech Engineering co., LTD: Maintain the quality of the manpower advantage good and financial sound, understanding the customers' needs.

Own brands originally developed where manufacturers' brand were weak particularly in the international market. In own the brands carry a high profile with the four leading manufacturers accounting for over 60 per cent of the market. Chiming company: Industrial products it issues to create brand, industrial products it have how long 's quality concept of holding etc. already in the market it will be the company name relatively. The natural intention brand is possible. Enertech Engineering co., LTD: From energy conservation and environmental protection professionals concerned about the established of brand image company.

Competitive Advantage of MNE and Critical Success Factors

MNE and critical success factors, mainly composed by two parts, one a competitive advantage, and the other are a business advantage. Competitive advantage is the extension of competitive strategy and the future, namely, low-cost advantages, differences and advantages and advantages of decentralization, it is to analyze the critical success factors are as follows:

The Cost of Leading Edge.

Although the MNE are the growth face of clinical performance pressure, but also low-cost strategy that is market access the fastest method of performance. Chiming company: We can expand economic scale and reduce manufacturing cost basically. And then in the internal systems management, whole information is our cost advantage. Enertech Engineering co.,LTD: Maintain the quality of the manpower advantage good and financial sound, understanding the customers needs that is, the number of branches of the performance of stores, profitability and management of profit and loss and service quality, future payment of performance bonus as the standard, so more and more stores that give lowcost strategy and the additional shortterm possession of goods is the best way to market. Sonjiu is not the performance of the system in order to profit as the goal, but set a number of other quality management project, which lost its low-price promotion is more subtle. All-round physical preparation of the advantages of the company to obtain market share, rather than through price competition to be the commodity side of the business is the best strategy.

Centralized Advantage.

Development of market trends of a particular commodity or investment objectives to drive the market's special needs, such as the development of abroad market, Chiming company: Developing resources and reducing expenditures, the business is reached and uncertain the cost will increase, it has no relevance, basically do quantization to manage, only so-called cost budget management. Enertech Engineering Co., LTD: The cost of leading the use of business strategy to achieve cost control rate and rate, in fact, is positively related to the cost of control rate as well, and low cost will enhance competitiveness and improve business operations will help to reach a rate reached a low rate because of cost enhance the competitiveness. What is more service industry to enhance customer service-oriented, emphasizing the goods is made to attract marketspecific customer groups, and warm and enthusiastic service to customers and win consumer appreciation of mental, to win more of the added value of products industry.

The operating advantages.

In addition to the three competitive advantages, the need to test the company's core resources volume competitiveness, such as: cultural differences. Three MNE enterprises for the training of its staff are very positive, they are convinced that "people" are the most important assets, is the most worthwhile investment of resources. The company's vision and culture through education and training are passed down from generation to generation.

Aspects of the Company's financial position, product development capacity, the company's degree of science and technology information, the international company's support to the customer side of brand image and brand experience survey to explore the importance rating and a profit are the core of the case to compete for resources.

Conclusion and Suggestions

The purpose of business is the disposal of the existing resources effectively, with a view to the future, to get the most benefits, and risks of competition are not the course of business challenges can be avoided. Therefore, the enterprises operating in the efforts by management to increase profit opportunities and competitive ability at the same time, it should strive to reduce and to avoid complicated business environment and in response to the needs of modern life resulting from a variety of competitive disadvantage. MNE enterprise the rapid expansion in the scale of operation at the same time, the tangible or intangible assets of equipment management and possible competition trends, metropolis will be accompanied by the rapid growth of enterprise and become more complex, that is, the competitiveness of enterprises in strategic planning the more the more important future.

This study aimed at understanding the development of Taiwan's MNE enterprise, as well as the development trend of the future and to explore the new investment environment in the other country in the face of strong competition in the market parties, under the pressure of their competitive strategy should be developed. First of all explore the related literature, the theoretical basis for the study, and then depth interviews conducted from the following conclusion: After almost two decades of gradual reform, Vietnam is a mixed economy with a vibrant private and foreign investment sector competing in fast growing markets, yet also with state-controlled enterprises and remnants of central planning. Opportunities for 28 international business arise both in the fast growing local market driven by rising incomes and population growth, and based on the inexpensive low to medium skilled workforce. Moreover, specific investment opportunities arise in sectors prioritized by government policy such as telecommunications, software development and shipbuilding. For potential business partners in Vietnam created a basis for trade and investment, and business flourished since. Vietnam's WTO membership, which will create new business opportunities.
Companies considering engaging in business with Vietnam will encounter a business culture that shares many traditions with other East Asian nations, and a legal framework that is incomplete but rapidly evolving. Thus, building personal relationships with potential business partners and careful analysis of the institutional framework governing the targeted industry may be appropriate first steps to prepare the business.

The development of centralized marketing strategy, the Department is a one-to-many marketing, to be able to reduce the cost of pass routes, but also to create the goods or services to sell their own profession or the image is not easy to imitate competitors the development of a strategic highway pass can be doubly effective. MNE strategy in general and the competitiveness of core resources, corporate culture, heritage, the company's attempt to vision, education and training opportunities for learning, active employees and enthusiasm are the competitiveness of its core resources, the cornerstone of Taiwan's MNE are also critical success factors.

A related issue is whether the competitiveness of company is weakened or enhanced by relocating critical value-chain activities to the triad. Porter (1990) would argue that the core competitive advantage of an company must be drawn from the cluster of the home-base diamond. While it would be theoretically simpler if this could occur, in practice we observe that virtually all resource-based, manufacturing and service companies rely on access to the triad market for the success of their business; for example on average the great majority of sales of resourcebased and labour-intensive products occur in triad markets. Given this dependence on the triad markets, the contingent location of production and distribution in the triad, instead of in MNE alone, can never weaken the performance of MNE firms, given that the alternative is to lose access to the triad market and go out of business.

Taiwan's industry in the direction of competitive strategy, it should be towards the development of new products in order to reduce costs and enhance the advanced service capabilities in line with the trend and pattern of concentration to create a unique advantage in order to create demand for the development of differences in three areas. So Taiwan's MNE strategy for success in the future should be towards the development of the following three:

- Reducing expenses and reduce costs
- Improve service quality and service skills
- Centralized marketing strategy to promote

In recently, MNE invested to China and Vietnam. In order for the consumer business, product development and channel management more efficient, reduce costs, to win the proceeds, and the brand will be the spirit of industry products and services extended to the level of brand value and assets to improve efficiency, are a very important industry issues. How to build the strong brand of Taiwan's MNE in new market? In addition, the market does not have to complete the development of innovation, back again to view the company's core products and assets, whether or not have been fully

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utilized to extend from the core products, not only can reduce the risk, but also allows the brand can be extended to a more secure and complete. Building new strategy in order to allow the brand maintain competitive advantage.

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BUILDING COMPETITIVE ADVANTAGES AND RESTRUCTURE RE-SOURCES: A CASE OF TAIWAN'S EXHIBITION INDUSTRY

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Abstract

Under the irresistible trend of globalization, MICE Industry (Meetings, Incentives, Conventions, Exhibitions) gains more and more people's attention because of its high growth potential and high added value, high innovation efficiency, and large chance of creating employment. However, this is also a very competitive industry. From 2008 Beijing Olympic Games and 2010 World Exposition, we can see that Mainland China has made a large progress. Facing the gradually growing competitor among Mainland China, Japan, Hong Kong, and Korea, etc., what should Taiwan do to keep up with their steps is an urgent problem. This paper tries to explore an exhibition company, from the definition, characteristics of exhibition industry, general situations of development of international exhibition industry to Mainland China's development in this field. We use Transaction Costs Theory, Resource -based Theory, a Corporate Core Competence, Competitive Advantage and Strategy and second data of qualitative research as the main methods to collect data. Besides, we will invite the company's Vice-President, Mr. Yao to proceed with face-to-face interview, and to transform the interview into writing as the critical subject and core concept.

This study will find out (1) a corporate's core competence and capabilities; (2) a corporate's competitive advantage in the exhibition industry in Taiwan; and (3) the future direction.

Key words: MICE, Transaction Costs Theory, Resource-based Theory

Introduction

Taiwan is an island country. Its foreign trade has always been one of the factors to create economic prosperity, and participating in the exhibition is recognized as the most economical and effective business marketing activities. According to the American research center's (CEIR) statistics show that the regional economic effect that the exhibition industry brings is 1:10. That is, exhibitions events of every dollar of output will bring other industries in the region NT\$10 output value. ^{[1 Note - See} numbered references at the end of this article]

The exhibition industry to a country's economy as a whole has a significant position.

For the purpose of enhancing national competitiveness and promoting the domestic economy, our government puts the convention and exhibition services sector as a key support of the industry. With the hope of accelerating industrial development and creating business opportunities, our government also expects to expand our chances of participating in the international events. The reasons for the government to attach importance to the exhibition industry are due to the following characteristics^[2]:

1. Exhibition is included in the tourism industry, fostering easier and benefits quickly appear.

- 2. Exhibition industry brings highexpansion effect to the economic growth.
- 3. Economic era of globalization leads the development of the exhibition.
- 4. We join international communities; market opens; foreign trade increases rapidly.

Under the joint efforts of government and private industry of the exhibition industry, we have seen at least two advantages. First, Taipei World Trade Center was established for 30 years, and we have long-term accumulation of experience and good reputation for the exhibitions. Second, the opening of Nangang Exhibition Hall in June 2006 and Kaohsiung Exhibition & Convention Center in 2013 brought a lot of business subjective and objective advantages, but also can produce the benefits of a high degree of industrial relevance. However, the research of this field is still not enough. Therefore, this paper intends to explore the management strategy of one of the exhibition corporates in order to understand the industrial development and future prospects.

Literature Review

Exhibition Categories and Industrial Characteristics

The term exhibition, which includes fairs, exhibitions, trade fairs, demonstrations and so on, means that "exhibitors display products for buyers to browse and trade"^[4] (Linning, 1999). Therefore, exhibition display activities usually mix with business sense. Basically, an exhibition is to be formed by three units, including the organizers, exhibitors and visitors. Organizers are responsible for all the software and hardware equipments, launch advertising propaganda, collect the sellers to come to the exhibition and attract buyers to visit and to purchase. They are the promoter of the exhibition activities^[5]. Some professional exhibition companies will rent part of the space at first, and then collect a wide spectrum of exhibitors. Some companies will make up a team to take part in domestic and foreign exhibition activities.

According to industry exhibitors, the exhibition can be divided into vertical shows and horizontal shows^[6] (Lei-en Duan, 2007). Vertical shows mean that only the same industry products can be displayed at the exhibition, including raw materials, semi-finished products, parts, machinery, equipment and technology. Horizontal shows mean that exhibitors include a number of industries, or no limited to industry.

Developed countries are promoting the exhibition as an important measure. Through exhibitions, they promote their products, build their image, and achieve the purpose of economic development. So, the exhibition industry has the following characteristics (Bi-hui Yang, 2005): "(1) It is a high-income, high-profit industry, whose profit is around 20% to 25%; (2) Through the exhibition, the products are easy to raise awareness and to sell, and at the same time to promote the local prosperity. Beneficiaries of the exhibition industry include the surrounding service industries and the city where the exhibition hall is located; (3) Political environment and qualities of service will affect the development of the exhibition industry; (4) It can play the role of social integration"^[7].

Transaction Costs Theory

Anderson and Gatignon (1986) explore the entry mode of overseas markets with transaction cost. According to the level of the degree of control, they divide into three types--high, medium and low degree of control. They believe that there are four variables which affect the entry mode choice: the external uncertainty, internal uncertainty, transaction specific assets and the possibility of free-riding^[8].

Figure 1. describes the relationship between influence factors of entry mode and the performance under the transaction cost structure. Their research results are as follows^[9]:

- (1) When country risk and transactionspecific assets are higher, the entry mode control is also higher.
- (2) When the product is more mature, manufacturers have the lower control to overseas business.

(3) When manufacturers have more



(Resources from Anderson, E. and H. Gatignon (1986), "Modes of Foreign Entry: A Transaction Cost Analysis and Propositions." Journal of International Business Studies, 17(3), pp. 1-26.)

Figure 1. The relationship between influence factors of entry mode and the performance under the transaction cost structure.

- international experience, they have the higher control to overseas business.
- (4) When the scale of foreign firms is larger, the need for the degree of control is lower.

Erramilli and Rao (1993) think that the hypothesis of traditional transaction cost theory is: If firms have low asset specificity, the market- contracting or low-control mode is the predetermined choice. Under such hypothesis, they will follow two conditions. First, In incomplete market, if they want to get the benefits of integration, they will only reduce transaction costs. Second, Integration costs are always high. However, they do not think so, because when manufacturers integrate, they will engage in many non-related transaction costs things such as: control, expand market power, and overcome the shortcomings of equity joint ventures and so on. In addition, the cost of integration is not always high. For example, some hospitality industries such as consultants and advertising agency just own the office without massive investment in plant, machinery and equipment. Therefore, there must be some other factors that may affect the relevant cost and integration benefits between manufacturers of asset specificity and shared control modes. Hence, they propose amendments to the transaction cost analysis to explore the mode choice for overseas market of service industry; its research structure is as Figure 2.



(Resources from Erramilli, M.K. and C.P. Rao, (1993) "Service Firms' Choice: A Modified Transaction-Cost Analysis Approach," Journal of Marketing, Vol. 57, pp. 19-38.)^[10]



They chose 114 international companies operating in the U.S. service sectors targeted for empirical study. The result was that increasing capital intensity meant more investment of resources, and would also expand its integration costs. When the capital-intensive was high, the low asset specificity and low share firms tended to use controlled access mode. In the high-risk countries, companies must have flexibility to change its mode of operation to adapt to the unpredictable circumstances. Larger scale manufacturers had the stronger ability to spend more resources and to absorb the risk; its bargaining power was also better. Therefore, when the scale was larger, low asset specificity firms did

not tend to use shared-control entry mode.

Resource-based Theory

In 1984, Wernerfelt talked about strategic management from resource-based perspective^[11]. From then on, this theory began to receive the academic attention. Resource-based theory adopts complementary view, focusing on the company's internal analysis: What is the strengths and weaknesses of their own resources and capabilities? This school thinks that a company is different from the other company because of their different organizational resources and organizational capacity^[12].

Grant (1990) divided resources into three kinds: tangible, intangible, and personnel^[13]. Tangible resources included capital and physical assets; intangible resources are business reputation, brand image, the quality of products, etc; personnel resources consisted of professional knowledge and intellectual capital such as organizational culture, personnel training and loyalty¹². Based on the resources that a corporate owned, he divided the analysis model into five phases:

- (1) Confirm and classify the corporate resources: compare their own strengths and weaknesses with the competitors.
- (2) Confirm their abilities: try to find the necessary resources and to analyze the complexity of each ability.
- (3) Evaluate the profit potential of corporate resources and capabilities. Generally, the corporate rewards come from two factors—one, company sustained competitive advantage, and second, whether they properly use corporate resources and capabilities. In the long run, these competitive advantage and the resulting reward will gradually disappear because of the imitation of competitors.
- (4) Develop strategies: The most valuable characteristics of a corporate resources and abilities are lasting difficult to recognize or understand, difficult to fully transfer, and difficult to duplicate. And so, the most important thing for a corporate is to design a strategy to make good use of these resources and capabilities.

(5) Identify resource gaps and develop resource base: In addition to clever use of available resources, a corporate must actively create new resources in order to maintain its dominant position."^[14]
(Qian Yang, 2004)

Resource-based theory explains that a company must have a specific set of resources and procedures to differentiate themselves. In general, if their resources can meet the so-called "scarcity, specificity, and market demand"^[15], the business value and competitive advantage of their resources will be greater.

A Corporate's Core Competence

Prahalad and Hamel (1990) claimed that a corporate's core competence was the source of competitive forces. The short-term competitiveness of a corporate comes from the product price and performance of the structure. It can survive due to the fact that it maintains the quality and costs of the products and to the fact that it continuously reduce barriers to continued competition^[16]. Here, we give a clear definition. A corporate's core competencies are (1) collective learning in an organization; (2) particularly in the coordination and integration of different production technology and related technology; (3) operation in crosssectoral units for communication, participation, and commitment; (4) emphasis on the application and sharing of customer needs; (5) combination with business strategy.

During the development process of a corporate, core competence has the deepest meaning, and is the major force in face of outside competition. As the corporate has limited resources, it must focus them on a small number of core competencies with a view to achieving dominant position in the market. And then, from extending this core competence, a corporate tries to create opportunities for its growth.

The formation of strategy begins from the company itself. In the beginning, a corporate has the financial resources. It can use financial resources to attract the talented personnel, and to develop technology. Through management procedures, it can combine these two resources and cultivate a core competence. After a corporate owns its core competence, it can move to its strategic intentions.

Competitive Advantage and Strategy

Cultivating core competence is essential to the modern corporate developmental activities, so that it can survive in this volatile industrial environment. In order to enhance a corporate competitiveness, it needs to understand its competitive advantage. Competitive advantage is unique capabilities that a corporate owns, which is relative to their competitors, and can cause good performance on getting better profits or higher market share.

Porter (1999) believed that competitive advantage came from many activities within the corporate; that was, the value chain: many independent activities such as product design, production, marketing, transportation, and support operations. The association and interaction with external suppliers and customers made up a substantial contribution to the corporate, and at the same time constituted the basis for differentiation^[17].

Competition is the core of corporate success, and competitive strategy means that a corporate tries to find out a powerful competitive position and action project in the industrial battlefield. Competitive strategy aims to establish a profitable and sustained competitive position through decisive factors, and still maintains its longterm advantage.

In the study of competitive strategy, Porter combines two basic competitive advantages (cost advantage and differentiation advantage) and summarizes three general strategies: low-cost leadership, product differentiation, and focus. The focus strategy has two variants, cost focus and differentiation focus.

Research Methods

Research Structure

The corporate is a combination of mix resources; it must focus on the management resources, core competence and capabilities in order to get competitive advantage. When a corporate's internal resources could not meet the needs of customers, the corporate should try to find out external resources (e.g. to cooperate with other enterprises) so as to enhance its com-

petitive advantage. Nowadays, the competition emphasizes professional-

ism, especially in the exhibition

Competitive Advantage

	Lower Cost	Differentiation
Broad Target Competitive	1. Cost Leadership	2. Differentiation
Scope Narrow Target	3a. Cost Focus	3b. Differentiation Focus

Figure 3: Porter's competitive advantage

industry; therefore, how to create a unique feature for the exhibition industry's competitive advantage is essential for PEO (Professional Exhibition Organizer).

Research Methods

In this study, I use the method of case study analysis. From the beginning, I collect three detailed data: 1. open Interview; 2. direct observation; and 3. writing document. The theories that I adopt are from the point of view of competitive advantage: from the transaction costs theory, resource-based theory, core competence theory of an enterprise to competitive corporate strategies in order to create a competitive advantage status in the exhibition industry. The person I talk with is the Vice-President of Chan Chao International Co., Ltd., Mr. Yao Wu-yi.

The Introduction of the Target Company

The Reason for Choosing Chan Chao International Enterprise Group

Chan Chao does not restrict itself as a regional exhibition company. Due to the continuous business expansion throughout the years, Chan Chao has developed into a global enterprise, establishing numerous subsidiary companies and branch companies; striving to develop a complete exhibition marketing system. Since the expansion of overseas business in 1990, Chan Chao has organized and obtained official or general sales agent in over 42 countries, 76 cities worldwide. Forming strategic alliance with international organizations is one of the major reasons to the rapid expansion of Chan Chao. By maintaining a long-term beneficial cooperation with all of the



The following chart is the research structure:

Figure 4 : Research structure

partners, Taiwan's Chan Chao Enterprise Group has established a strong trust and excellent reputation amongst the exhibition industry across the globe. In order to meet a growing number of international customers' trade patterns, Chan Chao International Enterprise Group seeks to expand overseas business alliance partnerships, and to learn more the modern development trend of integrated marketing services. They particularly focus on the integration of global experience in personnel training, and the level of marketing services also expands from sponsored exhibition, distributing professional journals, Professional Disc, Agent trade advertising business, to further organize a series of international forums, seminars, and other large

activities such as venture capital luncheons^[18]."An exhibition company with ideals must have the passion and the sense of mission to bring forth the economic development."^[19] This is the philosophy and foundation of Chan Chao Enterprise. "Wherever the market is, there will be Chan Chao. When facing changes in any industries, the ability to quickly and accurately grasp the direction and movement of the industry is Chan Chao's greatest competitive advantage." (Resources from http://www.chanchao.com.tw/about_pr ofile.asp)

The Core Competence and Capabilities of Chan Chao International Enterprise Group

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As mentioned earlier, the company has four important resources: management teams, domestic and overseas exhibition experience, increased corporate visibility and credibility, and a number of subsidiaries supporting each other. The focus of this part is to analyze the corporate's core competence and capabilities in order to understand its power of competitiveness, its strategy and the risks it may face. Finally, I will make a general assessment for the sake of understanding its decisionmaking and business strategy factors.

The Analysis of Core Competence of Chan Chao International Enterprise Group

1. Management teams:

To run an exhibition, close cooperation between the team members is a must. Chan Chao International Enterprise Group bears the responsibility of personnel training. Senior officers will always give the new staff guidance so as to meet the standards required by the company.

2. Domestic and Overseas Exhibition Experience:

Chan Chao International Enterprise Group has many years of experience to hold the exhibition. The corporate itself is very sensitive to the changes of this industry, and is also good at using different marketing point of view to create a different market segment of the exhibition. Take an example of food show, Vice-president Yao points out that they put the main focus on coffee, tea and alcohol products. This gives the relevant industry participants a clearer direction, and advocacy resources can be more focused.

3. Increased Corporate Visibility and Credibility

Since the establishment of the corporate in Taiwan, various large-scale professional exhibition are held for a total of more than 280 shows so far, and 90 machinery shows. The exhibition category contains 41 kinds, while cooperative associations are over 25 units. As for the overseas shows, the corporate runs its own exhibition or co-sponsors with local exhibitors in Malaysia, Vietnam, Singapore, Vietnam, Thailand, Bangladesh, Egypt and China in Chengdu, Dongguan, Xiamen, Shenzhen and other cities. Through longterm operation, the corporate accumulates much professional knowledge and technologies, and also creates a good reputation for itself. Its competitiveness is far more than others.

4. A Number Of Subsidiaries Supporting Each Other:

In response to continued business expansion over the years, many companies are setting up one after another, and the corporate strives towards a complete exhibition marketing system. Currently, there are four companies in Taiwan and two overseas companies. In addition to organizing major exhibitions, the corporate also publishes exhibition magazine for special issue, CDs, acts as agents for the worldrenowned exhibition to search for exhibitors, and build a digital online exhibition.

The Analysis of Competitive Advantage of Chan Chao International Enterprise Group

From its developmental process, we can understand the reason why the corporate have been able to break through every stage of bottleneck is mostly due to the use of its core competence, and therefore produces a synergy derived from its core competitiveness.

According to Porter's competitive advantage theory, we find that the biggest advantage for Chan Chao International Enterprise Group is differentiation. The corporate has given up large mixed-type activities, and focuses on the segmentation. Under this trend, the corporate can grasp accurately the main stream.

Business Running Experience in Mainland China

Chan Chao International Enterprise Group entered the market of Mainland China in 2004. They adopted the strategic alliances, with the entry mode of joint ventures, and got the third-party support. The reasons that they considered to take joint ventures was (1) because the law in Mainland China did not allow foreigner-owned company in the exhibition industry, and (2) because they considered cultural differences. Now, they have two Joint-venture companies in Mainland China--one in Shanghai, and the other one in Chengdu. The Chan Chao International Enterprise Group continues to replicate

successful experiences in Mainland China, and these experiences will turn into important resources of the corporate in the end.

Differentiation Focus

With the higher and higher quality requirements of domestic exhibition industry. Chan Chao International Enterprise Group focuses on professional domestic market such as machinery exhibition, or bread, coffee, furniture, and cosmetics. In recent years, following the trend of industrial development, they also open up computer, communication, optoelectronics, electronics, information appliances, e-commerce, biotechnology, printed circuit and other high-tech exhibition. "Keep the key focus on professional, and on solid and deep plowing"^[20] is the corporate's motto and is the reason that the corporate can reach the size of today. It depends on long-term accumulation in the professional management of knowledge and technology.

Conclusion

After examining the target company--Chan Chao International Enterprise Group, from the establishment of its reputation, its core competence and capabilities to its internal and external competitive strategies, we find that through many years of efforts, the corporate strives hard to obtain its core competence and capabilities. They quickly spring up and also show excellent performance. And so, they got the lasting competitive advantage in the exhibition industry. As we know, a successful reputation can create the value for the corporate forever, especially in the exhibition industry. Moreover, reputation also has a continuing differentiation advantages.

From the resource-based perspective, a corporate's internal resources and capabilities can become its longterm competitive advantage; therefore, resources and capabilities can be used as the basis of a long-term strategy and focus of strategic thinking. Vice-President Mr. Yao points out that "holding an exhibition, an organizer must think from the perspective of the audience, combined with a variety of marketing techniques and tools. Inside, he must integrate different opinions and resources of different departments; outside, he knows how to integrate marketing communication program to

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convey messages. Under such efforts, exhibitors can maximize performance."

In recent years, the exhibition in Mainland China has been toward regularly, specialized, branding, and international development^[21]. The only part that Taiwan can win Mainland China is the quality of our exhibition personnel. In addition, having a virtual trade show is a trend. The size of the online audience is increasing rapidly. Advertising costs are likely to be lower because of the mass reach of the Internet. Luckily, Taiwan has high-tech network technology to tackle the high-flow problem. From the above analysis of the target company, we quote the words of Mr. Yao: "This industry is still bright for many years to come. We should make good use of our advantages, and create a new future."

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THE OPTIMAL PRICING MODEL FOR WALK-IN POTENTIAL CONSUMERS WITH EXTENDING BASS DIFFUSION MODEL

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Abstract

When a new product is released in the market, its product information will be diffused by the Bass Diffusion Model as epidemic. This paper extended the source of the diffusion power from a single source (numbers of actual buyers) in the Bass Diffusion Model into dual sources of diffusion power with numbers of walk-in potential consumers and the product price level. The study tried to more completely extend the hypothesis on the source of diffusion power for the product information according to the Bass Diffusion Model. Given period of [0, T], when a firm seeks to decide price of P_0 in order to achieve the goal of maximizing discounted profit in the interval [0, T], what will be the characteristics of optimal solution P_0^* at the period? The research also developed a probability density function of potential consumers' ceiling price to estimate numbers of actual consumers who are turned from walk-in potential consumers in order to calculate the revenue of the new product.

Key Words: Bass Diffusion Model; walk-in potential consumers; purchase proportion function; optimiztion; probability density function

Introduction

The Bass Diffusion Model (1968) is based on cumulated sales as the source of diffusion power. Along with a product that cannot be easily moved or worn by consumers, such as houses and furniture, its information will not be easily propagated from actual consumers to other potential consumers who mostly use their eyeconsciousness to receive the product information. In other words, the source of diffusion power must be based on their word-of-mouth among actual consumers. With expanding the sources of diffusion power, the Bass Diffusion Model will be more practical.

Literature Review

Consumer value is derived from the gap which differs between perceived quality and the price paid by consumers (Dodds & Monroe, 1985; Gale, 1994). Kotler (1999) suggested that consumer value means the total value obtained from consumer through products or services, including products, services, individuals, and image value. Consumer perceived value determines the ceiling price of a product to be accepted. When perceived benefit is higher than perceived cost, there will be an positive net value, and consumers will have purchasing intention perceiving a product having high-quality with low prices. On the contrary, when perceived benefit is lower than perceived cost, consumers' purchase intention will stay at much low.

By probability density function, g(p), p is the ceiling price that consumers are willing to buy. The study is to define ceiling price that consumers perceive the product value. The purchase proportion among potential consumers was estimated through g(p) function. And, the number of sales at the period would be further estimated. Revenue orientation is the goal of pricing strategy of the firm.

Mahajan, Muller, and Bass (1990) followed the research of scholars (King, 1963, Frank, Massy & Morrison, 1964, Silk, 1966, Arndt, 1967, Bass, 1969) regarding new product promotion and diffusion. Bass (1969; 2004) observed the diffusion of new product adoption, and proposed the growth model of timing to purchase new products for the first time. In the model, it was assumed that, after being introduced in the market, a new product would be diffused as epidemic.

The reason, that the Bass Diffusion Model is commonly applied by management scholars, is that, according to the data of time series of sales of new products, scholars recognize the pattern of sales and use it to predict sales (Mahajan & Wind, 1986; Kalish & Lilien, 1986). Because the Bass Diffusion Model to describe new product diffusion could be established as the form of mathematical models, many scholars have developed extensions of the model or proposed empirical research to focus on the effect of prices on the number of potential consumers in the market (Robinson & Lakhani, 1975; Bass, 1980; Dolan & Jeuland,

1981; Bass & Bultez, 1982; Kalish, 1983, 1985; Horsky, 1990).

The diffusion of price information influences the evaluation of product value for consumers. Valente (1995) suggested that the new product diffusion is the process of communication through which consumers who have used the product convince those who have not used it to adopt it. Therefore, through the marketing investment from firms and word-of-mouth from users, the product information can be continuously diffused in the market.

The diffusion speed of products in the market will influence consumers' cognition of product functions. Moreover, different cognitive levels will result in different evaluations of products, which will affect consumers' purchase intentions. Due to different product information acquired, consumers have different assessment of the same product, which is the reason that economists suggest consumers' demand probability density function can be distinguished (Lee & Wong, 2005). Shi (2008) proposed a conceptual framework to establish demand probability density for new products based on the new products diffusion model and demand theory. Through differential

equations of new product information diffused with time, the demand function and the Bass Diffusion Model (Bass, 1969) could be used to construct an optimal pricing model for a new product.

Potential consumers who realize new product information do not necessarily buy the new product. Using the Bass Diffusion Model to predict the trend of sales for new products, with the same price, the scholars estimate the model parameters of α (innovation), β (imitation), and N (numbers of potential consumers) through the difference of numbers of potential consumers N and numbers of actual buyers x(t). The parameter of α could be overestimated, while parameters of β and N could be under-estimated. Shi (2008) suggested that, at time t, in order to estimate the number of potential customers, N - x(t) should be replaced with N - y(t), where y(t) is the number of people who know thoroughly the new product information and attributes or is the number of walk-in potential customers. Through above displacement, it is one of the important and feasible measures to extend and modify the Bass Diffusion Model.

Hypotheses and Symbols (Editor's Note: the format of this article changes at this point to read the formulas better).

This paper introduced its research background with the following hypothesis and symbols. It assumed when a new product is introduced into the market at time t = 0, the number of potential consumers for the new product is N, which means the number of products sold by the firms with capability and opportunity even while the price is lowered down to 0. In order to match the number of consumers with the number of product sold, this study assumed that one consumer buying n units of the product would be treated as n of consumers buying 1 unit of the product. In this study, g(p) means probability density

function of potential consumers' ceiling price z. The g is of normal distribution with mean μ and variance σ^2 .

the cumulative distribution of probability density function *g* D_Dd

N: Numbers of potential consumers.

c: The unit product cost of firm, c > 0.

 P_0 : The price within the period, $t \in [0, T]$, $P_0 \ge c$.

T: The length of time interval to maintain price at P_0 .

r : The discount rate of cash flow.

<u>A</u> D_Dd______Bü82______D_Dd_____ää82_____

that firm's advertising and sales expenditure of new products within unit time are set to ${\mathbb A}$

 \mathcal{Y}_t : The cumulated number of walk-in potential consumers before *t*. Walk-in potential consumers before *t* means that, before certain time *t*, a potential consumer thinks that he/she has fully recognized the characteristic of the product and only its price can determine his/her purchase.

 x_t : The cumulated number of actual consumers before *t*. It is valid that

 $y_t \ge x_t \forall t \text{ D_Dd}$

Hypothesis: at different time t

(______) to become walk-in potential consumers, with increase rate y'_t . The intensity of the attraction is a linear function of walk-in potential consumers y_t . y_t satisfies the following differential equations:

$$y'_{t} = (\alpha + \beta y_{t})(N - y_{t}) \forall t \in [0, \infty) D_{a}$$

$$\alpha \ge 0, \beta \ge 0 \ (a < 0, \beta) \ge 0 \ (a < 0, \beta)$$

Equation (3) represents the expansion of the Bass Diffusion Model for new products. The original diffusion differential equation of the model is denoted as:

$$x'_t = (\alpha + \beta x_t)(N - x_t) \quad \forall t \in [0, \infty)$$
(4)

In the model (4), cumulated sales x_t represents the source of diffusion power at time t. In model (3), the consumption of walk-in potential consumers y_t represents the source of diffusion power for walk-in potential consumers at time t. Regarding products that cannot be easily moved or worn, such as houses and furniture, the product information cannot easily be propagated from actual consumers to other potential consumers who mostly use their eye-consciousness to receive the product information. Hence, the source of diffusion power must be based on word-of-mouth from walk-in potential consumers. Before being an actual consumer, potential consumers must become to be walkin potential consumers, see equation (2), $y_t \ge x_t \quad \forall t$. Hence, y_t is the source of diffusion power of product information with the two-stage diffusion model; i.e. potential consumers become to be walk-in potential consumers and then turn into actual consumers. The equation (3) is seemingly more complete than that of one-stage diffusion model that potential consumers directly become consumers, see equation (4). When a marketing program is initiated, i.e., the new product is currently introduced to the market, the cumulated number of walk-in potential consumers is 0, i.e. y(0) = 0, thus equation (3) is derived into:

$$1 = \frac{y'_t}{(\alpha + \beta y_t)(N - y_t)} = \frac{1}{\alpha + \beta N} \left[\frac{y'_t}{N - y_t} + \frac{y'_t}{y_t + \frac{\alpha}{\beta}} \right]$$

Integrating the above equation with respect to t, it yields that

$$\frac{t+k = \frac{1}{\alpha + \beta N} \ln\left(\frac{\alpha}{\beta} + y_t\right)}{N - y_t}$$

where k is a constant determined by the condition $\mathbf{y}(\mathbf{0}) = \mathbf{0}$, i.e.

$$e^{(\alpha+\beta N)(t+k)} = \frac{\alpha/\beta + y_t}{N - y_t} = -1 + \frac{\alpha/\beta + N}{N - y_t}$$
$$N - y_t = \frac{\alpha/\beta + y_t}{1 + e^{(\alpha+\beta N)(t+k)}}$$

(by using $\mathbf{y}(\mathbf{0}) = \mathbf{0}$

$$=\frac{\alpha_{\beta}+N}{1+(\alpha_{\beta N})e^{(\alpha+\beta N)t}}$$

This implies that

$$y_t = N - \frac{(\alpha + \beta N)N}{\alpha e^{(\alpha + \beta N)\mathbf{t}} + \beta N} \qquad = N \frac{\alpha e^{(\alpha + \beta N)\mathbf{t}} - \alpha}{\alpha e^{(\alpha + \beta N)\mathbf{t}} + \beta N} \qquad t \in [\mathbf{0}, \infty)$$
(5)

Construction Model

Given the value of T, the maximum of discounted profit $\pi(P_0)$ of the firm is given by

$$\max_{P_0} \pi(P_0) = (P_0 - c) G(P_0) \left[\int_0^T e^{-rt} y'_t dt + y_0 \right] - \int_0^T e^{-rt} A dt, P_0 \ge c$$
(6)

The first item in the right side of equation (6) is the firm's discounted revenue from period [0, T]. Let P_0^* be optimal solution of model (6). It is valid that P_0^* is also the optimal of the following problem (see Figure 1)

$$\max_{P_0} (P_0 - c) G(P_0), P_0 \ge c \quad (7)$$

Propositions

Differentiating equation (6) with respect to P_0 , it yields

$$\frac{d\pi(P_0)}{dP_0} = [G(P_0) - (P_0 - c)g(P_0)] \left[\int_0^T e^{-rt} y_t' \, dt + y_0 \right]$$
(8)

The attribute of function (P - c)G(P) is now discussed as follows:

Property 1: $\lim_{P \to c^{+}} (P - c)G(P) = 0$ Property 2:

$$\lim_{P \to \infty} (P - c)G(P) = \lim_{P \to \infty} \frac{G(P)}{\frac{1}{P - c}} ; \text{ (by the L'Hopital's Law of calculus)}$$
$$= \lim_{P \to \infty} \frac{g(P)}{\frac{1}{(P - c)^2}}$$
$$= \lim_{P \to \infty} (P - c)^2 \frac{1}{\sqrt{2\pi\sigma}} e^{\frac{-(P - \mu)^2}{2\sigma^2}} = 0$$
(9)

Property 3:

$$0 = \frac{d}{dP} [(P - c)G(P)]_{P=P^*}$$

= [G(P) - (P - c)g(P)]_{P=P^*}
= G(P^*) - (P^* - c)g(P^*) (10)

Property 4:

$$\begin{aligned} \frac{d^2}{dP^2} [(P-c)G(P)] \\ &= -2g(P) - (P-c)g'(P) \\ &= \frac{-2}{\sqrt{2\pi\sigma}} e^{\frac{-(P-\mu)^2}{2\sigma^2}} + \frac{(P-c)}{\sqrt{2\pi\sigma}} \frac{(P-\mu)}{\sigma^2} e^{\frac{-(P-\mu)^2}{2\sigma^2}} \\ &= \frac{1}{\sqrt{2\pi\sigma}} e^{\frac{-(P-\mu)^2}{2\sigma^2}} \left[\frac{(P-c)(P-\mu)}{\sigma^2} - 2 \right] \\ &= \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-(P-\mu)^2}{2\sigma^2}} [P^2 - (c+\mu)P + c\mu - 2\sigma^2] \\ &= \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-(P-\mu)^2}{2\sigma^2}} \left[P - \frac{(c+\mu) + \sqrt{(c-\mu)^2 + 8\sigma^2}}{2} \right] \\ &= \left[\frac{P - \frac{(c+\mu) - \sqrt{(c-\mu)^2 + 8\sigma^2}}{2} \right] \end{aligned}$$
(11)

where

$$\frac{(c+\mu) - \sqrt{(c-\mu)^2 + 8\sigma^2}}{2} \le \min(\mu, c)$$

and
$$\frac{(c+\mu) + \sqrt{(c-\mu)^2 + 8\sigma^2}}{2} \ge \max(\mu, c)$$
(12)

Hence, the graph of function (P - c)G(P) can be shown as in Figure 1.



Proposition 1

(i) The function (P - c)G(P) has only one maximum point at P^* , without minimum, and it has only one inflection point at

$$\frac{(c+\mu)+\sqrt{(c-\mu)^2+8\sigma^2}}{2}$$

as shown in Figure 1.

(ii) The necessary and sufficient condition for $P^* > \mu$ is the inequality $\sigma \sqrt{\frac{\pi}{2}} > \mu - c$ holds.

Proof:

- (i) It is proved immediately by equation (13)
- (ii) By equation (10) and Figure 1, it obtains that the inequality $\mu < P$ holds if and only if

$$0 < \frac{d[(P-c)G(P)]}{dP}\Big|_{P=\mu}$$

= $G(\mu) - (\mu - c)g(\mu)$
= $\frac{1}{2} - \frac{(\mu - c)\mathbf{1}}{\sqrt{2\pi\sigma}}$ (14)

This proves (ii).

Conclusions

Bass and other scholars have suggested that, after new products are introduced to the market, product information is diffused with time as epidemic. The power of the diffusion at different times is a linear function with the positive slope of the number of buyers. Although this paper agrees that, after new products are introduced to the market, product information will be diffused as epidemic, the study does not completely rely on the hypothesis of the diffusion sources. Products, such as houses and large furniture, which cannot be easily moved or worn, are not frequently exposed to other consumers in public, because the product information cannot easily be propagated to other potential consumers who use their eye-consciousness to receive the product information.

Thus, this paper developed the concept of "walk-in potential consumers" and, accordingly, refined the above

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source of diffusion power of new product information. Walk-in potential consumers mean consumers think that they fully understand the product function and its attributes and only the price can determine their purchase. The people should first become walk-in potential consumers to turn into actual consumers by satisfying with the prices. Thus, this paper adopted the source of diffusion power of new products in Bass model and replaced numbers of actual consumers with numbers of walk-in potential consumers in order to complete source of diffusion power of product information, instead of rejecting the original assumption of Bass Model.

The research also developed a probability density function of potential consumers' ceiling price to estimate numbers of actual consumers who are turned from walk-in potential consumers in order to calculate the revenue of the new product.

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Appendix

List of Equations

$$g(p) = \frac{1}{\sqrt{2\pi\sigma}} e^{\frac{-(p-\mu)^2}{2\sigma^2}} p \in (-\infty, \infty)$$
(1)

$$G(p) = \int_p^{\infty} g(z)dz, \text{ i.e. } 1 - G(p) = \int_0^p g(z)dz$$
(1.1)

$$y_t \ge x_t \ \forall t$$
(2)

$$y'_t = (\alpha + \beta y_t)(N - y_t) \ \forall t \in [0, \infty)$$
(3)

$$x'_t = (\alpha + \beta x_t)(N - x_t) \ \forall t \in [0, \infty)$$
(4)

$$y_t = N - \frac{(\alpha + \beta N)N}{\alpha e^{(\alpha + \beta N)t} + \beta N} = N \frac{\alpha e^{(\alpha + \beta N)t} - \alpha}{\alpha e^{(\alpha + \beta N)t} + \beta N} \quad t \in [0, \infty)$$
(5)

$$max_{P_0} \pi(P_0) = (P_0 - c) \ G(P_0) \left[\int_0^T e^{-rt} y'_t dt + y_0 \right] - \int_0^T e^{-rt} A \ dt, \ P_0 \ge c$$
(6)

$$\frac{max_{P_0}(P_0)}{dP_0} = [G(P_0) - (P_0 - c)g(P_0)] \left[\int_0^T e^{-rt} y'_t dt + y_0 \right]$$
(8)

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$$\begin{split} \lim_{P \to \infty} (\mathbf{P} - \mathbf{c}) \mathbf{G}(\mathbf{P}) &= \lim_{P \to \infty} \frac{\mathbf{G}(\mathbf{P})}{\frac{1}{\mathbf{P} - \mathbf{c}}} \\ &= \lim_{P \to \infty} \frac{\mathbf{g}(\mathbf{P})}{(\mathbf{P} - \mathbf{c})^2} \\ &= \lim_{P \to \infty} (\mathbf{P} - \mathbf{c})^2 \frac{1}{\sqrt{2\pi\sigma}} \mathbf{e}^{\frac{-(\mathbf{P} - \mu)^2}{2\sigma^2}} = \mathbf{0} \end{split}$$

$$(9)$$

$$\mathbf{0} &= \frac{d}{dP} [(\mathbf{P} - \mathbf{c}) \mathbf{G}(\mathbf{P})]_{P = P} = [\mathbf{G}(P) - (P - \mathbf{c}) \mathbf{g}(P)]_{P = P} \\ &= \mathbf{G}(P) - (P - \mathbf{c}) \mathbf{g}(P) \end{aligned}$$

$$(10)$$

$$\frac{d^2}{dP^2 [(\mathbf{P} - \mathbf{c}) \mathbf{G}(P)]} = -2\mathbf{g}(P) - (P - \mathbf{c}) \mathbf{g}'(P) \\ &= \frac{-2}{\sqrt{2\pi\sigma}\sigma} \mathbf{e}^{\frac{-(\mathbf{P} - \mu)^2}{2\sigma^2}} + \frac{(P - \mathbf{c})}{\sqrt{2\pi\sigma}\sigma} \frac{(P - \mu)}{\sigma^2} \mathbf{e}^{-\frac{(P - \mu)^2}{2\sigma^2}} \\ &= \frac{1}{\sqrt{2\pi\sigma}\sigma} \mathbf{e}^{\frac{-(\mathbf{P} - \mu)^2}{2\sigma^2}} \left[\frac{(P - \mathbf{c})(P - \mu)}{\sigma^2} - 2 \right] \\ &= \frac{1}{\sqrt{2\pi\sigma}\sigma^2} \mathbf{e}^{\frac{-(\mathbf{P} - \mu)^2}{2\sigma^2}} \left[P^2 - (\mathbf{c} + \mu)P + c\mu - 2\sigma^2 \right] \\ &= \frac{1}{\sqrt{2\pi}\sigma^3} \mathbf{e}^{\frac{-(\mathbf{P} - \mu)^2}{2\sigma^2}} \left[P - \frac{(\mathbf{c} + \mu) + \sqrt{(\mathbf{c} - \mu)^2 + 8\sigma^2}}{2} \right] \left[P - \frac{(\mathbf{c} + \mu) - \sqrt{(\mathbf{c} - \mu)^2 + 8\sigma^2}}{2} \right] \end{aligned}$$

$$(11)$$

$$\frac{(c+\mu) - \sqrt{(c-\mu)^2 + 8\sigma^2}}{2} \le \min(\mu, c) \text{ and } \frac{(c+\mu) + \sqrt{(c-\mu)^2 + 8\sigma^2}}{2} \ge \max(\mu, c)$$

$$0 < \frac{d[(P-c)G(P)]}{dP}\Big|_{P=\mu} = G(\mu) - (\mu-c)g(\mu) = \frac{1}{2} - \frac{(\mu-c)\mathbf{1}}{\sqrt{2\pi}\sigma}$$
(13)

(12)

 $\frac{\text{http://www.turnitin.com/viewInternet.asp?r=64.4950313880475\&svr=3\&oid=702118525}{\&key=9dacb51a9bb74ca474f9c1b9e8efaffe}$

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CAMELS: THE TROUBLE BANK PREDICTION

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Abstract

This study aimed to analyze and test empirically CAMEL Sratioto predict trouble banks. CAMEL Sratioused include Capital Adequacy Ratio (CAR), Non Performing Asset (NPA), Net Profit Margin (NPM), Return On Asset (ROA), Quick Ratio (QR), and Net Deviation Position (NDP). The data used from annual published financial statement of Commercial bank period 2011-2013. The population in this study are 35 commercial bank, after pass the purposive sampling there are 19 bank samples. The sample of research was devided in two categoriest bank with no problem are 16 bank and 3 bank in trouble. Method of analyze used to test the hypothesis of the research is logistic regression. The result of the research show that NPM is significant effect of the trouble bank prediction. Other variables such as CAR, NPA, ROA, QR, and NOP do not have significant effect the trouble bank prediction.

Keyword : The Trouble Bank, CAMELS ratio, commercial bank, and logistic regression

Introductiontions into bankruptcy. Bankruptcy This
is because banks and financial institu-
tions are experiencing liquidity prob-
lems. Judging from the terms of liquid-
ity, is not the flow of money are fluid

(liquid), of course if it does not exist in a particular bank, it must liquidity will flow into other banks. Phenomenon is often the case, many banks experienced liquidity problems at the same time, so it must be put high interest to attract the money of the depositors, that they are willing to deposit money in the bank.

The system prevailing in the banking world is Fractional Reserve Banking. The system creates liquidity of the money as we know banknotes and coins, but from the bank money generated through a process of money creation (money creation). FRB systems require to set aside a percentage of savings for daily operations. Reserve 5% is assumed, that the depositors, will only take money daily average of 5% of deposits in the Bank. The remaining 95% of deposits entrusted by the depositor to fully managed by the Bank.

Banking is the heart of the economy of a country. The banking sector vulnerable to a variety of risks, especially systemic risk, namely the failure of the banks that have an impact on the economy in the long term. According to (Goei, 2015), in order to avoid bank failures, regulators make rules governing capital adequacy and liquidity. This is key to the health of the banking awake and avoid systemic risks. The capital adequacy is, he acknowledges, is associated with the risk taken by the bank. The greater the risks, the greater the capital must be owned bank. The bank's capital usually only around 10 percent-15 percent of the total assets. It means that most of the bank's activities are financed from

the loan aka Third Party Fund (DPK), such as demand deposits, savings deposits.

According to him, there are four major risks that could threaten the continuity of business bankers, namely credit risk, market risk, operational risk and liquidity risk. Credit risk is the losses due to defaults of debtors of the bank. This risk can arise from bad debts, forward or derivative transactions (treasury), investment and trade finance.

Troubled banks decreased continuously called financial distress (financial trouble) is a very difficult situation and can even be said to be nearing bankruptcy which, if not resolved will have a major impact on banks with a loss of confidence of customers. The cause, the swelling amount of troubled loans and bad loans. Increasing number of non-performing loans and bad credit can disturb the atmosphere even be the impact of the financial difficulties in the banking (Zaki and Bah, 2011). Model problematic conditions this needs to be developed continuously, because by knowing the condition of troubled companies early on is expected to take measures to anticipate that lead to bankruptcy (Almalia and Herdiningtyas, 2005).

Development Hypothesis

CAR influence on the Trouble Bank Prediction

Capital Adequacy Ratio (CAR) is used to measure the ability of existing capital to cover possible losses in

the lending and securities trading (PBI number 13/1 / PBI / 2011). If the CAR owned the lower means less capitalowned bank to bear the risk assets, so the more likely the bank will experience problematic conditions because capital owned banks are not enough mnanggung impairment of assets at risk. Almalia and Herdiningtyas (2005); Gunzel (2007); Iramani (2008); Endri (2009); Zaki and Bah (2011); Sabir et al. (2012); Bestari and Rohman (2013) states that the CAR significant negative effect on the condition of troubled banks. That is, the greater this ratio, the smaller the probability of a bank bankruptcy.

H1: CAR negatively affect predictions problematic conditions in the banking sector in Indonesia.

NPA influence on the Trouble Bank Prediction

Non Productive Assets (NPA) is earning assets (loans, placements with other banks, securities and investments) as substandard ((PBI number 13/1 / PBI / 2011). The ratio of the NPA showed a high asset unproductive or less smoothly in the bank. That is, the greater the NPA showed the greater the risk of assets that are not productive, so the bigger the bank facing problematic conditions. NPA positive effect, because if the condition of the NPA a high bank will increase the cost of reserve assets productive and other costs, so the potential for bank losses. According Fetrianto and Mawardi (2006) and Budiwati and Jariah (2012) showed that the NPA ratio has a positive and significant impact on the predictions of the health of banks.

H2: NPA positive effect on predictions problematic conditions in the banking sector in Indonesia.

NPM influence on the Trouble Bank Prediction

Net Profit Margin (NPM) is a ratio used in the management of quality which demonstrates the ability of bank management to identify, measure, monitor, and control risks that arise through policies and business strategies to achieve the target (PBI number 13 / 1 / PBI / 2011). The success of the bank's management is based on a qualitative assessment of management that includes several components. Management of the bank can be classified as healthy when at least have met 81% of all these aspects. The greater this ratio, the increase in net income over the bank's operating profit managed so that the possibility of a bank in error gets smaller (Almalia and Herdiningtyas, 2005). Almalia and Herdiningtyas (2005); Gunzel (2007); Endri (2009); Zaki and Bah (2011), NPM significant negative effect on bank bankruptcy.

H3: NPM negatively affect predictions problematic conditions in the banking sector in Indonesia

ROA influence on the Trouble Bank Prediction

ROA is used to measure the ability of bank management in profit (profit before tax) resulting from the average of total assets of the bank con-

cerned (PBI number 13/1 / PBI / 2011). The higher the ROA, the more effective the asset management company, so it is likely the bank will fail to be smaller (Almalia and Herdingtyas, 2005). Almalia and Herdiningtyas (2005); Gunzel (2007); Iramani (2008); Endri (2009); Zaki and Bah (2011); Sabir et al. (2012); Bestari and Rohman (2013) stated that ROA significant negative effect on the prediction of troubled banks. On the basis that it can be proposed hypothesis as follows:

H4: ROA negatively affect predictions problematic conditions in the banking sector in Indonesia.

QR influence on the Trouble Bank Prediction

Quick Ratio (QR) or often called the acid test ratio is used to measure the ability of a company to meet its short term obligations (PBI number 13/1 / PBI / 2011). A quick calculation by subtracting the ratio of current assets to inventories. This is because inventory is an element of current assets low liquidity and frequent price fluctuations as well as causing damage in the event of liquidity. So this ratio is the ratio that indicates the ability of the most liquid current assets able to cover current liabilities (Sawir, 2009). Sawir (2009: 10) says that the quick ratio is generally considered good greater this ratio, the better the condition of the company. Almalia and Herdiningtyas (2005); Iramani (2008); Endri (2009); Zaki and Bah (2011); Sabir et al. (2012); Bestari and Rohman (2013) showed that the

ratio QR positive and significant impact on the bankruptcy of banks. H5: QR negatively affect predictions problematic conditions in the banking sector in Indonesia

NOP influence on the Trouble Bank Prediction

Net Open Position or a Net Open Position is the sum of the absolute values of the net difference between assets and liabilities in the balance sheet for each foreign currency is added to the net difference between claims and liabilities, comprising both commitments and contingencies in administrative account for each foreign currency all stated in rupiah (PBI / No. 12/10 / PBI / 2010 dated July 1, 2010).

Each transaction of sale and purchase of foreign currency exchange rate risk because it contains lead to the open position (open position) in a particular currency can be a speculation tool for banks with the aim of obtaining profits from foreign exchange. The open position causes the potential profit if the exchange rate strengthened during long position or weaken the exchange rate at the time of short positions and the potential loss if the exchange rate strengthened during short position or weaken the exchange rate at the time of a long position. Which meant a long position is a condition in which assets greater than liabilities in foreign currency and the currency in question is a condition in which a short position in foreign currency assets is smaller than the foreign currency liabilities.

Sawir (2009) states that the greater the position (long or short) held the potential profits and losses will be even greater, so that in case of exchange rate movements, the number of positions will determine how much profit is obtained or how big the losses suffered. Thus the net open position needs to be managed properly to minimize the risk of problem banks.

H6: NOP negatively affect predictions problematic conditions in the banking sector in Indonesia

Research Methods

Identification Variables

This study uses a variable that consists of the dependent variable (the dependent variable) and the variable is not bound (independent variables). The dependent variable used in this study is the prediction of problematic conditions in the banking sector. A bank is said to be experiencing problematic conditions ie when bank's net profit (net income) is negative for at least 2 consecutive years or bankruptcy (Almalia and Herdinintyas, 2005; Bestari and Rohman, 2013). The dependent variable used is the categorical variables (dichotomous variable), 0 for banking companies that are not experiencing problematic conditions and one for companies experiencing problematic conditions.

Variables are not bound (Independent variable) is the ratio CAMELS in proksikan in several CAR ratios that can be measured by bank capital compared to risk-weighted assets. NPA can be measured by comparing the amount of non-productive assets to total earning assets owned by banks. NPM can be measured by net income as compared to operating profit. ROA can be measured by comparing the profit (before taxes) by total assets of the bank. QR can be measured by comparing the current assets by current liabilities. NOP is measured by comparing the difference between the amount of foreign currency assets off balance with a net difference of foreign exchange capital owned.

Population and Sample

Population of this research is the Conventional Banking Companies listed or listing on the Stock Exchange during 2011-2013. The total population was 35 banking companies listed on the Stock Exchange. The sample in this study using purposive sampling, as the information needed can be obtained from one particular group that is able to provide information and met the study criteria. Criteria for selection of the sample to be examined as follows (Bestari and Rohman, 2013):

- a) Banking companies issuing financial statements and financial statement data available complete overall published for three consecutive years in the period 2011-2013 submitted to Bank Indonesia
- b) Financial reports should have the fiscal year ended December 31, and available financial ratios that support research.

- c) Bank sampled divided into two categories:
 - 1. The Bank is not problematic, namely:
 - The banks do not suffer losses and are not included in the bank restructuring program seta not under special surveillance in the year 2011-2013

- The banks which operated until the date of December 31, 2013
- 2. Banks problematic, namely:
 - Banks which suffered losses of at least two consecutive years in 2011 – 2013
 - The banks are declared bankrupt or have been closed by Bank Indonesia in 2013
 - Bank are under special supervision in 2011-2013

Description	Amount
Number of banking companies listed on the Stock Exchange	35
Financial statement data is incomplete for 2011-2013	(10)
Does not include the complete financial ratio	(6)
The number of companies sampled	19
Years of observation (years)	5
Total number of samples during the research period	95
Source: processed data	

Table 1. Samples with Criteria Selection Process

Analysis Method

This study uses a logistic regression model because the model the dependent variable in the model are categorical variables (dichotomous variable), giving a value of 1 for banks experiencing problematic conditions and the value 0 for banks that do not experience problematic conditions.

Results And Discussion

Logistic Regression coefficients

Results if the data indicates that

CAR not significant effect on the prediction of troubled banks. This happens because of troubled banks will be encouraged Bank Indonesia to conduct a merger or acquisition of additional capital that cause greater (PBI number 13/1 / PBI / 2011). The average CAR of 16.5% in 2011-2013, shows that over the last three years at the bank's CAR quality is very good, because the percentage figure is far above or exceeded as determined by Bank Indonesia of 8%. Under the provisions of Bank Indonesia, the healthy banks should have a CAR of at least 8%, so the probability of experiencing the

condition of troubled banks is getting smaller (Circular Letter No. 7/10 / DPNP March 31, 2005).

NPA ratio is not significant effect on the prediction of troubled banks. NPA is an asset quality assessment that reflects the ability of bank management to manage their productive assets. For banks that have a high degree of collectibility and have sufficient earning assets, the capital requirement will be obtained from the operating profit of the bank concerned, and vice versa if the bank is continuously loss then there is also the possibility of capital will be eroded little by little. The smaller the NPA, the smaller the risk borne by the banks, but if the condition of the NPA a high bank will increase its productive asset allowance which can lead to potentially insolvent banks. The average of the years 2011-2013 with the NPA in 2011 amounted to 4.64%, indicating the bank has met the NPA maximum limit of 5% in accordance with the criteria NPA value allowed by Bank Indonesia.

NPM average of the years 2011-2013 amounted to 82.18%, this indicates that the ability of both bank management to identify, measure, monitor, and control risks that arise through policies and business strategies to achieve the target. Management of the bank can be classified as healthy when at least have met 81% of all these aspects (PBI number 13/1 / PBI / 2011). This study shows that the ratio NPM significant negative effect on the prediction of the troubled bank, which means the higher the NPM, the smaller the probability of the condition of troubled banks.

ROA ratio is not significant, meaning that the company's ability to generate profits by using the company's total assets can not be used to predict the troubled bank. The average ROA of 0.92% in 2011-2013, this shows that the amount of ROA is less than that determined by Bank Indonesia in the amount of 1.2% (SE BI No. 7/10 / DPNP March 31, 2005).

The results if the data shows that OR effect is not significant. This can happen because of the QR ratio will affect the fulfillment of short-term liabilities. The quick ratio calculation by subtracting current assets, inventories, where inventory is an element of current assets low liquidity and frequent price fluctuations as well as causing damage in the event of liquidity. So the bigger the better QR bank conditions. Average - average LDR of the year 2011-2013 amounted to 6.34%, this suggests that QR is still in a healthy condition. Bank Indonesia requires a minimum threshold of 5% ratio of QR as a reference condition healthy banks (Circular Letter No. 7/10 / DPNP March 31, 2005).

NOP ratio has no significant influence on the prediction of troubled banks. Bank Indonesia stipulates that the amount of NOP overall maximum amount of 20% of the capital of the bank concerned. NOP average of 8.1% in 2011-2013. That is, the greater the position (long or short) held the potential profits and losses will be even greater, so that in case of exchange rate

movements, the number of positions will determine how much profit is obtained or how big the losses suffered. Thus the net open position needs to be managed properly to minimize the risk of problem banks (Sawir, 2009).

Conclusion

Results of logistic

Regression test showed six CAMELS ratio is just the ratio of net profit margin (NPM), which has a significant negative influence on the prediction of troubled banks. Fifth other variables(CAR, NPA, ROA, QR, and

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NOP) does not influence significantly to the prediction problematic conditions in the banking sector in Indonesia. Limitations contained in this study is the small number of samples and variables as well as its short observation period. Therefore, the next researcher should analyze aspects of compliance such as violation and overrun Lending Limit (LLL) and Statutory (GWM), adding a larger sample that will be more representative of commercial banks listed on the Indonesia Stock Exchange and extend the period of observation in order to know the development of the commercial banks which became the subject of research.

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ENHANCE THE COMPETITIVENESS ANALYSIS FOR BED AND BREAKFAST EXPERIENCE SERVICE ON LEISURE AGRICULTURE

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> > Abstract

The popularity of traveling stimulates the demand for accommodations and the growth of bed and breakfasts on leisure agriculture. In the competitive market of B & B services, how to outperform competitors has become an important issue that concerns the proprietors. Therefore, this research aims to identify the factors that contribute to improving the competitiveness of B & B services on leisure agriculture. In this research, the major findings of the key success factors in B & B viability using the Modified Delphi Method. Ten experts participated in supplying the raw data to which the Modified Delphi Method was then applied. The results show that the hardware, the quality of service, the environment and landscape, and the management are the aspects of key success factors for B & B services on leisure agriculture. In total there are 14 key success factors which may be divided into the four aspects.

Keywords: bed and breakfast, key success

Introduction

Since there is increasing frequency of travel in Taiwan, the demand of accommodations has increased. As the demand of accommodations goes up, the supply of lodgings must as well. The number of bed and breakfast rises along with the increase in accommodation demand (Yang, Chen, & Chien, 2014). According to Regulations for the Management of Home Stay Facilities, B & B services on leisure agriculture that merge landscape, cultures, ecology, environmental resources, and other activities are established based upon the extra space that the owners have in their houses.

B & B services which provide accommodation and recreation have become more and more popular. Therefore, the number of individuals who stay resides in B & B services keeps increasing. Within the numerous of B & B services in Taiwan, how to overpower the other competitors is an area of emphasis for those who hope to improve their business. In order to be a successful lodging place, there are key factors that should guide the B&B owners to success. The B&B proprietors should know what factors will help them gain customers when operating their B & B services.

Based on the discussion above, since there is a large number of B & B services in the sightseeing spots in Taiwan, they have competitiveness in the accommodation field. Therefore, this study tries to pick out the key success factor for B & B services on leisure agriculture. The proprietors can comprehend and learn the key success factor for B & B services on leisure agriculture in order to assist the B&B owners in managing and operating their businesses (Chan, Yim, & Lam, 2010; Wu, 2011).

The B & B services on leisure agriculture industry encounters intense competition. In order to outperform competitors, the proprietors should take advantage of the success factors. In this research, there are two purposes: 1. The research is to the find out the key success factors by analyzing what experts have said on the topic. This research is expected to make a contribution to improving the competitiveness of B&Bs. 2. Although some researchers have performed similar research, none of them utilizes the Modified Delphi Method. This study tries to analyze whether the results when using the Modified Delphi Method differ from the other researches.

Literature Review

Characteristics of B&Bs

Stutts and Wortman (2006) said that the quantity of rooms in a B&B usually under 20. After a night rest, the B&B operators will offer breakfast to the guests. The B & B services are private facilities which the owners operate the B&Bs by themselves. Timothy and Teye (2009) described that the scale of B&B is small and it possesses one to twenty rooms. American bed and breakfast association said that the intimate and home-like atmospheres are

two points which could attract the tourists to lodge. Lodging in B&Bs could release the pressures of daily lives (Yang, Chen, & Chien, 2014).

Since different scholars have different opinions on the characteristics of a B&B. According to Pearce and Moscardo (1992), the specialist accommodation includes four characteristics: 1. The guests have interaction with the hosts that is defined as personal service. 2. The guests have opportunities to experience the environment or take part in special activities. 3. The owner operates the accommodation personally. According to Chen and Yang (2005), there are five characteristics typical of B&Bs: 1. They solve the problem of insufficient accommodations in sightseeing areas. 2. Tourists can learn about farming, farming culture, and farming customs. 3. They improve the opportunities of employees in farming and income. 4. They solve a portion of agricultural production and marketing via direct trade. 5. Improve the living quality of the country side.

This study analyzed the characteristics via the opinions of a number of scholars. Some of the B&Bs contain unique features that aid the traditional industry and the local economy. Moreover, for the tourists, they could experience the culture and landscape around the B&Bs.

Aspects of B&B Key Success Factor

Islam (2010) pointed out that the key success factor is used to deal

with the challenge. Wu (2010) stated that the differences between industries and products will make the key success factors different. The manager focuses on some key success factors to form strategies. Focusing on the key fields is the application of key success factor. According to Wu (2010), there are four aspects to be considered when evaluating a B&B. The hardware, quality of service, environment and landscape, and management are included in the four aspects. In this research, these four aspects are considered the key success factors for B&Bs. There are fifteen key success factors that are contained in the research. The study analyzed and generalized different factors, demands, motivations, satisfaction, expectation, attraction. etc. from other researchers to organize the key success factors for B&B.

There are four key success factors in the hardware aspect. These four factors are: parking spaces, cooking equipment, room equipment, and safety equipment. Four scholars mentioned that the parking space is one of the factors in accommodation. The cooking equipment is mentioned by two researchers in the research. Then the room equipment and safety equipment are described by five scholars.

The meals, the recreation arrangements, the consulting service, and the interaction are the four factors in the quality of service aspect. As far as the meals factor, there are three researchers who described it as one of the demands of those seeking quality accommodations. The importance of

the recreation arrangements is attested to by three researchers and a journal. Wu (2010) asserted that the consulting service is also one of the key factors in evaluating B&Bs. Yen (2003) and other three researchers mentioned that the interaction is one of the major points for the tourists.

As far as the environment and landscape aspect is concerned, it is divided into four key success factors. They are the interior decoration and outdoor landscaping, natural or beautiful scenery around the B&B, the building exterior, and the proximity to the recreation sites. The study looks at eight cases in the research for help in how to organize these four factors.

The price, the website, and the strategic alliances are the three factors in the management aspect. This study organizes the price factor via the opinions of five researchers. The price factor, which is proposed by several researchers, is one of the factors in the management. According to Yeh (2005) and Lin (2008), strategic alliances can give a positive advantage to a B&B. Lin (2008), and Lai, Chang, and Chang (2011) mentioned that the website is the factor of marketing the B&B or providing information.

Methodology

Interview

Before executing the Modified Delphi Method, the study interviewed three experts to evaluate the importance of each item. Through this process, the study was able to remove some unnecessary items and keep the necessary ones. This study can make sure that every item which the research keeps via the interview in the questionnaire is indispensable.

The researchers developed the questionnaire which contained all the possible key success factors for B & B services on leisure agriculture as decided upon through the literature review before having the interview with the experts. The study generalized all of the possible factors for the B&B to organize the key success factors. This study invited the experts who have the related background knowledge in similar industries to evaluate the key success factors on the questionnaires.

The purpose of the interview was to revise each item on the questionnaire to make sure every item on the questionnaire was necessary. The researchers then revised the items on the questionnaire according to the answers of the experts. Through this process, some unnecessary factors were omitted from in this research. The revised questionnaire was then applied in the Modified Delphi Method.

The Modified Delphi Method

The Modified Delphi Method used in this research required experts who have background knowledge that is related to the research to participate in the method to give their opinions to help this study to pick out the key success factors. The Modified Delphi Method is the main focus in the research. Since this research tried to comprehend the key success factors for B & B services on leisure agriculture. The researcher utilized the Modified Delphi Method to attain the knowledge and opinions from the experts (Hsu, & Sandford, 2007).

There were several participants who have professional knowledge regarding the B&B or related industries that participated in the Modified Delphi Method for two rounds to find the key success factors for B&Bs. The purpose of doing this process was to get consensus among the experts.

The participants in this study contained the experts in accommodation industries, academic circles, and official. The first criterion to pick out the participants in this research showed that the B&Bs or hotels should be legitimate, and the participants have to operate or work for the facilities for more than five years. The second criterion was that there should be some scholars who specialize in B&B fields in this study. The last criteria pointed out that the participants should also include the official expert.

In the first round, the study invited 10 participants to evaluate the importance of each factor and aspect. The participants were able to give advice if they have different opinions regarding aspects and factors on the questionnaires. The participants scored each items on the questionnaire according to their specialties. The study revised the items on the questionnaire according to their answers and suggestions. The factors which the participant disagreed with were removed from the questionnaire.

Before executing the questionnaire in the second round, this study analyzed the data by SPSS. The items with lower agreement were skipped in the second round. In the second round, the participants did the same thing as they did in the first round. At the same time, the results of the first round which contain mean and standard deviation are displayed in the questionnaire so that the participants can better understand the opinions among the participants in the second round. The participants could learn the opinions from the other anonymous participants so that they could modify their viewpoints that they filled in the first round. So the results of the questionnaire could converge to achieve the standard in the research.

Data Analysis

After collecting all the questionnaires of the Modified Delphi Method, the study used SPSS to analyze the statistics from the questionnaires. There were three major points which the study analyzed. The first one is the mean. The study utilized the Likert five-point scale to evaluate the importance of the key success factors for B&Bs. A score of five-points means the highest level of agreement and onepoint means that the participant strongly disagrees with the item. If the mean is equal to or greater than four, it indicates that the experts agree with this

aspect or factor to be applied in this research.

Then the second one is standard deviation. The data from this research can also be analyzed by the standard deviation. According to Wikipedia, the opinions among the experts are close if the standard deviation is low. Finally, the third area which the study analyzes is the quartile deviation. According to Fatherty (1979), there were three levels used for evaluating the quartile devia-The first one shows that when tion. the quartile deviation is higher than 1.0, the responses show low consensus. The second one means that the responses have moderate consensus when the quartile deviation is between 0.6 and 1.0, and finally, high consensus appears when the quartile deviation is equal to or less than 0.6.

Results

Aspects of the Key Success Factors for B&Bs

The study collected the key success factors from the literature review which comes from the results of researches.

Hardware.

B&Bs are one of the options for the tourists lodgings. Accommodations are one of the basic demands of tourists, thus, the B&B owners provide the equipment that tourists need. The hardware aspect can reflect the completeness of the B&B equipment. In this research, the hardware aspect is divided into four factors: parking spaces, cooking equipment, room equipment, and safety equipment.

Quality of Service.

The quality of service that the B&B proprietors provide is different from that of hotels. The B&B owners are more intimate and enthusiastic when compared with those of hotels. In addition, the B&B owners have interaction with the tourists that make the tourists feel more comfortable and personally cared for, as they might at home. Finally, the B&B proprietors also offer different kinds of services according to the sightseeing spots near them. There are four factors contained in the quality of service. They are meals, the recreation arrangements, the consulting service, and the interaction.

Environment and Landscape.

One of the reasons tourists stay in the B&Bs is related to the environment and landscape. The B&Bs which combine the lodging and leisure are different from hotels. The tourists can experience the beautiful and natural environment as well as the accommodation. The interior decoration and outdoor landscaping, natural or beautiful scenery around the B&Bs, the building exterior, and the proximity to the recreation sites are four key factors related to environment and landscape.

Management.

The growth of the quantity of B&Bs enhances the competition in the

industry. The management has become an important part in the great competition. With great management, it can improve the fame and competitiveness of B&Bs. The three factors in the management are the price, the strategic alliances, and the website.

Results in First Round of Modified Delphi Method

Following the best suggestions discovered in the literature review, this study collected the opinions from several researchers to organize the aspects of the key success factors. In this section, the data of the first round is analyzed and discussed. The questionnaire distributed in the first round contains four major aspects. They are the hardware, the quality of service, the environment and landscape, and the management. Statistically, the means for most of the aspects were higher than four which indicated that the panelists agreed with the aspects as the factors most closely related to success; those ranked less than four were omitted from this study (see table 1). 10 participants who came from industries, official, and academic fields participated in the research. In the first round, all of the questionnaires were sent back. The recycling rate was 100%. There were not any missing questionnaires in the first round of the modified Delphi method.

Aspect	М	SD	IQR	Result
1. Hardware	4.72	0.55	0.5	
Apply				
2. Quality of Service	4.63	0.40	1.0	
Apply				
3. Environment and Landscape	4.81	0.42	0.5	
Apply				
4. Management	4.76	0.53	1.0	
Apply				

Table 1. Means, SD, and IQR of Four Aspects in First Round of Modified Delphi Method

M: Means, SD: Standard deviations

Results in Second Round of Modified Delphi Method

This study sent 10 questionnaires of the second round. A total of 10 questionnaires were sent back. The recycling rate was 100%. The result of the second round indicates that these four aspects are suitable for the key success factors for B&B. Table 2 shows that the means of them are all more than 4, which meant that the participants agreed that these four aspects are key success factors for B&Bs. According to the statistics, the participants had high consensus on the hardware

and the environment and landscape aspects, although the quality of service and the management aspects only received moderate consensus among the participants.

Conclusion And Future Research

The aim of this research was to find the key success factors necessary

for B & B services on leisure agriculture. The proprietors of B&Bs can better understand the key success factors for B&B, so that they may know the precise way of successfully managing B&B. The competitive ability of the B&Bs could be improved due to the results of the research. For the tourists who will

Table 2.	Means, SD, and IQR of Four Aspects in Second Round of
	Modified Delphi Method

Aspect	М	SD	IQR	Result
1. Hardware	4.26	0.55	1.0	
Apply				
2. Quality of Service	4.56	0.40	0	
Apply				
3. Environment and Landscape	4.31	0.42	1.0	
Apply				
4. Management	4.29	0.53	1.0	
Apply				

M: Means, SD: Standard deviations

consider staying in B&Bs as an accommodation option when they travel, they could experience better services when they lodge in successful B&Bs. Once the proprietors of B&Bs grasp the key success factors for B&Bs, the proprietors could improve the fine points of their management. The tourists could enjoy what they expect to experience as the proprietors employ the key success factors.

The B & B services on leisure agriculture in Taiwan is the major point which this study concerned, thus the literature review mentions the B&Bs used domestic literature instead of the literature from abroad so that the literature review of B&B would apply the environment in Taiwan. Secondly, the limitation of interpersonal relationship make imbalance of sample distribution. There are more B&B owner than the experts from other fields participated in the study by the influence of interpersonal relationship. Finally, most of the experts, who participated in the Modified Delphi Method, came from the same city. The opinions of all the other experts or B&B proprietors could not be represented by the opinions of the

experts who participated in this research.

As this study pointed out the characteristics creation could be one of the aspects of the key success factors. In addition, the recreation arrangements and literature and history commentary should be modified as guided tours which can cover comments on the industries, geologies, and natural scenery. These two points could be investigated in future research. Besides, the select of the participants in this research was through the seniorities. Thus, the select of the participants can

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be evaluated through business performance and occupancy rate, or after-tax income. Moreover, the Delphi Method and key success factor are two major points here in the research. This study thought that these two ways could not only be utilized in analyzing the B&Bs but also other kinds of businesses. Finally, the research focuses on the opinions of the participants. The number of participants is smaller than in quantitative research. Other researchers who are interested in similar research could consider using a quantitative method as the major survey in the research. In that way they could get different results.

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ANTECEDENTS OF FUTURE MARKET ANTICIPATION: A BETTER UNDERSTANDING FROM THE FASHION INDUSTRY IN INDONESIA

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Abstract

Batik (local fashion in Indonesia) has become a national pride for Indonesia. UNESCO has declared batik as a world heritage. This article will analyze the antecedents of future anticipation which is believed to be very important for all entrepreneurs in the batik industry. The purpose of this article is to identify the effects of a model design, raw materials, human capital, competition, the ASEAN Economic Community (AEC), and the product price toward future market anticipation. In addition, this study is also conducted to find out the anticipation of future events done by batik entrepreneurs in creating customer value. The method used is a quantitative approach using structural equation modeling methods in order to understand the antecedents of future anticipation in SMEs for batik in Pekalongan, Solo, and Lasem. The results show that competition positively functions as the only antecedent for future anticipation. The managerial implications are also discussed in this article.

Keywords: batik, design model, human capital, competition, AEC, product price, future market anticipation

Background

Batik is acknowledged as a cultural product of Indonesia which is admired by people all over the world. Batik is not just cloth but this product is a manifestation of styles, patterns, and colors that reflect Indonesian culture. Admiration was even given by UNESCO on October 2, 2009. Therefore, the government of Indonesia has decided that October 2 is National Batik Day.

Recognition given by UNESCO is the result of a long struggle by the Indonesian government as other countries (such as Malaysia) also consider batik as part of their culture. Malaysia has acknowledged that historically batik comes from Java. Malaysia also has patented batik; they argue that they patented the patterns and motifs separately, which are different from Indonesian original batik motifs and patterns. Efforts to obtain admission to UNESCO basically are to anticipate other countries' claims of the batik ownership in the future.

However, the appreciation from the world has not been responded proportionately by Indonesian consumers. Instead of increasing the number of purchases of real batik (handmade and stamped batik), printed batik sales that are actually not considered as batik have increased. The momentum of increasing international appreciation has not yet been able to switch to become an incentive for entrepreneurs to take advantage of this situation. This is evident from the stagnant sales of batik.

Previous work done by Haryanto and Priyanto (2013) has shown that future market anticipation plays a very important role for batik entrepreneurs. This future anticipation will create customer value as well as perceived market performance. However, their research has not shown the antecedents of future anticipation which is the central point of their findings. Since future market anticipation is very important for entrepreneurs, it is surprising that only a limited number of studies have analyzed future market anticipation, especially its antecedents.

This research intends to analyze the antecedents of future market anticipation in the batik industry. Previously, in-depth interviews and focus group discussions were conducted with batik entrepreneurs in Solo, Lasem, and Pekalongan, which are central locations for most batik producers in Indonesia. It is proposed that model design, alternative of raw materials, human capital, local competition, competition from the ASEAN economic community (AEC), and price of product are the antecedents of future market anticipation (see Figure 1).

Several hypotheses are developed to see whether there is a positive effect of every antecedent toward future market anticipation.



Figure 1: The Antecedents of Future Market Anticipation

Research Issues

Based on the above background, several research issues can be arranged for later field tests. The results are then summarized. Several research issues are:

- 1. Does model design positively influence future market anticipation?
- 2. Do raw materials positively influence future market anticipation?
- 3. Does human capital positively influence future market anticipation?
- 4. Does competition positively influence future market anticipation?
- 5. Does competition within AEC positively influence future market anticipation?
- 6. Does price of product positively influence future market anticipation?

Literature Review

Future Market Anticipation

Entrepreneurs face a very dynamic market. Consumer needs and meaning about the products can change from time to time. These changes can make consumers keep using a product or switch to another product. In a situation of tighter competition, the ability to read market changes and take action to meet these changes will cause companies to survive in the market or exit the market. Therefore, entrepreneurs need to continuously anticipate the changes. Jay and Duddy (1999) emphasize that anticipating the market is a tool to maintain competitiveness. According to Jay and Duddy, in addition to product improvements and innovations, anticipating consumer needs is very important. Meanwhile, anticipa-

tion is also necessary for customer value. According to Flint et al. (2008), customer value anticipation (CVA) is a driving factor for customer satisfaction and loyalty.

Future market anticipation or many times just referred to as future anticipation is customer perception about all the activities undertaken by producers who are trying to provide solutions for customer needs and requirements in the future. However, not much research about future market anticipation has been conducted and literature on this topic is limited. In order to discuss the theoretical framework of future anticipation, the author used a futuristic approach or futurology, which is the science that studies the future. It is currently continuing to grow and gain in-depth attention from academics (Mello, Bhadare, Fearn, Galaviz, Hartmann, and Worrel, 2009). Although this science can provide enormous implications in the world of marketing, research and theories about the future are still rarely discussed in the realm of marketing science.

Focusing on the future necessitates an understanding of the dynamic environment and requires an understanding of the various factors, both short term and long term, which will have an impact on businesses and markets. To achieve the aim of maintaining growth and market leadership, it requires a strong future orientation and willingness to make long-term commitments to key stakeholders such as customers, employees, suppliers, partners, shareholders, the public, and the community. Organizational planning should anticipate many factors such as customer expectations, new business opportunities and partnering opportunities, increasing the global market, developments in technology, the increasing e-commerce environment, new customers and new market segments, development regulations, public expectations and the community, as well as strategic moves conducted by competitors. Strategic objectives and resource allocations need to accommodate these various influences. Focusing on the future includes developing employees and suppliers, creating innovation opportunities, and anticipating responsibility to the public.

According to Adam (2008), employees and the company have a right to create and shape their future. Shaping the future is the task of a company or the company is also a future shaper. A company uses resources in order to get profits and maintain its competitiveness. The fact is companies spend money and large amounts of funds for research and development activities in order to deliver superior customer value in the future. Companies compete for innovation of innovate product development and services as part of future anticipation. When companies do not anticipate the future then they just wait for their death. One interesting example is Nokia which had been a market leader for decades in the mobile phone market. Nokia failed to maintain a strong will to innovate as a part of its future anticipation, which finally ended up being a major market acquisition by Iphone and Blackberry.

The future is an activity related to the awareness of alternative materials, social, and political environment. Social concerns are related with a lot of people to predict what will happen in the future (De Roo, 2009). Regarding the material, it requires a lot of funds needed by the company to identify trends in the future. It is said to be political because the company actually wants to dictate the market to greater competitiveness. Although the future is a very complex matter to study, this does not mean that the future cannot be predicted. Many corporate leaders in multinational companies such as Pizza Hut or United Colors of Benetton have conducted research by doing in-depth talks and even by living together for a few days with the younger generation to understand their current needs as well as to try to understand their preferences in the future (Ebert & Griffin, 2010). They do so in order to try to understand the future. By comprehending the future, they can carry out a series of anticipations to get the benefits out of them (Adam, 2008).

Chang, Hung, and Ho (2007) introduced the process of finding potential customers through a needs analysis in the future. This process begins with the profile determination of loyal customers, continued with a search of potential customers that leads to potential customer searches through predictions about their needs in the future. It shows the importance of identifying sales patterns for core products and customer background to understand the profile of loyal customers. It is also necessary to analyze the potential buyers who have never made a purchase, along with their characteristics to understand the buying opportunities that exist. The last part is to use existing data to understand buying opportunities in the future resulting in a projection for potential customers.

For SMEs, this analysis is important as SMEs rarely identify the pattern of their sales and customer profiles (Haryanto, 2007). SMEs need to understand patterns of sales and customer profiles, combined with anticipated future needs and desires. The opportunity to gain market potential will become large, which means an increase in the performance of the SME marketing.

Product Characteristics

Product characteristics are distinctive characteristics from the products which differentiate them from the competitors and could be offered to the markets to fulfill the customer needs and wants (Kotler & Keller, 2006; Brown, 1998). Thus, every product has its own characteristics which make it different from its competitors. Marketers try to develop products with their own unique traits, in order to gain specific perceptions from customers. This later concept is called positioning strategy (Kotler & Keller, 2006). A product which is unique, competitive, and difficult to imitate by competitors will facilitate service providers to have a competitive advantage.

One of the competitive advantages that could be offered is product characteristics (Acuff & Reiher, 1997). The uniqueness of a product and

its specific competencies will differentiate the product from its competitors. Three important product characteristics in this research are model design, alternative of raw materials, and price of product (Solomon, 2007).

In accordance with the product characteristics, Levin and Paige (2003) conducted a research to prove that product choices are influenced by the specific characteristics of those products. Previous research has shown the relationship between product characteristics on the intention to consume (Levin & Page, 2003; Mizerski, 1995; Gruner & Homburg, 2000). Customers are very concerned about the product characteristics when they want to buy or consume the products (McNeal, 1992).

If entrepreneurs are able to create an up-to-date model design, then customers will perceive this as future anticipation. Entrepreneurs who think about the future will also seek alternative raw materials to make their products become better and cheaper. Hence, raw materials and price of product play a significant role in building future anticipation. On the other hand, entrepreneurs will always look for better human capital to be perceived as future-oriented and will think beyond the competition. In a more formal framework, the following hypothesis can be devised:

H1: Model design positively influences future anticipation.

H2: Alternative raw materials positively influence future anticipation.

H3: Human capital positively influences future anticipation.

H4: Competition positively influences future anticipation.

H5: AEC positively influences future anticipation.

H6: Price of product positively influences future anticipation.

Research Method

The Type of Research and Location

This research was conducted in three areas known as large batik producers in Pekalongan, Lasem, and Solo in Central Java. Those three locations were selected because in these regions there are many batik SMEs, both exporters and non-exporters.

Data Sampling and Data Processing

The population for this research is batik entrepreneurs in Solo, Lasem, and Pekalongan. Questionnaires are distributed with a Likert scale of 1-7 to obtain respondents' perceptions of the variables examined in this study. A snowball sampling method is used in this study with 50 respondents from each city, so that a total of 150 samples are obtained. However, there are 6 questionnaires which could not be used in this research because of some missing data. Hence, a total of 144 respondents are involved in this research. The data is then processed through a structural equation modeling method with LISREL 8.80 software to test the hypotheses.

Results

By using SEM and Lisrel 8.8, a suitability test is obtained of the overall structural model, which produces a suitability value or GOF. In full, the conformity values are displayed in Table 1.

GOF Indicator	Value Expected	Estimation Results	Findings
GFI	GFI > 0.90	0.83	Marginal fit
RMSEA	RMSEA < 0.08	0.039	Good fit
NNFI	NNFI > 0.90	0.96	Good fit
NFI	NFI > 0.90	0.87	Marginal fit
RFI	RFI > 0.90	0.86	Marginal fit
IFI	IFI > 0.90	0.97	Good fit
CFI	CFI > 0.90	0.97	Good fit
	0.014		

 Table 1: Suitability Value of the Overall Structural Model

Source: Primary Data, 2014

Based on the Table 1. above, in general it can be concluded that the research model has a good level of fitness. This is shown by the estimated value that is dominated by the value of good conformity (good fit).

Hypothesis Testing Results

The results show the value of the subsequent coefficients and t || value. When the structural trajectory has a value of t | | \geq 1.96, then the path coefficient is significant. Then if | t | \leq 1.96, it is concluded that the coefficient of the path is not significant (Hair et al., 2010).

Based on the results above, it is found that model design does not positively influence future market anticipation. This is seen in the value of | t |in Table 2, which is in accordance with the predetermined statistical requirements ($|t| \le 1.96$), so it is not confirmed that the hypothesis in this data is supported. An up-to-date model design is perceived as the company effort to increase sales. Customers do not appreciate this up-to-date model because other competitors do the same thing.

Based on the results above, it is discovered that raw materials have no positive effect on future anticipation. This is seen from the value of |t| in Table 2, which is in accordance with the predetermined statistical terms (t $|\leq 1.96$); this means the hypothesis in this data is not supported. In hypothesis 2, testing results found that there is no improvement in searching for alternative raw materials. Batik entrepreneurs think that raw materials are given and they cannot look for substitutes. For instance, previously gondorukem (one of the main materials) was very cheap

because only batik uses this material. However, due to the increasing number of batik entrepreneurs, it has made the price of gondurukem become high, as it is now sold in US dollars. Batik entrepreneurs are reluctant to find new alternative materials, because they think that new materials are not genuine for batik.

Table 2. Hypothesis Testing Results

Hypotheses	t-value	(Not) / Supported
H1: Model design positively influences future market	-0.27	Not supported
anticipation.		
H2: Alternative raw materials positively influence	-0.28	Not supported
future market anticipation.		
H3: Human capital positively influences future market	-0.02	Not supported
anticipation.		
H4: Competition positively influences future market	2.13	Supported
anticipation.		
H5: AEC positively influences future market anticipa-	-1.94	Not supported
tion.		
H6: Price of product positively influences future mar-	-1.10	Not supported
ket anticipation.		

Based on the analysis above, it is determined that human capital has no positive effect on market future anticipation. This is viewed from the value of | t | in Table 2, which is in accordance with the predetermined statistical terms (t $| \leq 1.96$); this means that hypothesis 3 is not supported by the data. In hypothesis 3, testing results found that human capital, i.e. employees do not play a significant role in developing future anticipation. Most of the employees in batik are older persons with old-fashioned technology. They do not want to adapt to or learn from new technology. In Lasem and Pekalongan, most of them are part-time worker, so loyalty and commitment is questioned here. This provides an explanation as to why human capital does not positively influence future anticipation.

Based on the results of the above analysis, it is found that competition has a positive effect on future anticipation. This is proved by the value of | t | in Table 2, which is in accordance with the predetermined statistical terms (t $| | \ge 1.96$); this means hypothesis 4 is supported by the data. In the hypothesis 4 testing results, it is revealed that competition is the only antecedent of future anticipation. The competition in batik is very intense, because there are so many players there. Since most of the batik entrepreneurs are skillful, it is very easy for

them to copy or duplicate other producers' designs. On the other hand, this competition comes from batik entrepreneurs who have limited funding. Every weekend, these entrepreneurs have to pay their employees. If they have no money on that weekend, then they will sell their batik below the market value in order to obtain cash. This has resulted in price wars among the batik entrepreneurs. However, this competition also pushes the batik entrepreneurs to think about a new way to anticipate the future. They are expanding their market abroad or to other islands in Indonesia, in order to cope with the competition on Java Island.

Based on the analysis above, it is found that AEC has no positive effect on future anticipation. This is proved by the value of | t | in Table 2, which is in accordance with the predetermined statistical terms (t $\mid \mid \leq$ 1.96); this means the hypothesis is not supported by the data. In the hypothesis 5 testing results, it is discovered that batik entrepreneurs in Solo, Pekalongan, and Lasem do not think about the competition in AEC. They think that batik is an Indonesian heritage. Even though Malaysia also has batik, they consider this to be very different. On the other hand, most of the batik entrepreneurs are not university graduates. This low educational background makes them incapable of thinking about global competition. Research conducted by Andadari (2014) found that almost half of SMEs do not know about the plan of ASEAN economic community implementation in 2015.

Based on the analysis above, it is determined that price of product has no positive effect on future market anticipation. This is proved by the value of |t| in Table 2, which the value $t \leq$ 1.96, so the hypothesis is not supported by data. In the hypothesis 6 testing results, it found that price is something to be considered as being determined by batik entrepreneurs. They perceive that the competition has decreased the price of the batik. On the other hand, the cost of raw materials has increased because they have to import most of the materials from China. Thus, batik entrepreneurs are not seeking a strategy to cut their costs as a form of future anticipation.

Conclusion & Recomendations

Conclusion

Future market anticipation is customer perception about all the activities undertaken by producers who are trying to provide solutions for customer needs and requirements in the future. Future market anticipation is important for marketing performance improvement. However, not much research about future market anticipation has been conducted and literature on this topic is limited. More study on future market anticipation is needed.

This study found that among six factors that are derived as the antecedents of future market anticipation (model design, alternative raw materials, human capital, competition, competition in AEC, and price of product), only one factor, competition, is supported as an antecedent of future mar-

ket anticipation. This means all efforts taken by businesspeople are not related to future anticipation except in considering competition.

Recomendations

As future anticipation is important for marketing performance improvement, the entrepreneurs need to make strategic plans regarding future anticipation.

- How that can be done is to do an analysis of what has been done so far related to the company's marketing strategy. Also note the strengths and weaknesses of a company that has been there all along. Then need to analyze recent consumer behavior and projections about future consumer behavior. Combination of these things are used to formulate future strategies anticipation.
- 2. Need to set up a special team. The team will continue to work to audit specific consumer behavior and condition of the company, which is then used as the basis for future strategy. This team could be formed from the marketing and production divisions.
- 3. To be competitive, businesses need to understand that they

can take advantage of a variety of ways such as modify the design of the model, look for alternatives other than the use of current raw materials that increase the quality of a product and lower the cost, improve human resources, as well as price of product. Some of these variables are important in creating the uniqueness of the products.

4. With the enactment of the AEC, SMEs in Indonesia are mostly unaware of the opportunities and threats that they may face. Most firms do not know or even do not care about the implementation of this agreement. This is because most of them are still busy with their internal problems. Socialization of the AEC needs to be intensified and improved. Also, SMEs should be encouraged to try to take advantage of opportunities and avoid threats that may be faced.

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CONSTRUCTING REASONABLE COMMON WEIGHTS IN DATA ENVELOPMENT ANALYSIS

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Abstract

Data envelopment analysis (DEA) is an evaluation technique that computes the relative efficiencies of all decision-making units (DMUs) by finding a set of optimal weights for each DMU, which not only maximizes the efficiency of that DMU but also typically results in numerous relatively efficient DMUs. Several researchers have attempted to modify the DEA model to fit different situations. However, these models cannot provide a meaningful connection between the weights obtained using the models and the importance of input and output factors. Using the concept of the elasticity coefficient and considering the situations of all DMUs, this study proposes a common weights model in which the weights represent the importance levels of input and output factors. Mathematical theorems are developed for obtaining the set of weights. Numerical examples are used to illustrate that the set of common weights obtained using the proposed model is consistent with the importance of the input and output factors.

Key Words: Data Envelopment Analysis (DEA), Common Weights (CWs), Elasticity Coefficient (EC)

Introduction

Charnes, Cooper, and Rhodes (1978) developed an evaluation model that computes the relative efficiencies of a group of decision-making units (DMUs) with multiple input and output factors by assuming a constant return of scale. This model is called the CCR model of data envelopment analysis (DEA). The CCR model constructs n similar DMUs (each with *m* input and *s* output factors) to evaluate the relative efficiency of the k^{th} DMU and emphasizes maximizing the ratio of outputs to fixed inputs. This approach is the basis for the input- oriented CCR model. The mathematical model can be represented as follows (Charnes et al., 1978):

$$Max. \ \theta_{k} = \sum_{r=1}^{s} u_{rk} y_{rk}$$
s.t.

$$\sum_{i=1}^{m} v_{ik} x_{ik} = 1$$

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

$$u_{rk}, v_{ik} \ge \varepsilon > 0$$

$$j = 1, 2, ..., n$$

$$k = 1, 2, ..., n$$
(1)

where:

 θ_k : relative efficiency of the k^{th} DMU, k = 1, 2, ..., n y_{rk} : r^{th} output of the k^{th} DMU x_{ik} : i^{th} input of the k^{th} DMU y_{rj} : r^{th} output of the j^{th} DMU x_{ij} : i^{th} input of the j^{th} DMU u_{rk} : weight of r^{th} output of the k^{th} DMU v_{ik} : weight of i^{th} input of the k^{th} DMU ε : a small positive real number, usually 10^{-4} or 10^{-6} .

This model restricts the ratio of the weighted sum of outputs to the weighted sum of inputs to unity, and the values of the weights are set as unknown variables. When computing the relative efficiency θ_k of DMU_k, the values of the weights were chosen to maximize θ_k . DMU_k is called "relatively efficient" if θ_k equals unity and "relatively inefficient" if θ_k is less than unity.

The DEA evaluation technique can evaluate the efficiencies of DMUs with multiple inputs and outputs and is flexible in practical applications. The technique has been applied for performance evaluation problems in several fields (Charnes, Cooper, & Rhodes, 1981; Hwang & Chang, 2003; Kao, Huang, & Toshiyuki, 2003). Numerous researchers have attempted to modify the DEA model to fit different situations. For example, Thompson, Singleton, Thrall, and Smith (1986) proposed the assurance region model and Sexton, Silkman, and Hogan (1986), and Doyle and Green (1994) introduced the crossefficiency model. In 1991, Roll, Cook, and Golany introduced the common weights model. Later, Roll and Golany (1993), Bao (2007), Chen (2009), and Bao, Tsai, and Tsai (2011) proposed different versions of the common weights model for deriving the set of weights for the input and output factors of DMUs.

For computing the crossefficiency, some researchers assign different weights to DMUs and input and output factors. For example, Wang and Wang (2013) introduced three approaches for determining the relative crucial weights of DMUs for crossefficiency aggregation in DEA. Lam and Bai (2011) proposed a model that minimizes the deviations of input and output weights from their means. Liang, Wu, Cook, and Zhu (2008a) extended the model proposed by Doyle and Green (1994) by introducing numerous secondary objective functions in computing cross-efficiency. Liang, Wu, Cook, and Zhu (2008b) also applied the concept of game theory to computing cross-efficiency. However, these evaluation models do not satisfactorily explain the weights obtained. In reality, weights and the importance of factors are fairly connected. For example, managers typically assign higher weights to input and output factors that contribute more to the organization.

To meaningfully explain the weights obtained using the models, an expression must be deduced to represent the relationships between these variables, including the weights and the importance of input and output factors. In economics, elasticity represents the responsiveness of one variable to changes in another, with both changes expressed in percentages (Wessels, 1993). The elasticity coefficient is defined as the absolute value of the percentage change in the quantity demanded or the supply divided by the absolute value of the percentage change in price; this value is greater than or less than unity when the demand or supply is price elastic or inelastic, respectively (Welch & Welch, 2007).

The concept of elasticity coefficient has been widely used in economics (Stiglitz and Walsh, 2006; Taylor, 2004; Tucker, 2005; Welch and Welch, 2007). However, this concept is rarely applied in the field of performance evaluation. According to our thorough review of the literature, only Alirezaee and Afsharian (2009) used the elasticity concept in DEA to propose an algorithm for improving efficiency.

Using the elasticity coefficient concept, this study proposes a common weights evaluation model in which the weights represent the relative importance of the input and output factors. A mathematical theorem is developed to obtain the set of common weights. Finally, numerical examples are used to illustrate how the set of common weights obtained using the proposed model is consistent with the importance of the input and output factors and to compare the virtues and defects of the proposed model with those of current evaluation models.

This paper is divided into four sections. First, the importance of this study is explained in the first section. Second, a detailed discussion on the construction of the proposed model is provided in the second section. Numerical examples are used to illustrate the advantages and disadvantages of the proposed model and compare them with those of current evaluation models in the third section. Finally, the conclusions of this research are discussed in the last section.

Model Construction

The DEA evaluation technique evaluates the relative efficiencies of DMUs with multiple input and output factors. However, DMUs can contain only input or output factors in practice, such as when investigations of customer satisfaction and questionnaires are used to obtain customer opinions on specific service items. Such opinion scales can be considered the output factors of DMUs. No input factor exists in this case. By contrast, when managers are interested in how much of a resource (time, cost, workforce, etc.) is required for completing a given job or task, only input factors are considered. In such cases, it is still suitable to evaluate the relative efficiencies of these DMUs using the DEA evaluation technique. Two scenarios are discussed in this section: (a) DMUs that contain only output factors and (b) DMUs that contain both input and output factors. These scenarios are discussed to illustrate the proposed model.

DMUs Containing Only Output Factors

When DMUs have no input factor, it is reasonable to assume that all of them contain only one input factor with a value equal to unity. Then, using equation (1), the relative efficiency θ_k of each DMU k can be calculated successively as follows:

$$\theta_{k} = \sum_{r=1}^{s} u_{rk} y_{rk}, k = 1, 2, ..., n$$
(2)

To match the importance of each output factor with the relative efficiency of the DMU, this study uses the elasticity coefficient concept from economics. First, the importance of the r^{th} output factor y_{rk} and t^{th} output factor y_{tk} to the relative efficiency θ_k is defined as follows:

Definition 1: The importance of the contribution of the output factors y_{rk} and y_{tk} of DMU k to its relative efficiency θ_k can be represented as the elasticity coefficient e_{rtk} as follows:

$$e_{rtk} = \frac{\partial y_{rk} / y_{rk}}{\partial y_{tk} / y_{tk}}, \ r, t = 1, 2, \dots, s.$$
(3)

Because θ_k already has a fixed value, e_{rtk} represents the ratio of the amount of θ_k that can still be increased with a contribution of the output factor y_{rk} to the amount of θ_k that can still be increased with a contribution of the output factor y_{tk} . On the basis of this definition, this study first deduces the following theorem.

Theorem 1: The elasticity coefficient e_{rtk} for output factor y_{rk} to output factor y_{tk} of DMU k is the ratio of their weights multiplied by the values of their output factors.

$$e_{rtk} = \frac{u_{tk}}{u_{rk}} \times \frac{y_{tk}}{y_{rk}}$$
(4)

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Proof:

From equation (2), the partial derivative of the relative efficiency of DMU k, θ_k , to the r^{th} output factor of DMU k is computed; the result is $\partial \theta_k / \partial y_{rk} = u_{rk}$. Then, the elasticity coefficient e_{rtk} for "output factor y_{rk} to output factor y_{tk} " of DMU k can be obtained through simple algebraic computation.

$$e_{rtk} = \frac{\partial y_{rk} / y_{rk}}{\partial y_{ik} / y_{ik}}$$

$$= \frac{\partial y_{rk}}{y_{rk}} \times \frac{y_{ik}}{\partial y_{ik}}$$

$$= \frac{\partial y_{rk}}{\partial \theta_{k}} \times \frac{\partial \theta_{k}}{\partial y_{ik}} \times \frac{y_{ik}}{y_{rk}}$$

$$= \frac{u_{ik}}{u_{rk}} \times \frac{y_{ik}}{y_{rk}}$$
(5)

Q.E.D.

Because θ_k has a fixed value, when the value of e_{rtk} is greater than unity, the amount of θ_k that can still be increased with the contribution of the output factor y_{rk} is higher than the amount of θ_k that can still be increased with the contribution of the output factor y_{tk} . This scenario indicates that the contribution of the output factor y_{rk} to θ_k is currently lesser than that of the output factor y_{tk} to θ_k . Therefore, a higher e_{rtk} value denotes that the output factor y_{tk} is more important than the output factor y_{rk} .

The relationships can be explained as follows: the contribution of y_{tk} to the relative efficiency θ_k is e_{rtk} times the contribution of y_{rk} to θ_k . When evaluating the relative performance or efficiency of DMUs in reality, managers typically assign higher weights to the factors that contribute more to the organization. Let E_{rt} represent the sum of e_{rtk} for all DMUs.

$$E_{rt} = \sum_{k=1}^{n} e_{rtk} \tag{6}$$

Moreover, let E_t represent the relative importance of the output factor t.

$$E_t = \sum_{r=1, r\neq t}^{s} E_{rt} \tag{7}$$

Then, a set of common weights for all output factors of the DMUs that correspond to the contribution of each output factor can be obtained by normalizing E_t .

$$w_{t} = \frac{E_{t}}{\sum_{r=1}^{s} E_{r}}, t = 1, 2, ..., s$$
(8)

Using the weights obtained from equation (8), the relative efficiencies of DMU_k , h_k , are computed as follows:

$$h_{k} = \sum_{r=1}^{s} w_{r} y_{rk}, k = 1, 2, ..., n$$
(9)

Finally, the efficiency values are unified as follows:

$$\theta_{k} = \frac{h_{k}}{\max\{h_{j}\}}, \ j = 1, 2, ..., n$$
(10)

DMUs Containing Both Output and Input Factors

If the DMUs being evaluated contain m input and s output factors, the DMUs can be transformed into new DMUs that contain only m*s new output factors by simply dividing each output factor by each input factor. Next, a set of common weights for these m*s new output factors can be computed using the method introduced in the previous section. Note that the weights obtained here represent the relative importance of the new output factors and not that of the original input and output factors.

In the next section, numerical examples are used to illustrate the advantages and disadvantages of the proposed model and compare them with those of current evaluation models.

Numerical Example Illustration

DMUs Containing Only Output Factors

Example 1: Assume that 10 customers score four service items. The scores are listed in Table 1.

First, an input-oriented CCR model is used and ε is set to 10^{-6} to determine the set of optimal weights for each DMU; the results are listed in Table 2.

Second, using equation (5), the elasticity coefficients e_{rtk} , k = 1, 2, ..., 10 for all service items (output factors) are computed and listed in Table 3.

Third, using equation (6), the sums of the elasticity coefficients are computed

as follows:

 $E_{21} = \Sigma e_{21k} = 333,330 + 333,330 + 0.00 + 0.00 + 2.50 + 0.00 + 0.00 + 333,330 + 2.00 + 0.00 = 999,995$

 $E_{31} = 833,327, E_{41} = 1,333,329, E_{12} = 761,898, E_{32} = 333,335, E_{42} = 1,142,851, E_{13} = 819,042,$

 $E_{23} = 500,006, E_{43} = 1,285,710, E_{14} = 250,001, E_{24} = 499,998, E_{34} = 333,332$

DMU	y 1	y 2	y 3	y 4
1	5	3	4	3
2	5	3	4	2
3	4	2	4	2
4	3	3	3	2
5	5	2	5	3
6	4	3	4	3
7	3	3	4	2
8	5	3	3	2
9	4	2	3	3
10	4	3	4	3

Table 1. Customers' Comments to Service Items

Table 2. The Weights of Service Items

DMU	<i>u</i> ₁	u ₂	U 3	U 4
1	0.199998	0.000001	0.000001	0.000001
2	0.199998	0.000001	0.000001	0.000001
3	0.000001	0.142856	0.142856	0.000001
4	0.000001	0.333329	0.000001	0.000001
5	0.000001	0.000001	0.199998	0.000001
6	0.000001	0.142856	0.142856	0.000001
7	0.000001	0.142856	0.142856	0.000001
8	0.199998	0.000001	0.000001	0.000001
9	0.000001	0.000001	0.000001	0.333329
10	0.000001	0.142856	0.142856	0.000001

DM U	<i>e</i> ₂₁	<i>e</i> ₃₁	<i>e</i> 41	<i>e</i> ₁₂	<i>e</i> ₃₂	<i>e</i> ₄₂	<i>e</i> ₁₃	<i>e</i> ₂₃	<i>e</i> 43	<i>e</i> ₁₄	<i>e</i> ₂₄	<i>e</i> 34
	2222	2400	2222									
1	3333	2499	3333	0.00	0.75	1.00	0.00	1.33	1.33	0.00	1.00	0.75
	30	98	30									
2	3333	2499	4999	000	075	1 50	000	1 33	200	000	067	0.50
	30	98	95	0.00	0.75	1.50	0.00	1.55	2.00	0.00	0.07	0.00
3	0.00	0.00	2.00	7142	0.50	1428	1428	200	2857	0.50	0.00	0.00
				8	0.50	56	56	2.00	12	0.50	0.00	0.00
4	0.00	1.00	1.50	3333	3333	4999	1.00	0.00		o (-		o (-
				29	29	94	1.00	0.00	1.50	0.67	0.00	0.67
5	2 50	000	167	_>	_>	<i>_</i>	1999	4999	3333			
5	2.50	0.00	1.07	0.40	0.00	0.67	08	05	30	0.60	1.50	0.00
6	000	000	1 22	1071		1/20	1/20	95	1004			
0	0.00	0.00	1.55	10/1	0.75	1420	1420	1.33	1904	0.75	0.00	0.00
-	0.00	0.00	1.50	42		30	30		15			
1	0.00	0.00	1.50	1428	0.75	2142	1904	1.33	2857	0.67	0.00	0.00
				56	0.110	84	75	1.00	12	0.07	0.00	0.00
8	3333	3333	4999	000	100	1 50	000	100	1 50	000	067	067
	30	30	95	0.00	1.00	1.50	0.00	1.00	1.50	0.00	0.07	0.07
9	2.00	1.33	0.00	0.50	0(7	0.00	0.75	1.50	0.00	2499	4999	3333
				0.50	0.67	0.00	0.75	1.50	0.00	97	94	29
10	0.00	0.00	1.33	1071		1428	1428		1904			
				42	0.75	56	56	1.33	75	0.75	0.00	0.00

Table 3. The Elasticity Coefficients of all Service Items

Fourth, the relative importance of each output factor is computed using equation (7) as follows:

 $E_1 = \Sigma E_{r1} = 3,166,651, E_2 = \Sigma E_{r2} = 2,238,084, E_3 = \Sigma E_{r3} = 2,604,758, E_4 = \Sigma E_{r4} = 1,083,331$

Furthermore, sets of common weights for all output factors of the DMUs that correspond to the contribution of each output factor are obtained as follows:

 $w_1 = 3,166,651/(3,166,651 + 2,238,084 + 2,604,758 + 1,083,331) = 0.3483,$

 $w_2 = 0.2461, w_3 = 0.2865, w_4 = 0.1191$

Finally, the relative efficiencies of all DMUs are computed using equations (9) and (10), and the results are listed in Table 5.

To illustrate the advantages and disadvantages of the proposed model and compare them with those of current evaluation models, four existing evaluation models are used to analyze the data in Table 1, assuming that all DMUs contain only one input factor with a value equal to unity. The four models are the CCR model, the common weights models proposed by Bao (2007) and Chen (2009), and the common compromise weights (CCW) model proposed by Bao et al. (2011). The common weights of output factors obtained using these models are listed in Table 4, and the relative efficiencies of all DMUs are listed in Table 5.

The computed total scores of customer ratings for all service items in Table 1 are 42, 27, 38, and 25. Thus, customers assign the highest score to service item 1, followed by service items 3 and 2, and service item 4 receives the lowest score. These results imply that service item 1 contributes considerably more to the overall satisfaction (efficiency) of DMUs than other service items in this example do. Intuitively, managers should assign the highest weight to service item 1, followed by service items 3 and 2. Service item 4 should be assigned the lowest weight. In Table 4, only the proposed model assigns the weights appropriately; the model proposed by Chen not only assigns the weights incorrectly but also yields two zero weights, which is not acceptable in practice.

	u_1	u_2	U 3	U 4
Bao	0.074	0.074	0.074	0.037
Chen	0	0.014	0.014	0
CCW	0.060	0.090	0.077	0.033
Proposed	0.348	0.246	0.287	0.119

Table 4. The Weights Obtained from Different Models

DMU	CCR	Bao	Chen	CCW	Proposed
1	1	1	1	1	0.990
2	1	0.963	1	0.966	0.960
3	0.857	0.815	0.857	0.812	0.813
4	1	0.741	0.857	0.765	0.716
5	1	1	1	0.986	1
6	1	0.926	1	0.939	0.903
7	1	0.815	1	0.844	0.787
8	1	0.889	0.857	0.887	0.889
9	1	0.778	0.714	0.768	0.771
10	1	0.926	1	0.939	0.903

Table 5. The Relative Efficiencies of DMUs

According to Table 5, the CCW model proposed by Bao et al. (2011) and the proposed model provide the optimal distinguishability in this example. Because the relative efficiency of one specific DMU is different when computed using a different model, determining which model is more suitable for evaluating performance is difficult. One method is to compare the correlation coefficients for the relative efficiencies derived using different models; the results are listed in Table 6.

DMUs Containing Input and Output Factors

In this subsection, DMUs with two input and two output factors are used as examples to illustrate the proposed model. In this example, 14 DMUs with two input and two output factors are illustrated. The data are listed in Table 7.

Table 6. The Correlation Coefficients of the Efficiencies Derived from Five Models

	CCR	Bao	Chen	CCW	Proposed
CCR	1				
Bao	0.266	1			
Chen	0.248	0.719^{*}	1		
CCW	0.312	0.989^{**}	0.804^{**}	1	
Proposed	0.217	0.994^{**}	0.655^{*}	0.969^{**}	1

*Significant when 0.05 (two tail)

**Significant when 0.01 (two tail)

DMU	<i>x</i> ₁	<i>x</i> ₂	<i>y</i> 1	y 2
1	3008	20980	97775	101225
2	3985	25643	135871	130580
3	4324	26978	133655	168473
4	3534	25361	46243	100407
5	8836	40796	176661	215616
6	5376	37562	182576	217615
7	4982	33088	98880	167278
8	4775	39122	136701	193393
9	8046	42958	225138	256575
10	8554	48955	257370	312877
11	6147	45514	165274	227099
12	8366	55140	203989	321623
13	13479	68037	174270	341743
14	21808	78302	322990	487539

Table 7. Input and Output Data of 14 DMUs

First, each output factor is divided by each input factor; the results are treated as a new data set that includes only output factors, as listed in Table 8. The differences among the values of the output factors in Table 8 are relatively high and affect the weights obtained using the CCR model.

To demonstrate the importance of each output factor and circumvent the influence of the values of the output factors, the values of the output factors in Table 8 can be normalized by dividing by the standard deviation of each output factor; the results are listed in Table 9.

DMU	y_{1}/x_{1}	y_{1}/x_{2}	y_2/x_1	y_2/x_2
1	32.50	4.66	33.65	4.82
2	34.10	5.30	32.77	5.09
3	30.91	4.95	38.96	6.24
4	13.09	1.82	28.41	3.96
5	19.99	4.33	24.40	5.29
6	33.96	4.86	40.48	5.79
7	19.85	2.99	33.58	5.06
8	28.63	3.49	40.50	4.94
9	27.98	5.24	31.89	5.97
10	30.09	5.26	36.58	6.39
11	26.89	3.63	36.94	4.99
12	24.38	3.70	38.44	5.83
13	12.93	2.56	25.35	5.03
14	14.81	4.12	22.36	6.23

Table 8. The New Output Data of 14 DMUs

Table 9. The Normalized Output Data of 14 DMUs

DMU	<i>yı</i> '	<i>y</i> 2'	<i>y3</i> '	<i>y4</i> '
1	4.28	4.30	5.57	6.99
2	4.49	4.89	5.43	7.37
3	4.07	4.57	6.45	9.04
4	1.72	1.68	4.70	5.73
5	2.63	4.00	4.04	7.65

6	4.47	4.48	6.70	8.39
7	2.61	2.76	5.56	7.32
8	3.77	3.22	6.71	7.16
9	3.69	4.84	5.28	8.65
10	3.96	4.85	6.06	9.25
11	3.54	3.35	6.12	7.22
12	3.21	3.41	6.37	8.44
13	1.70	2.36	4.20	7.27
14	1.95	3.81	3.70	9.01

Second, the optimal weights for each DMU are computed successively using the input-oriented CCR model and listed in Table 10.

Third, the elasticity coefficients e_{rtk} , k = 1, 2, ..., 14 for all output factors are computed using equation (5) and listed in Table 11.

DMU	U 1	U 2	U3	U 4
1	0.218553	0.000001	0.003441	0.000001
2	0.038881	0.123754	0.040564	0.000001
3	0.000001	0.000001	0.100735	0.038745
4	0.000001	0.000001	0.147750	0.001200
5	0.000001	0.000001	0.000001	0.108107
6	0.000001	0.001177	0.148465	0.000001
7	0.000001	0.000001	0.100735	0.038745
8	0.000001	0.000001	0.149029	0.000001
9	0.000001	0.198143	0.000001	0.004216
10	0.000001	0.000001	0.043032	0.079915
11	0.000001	0.000001	0.147750	0.001200
12	0.000001	0.000001	0.100735	0.038745
13	0.000001	0.000001	0.000001	0.108107
14	0.000001	0.000001	0.000001	0.108107

Table 10. The W	Veights of	Output Factors										
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DM	<i>e</i> ₂₁	<i>e</i> ₃₁	e 41	<i>e</i> ₁₂	<i>e</i> ₃₂	<i>e</i> ₄₂	<i>e</i> ₁₃	<i>e</i> ₂₃	e 43	<i>e</i> ₁₄	<i>e</i> ₂₄	<i>e</i> 34
----	------------------------	------------------------	-------------	------------------------	------------------------	------------------------	------------------------	------------------------	-------------	------------------------	------------------------	-------------
U												
1	2176	48.8	1339	0.00	0.00	0.00	0.02	4450	27.45	0.00	1.0	0.00
	14	0	55	0.00	0.00	0.62	0.02	4459	2745	0.00	1.62	0.00
2	0.29	0.79	2368 4	3.46	2.75	8206 2	1.26	0.36	2985 2	0.00	0.00	0.00
3	0.89	0.00	0.00	1.12	0.00	0.00	1596 21	1421 73	1.86	8604 0	7663 5	0.54
4	1.02	0.00	0.00	0.98	0.00	0.00	4032 85	4131 57	101.0 8	3990	4087	0.01
5	0.66	0.65	0.00	1.52	0.99	0.00	1.53	1.01	0.00	3141 20	2070 43	2047 34
6	0.00	0.00	0.53	1180	0.01	629. 18	2224 52	188.5 6	1186 35	1.88	0.00	0.00
7	0.95	0.00	0.00	1.05	0.00	0.00	2142 28	2031 17	1.97	1084 78	1028 52	0.51
8	1.17	0.00	0.53	0.85	0.00	0.45	2650 37	3099 97	1396 43	1.90	2.22	0.00
9	0.00	0.70	0.00	2599 63	1814 60	26.2 8	1.43	0.00	0.00	9891	0.04	6904
10	0.82	0.00	0.00	1.22	0.00	0.00	6576 2	5372 8	0.35	1865 88	1524 46	2.84
11	1.06	0.00	0.00	0.95	0.00	0.00	2552 14	2697 68	104.3 0	2447	2587	0.01
12	0.94	0.00	0.00	1.06	0.00	0.00	1996 58	1878 62	1.96	1018 75	9585 6	0.51
13	0.72	0.41	0.00	1.39	0.56	0.00	2.47	1.78	0.00	4616 44	3326 58	1872 68
14	0.51	0.53	0.00	1.95	1.03	0.00	1.90	0.97	0.00	4995 52	2560 60	2632 66

Table 11. The Elasticity Coefficients for All Output Factors

Fourth, the sums of the elasticity coefficients are computed using equation (6) and listed as follows:

181,464.93,

 $E_{42} = 82,718.23, E_{13} = 1,785,265.27, E_{23} = 1,584,454.36, E_{43} = 291,087.14, E_{14} = 1,774,629.86,$

 $E_{24} = 1,230,227.69, E_{34} = 662,176.52$

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The relative importance of each output factor is then computed using equation (7) as follows:

 $E_1 = \Sigma E_{r1} = 375,315, E_2 = \Sigma E_{r2} = 525,342, E_3 = \Sigma E_{r3} = 3,660,807, E_4 = \Sigma E_{r4} = 3,667,034$ Using equation (8), a set of common weights is then obtained for all output factors of the DMUs; these weights correspond to the contribution of each output factor.

 $w_1 = 0.046, w_2 = 0.064, w_3 = 0.445, w_4 = 0.446$

Finally, the relative efficiencies of all DMUs are computed using equations (9) and (10) and listed in Table 13.

To illustrate the advantages and disadvantages of the proposed model and compare them with those of current evaluation models, the CCR and CCW models and the models proposed by Bao (2007) and Chen (2009) are used again to analyze the data in Table 9. The common weights of the input and output factors obtained using three of these models (CCW and those proposed by Bao [2007] and Chen [2009]) are listed in Table 12 and compared with those of the new output factors obtained using the proposed model. The relative efficiencies of all DMUs computed using all models are listed in Table 13.

	u ₁	u_2	<i>v</i> ₁	<i>v</i> ₂
Bao	0.0000008	0.0000069	0.0000203	0.0000447
Chen	0	0.0000003	0	0.0000017
CCW	0.0000024	0.0000026	0.0001233	0.0000096
	u_1	u_2	И3	\mathcal{U}_4
Proposed	0.046	0.064	0.445	0.446

Table 12. The Weights for Input and Output Factors

In Table 12, the weights obtained using the previous models are relatively low. This is because of the high values of the input and output factors. The model proposed by Chen again yields two zero weights, which is not acceptable in practice. By contrast, the weights obtained using the proposed model are more practical.

DMU	CCR	Bao	Chen	CCW	Proposed
1	0.95	0.78	0.75	0.89	0.82
2	1	0.78	0.80	0.92	0.84
3	1	0.97	0.98	0.98	1
4	0.70	0.52	0.62	0.56	0.66
5	0.83	0.62	0.83	0.68	0.76
6	1	0.86	0.91	1	0.98
7	0.84	0.65	0.79	0.74	0.82

Table 13. The Relative Efficiencies of the DMUs

8	1	0.60	0.77	0.88	0.89
9	0.99	0.86	0.93	0.88	0.91
10	1	1	1	0.96	0.99
11	0.91	0.54	0.78	0.84	0.86
12	0.97	0.74	0.91	0.87	0.94
13	0.79	0.17	0.79	0.58	0.72
14	0.97	0.67	0.97	0.61	0.81

According to Table 13, the models proposed by Bao (2007) and Chen (2009) and the CCW and proposed models provide the optimal distinguishability in this example. The correlation coefficients for the correlations between the relative efficiencies derived using all models are listed in Table 14.

Table 14. The Correlation Coefficient of the Efficiencies Derived from Five Models

	CCR	Bao	Chen	CCW	EC
CCR	1				
Bao	0.720^{**}	1			
Chen	0.697^{**}	0.633^{*}	1		
CCW	0.819^{**}	0.771^{**}	0.457	1	
EC	0.857^{**}	0.775^{**}	0.766^{**}	0.886^{**}	1

*Significant when 0.05 (two tail) **Significant when 0.01 (two tail)

According to Table 14, the correlation coefficients for the correlations between the proposed model and the other four models are significantly higher than 0.75. Therefore, the relative efficiencies of the DMUs derived using the proposed model are highly similar to those of the DMUs derived using the other models. However, the weights obtained using the proposed model are more practical.

Conclusions

The DEA evaluation technique computes the relative efficiencies of all DMUs by finding a set of optimal weights for each DMU that can maximize its efficiency. Numerous researchers have attempted to modify the DEA model to fit different situations. However, these models do not provide a meaningful explanation for the weights obtained.

Using the concept of the elasticity coefficient and considering the situations of all of the DMUs, this study proposes a common weights evaluation model in which the weights represent the importance of the input and output factors. A mathematical theorem is developed to obtain the set of common weights. Finally, numerical examples are used to compare the virtues and defects of the proposed model with those of current evaluation models.

The results reveal that the proposed model and the CCW model proposed by Bao et al. (2011) provide the optimal distinguishability. The CCR model and the models proposed by Bao (2007) and Chen (2009) do not provide sufficient distinguishability. Moreover, the model proposed by Chen yields zero weights, which is not acceptable in practice. Notably, the weights derived using the existing models do not provide a meaningful connection between the weights obtained using the models and the importance of the input and output factors. The weights obtained using the proposed model are more meaningful because they correspond to the importance of the input and output factors. The situations of all DMUs were considered in computing the elasticity coefficients, and this study furnishes not only a theoretical explanation but also a practical reason for the values of the weights.

The correlation coefficients for the correlations between the proposed model and existing models are significantly higher than 0.6 in both numerical examples. Thus, the relative efficiencies of the DMUs derived using the proposed model are highly similar to those derived using the existing models.

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ESTABLISHMENT OF CRISIS MANAGEMENT MECHANISMS IN PUBLIC HOSPITALS

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Abstract

This research discusses the management variables of antecedents influencing the establishment of crisis management mechanism in public hospitals. Through the questionnaire distribution in a large scale, this research takes the public hospitals in Taiwan as objects of research, and those filling out the questionnaires are presidents or the physicians serving as administrative managers of medical institutions. A total of 450 questionnaires were distributed, and 159 valid samples were retrieved, with a valid return rate of 35%. Nonlinear fuzzy ANN mode was used to verify the hypothesis. The empirical results: the variability of hospital management environment has positive correlation with the establishment of crisis management mechanism; the operation of crisis management mechanism is closely in positive correlation to the establishment of medical risk system. However, the hypothesis that the organization culture of public hospitals is uneasy to promote the operation of crisis management mechanism. This paper also proposes research contributions and limitations.

Keywords: crisis management; medical risk; fuzzy ANN mode

Introduction

Since the implementation of nationwide health insurance in Taiwan in 1995, there have been controversies, mainly reflected in the following aspects.

First, in terms of the post review system of health insurance payment by the Bureau of National Health Insurance, although the standards and procedures of payment to medical institutions have been developed, yet there is the problem that the competent authority has subjective discretion in the identification of fuzzy region, therefore, the medical institutions have been often unsatisfied with and complained the payment.

Second, since the implementation of national health insurance, financial hole, namely loss, has been increased year by year, for example, the unpaid insurance premium (subsidy) by the governments at different levels reached as high as 40 billion by 2005.

Third, as all people have been included in the national health insurance, and the contributing ratio of medical institutions throughout the nation has reached as high as over 90%, therefore it is quite convenient for people to get medical treatment, causing the waste of medical resources, for example, by June 2004, the average outpatient medical treatment frequency of people in Taiwan reached 14.85 times, much higher than the 4-5 times in western countries. Fourth, as the public of Taiwan universally have not built the idea that "go to big hospitals to seek for medical advices for serious illness while go to local clinics for minor illness" and have excessively and blindly believed in the medical level of large hospitals and the professional skills of wellknown doctors, besides, the family doctor's referral constitution has not been established, thus, the improper allocation and waste of medical resources can be found everywhere.

Fifth, as the public has increasingly realized and stressed the right of medical right, and the medical disputes have been growing year by year, as for hospitals, in addition to the operation finance and management, it is urgent and important for them on how to actively establish medical dispute warning mechanism. The settlement of medical disputes in Taiwan has roughly depended on two ways: the first one is to solve through legal channel: for example, the medical disputes can be solved through the conciliation of Taiwan Health Reform Foundation or in the way of criminal action of judicial channel (in European countries, USA and Japan, the medical disputes are mainly solved through civil liability), this way is civilized, because the professional knowledge between doctors and patients is excessively unbalanced, so even the patients win the judicial litigation, they are not necessarily able to get a reasonable compensation, and moreover, they need to experience conciliation or the physical and mental suffering of litigation time; the second one is that the patients or their families remedy by themselves or ask for the

local powerful people to involve in mediation, and even take offensive means and other uncivilized actions, in this way, both the doctors and the patients are losers, therefore it is one of the valid ways to actively reduce the medical disputes by understanding the signs before the occurrence of medical disputes and checking erroneous ideas at the outset to make the relationship between doctors and patients more harmonious.

The past researches on crisis management and mechanism are mostly focused on the following directions: (1) system integration is necessary to crisis management (Demichela, 2004; Vaughn, et al., 2014; Sahinoglu, et al, 2014), system integration includes the network participation in crisis management policy (Hallikas et al., 2004; Sahinoglu, et al, 2014) or the content on how the system builds crisis and opportunity detection management (Link & Marxt, 2004; Sahinoglu, et al, 2014), like EMS (Environmental Management System) and QMS (Quality Management System); (2) the role of crisis management plan and program presenting (Mitroff, et al., 1992; Tzeng,2006) and planning in crisis management (Penrose, 2000), stressing the theoretical research; (3) treat profitseeking enterprises as the targets (Elsubbaugh, et al., 2004; Sommer & Pearson, 2007; Israeli, 2007), and moreover, most are analyzed by cases (Israeli & Reichel, 2003; Acquier, et al., 2008), while the non-profit enterprises like medical institutions are rarely discussed; (4) public organizations are often inferior to private organizations in efficiency and effectiveness (Parhizgari & Gilbert, 2004), and similarly, Taiwan's public hospitals are often inferior to private hospitals in efficiency and effectiveness, although so, in front of the challenge of hospital management environment and the increasingly growing of variability, the risk perception level of employees in public hospitals is very important to the establishment of hospital crisis management mechanism, and this is a part worthy discussion; (5) the previous researches mostly adopted the ways of case discussion or qualitative analysis, while rarely developed discussion based on the combination of qualitative and quantitative data.

Based on the above, the research directions of this study are as follows. First, it is necessary to discuss the crisis management mechanism of non-profit organizations like medical institutions. The absolute dominance in doctor-patient relationship of hospitals in the past has been gradually broken as the hospital management environment competition is fiercer; the acts and institutions of public hospitals are imbalanced, and the excellent doctors have left and been poached, therefore intensifying the operation of public hospitals, and the public hospitals will be faced with a greater challenge. Second, through literature review on empirical studies, this research develops discussion aiming at the factors influencing the establishment of crisis management mechanism in public hospitals.

Literature Review

Medical Environment

The increasing change and instability of Taiwan's medical environment in recent years are mainly caused by the followings: (1) with the improvement of patients' awareness of right protection and education level as well as the circulation of medical information, the patients' independent consciousness has increased; (2) the patients have been unsatisfied with the medical system for long time, and they have gradually lost the trust to medical personnel through the media, so in case of medical disputes, they often claim for compensation through a third party or self remedy; (3) the medical institutions are often self-assured for having professional medical knowledge, while the patients or their families often lack the medical knowledge, therefore resulting an imbalance of professional knowledge level between doctors and patients, and moreover, the medical personnel are unwilling to face the subsequent severity of medical disputes, and generally refuse to put down figure, and as a result, the situation becomes out of control and is unable to be improved (Taiwan Health Reform Foundation, 2003). However, in the researches by European and American countries, it is shown that the generation of medical disputes is mostly caused by poor communication between doctors and patients, accounting for a higher proportion (Gutheil et al.,1984;Beckman, 1994;Wang, et al, 2012), and besides, many researches hold that the problem of communication between doctors and patients is one important key factor influencing the claiming for medical disputes by patients or their families (Shapiro et al.,1989; Valenta et al.,1988; Meyers, 1987; Marabell & Fitzsimmons 1989; Levinson, 1997; Kairuz, et al, 2008;); (4) the change of Taiwan's health insurance policy: for example, to improve the medical quality, the doctor's amount of seeing patients is limited; as well as the increase of limiting conditions for insurance expenses paid to hospitals have indirectly impacted the operation performance of hospitals. In recent years, the patients have an increasing awareness of right; Taiwan's health insurance policy, due to the financial deficit, has directly influenced the hospital operation, causing the increase of variability of hospital management environment; and there are more and more medical disputes, so it has become one of important tasks for hospitals on how to establish crisis management mechanism.

H1: The variability of hospital management environment has positive correlation with the establishment of crisis management mechanism

Crisis Management

Crisis management is to assist the operation managers to effectively nip evil in the bud in systematic way and with systematic procedures step by step, so that the enterprise managers may depend on scientific method to exactly, rapidly and effectively reduce the enterprise losses. Crisis management tools include (1) "type" (the medical disputes can be classified into medical negligence and doctor-patient relationship), (2) "stage"—effective crisis management can be divided into 5 stages (a) signal detection stage: in which the warning signal is realized so

that the possibility of crisis occurrence is known in advance; (6) Preparation and prevention stage: crisis prevention and the response to occurred crisis; (c) damage suppression stage: it is expected not to influence the uninfluenced parts of company is its environment; (d) recovery stage: those making preparations for crisis will implement short-term and long-term corporate recovery plan, to assist the enterprises to recover the normal operation; (e) experience learning stage: the content in this stage includes learning lessons from the self experience or the experience of other enterprises (3) "system"-most enterprises stress technical factors and human factors in crisis discussion rather than organization culture and emotion factors, and the crisis generation may be often sourced from these mental or structural factors and (4) "stakeholders"—referring to that the personnel in related organizations have decisive influence on the crisis management (Mitroff & Pearson, 1993). It is also emphasized by Mitroff & Pearson (1993) that the cause of crisis occurrence cannot be only attributed to the deficiency in technology system, and the interaction relations between technology and system, organization structure and personnel factors are included. These factors cause the crisis and also they are the way for crisis prevention.

According to Mitroff (2001), any complicated organization can be analyzed with multiple onion model, and such model mainly includes 5 levels: the most superficial level is science level; the second level is organization structure; the third level is human factors; the fourth level is organization culture; and the fifth level also the innermost level is senior management psychology. These levels have their factors influencing the crisis. In addition, crisis management system is a dynamic combination of interdependency, and the system has diversified objectives in itself and such objectives can be completed through division of responsibility. According to Lerbinger (1997), crisis management lies in how to work out a complete plan, and to effectively solve the crisis, the followings shall be done well: (1) find out the potential crisis and risk zone; (2) understand own resources; (3) communicate with the related units and personnel outside of the organization; (4) set up crisis threshold. For this purpose, this research will, based on the selfdiagnosis framework of crisis management put forward by Mitroff & Pearson (1993), measure the hospital crisis management mechanism and perception from six aspects, namely, "technology system diagnosis", "organization structure system diagnosis", "human factor diagnosis", "cultural system diagnosis", "emotional system diagnosis", and "operation performance". According to Tzeng and Yin (2008), through the field survey to medical personnel in hospitals, it's discovered that the solution can be proposed and the crisis can be avoided through the operation of medical care practice. In addition, the operation of crisis management system needs the personnel's practical operation and familiarity and also the management personnel's support.

Medical risk system and operation

It was once put forward by Reason (1990a) that medical negligence can be described with "Swiss cheese theory", for Swiss cheese has many holes but these holes are not connected to each other, when the cheese is cut piece by piece and turned for a proper angle, all holes will be the potential medical negligence points, and the ray of light passing through the hole is the serious consequence caused by medical negligence. Perrow (1984) once put forward "normal accident theory": if the system has interactive effect in itself and is of close dependence, it will be normal to have accidents. According to him, the more complicated and more closely dependent the system is, the easier the accident is to occur, so this system shall stress the requirements for reliability. Taking medical care operation for example, an integration system to provide service with people as main body is involved, it is participated in by different professional personnel and equipment, so to speak, it is of various closely related and complicated integrative types.

Therefore, medical system should pay more attention to the reliability requirements. Just like that various risk evaluation tools are used in the industrial circles, JCAHO (the Joint Commission on the Accreditation of Healthcare Organization) supports the medical circles to use root cause analysis (RCA) and failure mode and effects analysis (FMEA) and requires the medical organization under jurisdiction to select at least one high-risk medical care procedure a year to implement preventative risk evaluation analysis operation. USA has implemented medical risk evaluation operation, but Taiwan's Department of Health has not made mandatory provisions. Currently, FMEA is only implemented in few teaching hospitals and large hospitals.

H2: The operation of crisis management mechanism is closely in positive correlation to the establishment of medical risk system

Although in terms of the implementation of medical management quality tools in hospitals, the quality important to administration and the quality of medical part are included, it is held by this research that, as for the establishment of crisis management mechanism, medical industry has the characteristics of high capital intensity and high knowledge intensity, and with the change of health insurance system and the increase of competition pressure, the overall industry environment has increasing variability and uncertainty. In addition, the organization culture formed based on the hospital leadership style is also an important factor on whether crisis system can be established effectively, for positive organization culture increases the close cooperation between staffs and the organization efficiency as well as improves the employees' productivity and commitment level (Barney, 1986).

According to Schein (1992), in different stages of organization development, leaders play an important role, and the function of such role will be different with the evolution of each stage, so the required leadership style is different. According to Fleeger (1993), in the two routes on research of hospital's organization culture style he put forward, one is formal and obvious protocol specifications, for example, the statement of organization mission, policy and procedure, and etc., all of these provide a channel for the organization structure to be understood and accepted; another one is metaphor, non-formal part, although there are no clearly specified standards and the expectations on communication, these phenomena will be spread to each working unit, and also influence the organization culture.

The results of past research on hospital's organization culture in western countries show that strong culture is universal in public hospitals, especially that the decision right has a high concentration (Shaw, 2002, Seren & Baykal, 2007), however, the success of organizational reform needs public and direct communication, provision of powerful information of reform, support from senior managers as well as the reward to employees for valuable opinions (Knox & Irving, 1997; Redfern & Christian, 2003).

Although there were many researches on hospital's organization culture in the past, for example, Seren & Baykal (2007) took the hospitals in USA as objects of research and got the conclusion that the hospital's internal organization culture is roughly manifested as strong culture; Chen (2008) took the small and medium hospitals in Taiwan as objects of survey and found out that the hospital culture is similar to the culture of general small and mediumsized enterprises, that is, the decisionmaking power is concentrated in the hands of the minority people, so there is no vision and short-term orientation, and employees' centripetal force is insufficient. Although the hospital employees have the characteristics of high specialization and fineness of division, yet in Taiwan, public hospitals and private hospitals have obvious differences in organization culture, private hospitals, due to large pressure of competition and survival, have gradually developed their business under the orientation of market and customers, so, organization culture is relatively inclined to strong culture, leader's decision-making style tends to centralization, but due to clear division of responsibility and between reward and punishment, the private hospitals will have a greater personal development space than the public hospitals in rigid system. However, compared with general government organs, public hospitals have a certain institutional guarantee, and the organization culture is inclined to individualism and leader's decision-making style is inclined to decentralization, so this is not good for the crisis management mechanism operated to respond to the external environment.

H3: The organization culture of public hospitals is uneasy to promote the operation of crisis management mechanism.

Research Method

Research Procedures

This research plans to firstly seek for the opinions given by different

experts on the antecedents regarding the hospitals' being inclined to market orientation through qualitative expert interview, and then make a deep understanding and research. Therefore, the first objects of depth interview in this research are the senior management personnel with medical background and leadership in regional hospitals, so as to facilitate the subsequent development of the questionnaire scale on related aspects. Secondly, the questionnaire content is worked out, and through the modification of pre-test, to finalize the questionnaire content. In addition, the so-called public hospitals in this research refer to the hospitals at city or county level; and the private hospitals refer to the hospitals which are established in the name of incorporated foundation and the management personnel of which do not have the qualifications of government functionaries or public doctors.

Research Framework Diagram



Figure 1. Research Framework

Questionnaire Distribution and Return

This research takes the public hospitals in Taiwan as objects of research, and those filling out the questionnaires are presidents or physicians serving as administrative managers of medical institutions. 450 questionnaires were distributed, in which, 150 valid ones were taken back, with valid return rate of 35%.

Reliability and Validity Analysis

According to Nunnally (1978), if the credibility is above 0.7, it means

a quite high degree of reliability. According to Cuieford (1965), it is a high credibility if Cronbach's α value is more than 0.7, an acceptable level if Cronbach's α value is ranged from 0.7 to 0.5, and should be refused if Cronbach's α value is less than 0.5 As the credibility of each aspect of this research is at least above 0.75 (as shown in Table 2), and a certain level of credibility is possessed. In addition, the related research scholars' views (as shown in Table 1) have been referred to in the questionnaire design content or view of this research, so the questionnaire questions have mostly covered the constructs of measurement, so the questionnaire of this research has a certain content validity.

The detection method of statistical nonlinear fuzzy artificial neural network is applied in the hypothesis verification of this research, for example, the variance detection and regression analysis. In addition, the nonlinear fuzzy artificial network mode is also used to verify the hypothesis. The reason for the use of nonlinear fuzzy artificial neural network mode in this research is mainly to understand the mutual interaction between variables more accurately, White (1989) also emphasized that artificial neural network has the ability of distinguishing the data type and relation, and it can be used for the multi-variable statistical analysis. Second, the main reason for the use of fuzzy artificial network mode in this research is that this mode has the widest application, and also the most developed one. It is not only applicable to the forecast and classification, but is also applicable to the uncertain behavior system, and this method has the following advantages: (1) it can fully approach any nonlinear function (the sample in this research is a representation of highly nonlinear function); (2) all quantitative or qualitative information is evenly distributed in the neuron in the network, so it has a very strong fault-tolerant ability and toughness; (3) the use of parallel distribution processing makes it possible to carry out large calculation, and it is appropriate for the nonlinear system of complicated behavioral science in the enterprise management; (4) there is less preset work needed, only the data of input layer and output layer and input system are required to get the relation between variables. (5) Through the learning circulation frequency and application, it has a broader application scope than the traditional statistical method without understanding the relation between variables in advance and on the basis of example of sampling method.

Fuzzy ANN framework

In this research, it is attempted to use the technology of fuzzy artificial network, and the fuzzy inference system of Sugeno (1985) is applied to fuzzify the data collected and is transformed into the fuzzy quantity expressed with

Research as-	Conceptual definition and question	Related references and modi-
pect	1 1	fications
Environmental	It refers to the adverse degree of hospital operation	Refer to the viewpoints of Lonial
variability	to overall competition environment. The questions	& Raiu (2002)
	in such aspect are shown as below: competition	
	degree of hospital operation: barrier degree of med-	
	ical industry: generally, the demand degree of pa-	
	tients for service quality; degree of regulation con-	
	trol and necessary quality provision in products and	
	services of hospitals.	
Organization	It refers to that organization culture is the belief, code of	Refer to the viewpoints of Hill and
culture	conduct, specification and value system jointly shared by	Janes (1998), as well as Jarvenpa
	organization members. The questions in such aspect are	and Staples (2001)
	shown as below: the hospital's internal working proce-	-
	dures are arranged clearly and smoothly; it is oriented by	
	abidance to acts and regulations internally; each internal	
	unit has their responsibilities and rights symmetrical; the	
	relationship of enterprise ethics is emphasized internally;	
	the internal members are passionate and active; a system	
	to encourage innovation is created internally; the internal	
	members often feel the pressure from work challenge; the	
	interpersonal relationship between members is harmoni-	
	ous; the members pay attention to the cohesion of team	
	spirit; there are many cooperation opportunities between	
	members; a caring atmosphere with high sense of safety	
	is created internally.	
Operation of crisis	It refers to hospital's continuous and valid operation	Refer to the viewpoints of Booth
management	activities, to reach the purpose of preventing, treating and	(1993) and Mitroff (2001), and
mechanism	resolving the crisis through systematic, planning and	modify the questionnaire content
	control-oriented way, so as to keep the dynamic process	
	of operating results. The questions in such aspect are	
	shown as below: clearly specify the crisis management	
	and treatment team; clearly specify the standard operation	
	procedures; formulate the treatment operation method	
	and manual; and specifically indicate the targets, respon-	
	sibilities and rights of system.	
Establishment of	It refers to that hospital construction is provided	Refer to the viewpoints of Leonard,
medical risk sys-	with the medical risk evaluation tools or methods.	et al. (2004)
tem	The questions in such aspect are shown as below: at	
	least one set of systematic method should be used	
	to measure the medical risks; at least one high-risk	
	medical care procedure should be selected to be	
	subject to preventative risk evaluation operation;	
	post-mortem review and analysis method should be	
	used for development of preventative system so as	
	to establish preventive measures; it is important to	
	establish medical risk mechanism; and now it is the	
	important time to establish medical risk mecha-	
	nism.	

Table 1. Conceptual definition of each aspect of this research

membership and fuzzy subset. In this way, it is possible to transform the internal relation between the original input and output data and the input and output of the description system (accurate mathematical model) into a corresponding fuzzy relation expressed with the conditional statement if (input language variable fuzzy subset) then (output language variable fuzzy subset), and in this way, the fuzzy model of the system is completed. The language variable can be distinguished into different degrees like low, medium and high variables, and even re-distinguished into finer variables to achieve a more accurate effect. In the fuzzy system, "fuzzification"-> "fuzzy reasoning"-> "fuzzy judgment" is the essential structure to constitute the fuzzy system. Expressing the fuzzy system into a network structure of connection method can get a fuzzy neuron network.

Latent variables	Number of Vari-	Cronbach's α coefficient
	ables of Meas-	
	urement	
Environmental varia-	4	0.821
bility		
Organization culture	8	0.856
Operation of crisis	5	0.795
management mecha-		
nism		
Establishment of med-	4	0.803
ical risk system		

Table 2. Reliability of all Variables of Measurement of this Study



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Figure 2. Fuzzy ANN framework

Layer 1: Input layer (Input Layer)

Input units :
$$I_1^{(1)} = X_1$$
, $i = 1,2$
Onput units : $O_{ii}^{(1)} = I_i^{(1)}$, $i = 1,2$; $j = 1,2,\Lambda,n$

Layer 2: Fuzzy interface (Linguistic term layer)

In this layer, the input of the first layer is used to infer the membership of relevant membership function with Gaussian function.

Input units: $I_{ij}^{(2)} = -\frac{(O_{ij}^{(1)} - a_{ij})^2}{b_{ij}^2}$, $i = 1, 2; j = 1, 2, \Lambda, n$

Onput units : $O_{ij}^{(2)} = \mu_{A_{ij}} = \exp(I_{ij}^{(2)})$, i = 1,2; $j = 1,2,\Lambda,n$

where are, respectively, the center and the width parameters of the Gaussian func- a_{ij} and b_{ij} tion.

Layer 3: Fuzzy reasoning (Rule layer)

In this layer, the applicability of each rule in the rule library is inferred.

Input units : $I_{(j-l)n+l}^{(3)} = O_{ij}^{(2)}O_{2l}^{(2)}$, $j = 1, 2, \Lambda, n$; $l = 1, 2, \Lambda, n$ Onput units : $O_i^{(3)} = \mu_i = I_i^{(3)}$, $i = 1, 2, \Lambda, m (= n^2)$

Layer 4: Defuzzification interface and output (Output layer)

Input units : $I^{(4)} = \sum_{p=1}^{m} O_p^{(3)} W_p$

Onput units: $O^{(4)} = \mu^* = \frac{I^{(4)}}{\sum_{p=1}^m O_p^{(3)}}$

It can be known from the above framework that the typical rule can be written as below:

if X_1 is $\mu_{A_{II}}$ then $W_1 = K_1$ $K_1 = \text{constant}(\text{zero - order Sugeno fuzzy model})$ or

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 $K_1 = p \times X_1 + q \times X_2 + r$ (first - order Sugeno fuzzy model, *p*,*q*,*r* are all constants)

As for the learning algorithm of membership function the steepest descent method in back-propagation is use in this research, while the learning algorithm of rule library (K) adopts the least squares estimation.

Research Procedures

 The data are sorted aimed at the recovered questionnaires, and there are totally 159 complete data.
 Define the input and output variables of the 3 hypotheses, and decide the number of each variable corresponding to its membership function
 Train the fuzzy artificial mode, measures an epoch after training of every 159 data, and during this period, update the parameters to achieve the optimal membership function shape and library rule.

4. After training, the fuzzy artificial neural mode, and at this time, it is possible to test the influence of input variables on the output variables. Here, it is the influence of an input variable on the output variable, so except the output variable, all other input variables are fixed value (take the average value of the 159 data to minimize the influence of these variables), while the rang of the input variable tested will be taken from 1.5 to 4.5 to conform to the range of the real data.

Empirical Results

a_{ii} and b_{ii}

First, discuss whether the environment is of significant correlation with the establishment of crisis management mechanism aimed at H1, and in terms of the empirical result of the fuzzy neural network mode, each input variable has two membership functions, respectively Low and High, while the rule library adopts zero-order sugeno fuzzy model, after about 132 times' learning cycle, the average testing error is 0.1847, and the test result is as shown in Figure 3, where ' represents the test data of input variable, while \blacklozenge represents the output data inferred from the fuzzy artificial network mode. It can be seen from the figure that the dispersal points of "environmental change" and "operation of crisis management mechanism" are very close, indicating that there is a significant correlation between the two, so H1 is supported.

Second, to verify H2, each output variable also has 2 membership functions, respectively Low and High, and the rule library also adopts zeroorder sugeno fuzzy model, after about 159 times' learning cycle, the average testing error is 0.1862, and the test result is as shown in Figure 4. It can be seen from the distribution pints of input variable and output variable of fuzzy artificial neural mode that the dispersal points of "operation of crisis management mechanism" and "establishment of medical risk system" are very close,



Figure 3. Each input variable and membership function of "environmental variability" and "operation of crisis management mechanism"





indicating that there is a significant correlation between the two, so H2 is also supported. In addition to verify H3, each output variable also has 2 membership functions, respectively Low and High, and the rule library also adopts zero-order sugeno fuzzy model, after about 128 times' learning cycle, the average testing error is 0.1529, and the test result is as shown in Figure 4. It can be seen from the distribution pints of input variable and output variable of fuzzy artificial neural mode that there is rule for the distribution of dispersal points between "organization culture" and "operation of crisis



Figure 5. Each input variable and membership function of "organization culture" and "operation of crisis management mechanism"

management mechanism", indicating that there is no significant correlation between the two, so H3 is not supported.

Conclusion and Suggestions

The empirical results suggest that: (1) the operation of crisis management mechanism is closely related with the change of external environment and the establishment of medical risk system of internal environment, which represents that the operation of crisis management mechanism is not only suppressed under the passive cooperation of external environment, but the operation management mechanism must also operate with the cooperation of internal equipment and tools, and this is consistent with Kairuz (2008): (2) H3 is not supported, indicting that the organization culture is not the necessary basis for the management mechanism operation of public hospital, but only the support of senior management

is likely to be one of the necessary conditions.

Compared with the previous researches, this research is characterized by the following: (1) the previous researches seldom discuss the antecedent variables for the establishment of crisis management mechanism of public hospital in Taiwan from the aspects of organization and system, and this is different from most of the previous researches limited to the discussion of Europe and America; (2) most of the hospital management tissues previously were concentrated on the medical system, for example FMEA discussion, while the factors influencing the establishment of crisis management system in hospital are seldom, and this is worth discussing; (3) there were seldom empirical methods of using nonlinear fuzzy artificial network model in the previous researches of relevant topics, and there might be more contribution to the theory.

The following research suggestions can be thought from the following: (1) discuss other disturbance items influencing the establishment of crisis management mechanism and their effect, for example, the disturbance effect of management leadership style and company policy on the establishment of crisis management mechanism; (2) it is possible to discuss the hardware and software equipment appropriate for the hospital to establish crisis management from the perspective of core competency, and its validation to the warning of hospital service fault; (3) it is possible to integrate other management modes influencing the establishment of crisis mechanism, for example, the variable of HR training mode or the long-term transverse investigation, so that the considerations for the mode factor are more complete; (4) it is also possible to use other different research methods to

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verify the result, for example, use the linear structure equation mode (SEM) to verify the data result and explain the reason, and this might have a great contribution theoretically.

The limitations of this research are as follows: (1) a sampling investigation is conducted aimed at the public hospital, but in Taiwan, the hospital scale and rating level might influence the willingness and competency of the hospitals to establish the hospital crisis management mechanism; (2) the cross section is used to discuss the mechanism of hospital to establish the crisis management, and it is suggested that the follow-up researches should discuss it with vertical section or substantial interview, and the result obtained might be able to more reflect the deep connotation behind it.

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LOCATION CHOICES OF DINING FOR STUDENT GATHERING: A CASE STUDY OF CHUNG HUA UNIVERSITY STUDENTS

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Abstract

The culinary industry in Taiwan has been flourishing in recent years. To understand college students' preference in choosing a restaurant, this study selects Chung Hua University students as its subject. The influence of college students' "perceived value" and "satisfaction level" toward restaurants is studied via survey of questionnaires, as well as by descriptive statistical analysis and factor analysis. In "perceive value", it is found that students value "quality perception" and "price perception" but not necessarily "customer expectation". In "satisfaction level", students value "environment", "food quality", and "service attitude.

Keywords: perceived value, satisfaction level, quality perception

Introduction

According to Taiwan Industry Economics Services, the culinary industry is referred as an industry that provides ready-made food and drinks to customers, such as restaurants, can teens, snack bars, tearooms, Cafés, ice/fruit shops, food stalls and similar others. Dining places in organizations, factories, guest houses, or clubs are other similar likes. The culinary industry is gradually becoming the predominant industry for Taiwan's develop-

ment in recent years. According to the statistics of Wholesale, Retail, and Culinary Industry by the Department of Statistics, Ministry of the Interior, culinary industry's total sales volume was NT\$32.19 billion in 2012, an equivalent of 3.3% annual growth rate. In addition, in a report by Chen (2012), Taiwan's culinary businesses are continually planning to go public. For example, F-Cuisine (85°C Café) was on the stock market in November of 2011. Wowprime Group was on the market in March of 2012. Thaitown was on the market in September of 2012. All of which showed tremendous growth and trend of the culinary industry in Taiwan.

Due to changes in the social environment, people have gradually begun paying attention to the demand for proper diets. In a study by Liao (2009), the meaning of "gathered dining" by college students is not limited to just dining with friends but a course of experiencing various cuisines with friends while socializing. Liu and Chang (2007) suggested the enhancement of family atmosphere by restaurant businesses for customers who are students living away from home, so that a cozy home feeling is resulted.

Studies had shown the weight of importance varies with price for college students. Liao (2009) found college students to value restaurant environment when the cost is under NT\$200. When the cost is more that NT\$200, students give weight to whether the price is reasonable. On the other hand, Liu and Chang (2007) listed other dimensions that are important for businesses. They are students' tangibility, reliability, responsiveness, authenticity, and empathy.

From the aforementioned, it is evident that college student value what they eat. Unfortunately, there have been limited studies concerning college students' perceived value and satisfaction level toward restaurants. This paper attempts to study college students' satisfaction level from their perceived value of restaurants.

Perceived value has always been regarded as an important factor that influences purchase intention (Dodds & Monroe, 1985; Zeithaml, 1988). Petrick (2004) found tourism businesses to have a better understanding of consumer behavior if perceived value is known. Perceived value reflects what consumers feel about products and services. For businesses, creation and transmission of consumer value have become major competitive advantages (Flagestad & Hope, 2001; Ryan, 2002). When consumers are deciding participation behaviors, they most likely choose products with the highest perceived value (Hansen, 2005: Zeithaml, 1988). Paras- uraman and Grewal (2002) believed that, in marketing, the concept of perceived value can be viewed as an important indicator of repurchase, as well as basis of decision-making.

To consumers, perceived value is the product value perceived by consumers, which is determined by perceived benefit and perceived cost

(Schiffman & Kanuk, 1991). Rust and Oliver (1994) believed that perceived value is the combination of what consumers believe to be the value they receive and the benefit they sacrifice. Dodds and Monroe (1985) believed that the closer of the product price to consumers' threshold of tolerance, the higher of their perceived value, thereby increased purchase intention.

From individual's perception of what a consumer believes to have paid and received as basis of the overall evaluation, Zeithaml (1988) categorized 4 concepts of value for perceived value. They are as follow.

(1) Value is low cost, as to what a consumer cares most about is simply the price.

(2) Value is what a consumer looks for in a product, as to whether satisfaction is filled by a consumer's subjective demand.

(3) Value is the equilibrium between the price being paid and the quality being received in return. In other words, value is the exchange of what is being paid and what is being received.

(4) Value is whether the surrendered corresponds to the received. A consumer takes into consideration of all related cost and gain.

Customer satisfaction has always been desired by businesses (Hansemark & Albinsson, 2004). With customer satisfaction, increased repurchase behavior would follow, as well as the likelihood of purchases on other products (Cardozo, 1965). Oliver (1981) believed that customer satisfaction is the evaluation formed from the moment of purchase to the level of excitement during consumption experience. Consumer purchase is affected by product price, service efficiency, service attitude, overall performance, and other similar factors (Ostrom & Iacobucci, 1995). A customer's purchase intention increases rapidly with increased customer satisfaction (Bowen & Chen, 2001).

By definition, satisfaction refers to the perceived level of enjoyment or disappointment via comparison of service perception and service expectations (Kotler & Keller, 2006). Oliver (1981) believed that satisfaction is an emotional response to a specific transaction. Each individual has different consumer experience and expectation prior to each purchase, thereby the formation of subjective psychological perception. When customer satisfaction was first introduced in marketing by Cardozo (1965), customer satisfaction is believed to exist between what a consumer feels and the level of expectation.

To businesses, it is critical to understand customer satisfaction. Hempel (1977) stated that businesses can grasp market's consumption trend from customer satisfaction measures, which is also an important tool to achieve market advantage. In addition, Kotler (1991) stated that the only principle never been changed in businesses operation is to satisfy consumers' needs.

The service industry is customeroriented and can never be taken lightly.

Customer satisfaction may be analyzed be various dimensions. Pangan (1984) categorized 6 dimensions of customer satisfaction for stores. They are: (1) facilities, (2) location, (3) service, (4) product, (5) atmosphere, and (6) promotion. Cadotte, Woodruff, and Jenkins (1987) categorized 7 dimensions of customer satisfaction for restaurants. They are: (1) food quality, (2) cleanness, (3) service speed, (4) price/value, (5) employees' friendliness, (6) service quality, and (7) atmosphere decoration. Barsky and Labagh (1992) categorized 9 dimensions of customer satisfaction for hotels. They are: (1) employees' attitude, (2) location, (3) rooms, (4) price, (5) facilities, (6) reception, (7) service, (8) parking, and (9) food and beverage.

As can be seen of the close relationship between perceived value and customer satisfaction, Monroe and Krishnan (1985) stated the intention to purchase is influenced by perceived value. A customer's perceived value significantly affects his or her satisfaction level and repurchase intention. The higher of a customer's perceived value makes the higher of his or her satisfaction level. Kotler (2006) stated that the level of customer satisfaction is the level of enjoyment or disappointment derived from expectation and perceived value of a product.

Based on the aforementioned literatures, this study categorizes 3 dimensions for "perceived value". They are "quality perception", "customer expectation", and "price perception". Similarly, the study categorized 4 dimensions for "satisfaction level". They are "environment", "food quality", "service attitude", and "food diversity".

The questionnaire was divided by three parts, "perceived value", "customer satisfaction", and "respondent's information". Three academic experts were invited for the validity test. Ten people with experience to the field were invited for the pilot test. A 5point Likert's scale is used for the questionnaire, with 1 being "strongly disagree", 2 being "tend to disagree", 3 being "neither agree nor disagree", 4 being "tend to agree", and 5 being "strongly agree".

Pretest was conducted on students from the Department of Management at Chung Hua University. After modification, the final version of the questionnaire was distributed to all students at the front gate of Chung Hua University during lunch hour from Dec. 1st to Dec. 25th of 2012. There were 201 valid returns out of 300 distributed questionnaires. SPSS Version 21 statistical software was used for the analysis.

The result found "gathered dining" by Chung Hua University students to be mostly one to three times per month (once per month = 23.9% of the returns, twice per month = 19.9%, three times per month = 25.9%). Most respondents are non- vegetarians and local students, from Hsinchu, Taiwan (69.7% of the returns are nonvegetarians, 75.6% of the returns are

local students). Most of the respondents are between 18 and 21 years old. Respondents' monthly allowances are mostly between NT\$3000 and NT\$5000 (42.3% of the returns), followed by NT\$5000 – NT\$7000 (26.9%) and below NT\$3000 (23.9%). The purpose of "gathered dining" is primarily for keeping-in-touch, followed by socializing and chatting (keeping-intouch = 40.3%, socializing = 21.9%, chatting = 21.4%).

Perceived Value

The study had categorized 3 dimensions for "perceived value", they are "quality perception", "customer expectation", and "price perception". More specifically, quality perception can be divided into "service quality" and "environment quality". Customer expectation can be divided into "expectation being met" and "advertisement". Price perception can be divided into "expected price" and "promotion".

As shown in Table 1, Cronbach's Alpha = 0.72 for "quality perception", 0.82 for "customer expectation", and 0.78 for "price perception", indicating high reliability for "perceived value". In "quality perception", it was found that Chung Hua University students valued "service quality" and "environment quality". In "customer expectation", students valued "expectation being met" but not for "advertisement". In "price perception", students valued "expected price" and "promotion".

	Quality	Customer	Price Per-
	Perception	Expectation	ception
Service Quality	0.76		
Environment Quality	0.82		
Expectation being met		0.63	
Advertisement		0.32	
Expected Price			0.91
Promotion			0.86
Cronbach's Alpha	0.72	0.82	0.78

Table 1. Factor Analysis of Perceived Value

Satisfaction Level

The study had categorized 4 dimensions for "satisfaction level", they are "environment", "food quality", "service attitude", and "food diversity". More specifically, environment can be divided into "seating comfort", "decoration", and "cleanness". Food quality can be divided into "hygiene" and

"taste". Service attitude can be divided into "employees' neatness" and "order's speed". Food diversity can be divided into "choice diversity" and "menu variation".

As shown in Table 2, Cronbach's Alpha = 0.74 for "environment", 0.84 for "food quality", 0.76 for "service attitude", and 0.92 for "food diversity", indicating high reliability for "satisfaction level". In "environment", it was found that Chung Hua University students valued "seating comfort", "decoration", and "cleanness". In "food quality", students valued "hygiene" and "taste". In "service attitude", students valued "employees' neatness" and "order's speed". However, neither "choice diversity" nor "menu variation" was valued by students in "food diversity. Due to rapid growth of the culinary industry in Taiwan, customers' options for restaurants are changing when deciding on a restaurant. The paper studied Chung Hua University students' perceived value and satisfaction level toward restaurants. The purpose of students' "gathered dining" is primarily for "keeping - in - touch", followed by "socializing" and "chatting". In "perceived value", Chung Hua University students valued both "quality perception" and "price perception", but not necessarily "customer expectation". Of "customer expectation", students did not value "advertisement". In "satisfaction level", students valued restaurant's "environment", "food quality", and "service attitude", but not "food diversity".

	Environment	Food	Service	Food Di-
		Quality	Attitude	versity
Seating Comfort	0.74			
Decoration	0.67			
Cleanness	0.72			
Hygiene		0.84		
Taste		0.92		
Employees' Neatness			0.72	
Order's Speed			0.74	
Choice Diversity				0.32
Menu Variation				0.41
Cronbach's Alpha	0.74	0.84	0.76	0.92

Table 2. Factor Analysis of Satisfaction Level

Other than food quality and price, the study recommends restaurants to improve students' expectation toward "advertisement", so that perception of expectation is enhanced. In addition to maintaining the current environment,

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food quality, and service attitude, the study recommends restaurants to enhance food diversity, be it choice diversity or menu variation.

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AN INNOVATIVE WAY FOR WAREHOUSE STORAGE ALLOCATION

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> > Abstract

Uncertainty in orders has been a problem frequently encountered in logistics centers. Conventional methods for analyzing logistics centers mainly focus on examining data for lump sum or single-period orders instead of multiple-period orders. Consequently, such methods are unsuitable for managing rapid changes in contemporary market orders, thereby reducing the performance of logistics centers, reducing the degree of customer satisfaction, and increasing operating costs. Accordingly, an innovative way was conducted to propose a logistics storage allocation, which integrates the entry-item-quantity (EIQ) method and sequential pattern mining method, for analyzing variations in multipleperiod orders. The proposed method is divided into two stages. In the first stage, EIQ and sequential pattern mining models are constructed to mine highly associated items in multiple-period orders according to temporal variations and EIQ factors. In the second stage, the items selected in the first stage are applied as a basis for assigning storage locations in a logistics center. A case study is described in this paper to illustrate the method.

Key Words: Entry-Item-Quantity (EIQ), Storage Location Assignments

ever, the types of transaction orders
must be considered when analyzing
such managerial aspects. In other
words, efficiently evaluating transac
tion orders facilitates effectively as-

sessing the characteristics of a logistics center, thereby reducing the costs of extra and unproductive operations. Previous studies have indicated that efficient storage management can lower the operating costs of a logistics center by 70%. Currently, diverse logistics products and consumer requirements have caused numerous scholars to assert that uncertainty in orders can directly influence logistics center operations. However, previous studies have mainly focused on reconfiguring logistics storage spaces or predicting the allocation of product orders. Such approaches are inadequate for managing the storage areas of logistics centers and inevitably incur extra operating costs.

According to the shortcomings of logistics center analyses in previous studies, the present study was conducted to propose a stable logistics storage method. The entry-item-quantity (EIQ) method developed by Suzuki (1988) was used to acquire logistics centerrelated factors, which were then applied as indicators for mining applicable data. The data mining process involved considering the temporal characteristics of multiple-period orders to ensure that the mined items were tolerant to temporal variations. The proposed method can be applied to supervise variations in multiple-period orders and allocate items for such orders to storage locations. This paper presents a case example to illustrate the proposed logistics storage method, which is better tolerant to variations in orders.

Suzuki (1988) proposed the EIQ method for analyzing large-scale operations in logistics centers. This method involves integrating the elements of order entry (E), item (I), and quantity (Q) and can be applied to define four characteristics of a logistics center: EQ (the shipment quantity of an order), EN (the number of items in an order), IQ (the total shipment quantity of an item), and IK (the total picking quantity of an item). These characteristics can be used to formulate analytical methods specific to each logistics center. An effective logistics center enables managers to fully utilize available resources, accurately manage storage information, and quickly access stored products. However, the operating system of a logistics center is complex and constantly affected by temporal factors i.e. order variations.

Numerous scholars have investigated the order variations of logistics centers. For example, Luara (1998) used a dynamic function analysis to evaluate the performance of a dynamic logistics center and asserted that temporal parameters are an essential factor affecting logistics center performance. Forrester (1950) used the concepts of system dynamics to simulate the dynamic distribution of order flows in logistics centers. Gui (2005) also used the method of system dynamics to develop an accurate order prediction method integrating the aspects of order flow simulation and logistics decisionmaking. By contrast, Sheu (2006) applied a mathematical planning method to predict order demands and develop an analytical method for rapidly re-

Literature Review

flecting the order demands of a logistics center. Linn and Wysk (1987) proposed a method for simulating storage usage rate. Their study confirmed that applying distinctive strategies for managing inventories of dissimilar periods facilitated achieving higher storage usage rates compared with those achieved by adopting an identical strategy for all periods. Furthermore, Vaughan and Peterson (1999) proposed a dynamic storage plan involving the aspects of path configuration to effectively reduce the distance of order picking and enhance the efficiency of picking operations. This type of storage method involves slightly modifying storage space allocation according to the order contents received in each period.

However, frequent storage reconfiguration can incur unwanted operating costs. Therefore, from the perspective of stability, the present study was conducted to propose a logistics storage plan applicable for managing transaction orders of dissimilar periods, and a data mining method was applied to explore the associations between items in such orders. Agrawal and Srikant (1995) proposed sequential pattern mining, a method based on frequent itemset mining that involves a chronological sequence in which customers purchase products at dissimilar periods; the sequence is used as a mining factor for predicting purchasing patterns. Conventional sequential pattern mining models are classified into two categories pertaining to either the aspect of algorithm technique improvement or practical applications. The first category, which involves enhancing sequential pattern mining methods, comprises Apriori-like algorithms and patterngrowth algorithms. These types of algorithms are used to correct and improve the deficiencies and outcomes of data mining methods, enhancing the calculation efficiency and accuracy of data mining results. The second category is related to practical applications. Algorithms in this category are applied to analyze databases for logistics channels, physical channels (e.g., markets and stores), and virtual channels (e.g., online browsing and electronic order entry). The AprioriAll algorithm, proposed by Agrawal and Srikant (1995), is the most prevalent algorithm in this category and can be used to evaluate the record of a chronological sequence in which customers purchase products at dissimilar periods; a transaction database is repeatedly searched and candidate sequences are successively generated to determine the purchase characteristics of customers.

According to the aforementioned literature, in the present study an innovative way applied the method of association rule and the EIQ method as a basis for analyzing a logistics center. Moreover, temporal variations in orders were considered to ensure that the associations between mined items were tolerant to changes in multiple-period orders. According to this method, a stable logistics center storage plan was better established.

Research Methods

The research is divided into two parts: item mining and storage location assignment. In the first part, the EIQ

method was used as the basis for analyzing the target logistics center. Additionally, the temporal variations of multiple-period orders were applied to adjust the supports for screening item associations and to enhance the dynamic tolerance of the mined sequential patterns, in which items tolerant to temporal influences were better identified. The second part of this research involved analyzing and applying the degree of closeness among highfrequency item sequences as a basis for assigning storage locations. Fig. 1 illustrates the overall research flow. The EIO method is applied to examine the target logistics center according to the aspects of entry orders, ordered items, and order quantities. The EIQ method facilitates assessing the characteristics of a logistics center. However, this method can only be used to analyze the temporal storage cells of available data and cannot be applied to reflect the internal influence exerted by dynamic order variations under dissimilar temporal conditions. For examples as shown in Figure 2, compiling the order data at t period and t + 1 period can result in dissimilar EIQ parameters, causing the assigned storage locations and picking distances of an item to vary according to the order characteristics at dissimilar periods. Therefore, this study was conducted to investigate the effect of dynamic order variations on the storage locations of items. First, the storage cells most likely to be affected by dynamic orders were identified. Subsequently, the aspects of storage location configuration and associations among the orders involving identical items were investigated.

In other words, the storage location of an item is easily influenced by its popularity, or the frequency at which it is ordered by customers. In other words, an item frequently ordered during a period can exert a large influence on the overall storage allocation of a logistic center. Therefore, in this study, the total quantity (IQ) and frequency (IK) of each ordered item were used as the indicators for conducting sequential pattern mining. Particularly, this study investigated the variations in storage location assignment caused by the difference between IKt (IK at t period) and IKt+1 (IK at t + 1 period) and that between IQt (IQ at t period) and IQt+1 (IQ at t + 1 period). Additionally, orders involving an identical item are easily affected by the recency of the item (how recently a customer has purchased the item). When a previously ordered item is no longer purchased in subsequent orders, the importance of the item begins to fluctuate with time. Therefore, the time at which an order entry is updated (order entry time) was also applied as an indicator for conducting sequential pattern mining. Finally, these three data mining indicators were used to investigate how multiple-period orders affect the variation of storage allocation and the performance of picking operations. Specifically, the minimum average total picking distance (([TD]] A)) of the items stored in Area A (Near Exit) was identified.

The following section details the method of sequential pattern mining and the abovementioned data mining indicators were applied to identify itemsets tolerant to variations in tem-
poral factors. Subsequently, these itemsets served as the basis for assigning storage locations in the target logistics center.

Data Mining with EIQ Characteristics

The data mining process is divided into two stages. According to the EIQ indicators (IQ and IK), the first stage involves using the sequential pattern mining method proposed by Agrawal and Srikant (1994) for identifying applicable sequential patterns. According to this approach, items with high pick rates are selected to generate a 1candidate sequence with a length of 1. The second stage involves the characteristics of multiple-period orders. Specifically, an additional indicator, order entry time, is applied with IQ and IK to adjust the supports for selecting sequential patterns, further ensuring that items with high pick rates are selected. Fig. 3 illustrates the calculation process of sequential pattern mining.

The AprioriAll method is then applied for mining sequential patterns. Initially, the IQ and IK data from the target logistics center are used as the initial supports for mining sequential patterns, and a 1-candidate sequence with a length of 1 is obtained. Subsequently, regarding each item in the candidate sequence, the difference between the order entry time of each item and a predetermined target time is used to determine the weight of the support required for conducting the subsequent mining process; thus, the effect of the temporal factor is quantified. When the duration of an order entry time exceeds

the predetermined recency value, the support of this customer sequence is increased by 1; otherwise, the following equation is used to determine the support of customer sequence:

Where:

Support<sequence>: the support of the customer order c: the customer meeting the transaction sequence requirements weight : the weight required for decreasing the support gap : the time gap required for decreasing the support Recency : the predetermined recency T(c) : the transaction time at which the customer ordered the item

Storage Location Assignments \succ This section details the item order pattern in the largest frequent-item sequence obtained using the sequential pattern mining method. According to the proposed storage allocation plan, the selected item sets (or the items in the largest frequent-item sequence) were paired with the corresponding order data. Moreover, the characteristic regarding how multiple items can be simultaneously purchased in an order was applied investigate the degree of closeness among the selected items. Next, the degree of closeness of the items was used as the indicator for assigning storage locations. Finally, the average picking distance among the items stored in near entrance was calculated.

✓ Degree-of-Closeness Calculation

The items in the largest frequent-item sequence were paired with the corresponding transaction records to investigate the degree of closeness (Di) among the items. The process for quantifying this parameter is described as follows: A binary method was used to determine the association (R) between two items simultaneously purchased in an order (Table 1). Subsequently, the R values of each item were summed to determine the degree of closeness.

The association (R) between two items was determined according to the following equation:

 $R_{_{(X,Y)}} = \begin{cases} 1, \text{ Item X and Y are purchased at the same time} \\ 0, \text{ Otherwise} \end{cases}$

The D_i of an item was calculated according to the following equation:

$$D_i = \sum_{j=1}^n R_{(I_i, I_j)^{*'}}$$

where Di represents the sum of the associations of an item i with the remaining items j. As shown in Table 1, Item 1 might be simultaneously purchased along with Item 2, Item 3, and Item n in a single order. The records of such purchase orders are used to determine the R values, or the associations of Item 1 with other items. The R values of Item 1 are summed to acquire the D value, or the degree of closeness, of the item.

✓ Storage Location Assignment

The process of storage location assignment was divided into four steps. In the first step, the Di values of the items were determined. In the second step, the items were sorted sequentially from the highest to the lowest Di values, and the items with high Di values were prioritized to the storage locations closest to the storage entrance, facilitating the order picking process. In the third step, the storage locations of two or more items with identical Di values were determined. In the final step, the results acquired in the third step were applied to assign storage locations. The process (Fig. 4) and parameters involved in storage location assignment are detailed as follows:

Step One: The transaction data corresponding to each item are collected to calculate the degree of closeness (Di) of each item. The rightmost column displays the level of each Di value.

Step Two: The items are sorted according their Di values and assigned into dissimilar levels. Next, the items in the highest level (with the highest Di value) are assigned first, followed by items in the subsequent levels.

Step Three: When two or more items exist in a level, the storage locations of these items are assigned through a secondary assignment process that involves determining the associations (dl, I) between the items (II, i) in that level and those (II-1, x) in the previous level. Specifically, among the items in a level, the item with the highest relative total appearance frequency (Z) is prioritized. An identical Z value of two items indicates that the items have a similar degree of closeness; hence, the priority of assignment is random. This step is skipped when the Di values of the items are dissimilar.

Step Four: The results obtained in the previous step are sorted into a sequence, which serves as the basis for assigning storage locations.

Where:

 $I_{l,x}$: the *x*th item (I) in the *L*th level $I_{l-1, x}$: the *x*th item (I) in the L - Ith level

 $I_{l+1, x}$: the xth item (I) in the L + lth level

 $d_{l, I}$: the association between the *x*th item (I) in the *L*th level and the item in the previous level

Z : the total frequency in which two related items simultaneously appear in an order

Case Study

This case study focused on a domestic logistics center to illustrate the proposed method. The data for orders received by the logistics center during one year period were collected to establish a transaction database. The center mainly sells dry food products and household goods to convenience stores, medium and small-scale retailers, and grocery stores. Specifically, the logistics center had a total of 420 types of items and received an average of 732 orders per month. During the selected one-year study period (January 1-December 31, 2014), the center received a total of 8,700 orders for 420 types of items. Because the amount of monthly orders received by the target logistics center was sufficient for determining the overall center characteristics, each interval of order data was defined as the data collected during each month. Subsequently, three consecutive intervals of monthly order

data were compared and compiled into a single period of order data. Finally, the proposed storage plan was applied to analyze the collected data.

Item Mining Process

The collected transaction data was used to analyze the variations in the items involving multiple-period orders. After the 1-canditate sequence was obtained in the first stage of the mining process, the supports of the selected items are ordered at dissimilar periods (e.g., transaction time, frequency, and item list) as shown in Table 2. In the second stage of the mining process, the minimum threshold value of support was set as 11. Therefore, items with supports less than 11 were removed, and the number of remaining items equaled the number of items assigned to area near to Exit. The items selected in this stage comprised the itemset used for generating the largest frequent-item sequence. Subsequently, these items were paired to the transaction database and used as a basis for assigning storage locations.

Storage Locations Assigning

The items in the largest frequent-item sequence were generated with corresponding transaction information. Subsequently, the binary method and the proposed assignment method were used to determine the Di values of the items. Finally, the items were sorted into a sequence according to their Di values (Table 3).

A secondary assignment process was applied to determine the stor-

age locations of the items with identical Di values. First, the items in the highest level (Item 4 and Item 53) were randomly assigned to the locations nearest to the picking exit/entrance. Subsequently, the associations between the items in the first and second levels were determined. Among the secondlevel items, Item 5 and Item 24 were equally associated with the first-level items, and the extent of this association was greater than that of Item 3. Therefore, the priority for assigning Item 5 and Item 24 was random, and Item 3 was assigned after the locations of these two items were determined. Figs. 5 and 6 illustrate the results of the storage location assignment acquired using the existing logistics center method and the proposed method, respectively.

The original storage location (Fig. 5) and the proposed location (Fig. 6) were used as the basis for comparing the storage locations using other periods with identical procedures, and variations in storage locations and the average picking distances were calculated and compared.

Performance Analysis

According to the storage locations (Figs. 5 and 6) and average picking distances determined, using the collected intervals of transaction data were compared to evaluate the performances of the existing and proposed storage method. Fig. 7 depicts the variation rates of the average picking distances acquired using both methods.

The variations in the average picking distance yielded by the pro-

posed method were <10%, lower than those yielded by the existing one, indicating that the original storage location method of the target logistics center manages temporal variations in orders unfavorably. Therefore, the existing method is applicable for allocating storage locations specific to an order period but is unsuitable for formulating a flexible storage configuration that can be applied to orders in any other period. By contrast, the storage configurations acquired using the proposed method slightly varied, implying that this method can be applied to items affected by temporal variations. Table 4 displays the average variations in the storage location assignments and picking distances acquired using both methods.

Conclusion and Suggestions

The results revealed that the average variations in the picking distance and storage allocation determined using the proposed method were stable and lower than those acquired using the existing method, showing that the proposed method can account for more items affected by temporal variations. Furthermore, the difference between the variations rates of the storage configurations acquired using both methods implies that variations in multipleperiod orders are mainly caused by a specific group of items. Therefore, subsequent studies can focus on formulating strategies specific to items in a group, thereby enhancing the efficiency of storage allocations more tolerant to temporal variations, thus the applicability and stability of the method can be improved.

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Figure 1. The Proposed Method

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Figure 2. Dynamic Variation of an Order



Figure 3. Sequential Pattern Mining Process

	Item 1	Item 2	Item 3	 Item n	D
Item 1	0	$R_{1, 2}$	R _{1, 3}	 $R_{1, In}$	D_1
Item 2	$R_{2, 1}$	0	R _{2, 3}	 $R_{2, n}$	D_2
Item 3	<i>R</i> 3, 1	$R_{I, 2}$	0	 $R_{3, n}$	D_3
Item n	$R_{n, 1}$	$R_{n, 2}$	$R_{n, 3}$	 0	D_n

Table 1. Degree of Closeness of the Items in the Largest Frequent-item Sequence

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Figure 4. Storage Location Assignment Calculation

Item	Support	Item	Support	Item	Support
2	9	31	17	66	12
3	28	32	22	69	15
4	19	33	36	72	15
5	13	34	11	73	11
8	33	35	16	76	16
9	8	36	10	80	17
10	6	37	27	81	18
11	41	38	13	84	7
12	7	39	16	87	15
14	7	41	8	89	13
16	17	42	31	91	14
17	7	44	16	93	15
22	22	49	15	97	11
23	15	50	24	103	24
24	29	51	14	111	15
26	35	53	12	112	4
27	20	55	10	122	16
28	53	56	16	123	8
29	16	59	13	125	7
30	8	63	12		

Table 2. Supports of the selected items in multiple-period orders

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Item	D_i	Item	D_i	Item	D_i
4	27	87	22	81	19
53	27	103	22	31	18
3	26	76	21	59	18
5	26	122	21	49	17
24	26	11	20	66	17
32	25	29	20	27	16
44	24	35	20	38	16
33	23	37	20	51	16
16	22	42	20	89	16
22	22	72	20	91	16
39	22	80	20	93	16
50	22	111	20 8		15
56	22	23	19 26		15
63	22	69	19	28	13

Table 3. D_i Values of the items



Fig. 5. Storage locations determined using the existing method

					91	51					
				89	35	11	93				
			27	29	87	76	81	38			
		66	80	103	22	50	122	23	8		
	49	42	63	33	5	3	39	72	69	26	
59	111	16	44	24	53	4	32	56	38	31	28

Fig. 6. Storage locations determined using the proposed method



Fig. 7. Variations in Average Picking Distances

Table 4.	Average	variations	in	picking	distances and	storage	location	assignments

	Existing method	Proposed method
Average variation in picking distance	15.5%	8.32%
Average variation in storage location assignment	25%	11%

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A STUDY OF EMPLOYEES' PERCEPTION OF INFORMATION TECHNOLOGY ADOPTION IN HOTELS

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Abstract

The use of information technology in the hospitality industry is driven by the need to improve and refine customer service. However, new information technology would not be successfully implemented if employee's factor are overlooked. This study was to explore hotel employee's behavioral intention towards adoption of information technology. The results indicated that employees' attitude, self-efficacy and subjective norm have positively impact on behavioral intention. Some advices were provided for hotel managers to enhance employees' intention in information technology application.

Keywords: Information Technology, Employee Perception, Behavior Intention

Introduction

The impact and importance of information technology (IT) in the hospitality industry have had solid strategic implications for industry leaders. The traditional hotel operators have put much emphasis on the provision of quality service to guests. With the increasing demand for intensive information from customers and hotel practitioners, hotels have adopted computer-based IT facilities to decrease costs, enhance greater productivity and increased revenues in the lodging industry, improve customer service and business operations (Siguaw et al., 2000). However, researchers have indicated that IT would not be fully accepted if barriers of human factors are neglected (Hasan, 2003). Such barriers include employees' willingness, ability, and managers' support. Therefore, the purpose of the study was to explore the relationship between self-efficacy, subjective norm, attitude and behavioral intention towards perceptions of adoption of IT by hotel employees.

Literature Review

Perceived IT beliefs

Management information system (MIS) researchers have identified perceived beliefs in usefulness, ease of use. Perceived usefulness is a user's perception of usefulness of a specific application system. Davis (1989) stated that within an organizational context, employees are generally reinforced for good performance by pay rise, promotions, bonuses, and other rewards. Yet, high-perceived usefulness of a system can help reinforcement of employees and gain their high performance. In addition, Perceived ease of use encapsulates the degree to which a potential adopter views usage of an information technology to be relatively free of effort (Rogers, 1995). That is, the more complex the innovation of an information technology, the lower the probability of its adoption will be. In this connection, Davis (1989) identified a positive correlation between perceived ease of use and behavioral intentions. Thus, based on the

literature reviews, a hypothesis was suggested:

H1. More positive perceived IT beliefs lead to a more positive attitude towards IT adoption.

TAM vs. TTF

Two significant models have emerged that provide a strong theoretical base for studies of IT utilization behavior. The first is the technology acceptance model (TAM). The goal of TAM is to provide an explanation of the determinants of computer acceptance that in general is capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified (Davis, 1989).

The second is the tasktechnology fit (TTF) model. Goodhue and Thompson (1995) proposed the TTF model that extends the TAM by considering how the task affects use. More specifically, the TTF model depicts that a technology will have a positive impact on individual performance if it is well utilized, and technology adoption depends in part on how well the new technology fits with the task it supports.

In the context of hotels, tasktechnology fit is the degree to which a technology can assist an employee in performing his/her portfolio of services or tasks on the job. The higher the degree of the fit, the better performance may result. Specifically, TTF corresponds to the relationship of matching among task characteristics, employee abilities and functionalities of technology in hotels. Thus, two further hypotheses were suggested in this study:

- H2. A better task technology fit will lead to a more positive attitude towards IT adoption.
- H3. A better task-technology fit and a more positive perceived IT belief are positively correlated with each other.

Attitude

Attitude is an individual's feeling of the favorableness or unfavorableness of his/her performance of the behavior (Lam et al., 2007). Attitude towards information system is an aggregate belief among other factors such as TTF, self-efficacy and IT beliefs in our model. It somehow reflects the internal tendency towards technology acceptance. Few managers would be happy if their employees were simply using a system because of their obligation but who privately felt very negative about the system. Liao and Landry (2000) argued that employee's attitude towards the acceptance of IT would affect the intention of IT adoption. Thus, a hypothesis was proposed:

H4. A more positive attitude will lead to a higher degree of intentions towards IT.

Self-efficancy

Self-efficacy is the belief in one's capabilities to mobilize the moti-

vation, cognitive resources, and courses of action needed to meet given situational demands (Lam et al., 2007). Self-efficacy also refers to one's interest and willingness to use and interact with information technology (Hasan, 2003). Among the various individual factors examined in the literature, computer self-efficacy has been identified as a key determinant of computer usage. Hayashi et al. (2004) found that computer self-efficacy, as a moderating factor, appeared to be a less salient factor to improve end-user satisfaction with e-learning systems, and this factor might also not directly affect end-user intention to continue using e-learning system. Thus, based on previous studies on self-efficacy, two relevant hypotheses were further suggested for the study:

- H5. The higher the level of selfefficacy, the higher the degree of positive attitude towards IT adoption.
- H6. The higher the level of selfefficacy, the higher the degree of intentions towards IT adoption.

Subjective norm

Subjective norm refers to perceived pressures on a person to perform a given behavior and the person's motivation to comply with those pressures, and a person's behavioral intentions were found to correlate with a subjective norm (Conner et al., 2001). Davis (1989) reported that organizational variables such as social norms are more important than user's perceptions of the information technology in predicting system usage and acceptance. Thus, the social normative component captures the collective effect of these influences on behavioral intention. A hypothesis related to subjective norm was suggested:

H7. A higher level of subjective norms will cause a higher degree of intentions towards IT adoption.

Methodology

Based on a comprehensive literature review, a questionnaire was developed to investigate the relationship between attitude, self-efficacy, and subjective norm and behavioral intention towards adoption of information technologies in Taiwanese hotels. Of the 788 questionnaires distributed, 678 were received, and among 678 completed questionnaires, 458 were usable. Structural Equation Modelling (SEM) and measures of correlations were applied to test causal relationships in the model. By using SEM, important latent

Item description	Factor	Eigen-	% of	Cumula-	Relability
	loadings	values	Variance	tive %	
IT Dependence		3.737	37.372	37.372	0.65
 The information system is available when needed 	0.811				
• IT is important to my job	0.824				
Information dependence		1,405	14.054	51.426	0.63
 The data is displayed in a readable and under- standable form when needed 	0.519				
 Accessible data from the information system are convenient and easy to use 	0.435				
• The information system is timely	0.811				
 The data generated from the information system is accurate 	0.532				
Decision making dependence		1.014	10.139	61.565	0.80
• The information system is able to integrate in- formation across multiple departments	0.580				
• The information system can help me to deal with unexpected affair	0.761				
• The information system can enable me to make good decision	0.848				
 Improves quality of decision 	0.853				

Table 1. Measures of task-technology fit

constructs can be modelled, while taking account of the unreliability of the indicators. Further, the SEM considers unknown reliability of the measures and ranks the measures in terms of their importance.

Finding and Discussion

In order to reduce the number of variables in the measurement of TTF and to group these variables into key categories, a factor analysis was employed using the principal component method with VARIMAX orthogonal rotation. Factor loadings greater than .50 were considered acceptable in the study. Data was first tested to ensure its adequacy for the application of factor analysis. The overall significance of the correlation matrix was 0.000. Bartlett's test of Sphericity was 1205.26, which is very significant (p = 0.000) in rejecting the hypothesis that the correlation matrix is an identity. The value for the KMO (Kaiser– Meyer–Olkin) model, which tests for the adequacy of the sample, was 0.824. Results indicate that data were significantly correlated and suitable for factor analysis. As shown in Table 1, the three factors were IT Dependence, Information Dependence, and Decision-Making Dependence.

Discriminate validity was tested in the study to examine the degree to which the attributes differentiate among the constructs. All attributes were fed into the factor analysis to assess whether they

	Mean	Standard	Factor	Cronbach's
		Deviation	loadings	alpha
Perceived belief				0.777
Perceived usefulness	3.77	0.68	0.702	
Perceived compatibility	3.79	0.67	0.675	
Perceived trial ability	4.10	0.73	0.411	
Task-technology fit				0.833
IT dependence	3.29	0.67	0.603	
Information dependence	4.13	0.61	0.560	
Decision making dependence	3.59	0.54	0.696	
Self-efficacy				0.882
I will understand the working principal of a new infor-	3.81	0.65	0.73	
mation system				
I will be able to learn the application of a new infor-	4.00	0.61	0.82	
mation system				
Attitude				0.876
IT is important to my job	4.10	0.92	0.717	
IT is relevant to my job	4.12	0.89	0.791	
IT is trifle	4.12	0.97	0.764	
IT is interesting	3.83	0.93	0.711	
IT is attractive	3.91	0.96	0.738	
Subjective norm				0.813
My supervisor always encourages me to use information	3.89	0.70	0.605	
systems				
My colleagues think that I should use information sys-	3.79	0.61	0.518	
tems				
My guests perceive using information systems to be	3.76	0.71	0.523	
useful in a hotel				
My hotel manager believes that there are advantages of	3.90	0.79	0.704	
using information systems				
Behavioral intention				0.910
I intend to work with IT more increasingly in the future	3.61	0.74	0.656	
I want to use IT for my work	3.54	0.77	0.494	
It is likely that I will use IT for my future work	3.92	0.69	0 747	

Table 2. Reliability analysis of observed variables

were loaded across the constructs; some were eliminated since they were not factorially pure. For example, the attributes of "perceived ease of use", and "perceived image" of the IT perceived belief construct, and those of "rapid change of information system", and "difficult to operate" of the selfefficacy construct were discarded because of their low factor loadings for maintaining the reliability and validity.

As a result, there were altogether 20 attributes. As shown in Table 2, the reliability coefficients (Cronbach's alpha) of the constructs ranged from 0.777 to 0.910, which exceeded the recommended acceptable level of 0.70. SEM was performed to investigate relationships between criterion variable of behavioral intention of IT adoption and the respective predictor variables of perceived IT beliefs, tasktechnology fit, attitude, subjective norm, and self-efficacy. Results of SEM and those of the causal path testing are shown in Fig. 1. In the first SEM procedure, the



Figure 1. Path diagram with standardized estimates of proposed model. *p = 0.05, **p < 0.01

initial hypothetical model showed that the four indices (GFI = 0.85, AGFI = 0.81, NFI = 0.97, and CFI = 0.98) were close to or over their respective common acceptance levels. This indicated that the model fitted fairly well. The RMSEA reached .0887, which was less than 0.1, and thus was acceptable.

As shown in Fig. 1, the correlations between attitude and respective perceived IT beliefs and self-efficacy were positive. Thus, Hypotheses H_1 and H_5 are supported as shown by the path coefficients. The absolute magnitude of the estimated standardized path coefficients showed that perceived IT beliefs had the greatest impact on attitude of hotel employees towards behavioral intention of adopting IT. This finding is consistent with previous studies (Davis, 1989), that when employees perceive stronger beliefs of IT in usefulness, ease of use, compatibility, image, and trialability, they would have a more positive perspective towards an innovation.

Moreover, an employee's capability of using IT will influence his/her attitude to adopting it on the job directly and indirectly through attitude. However, task-technology fit was negatively related to attitude. The results show that Hypothesis H₂ is not supported. Such a finding is contradictory to previous studies (Dishaw and Strong, 1999) which found that task-technology fit had positive impact on people attitude towards IT. One of the possible reasons was that even though hotel employees perceived a high degree of good fit between task requirement and technology application, lack of know-how and mastering skill might result in a non-positive attitude. The best result should be a good fit between IT application and task requirement, plus provision of training to equip employees with necessary knowledge and skills so that they can perform well. Under these circumstances, employees should have a positive attitude towards IT adoption.

Thus, training appears to be a possible moderator in this causal relationship. Given the inconsistent result with previous studies, future studies are suggested to further explore the relationship. A significant covariance relationship was found between perceived IT beliefs and task-technology fit indicating that there was an interaction between these predictors. Hypothesis H₃ receives support given the significant path coefficient. The correlations between behavioral intention and attitude, self-efficacy. and subjective norm were significant at .36, .40, and .21, respectively. Thus, Hypotheses H₄, H₆ and H₇ are supported in this study.

Conclusion and implications

Based on the literature review, this study integrated the constructs of theory of reasoned action, self-efficacy, and task-technology fit into a comprehensive research framework. Overall, the hypothesized research model explained behavioral intention of adopting IT by hotel employees in Taiwan moderately well. On one hand, perceived IT beliefs were found to have positive impacts on attitude. On the other hand, attitude, selfefficacy and subjective norm were related to behavioral intention of adopting IT. Congruent with this, analysis of the standardized path coefficients indicated that self-efficacy was the most important factor affecting behavioral intention.

The study has provided some preliminary evidence concerning employees' psychological factors to IT adoption. Based on these findings, a number of salient implications were suggested for hotel managers to consider. First, relevant training should be provided for employees to improve their competency of using IT, especially during the early stage of implementation of new IT in hotels. Hotels should work closely with trainers from IT suppliers to provide onthe-job and off-the-job training. The shorter the time for hotel employees to master the skills of information technology, the higher the motivation of the employees to adopt new IT will be.

Second, the significant effect of subjective norm on employees' behavioral intentions reveals that those persons who are considered by the employees as most important should be encouraged to provide support and motivation during the early stage of IT implementation. During this stage, the employees will likely encounter problems as well as exhibit resistance to using IT. Normatively, it is reasonably assumed the most important persons for the employees are their managers in the hotel. Thus, hotel managers should counsel their employees as soon as they have problems with IT adoption. They should also provide continuous feedback, support, and encouragement for employees so that they can master the technological skills within a short period of time.

Finally, employees should be aware of their performance progress as a result of adopting information technology. This is particularly important when an information system is implemented as they can observe and realize the benefits of using a new system that can help improve their performance and enhance guest satisfaction in hotels. Their motivation level will also noticeably increase.

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Managers should try to make known any improvement in the areas of sales, guest satisfaction, service quality, and productivity and even reduction of work-related accidents as a result of implementing new technology. Relevant indexes, if they exist, should be publicized to employees, and it can help improve their belief in IT usage.

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EXPLORING THE RELATIONSHIP OF CONFLICT BETWEEN FAMILY AND WORK AMONG HOTEL EMPLOYEES

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Abstract

The purpose of this study is to develop a model to investigate the conflict and facilitation between work and family among hotel employees. A questionnaire was developed to investigate the abovementioned relationships. A total of 216 Taiwanese hotel employees participated in this study. Data were analyzed through LISREL 8.30 path analysis. The results indicated that hotel employees receiving adequate support from family are confronted with less conflict between work and family. Moreover, hotel employees who cannot establish a healthy balance between family and work domains are dissatisfied with life in general. Therefore, managers at all levels should be trained to create a family - supportive work environment, and then the role of family and work can be balanced.

Keywords: Conflict, Facilitation, Hotel, Hotel employee

Introduction

For hotel employees, work and family responsibilities are important challenge. The conflict between work and family is the difficult issue which most hotel employees have to confront. Greenhaus et al. (2003) indicated that individuals have fixed amounts of resources such as time and energy, and their participation in multiple roles such as work and family results in the devotion of greater resources to one role and the devotion of less resources to another role. In this situation, individuals have to confront conflicts between work and family domains. On the other hand, Kinnunen et al. (2006) pointed out that involvement in multiple roles can produce a number of benefits for employees, and these benefits can outweigh the difficulties or costs associated with work and family roles. However, empirical research about whether work and family can facilitate one another is sparse. Therefore, the purpose of this study is to investigate the conflict between work and family, and the facilitation between work and family. Through this study, comprehensive picture of the work–family interface can be delineated.

Literature Review

Work-family conflict and familywork conflict are the two directions of conflict between work and family roles. Work-family conflict refers to "a form of inter - role conflict in which the general demands of, time devoted to, and strain created by the job interfere with performing family - related responsibilities"; and family-work conflict refers to "a form of inter-role conflict in which the general demands of, time devoted to, and strain created by the family interfere with performing work - related responsibilities" (Netemeyer et al., 1996). As discussed by Wayne et al. (2004), work and family research has extensively relied on the scarcity perspective, and the possibility that individuals engaging in multiple roles may have a number of benefits has been neglected in the relevant literature. On the contrary to the scarcity perspective, the expansion - enhancement perspective suggests that participation in multiple roles (e.g., work and family) does not deplete one's physiological and psychological resources, but leads to net gratification rather than strain (Aryee et al., 2005). Frone (2003) has suggested a four fold taxonomy of work-family balance that includes two directions of conflict and facilitation between work and family roles. Individuals receiving resources such as work support, job autonomy, and flexible work hours may develop decision skills to use at home and deal effectively with family responsibilities/ problems. Individuals receiving resources such as family/ spouse/ domestic support may focus effectively on work responsibilities, cope with pressures in the workplace, and have heightened performance.



Figure 1: Conceptual model

Accordingly, based on expansion - enhancement perspectives, this study develops and tests a model, which examines the antecedents and outcomes of work–family conflict, work–family facilitation, family– work conflict, and family–work facilitation. The relation - ships are shown in Figure 1. and the hypotheses are discussed below.

Social support at work is a coping mechanism in dealing with problems arising from stressors and can emerge from such sources as supervisors and

co - workers (Parasuraman et al., 1992). It has been found that once supervisors are interested in aiding in the resolution of employees' work - or family - related problems, employees experience less work-family conflict and family-work conflict (Karatepe and Kilic, 2007). Thus, work social support is an important coping mechanism that can decrease employees' work-family conflict and family-work conflict. In addition, employees may talk with their family members about the difficulties inherent in frontline service jobs and ask for their support in terms of home responsibilities. Hence, the ones who receive support from their family can cope with difficulties stemming from work-family conflict and family-work conflict. Therefore, we propose the following hypotheses:

- H1. Work social support is negatively related to frontline employees'
 (a) work-family conflict and (b) family-work conflict.
- H2. Family social support is negatively related to frontline employees'
 (a) work-family conflict and (b) family-work conflict.

Having a supportive environment in the workplace may enable employees to integrate work and family roles. In this case, employees may receive emotional support, feedback, and direct help from their supervisors and/or co workers in order to fulfill family responsibilities (Aryee et al., 2005). As such, employees having supportive families may have an opportunity to talk about the difficulties at work and receive emotional support, feedback, and direct help to better handle problems associated with work (Grzywacz and Marks, 2000). Although limited in the relevant literature, work and family support enhance facilitation in the work–family interface. For example, Aryee et al. (2005) demonstrated that family support triggered employees' family–work facilitation.

Wadsworth and Owens (2007) reported that social support emanating from both supervisors and co - workers made employees of public organizations facilitate the integration of their work and family roles. Based on the aforementioned discussion and findings, it appears that having supportive supervisors and/or co - workers in the workplace results in the integration of work and family roles. As such, the availability of family support may lead to both directions of facilitation between work and family roles. Accordingly, we propose the following hypotheses:

- H3. Work social support is positively related to frontline employees'
 (a) work–family facilitation and
 (b) family– work facilitation.
- H4. Family social support is positively related to frontline employees'
 (a) work-family facilitation and
 (b) family- work facilitation.

In empirical terms, Aryee (1992) showed that job–parent conflict reduced the quality of work for a sample of married professional women in Singapore, while job– spouse conflict decreased their satisfaction with life in general. Frone et al. (1997) illustrated that family–work conflict reduced work performance. In addition, Karatepe and Kilic (2007) found that family–work conflict had an adverse effect on frontline hotel employees' job performance in Northern Cyprus.

In sum, employees display lower job performance because of problems emanating from work–family conflict and family–work conflict. Likewise, once employees have difficulty in balancing work (family) and family (work) responsibilities, they experience conflicts in the work– family interface and their satisfaction with life in general starts to erode. Accordingly, we propose the following hypotheses:

- H5(a). Work-family conflict is negatively related to front - line employees' job performance.
- H5(b). Family–work conflict is negatively related to front - line employees' job performance.
- H6(a). Work–family conflict is negatively related to front - line employees' life satisfaction.
- H6(b). Family–work conflict is negatively related to front - line employees' life satisfaction.

As identified and discussed by Sieber (2004), participation in multiple roles can enhance the quality of life through different mechanisms such as role privileges, overall status security, resources for status enhancement and role performance, and enrichment of the personality and ego stratification. As also stated by Marks (2002), "Some roles may be performed without any energy loss at all; they may even create energy for use in that role or in other role performances". Accordingly, resources and learning opportunities gained in the work (family) domain can be utilized to have better functioning in the family (work) domain (Aryee et al., 2005). Limited evidence indicates that work-family facilitation and family-work facilitation significantly and positively influence life satisfaction (Hill, 2005). Thus, we propose the following hypotheses:

- H7(a). Work–family facilitation is positively related to frontline employees' job performance.
- H7(b). Family–work facilitation is positively related to frontline employees' job performance.
- H8(a). Work–family facilitation is positively related to frontline employees' life satisfaction.
- H8(b). Family–work facilitation is positively related to frontline employees' life satisfaction.

Methodology

From previous empirical studies in the relevant literature, a questionnaire was developed to investigate the relationship between work social support, family social support, work–family conflict, work–family facilitation, family–work conflict, family–work facilitation, job performance, and life satisfaction. Data were gathered from a sample of full - time frontline employees in five - star hotels in Taiwan in 2015. A number of 250 questionnaires were distributed to frontline employees working in these hotels. After removing the records containing heavily missing values, a total of 216 responses remained in the analysis. All measures were subjected to confirmatory factor analysis simultaneously. According to the initial results of the confirmatory factor analysis, one item from each of the stud constructs was dropped due to low

Variables	1	2	3	4	5	6	7	8
1 Work social support (WSS)	1.000							
2 Family social support (FSS)	.446	1.000						
3 Work - family conflict (W -	223*	401**	1.000					
FCON)								
4 Work - family facilitation (W -	.203*	061	064	1.000				
FF)								
5 Family - work conflict (F -	295**	510**	.585**	.207*	1.000			
WCON)								
6 Family - work facilitation (F -	.448**	.527**	197*	.077	305**	1.000		
WF)								
7 Job performance (JPERF)	.233*	.128	034	.310**	079	.344**	1.000	
8 Life satisfaction (LSAT)	.250**	.229*	312**	.320**	342**	.073	.167	1.000
Mean	3.57	3.95	3.00	3.11	2.73	3.74	3.51	4.28
Standard deviation	.59	.61	.79	.83	.98	.85	.68	1.13
Alpha	.80	.84	.72	.60	.84	.73	.74	.77

Table 1. Descriptive statistics of study variables and Cronbach's alpha

*Correlations are significant at the .05 level. **Correlations are significant at the .01 level. Correlations without any asterisks are not significant.

standardized loadings (<.40), nonsignificant t - values, and correlated measurement errors. Although the results of the final confirmatory factor analysis produced low model fit statistics (Comparative fit index, CFI = .77; Root mean square residual, RMR = .093), the magnitudes of the loadings ranged from .43 to .90 and all t - values were significant. In addition, of the 35 items, 19 had loadings greater than .60. Overall, the magnitudes of the loadings with their significant t - values provided evidence of convergent validity

Results

The correlation matrix in Table 1 was used as an input to test the study hypotheses using LISREL 8.30 through path analysis. This is consistent with prior research, which tested various relationships through path analysis based on relatively small sample sizes. According to the results depicted in Table 2, the model fits the data well (χ^2 = 10.89, df = 8, p = .21; Goodness of fit index, GFI = .99; Non-normed fit index, NNFI = .90; CFI = .99; Root mean square error of approximation, RMSEA = . 060; RMR = .029). The findings in Table 2 indicate that there was no empirical support for the significant negative effects of work support on conflicts in the work–family interface. Therefore, H1(a) and H1(b) were not supported. As predicted, family support was significantly and negatively related to work–family and family–work conflicts. There - fore, H2(a) and 2(b) were supported. The findings also demonstrate that work support had significant positive effects on work–family facilitation and family–work facilitation. Thus, H3(a) and 3(b) were supported. According to the findings in Table 2, family support significantly and positively influenced family–work facilitation. Family support, however, did not significantly influence work–family facilitation. Thus, H4(b) was supported, whereas H4(a) was not supported.

Table 2. Results of path analysis							
Control variables and	Standardized	<i>t</i> -	R^2				
Hypotheses	estimate	Value					
WSS→W - FCON	01	07	.19				
FSS→W - FCON	38	-3.15*					
WSS→W - FF	.25	2.34	.19				
FSS→W - FF	08	76					
WSS→F - WCON	14	-1.43	.31				
FSS→F - WCON	43	-4.43*					
WSS→F - WF	.19	2.04*	.38				
FSS→F - WF	.44	4.78*					
W - FCON→JPERF	.13	1.16	.30				
F - WCON→JPERF	18	-1.55					
W - FF→JPERF	.29	3.14*					
F - WF→JPERF	.33	3.55*					
W - FCON→LSAT	07	65	.37				
F - WCON→LSAT	41	-3.54*					
W - FF→LSAT	.41	4.25*					
F - WF→LSAT	07	72*					

Model fit statistics: $\chi^2 = 10.89$, df=8; p=.21; GFI=.9	9;
NNFI=.90; CFI=.99;RMSEA=.060; RMR=.029	

*The t - value demonstrate a statistically significant relationship at the .05 level. The other t - value without any asterisks are insignificant.

The results involving the paths from conflicts in the work–family interface to job performance were not significant. Hence, H5(a) and H5(b) were not supported. The result pertaining to the impact of work–family conflict on life satisfaction was not significant. Therefore, H6(a) was not sup-

ported. The results of the path analysis reveal that family–work conflict was significantly and negatively related to life satisfaction. Therefore, H6(b) was supported. As predicted, work-family facilitation and family-work facilitation exerted significant positive effects on job performance. Hence, H7(a) and H7(b) were supported. H8(a) and H8(b) stated that work-family facilitation and family-work facilitation had significant positive effects on life satisfaction. According to the results shown in Table 2, H8(a) was supported. However, there was no empirical support for H8(b). The summary of the results of the hypothesized relationships is presented in Table 3.

Conclusions and implications

This study developed and tested a model that examined the antecedents and consequences of work–family conflict, work–family facilitation, family– work conflict, and family–work facilitation. The findings of this study lent support to the majority of the purported relationships among the study constructs.

First, the results indicate that neither work–family conflict nor family– work conflict is a significant consequence of work support. In contrast, family support alleviates both work– family and family–work conflicts. These findings are not consonant with that of Demerouti et al. (2004). Overall, the findings suggest that frontline employees receiving adequate support in the family domain are confronted with less conflicts between work (family) and family (work) domains.

Second, the results that work– family conflict and family–work conflict do not

Antecedents of work - family conflict and facilitation								
H1(a)	Work social support→Work - family conflict	(-)	Not supported					
H1(b)	Work social support→Family - work conflict	(-)	Not supported					
H2(a)	Family social support→Work - family conflict	(-)	Supported					
H2(b)	Family social support→Family - work conflict	(-)	Supported					
H3(a)	Work social support→Work - family facilitation	(+)	Supported					
H3(b)	Work social support→Family - work facilitation	(+)	Supported					
H4(a)	Family social support→Work - family facilitation	(+)	Not supported					
H4(b)	Family social support→Family - work facilitation	(+)	Supported					
Outcomes of w	ork - family conflict and facilitation							
H5(a)	Work - family conflict→Job performance	(-)	Not supported					
H5(b)	Family - work conflict→Job performance	(-)	Not supported					
H6(a)	Work - family conflict→Life satisfaction	(-)	Not supported					
H6(b)	Family - work conflict→Life satisfaction	(-)	Supported					
H7(a)	Work - family facilitation→Job performance	(+)	Supported					
H7(b)	Family - work facilitation→Job performance	(+)	Supported					
H8(a)	Work - family facilitation→Life satisfaction	(+)	Supported					
H8(b)	Family - work facilitation→Life satisfaction	(+)	Not support					

Table 3. Summary of the results of the hypotheses

have any significant effects on job performance are not in accordance with that of Karatepe and Kilic (2007). The findings reported here suggest that participation in multiple roles creates benefits, and frontline employees gaining resources and learning opportunities in the work or family domain display effective performance in the workplace. The results suggest that frontline employees who cannot establish a healthy balance between family and work domains are dissatisfied with life in general. In addition, managers at all levels should be trained regarding the

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sustainability of a family - supportive work environment. Then, properly trained managers can organize various and ongoing workshops to make employees and their family members openly express their work and family problems. After receiving feedback, managers should highlight the importance of family support and the facilitation between work (family) and family (work) roles and can guide them about how to balance work and family roles. Hotel managers can also employ mentors to provide their employees with immediate support when needed.

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CENTRALIZATION EXTENT AND ORGANIZATIONAL COMMITMENT OF PART-TIME WORKERS IN TAIWAN'S CONVENIENCE CHAIN STORES

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Abstract

This study focuses on the effects of centralization extent to the organizational commitment of part-time staff working at convenience chain stores using questionnaire survey and a total 478 samples. Research results: First, the higher the centralization extent, the better recognition to job characteristics. Second, part-time workers with larger centralization extent increase partial positive organizational commitment significantly. Third, parttime workers with better understanding of job characteristics have partial positive organizational commitment. Finally, job characteristics have a partial intervening effect between centralization extent and organizational commitment.

Keywords: centralization extent, organizational commitment, part-time worker.

Introduction

Taiwan's ratio of 3,357 residents to one convenience store in 2002 was greater than Japan's ratio of 3,421 residents to one in the same year (Di et al., 2007). This recent statistic makes Taiwan the world leader in convenience store density. This phenomenon is recent and the rate of growth in terms of numbers of stores has resulted in new management problems. The industry has become highly competitive because of saturation and a declining economy.

These realities have caused mangers to think in new ways in order to maintain market share. The solution is familiar, that of cutting costs without sacrificing quality but the innovation is seen in the methods by which managers attempt to make these changes.

Cost control is important to maintaining competitiveness and managers look to cutting employee costs along with other areas (Di et al., 2007; Goto and Mano, 2012; Kobayashi, 2001; Tsao, 2002). One of the realizations that they have come to is that not all employees require a complete knowledge of the operation. Most jobs can be filled by people who need only the knowledge of specific tasks. This cuts down on training time as well as making it possible to employ more part-time workers at lower wages and benefits. The problem is maintaining quality, but with specialization and specificity of tasks being the object, rather than a comprehensive understanding of the business, managers feel that it is possible to hire part-time

workers without jeopardizing quality. This is also known as the strategy of "centralization extent" (Gonzalez-Cruz et al., 2012; Kobayashi, 2001; Kornai, 2012; Tsao, 2002).

This does not mean that fulltime employees are not needed, only that convenience store operators are combining part-time and full-time employees in new ways. This "human resource elasticity" is a modern phenomenon evident in the convenience store industry but becoming more prevalent in other enterprises (Carony et al., 1997). The crucial element is to make sure that the right combinations of full and part-time employees, those with complete knowledge and those with limited skills are made.

In recent years, businesses have been employing a strategy called the "part-time worker formulation" to decrease costs and promote competitiveness (Kunn-Nelen et al., 2013; Webster and Adams, 2010). Labour markets witnessed a steady increase in hiring part-time employees in the U.S., U.K., and European countries (Beham et al., 2012; Gannon and Roberts, 2011). However, hiring part-time workers has several limitations; for example, they can only do routine, repetitive and non- confidential tasks. Besides, the attrition rate of part-time workers is quite high (Jackofsky et al., 1986), resulting in increased recruiting costs, training and lost sales (Pinkovitz et al., 1997).

There is also very little related research on attitudes (job satisfaction,

job involvement and organizational commitment) of part-time workers (Booth and Van Ours, 2013; Kobayashi, 2001; Russo, 2012; Tsao, 2002). Most research focuses on job satisfaction or working attitudes and none use the mediation of job characteristics to explore the correlation of centralization extent's degree to organizational commitment. Therefore, the purpose of this study is: First, to explore the effects of part-time workers' degree of centralization extent to job characteristics; second, to explore the effects of parttime workers' degree of centralization extent to organizational commitment; third, to explore the effects of job characteristics of part-time workers to organizational commitment; finally, to explore the degree of part-time workers perceptual job characteristics to determine whether there is a mediation effect on the degree of centralization extent and organizational commitment. We used part-time employees in convenience stores as our sample to hopes of making a contribution to both academics and business.

Literature Review And Development Of Hypotheses

Centralization extent, job characteristics and organisational commitment

According to the Japanese Labour Research Institution's survey of the retail and catering trade, 35 per cent of stores show no difference between non-official employees (including students and part-time workers) and official employees in their job description and style. Of the stores responding to a survey, 26.6 per cent feel that their part-time employees perform as well or better than their full-time employees. Part-time workers' degree of centralization extent is unlimited only in some organizations or individuals but it is going to be higher in the future (Houseman and Osawa, 1995; Honda, 1999).

In fact, centralization extent has occurred globally and in Taiwan, for instance, 95 per cent of employees at McDonald's are part-time (Di et al., 2007). Therefore, how to best hire and allocate part-time workers, matching the demands of a fluctuating market and lower operation risk to attain a proper percentage of official and nonofficial employees, is a fair concern of convenience store owners and managers. Centralization extent is a stream and phenomenon of human resource hiring strategy (Kobayashi, 2001; Tsao, 2002; Di et al., 2007).

Kobayashi (2001), a Japanese scholar, points out that parttime workers are not only becoming the primary labourers in terms of numbers but also in terms of tasks for which they are responsible. The basis of this transformation is management seeking to lower wages while hiring part-time workers to replace full-time employees.

Though seeking to reduce personnel costs while improving labour quality to boost organizational performance, hiring part-time workers to do the jobs of full-time employees but with lower pay, may

create resentment and reduce job quality. This could result in a cycle of lower organizational efficiency.

Honda (1999) found the parttime worker centralization extent model by comparing results form the careers of a chain store's official employees. Kobayashi (2001) says there is very little research of employee attitudes on part-time workers. Basically, most research offers no conceptual model to generalize and predict workers' attitudes. There is no theoretical research, though several models have been created; one of the most effective theories, job characteristics model (JCM), is discussed in the degree of centralization extent and job attitude (Bala and Venkatesh, 2013; Hackman and Oldham, 1975; Katsikea et al., 2011).

Kobayashi (2001) thinks using JCM to verify the degree of centralization extent of part-time workers and working attitude is effective; the degree of centralization extent does improve job characteristics contents. If the extent of centralization really improves the duty complex, it will result in mental or job satisfaction and organizational commitment for part-time staff (Kobayashi, 2001; Tsao, 2002; Di et al., 2007). Therefore, we propose Hypothesis 1 and Hypothesis 2:

H1. The higher centralization extent's degree of part-time workers, the better their recognition of job characteristics.

H2. Part-time workers with larger centralization extent significantly increase positive organizational commitment.

Job characteristics include all related factors or attributes of a job. The importance of it was represented by Sims et al. (1976): job characteristics influence worker's job satisfaction and performance. Psychological research on job motivation indicates that both workers and management levels are all related to job characteristics in certain ways.

According to Hackman and Lawlers' research on observing human relationship factors (Barrick et al., 2013; Hackman and Lawler, 1971), when job characteristics appear on the job, job satisfaction, performance and attendance all increase. Hackman and Oldham (1975; 1980) aver that iob characteristics are all factors that relate to the job, including task variety, task identity, task significance, autonomy, feedback, feed-back from agents and dealing with others, a total of 7 factors. They propose the Job Characteristics Model and think there are some aggressive characteristics on the job to increase worker's motivation and job satisfaction such as autonomy, variety, identity and so on, especially to high growth demanding people. This model has become the basis of future related researches.

Becker (1960) points out that organizational commitment is a key factor to understanding the working behaviour of employees in organiza-

tions. Organizational commitment can be treated as an attitude or a trend of behaviour, an intention of leaving or staying in the organization (Meyer and Allen, 1991; Iverson and Roy, 1994). Morris and Sherman (1981) believe organizational commitment can well predict performance, absence and quitting behaviours.

Past research on job characteristics were most related to employee satisfaction, job press and quitting (Barrick et al., 2013), and very little were related to organizational commitment. From this, we know job characteristics can encourage high growth demanding workers to achieve better job performance, higher job satisfaction, stronger working motivation, lower turnover and absenteeism (Hackman and Oldham, 1980). Therefore, we propose hypothesis 3:

H3. Part-time workers with better understanding of job characteristics have a positive organizational commitment.

Mediation of job characteristics

From the Job Characteristics Model (JCM) of Hackman and Oldham (1975), which discusses the degree of centralization extent and job attitude, and the findings of Kobayashi (2001), Tsao (2002) and Di et al. (2007) which says that the degree of centralization extent can improve the content of job characteristics if it can raise the complexity of a task then part-time workers can satisfy their needs or tasks and then have commitments to the organization, we estimate that the higher the degree of centralization extent of part-time workers, the better the positive job characteristics and positive attitude of organizational commitment.

Therefore, we can conclude that a higher degree of part-time worker's centralization extent will have a positive attitude in organizational commitment that is perceived from part-time workers' job characteristics. It is that the relationship between part-time workers' centralization extent and organizational commitment is mediated from perceiving job characteristics. Therefore, we propose hypothesis 4 as below:

H4. Job characteristics have a significant intervening effect upon the degree of centralization extent and organizational commitment.

Methodology

Sample

We collected data from two main convenience chain stores (7-11 and Family Mart, total market share is approximately 77.7%) in Taiwan and focused on part-time workers. Questionnaires were used to collect the data for this study. A questionnaire was submitted as a pre-test to determine possible shortcomings in comprehension and to confirm its suitability. A pilot test of the survey was conducted with 40 part-time workers within the two main convenience chain stores in the Kaohsiung area who were asked to evaluate their perceptions.
Based on the results of the pretest, some revisions of items on the questionnaire were made. Questionnaires were administered between August and October 2015, with the sample being randomly selected from the two main convenience chain stores. Main city areas (including north, central, south and east) were sampled. Each chain store has collected 400 samples (each area has 100 samples to avoid external validity for only one single area). Questionnaires were conducted by self administered survey self report by respondents. Eighthundred questionnaires were sent and 546 were returned. Valid questionnaires numbered 478 (59.75 per cent), after excluding invalid ones. Following are variable measurements and operational definitions. Participants are asked to respond on a 5-point Likerttype scale ranging from 'strongly disagree' (1) to 'strongly agree' (5).

Operational definition and variable measurement

Centralization extent.

According to Kobayashi (2001), we defined the degree of centralization extent as an organization having parttime workers to do core jobs, both in quality and quantity of work. There are three dimensions as follows: 1. Assistant job description: sales support functions such as stocking, cleaning and arranging merchandise. 2. Administrative job description: ordering products; making POP; promoting products; handling customer complaints; obtaining customer information; organizing product data; staff scheduling and other data analysis; etc. 3. Management job description: standard operation management; training new staff; monitoring attendance; attending meetings and so on. Because no reliable measure of self-evaluated service effort is found in the literature, the present authors use and adjust the centralization extent measuring scales developed by Kobayashi (2001) and Tsao (2002). The scale consists of 4 items respectively, such as 'I put products on the shelf.'; 'I do the daily product ordering.' and 'I train new staff.' Cronbach's α is 0.87, 0.83 and 0.85 respectively.

Job characteristics.

Job characteristics are factors or attributes that relate to a job. Each characteristic of a job has different degrees affecting satisfied self demand (Hackman and Oldham, 1975; 1980). There are four dimensions as follows: 1. Task variety: using different skills, equipment and procedures at work. 2. Autonomy: autonomy in planning jobs, choosing used equipment and determining task procedures. 3. Feedback: evaluating job performance. 4. Dealing with others: cooperation with coworkers in order to do a better job. The present study uses and adjusts the job characteristics measuring scale developed by Hackman and Lawler (1971), which consists of 4 items respectively, such as 'My job is very challenging.'; 'I can decide to do my work at my own pace.'; 'I know my supervisor's opinion of my job performance.' and 'I need the ability to function productively with others in the work place.'

Cronbach's α is 0.86, 0.82, 0.80 and 0.77 respectively.

Organizational commitment.

Organizational commitment is generally defined as an emotional response, particularly when the individual believes strongly in the organization's goals and values and/or demonstrates a strong desire to maintain membership in the organization. The measuring scale is modified from the one developed by Mowday et al. (1979). It includes 8 items with 3 reverse items, such as 'There's not too much to be gained by sticking with this organization indefinitely.' Cronbach's α is 0.84.

Measurement model evaluation

We assess the quality and adequacy of our measurement models by investigating reliability, and performing a confirmatory factor analysis (CFA) to evaluate construct validity regarding convergent and discriminate validity. First, reliability is supported by the fact that all Cronbach alpha values exceed 0.70, indicating acceptable reliability levels (Nunnally, 1978). Moreover, all of the composite reliability measures are above 0.60, corresponding to Bagozzi and Yi's (1988) minimum values of 0.60. As a result, we can conclude that all constructs yield satisfactory reliabilities. Second, convergent validity is supported by the fact that the overall fit of the models is good, that all loadings are highly statistically significant (p < 0.01, all t-values>2) (Anderson and Gerbing, 1988; Hair et

al., 2006). Third, discriminant validity is supported by the fact that the square roots of average variance extracted (AVE) are higher than the correlation coefficients of constructs (Fornell and Larcker, 1981).

Results

Sample characteristics

Four hundred and seventy-eight validity questionnaires have been returned, female (60.3 per cent) more male (39.7 per cent); single (76.1 per cent) more than married (23.9 per cent). It matches the younger trend of present retailing employees. Next, for working years, there are 47.7 per cent respondents working less than 6 months, and only 15.8 per cent of them working more than 1 year. Therefore, it verifies a higher flow rate of part-time employees. Also, most of them are students (69.5 per cent). The reason for choosing the job is to get some pocket money or to have working experience earlier. There are 24.6 per cent of respondents who do not have a full-time job, they take part-time jobs because they're waiting for military service or cannot find a full-time job. Most of those part-time workers mainly clean up the store and put products in order or work as a cashier (90.3 per cent).

Variables' description

About delineating contents of all variables: In job contents of centralization extent, part-time workers principally deal with assistant tasks. Because of high flow rate of part-time employ-

ees and lack of working experience and ability, organizations do not often allow them to handle management and administrative tasks. In terms of job characteristics, part-time workers largely believe in a higher chance to build friendship with others. They can also learn cooperation with colleagues. In organizational commitment, pluralistic employees are willing to give extra effort, help business to succeed and tell good friends that their company is a great institution and worth working for. But thinking conversely, they will not just stay because they like the organization; when they find a better job they will quit.

Centralization extent and job characteristics

It attains a significant positive correlation between each dimension of centralization extent and job characteristic; from Model 1 of Table I, we also know the regression coefficients separately are: assistant job characteristic (0.14, p<0.05), administration job characteristic (0.17, p<0.01) and management job characteristic. It verifies Hypothesis 1: The higher centralization extent's degree of part-time workers, the better their recognition of the job characteristics.

Variables	Model 1	Model 2	
Assistant	0.14*		
Administrative	0.17**		
Management	0.21**		
Centralization extent		0.18**	
R ²	0.25	0.28	
Adjusted R ²	0.09	0.11	
F Value	7.36***	7.83***	

*p<0.05, **p<0.01, ***p<0.001, n=478

Centralization extent and organizational commitment

We detect each dimension of centralization extent and organizational commitment having a partial significant positive correlation; from Model 1 of Table II, we also know its regression coefficients are: assistant job characteristic (0.04, insignificant); administrative job characteristic (0.17, p<0.01)and management job characteristic (0.07, insignificant). It verifies partial

Hypothesis 2: Part-time workers with larger centralization extent's degree increase positive organizational commitment significantly.

Job characteristics and organizational commitment

We know each dimension of job characteristics and organizational commitment having a partial significant positive correlation; from Model 2 of Table II, we also found its regression

coefficients separately are: variety (0.22, p<0.01); autonomy (0.20, p<0.01); feedback (0.13, p<0.05) and dealing with others (0.04, insignificant). It verifies the Hypothesis 3 is partially supported, that is, part-time workers with better understanding of job characteristics have partial positive organizational commitment.

Mediation of job characteristics

We follow the suggestions of Baron and Kenny (1986), using step-wise regression analysis to test the mediation effects of job characteristics. First, both independent variables (the degree of centralization extent) and mediator (job characteristics) have a significant correlation with the dependent variable (organizational commitment); please see Model 3 and Model 4 of Table II. Second, the degree of centralization extent and the mediator has a significant correlation (Model 2 of Table I). Finally, after putting in independent variables and the mediator at the same time, the correlation between independent and dependent variables should be weaker than not having the mediator. In addition, if we control the mediator then the degree of correlation (independent variable to dependent variable) vanishes: it is a total mediation effect. However, if the correlation is weaker than not having the mediator, but still significant, it is called partially significant. From Model 5 of Table II, we know the regression coefficient β of centralization extent is lower from 0.16 to 0.12 but still significant, showing a partial significance. This also verifies Hypothesis 4: Job characteristics of part-time workers have a partial intervening effect between the degree of centralization extent and organizational commitment.

	Table II	. OC as a functio	on of CE and JC		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Assistant	0.04				
Administrative	0.17**				
Management	0.07				
Variety		0.22**			
Autonomy		0.20**			
Feedback		0.13*			
Dealing with others		0.04			
Centralization Ext.			0.16**		0.12*
Job characteristics				0.15*	0.10*
R ²	0.27	0.24	0.25	0.28	0.29
Adjusted R ²	0.10	0.08	0.09	0.11	0.13
F value	10.31***	9.15***	8.38***	9.53***	6.99***

*p<0.05, **p<0.01, ***p<0.001, n=478

Conclusion And Future Research

According to our research purpose and research hypotheses, we conclude with the empirical analysis result as follows. First, according to the verified result of Hypothesis 1, we know convenience store's part-time workers' centralization extent of each task should have variety, autonomy, feedback and dealing with others to cohere with demand in choosing job characteristics.

Second, according to the results of Hypothesis 2, if it is possible, owners of convenience stores should arrange administration tasks to future part-time employees to cause a positive attitude in organizational commitment, for example, the ordering of daily products, POP producing, participating in promotion activities and handling customer complaints.

Third, because part-time workers usually do boring assistant tasks, and according to the result of Hypothesis 3, if part-time workers have more tasks of independent autonomy, feedback and variety could increase their organizational commitment. Therefore, convenience store owners can vary assistant tasks and give employees more autonomy to increase better organizational commitment of part-time workers, if they want to boost organizational commitment of part-time workers.

Finally, we know from mediation effective analysis, because pluralistic employees always do labour work and hope to do engaging tasks which have variety, autonomy, feedback and dealing with others (those jobs that they seldom do now), that by adding management and assistant tasks will increase organizational commitment of part-time workers.

Our study shows the higher degree of centralization extent has only partial positive working attitude, which is similar to the research of Kobayashi (2001). We also found 1) most parttime workers think they are pretty involved in their jobs which is quite different from supervisors' cognition. 2) Perceiving higher cognition in job characteristics also creates partial positive attitude. 3) The higher degree of centralization extent has better positive cognition in job characteristics and a mediation effect as well. In conclusion, we accept organizational psychology job characteristics model to explore the effects of centralization extent's degree to organizational commitment. The result does not sufficiently support the original hypotheses; it is in conformity with Kobayashi's (2001) research.

Contributions and Implications

Our research has a number of important theoretical implications. First, according to related literature of scholars' theory and empirical research as a logical inference of this study, we found a certain high degree of support in the statistic analysis that can be a reference in future research. Second, from the correlation between degrees of centralization extent, job characteristics and organizational commitment, we propose job characteristics as a mediating effect between centralization extent and organizational commitment. It is also a valuable reference source for later related research.

In the management practice of part-time workers, our research has thus highlighted a number of important lessons for managers to operate within the retail industry: First, in the industry, the most important resource is human resources even for part-time workers who work for shorter a time (Becker and Gerhart, 1996). Therefore, owners of convenience stores need to understand that the higher degree of centralization extent causes a better positive recognition of job characteristics and also a better positive attitude of organizational commitment. Moreover, owners should intensify the assistant, administrative and management job contents of part-time workers more actively to avoid a higher turnover rate caused by boring jobs. Second, many scholars believe the higher cognition in job characteristics, the better organizational commitment, which the empirical results of our study also support by using part-time workers as samples. Accordingly, the owners of convenience stores need to be concerned more with the cognition of part-time workers to job characteristics including variety, autonomy, feedback and dealing with others.

Limitations

This study mainly explores the degree of part-time workers' centralization extent, perceiving job characteristics, to organizational commitment. However, there are so many effecting factors such as organizational climate, performance assessing, salary compensation, leadership style, job characteristics and so on. To avoid too many variables making multifarious questionnaire items affecting response rates and respondent's pleasures, we did not put all variables in the research to discuss. There has been little published about part-time workers in both national and international related research; most of them discuss official employees. And there are empty items of scale in parttime workers' centralization extent which cannot get deeply into analyzing the effect of part-time workers' centralization extent to organizational commitment. Therefore, the study needs more verification in centralization extent scale; it is developed by referencing related Japanese literature review and opinions of scholars and experts.

The study adopts transactions in timing which cannot be comprehensively pondered; part-time workers follow the environment side to do time sequence research, but time will change and affect the thinking of parttime employees. We can only use present feelings of part-time workers to analyze, and this external validity cannot be inferred from other conditions. This study is limited and it is not easy to collect the samples, so we cannot adopt random sampling. Therefore, different characteristic industries and divergence job traits cannot be generalized.

Suggestions For Further Research

At the present, the research of centralization extent is not familiar. We hope later research can use JCM in the future, because it is able to explain job characteristics and job relationships fairly in most research. But is it suitable for pluralistic employees? This is worth following-up on for future researchers. Our sample only concen-

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trates on part-time workers in convenience stores in Taiwan. Future research can make a comparison analysis to fulltime and part-time employees in different industries. At the same time, for temporizing global business environment, research can also do cross-nation correlation research.

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SERVICESCAPE, SERVICE CONVENIENCE, AND SERVICE EVALUATION IN FOOD AND BEVERAGE INDUSTRY

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Abstract

The food and beverage industry has stepped up in recent years. The rapid growth also causes sharp competition between industries. Therefore, service quality becomes the important facet. Moreover, time and efforts are perceived vital during the service delivered, and consumed by the consumers. The literature review and arguments were conducted to provide a systematic discussion of the study. This study proposed the importance of time and efforts perception perceived by service providers and customers at restaurants, which will show the influences on service quality and customer satisfaction. This perception can be identified to evaluate the service convenience, service quality, and customer satisfaction received from the service sites. The results of this study were found that service employees' (service providers) understanding of service convenience and a set of extra role behaviors are important during the service delivery.

Keywords: Servicescape, service convenience, service evaluation, food and beverage industry

Introduction

The food and beverage industry flourishes vigorously and competes intensely in recent years. Therefore, it is important to satisfy the needs of target market and strengthen service management to achieve better service performance. To understand perceived time and effort during the service delivery and consumption is still encouraging (Robbins & Judge, 2013). This can be concluded that 'the higher the ratio of what is spent and given, the higher convenience is perceived, and the convenience will be seen appeared. In addition, this attracts the attention to other factors that help enhance and facilitate these issues of wait experience and effort consumers spend during the use of services. The effect of atmospherics, or physical and décor elements, on consumers and workers is recognized and well documented. Bitner (1992) pinpointed that the ability of the physical environment to influence behaviors and to create an image is particularly apparent for service businesses, which cannot be hidden and may strongly influence the customer's perceptions of the service experience. So far, various application of service quality and its related theories or findings have been seen in service industries. Still, the topic of service quality and satisfaction made by service industries are often put on research agenda (Berry, Wall, & Carbone, 2006). And how customers and employees evaluate the service quality will be helpful for the service management to provide a better quality service by determining and improving the weaker aspects of

their service delivery system. Consequently, there is still opportunity to examine and understand more about the services at food and beverage industry. Importantly, the perception of time and effort spend during the service consumption is still significant factor to examine the service evaluation – service quality and customer satisfaction.

Materials And Methods

Literature review and arguments provide a systematic discussion on servicescape, service convenience, and service evaluation in food and beverage industry. The following sections will illustrate concepts of servicescape, service convenience, and service evaluation. Next, the relationships or influential effects of each construct will be explained and agued. From this point, hypotheses will be developed based on various findings and theories.

Servicescape

The term 'servicescape' was defined by Bitner (1992) as 'the built environment (e.g. the manmade physical surroundings as opposed to the natural or social environment). According to Bitner (1992), the physical environment has the ability to influence behaviors and to create an image for service industries. Similar to Bitner's servicescape concept, Lovelock and Wirtz (2006) pinpointed that the service environment is the style and appearance of the physical surroundings and other experiential elements which are encountered by customers at the service

delivery sites. Additionally, Grewal et al. (2003) included another three elements of environmental factors: the number of visible employees, the number of customers, and the presence of classical music. Zeithaml et al. (2013) also referred to as facility exterior (exterior design, signage, parking, landscape, surrounding environment), and facility interior (interior design, equipment, signage, layout, air quality/temperature). By other tangibles, such items as business cards, stationery, billing statements, reports, employee dress, uniform, brochures, web pages, virtual servicescape are included. In this study, servicescape is defined as any tangible or physical built environment and visible employees to help facilitate and enhance the service delivery to customers.

Service Convenience

More and more alternatives of retailing than ever before such as from one-stop shopping to the internet are made available for customers to enjoy their shopping; however, due to time consuming and other constraints, customers turn to value quick-and-easy shopping excursions (Seiders, Berry, & Gresham, 2000). Indeed, from prepurchase through post-purchase, customers prefer convenience since more of those retailers offer more alternatives and available sites competitively. Therefore, Seiders et al. (2000) argued that the management did not well define or understand what or how 'convenience' is. According to Berry's et al. (2002) study, service convenience is conceptualized as consumers' perceptions of time and effort related to buying or using a service. They discussed the perception of time and effort, and finally conceptualized convenience of five main dimensions: decision convenience, access convenience, transaction convenience, benefit convenience, and post-benefit convenience. In addition, Lovelock and Wirtz (2006) explained the nonmonetary costs the consumers spend on buying services. The time, effort, and discomfort associated with search, purchase, and use of a service are referred to as the elements of nonmonetary costs the consumers spend. These costs tend to be high during such time as self-service and people-processing service, traveling to the service site, wait for service, figure out queuing systems and service process etc. Therefore, they categorize nonmonetary costs into four distinct groups: time costs, physical cost, psychological costs, and sensory costs. In this study, service convenience is as the perception of time and effort the customers spend to buy or use; the question is how much time and effort the customers spend to receive a service, and whether this is matched with how much effort and time the service providers spend back or compensate.

Service Evaluation

Basically, an organization's service evaluation should be the performance and feedback from consumers. According to Brady's *et al.* (2005) study, sacrifice, service quality, service value, customer satisfaction, and behavioral intention are five constructs that have been studied individually,

which are more often depicted as tenets or models of service evaluation. Chang and Chelladurai (2003) identified nine elements of overall service quality; and concluded that service analysis requires critical targets of quality evaluation; the standards of quality applicable to a given service; and the appropriate evaluators of quality. In addition, Berry's et. al., (2002) the service convenience model conceptually include three components of customers' assessment of the service: customer satisfaction, service quality, and perceived fairness. Since customer satisfaction and service quality are found related in various studies (Shu, Crompton, & Willson, 2002; Taylor & Cronin, 1994). Satisfaction is a summery psychological state resulting when the emotion surrounding disconfirmed expectations is coupled with the consumer's prior feelings about the consumption experience. Service quality is identified earlier as the gaps of customer's expectation and performance of the service (Parasuraman et al., 1985). In this study, service evaluation is defined as the overall perception of satisfaction and quality of service received based on how conveniently the service is delivered and received.

Results

Servicescape and Service Convenience

Based on the economic pricing models which support that time/effort costs have influential impacts on consumers' perceptions of their exchange for (service) purchase, it can be clarified that time/effort cost captures consumers' perceptions of their time and effort spent during the service consumption (Baker et al., 2002). Baker et al. (2002) also reported that the psychic cost is of consumers' mental stress or emotional labor during the shopping experience, and this is influentially affected by the environmental settings. Moreover, convenience is realized as the process or speed of getting in and out of the service sites, or finding the merchandise the customers seek easily. And this is facilitated by the layout which is seen influencing customers' expectations of the efficient movement through the service sites. Consequently, they assumed that customers would perceive time/effort costs to be lower as customers' perceptions of store design clues become more favorable.

Furthermore, it is said that having more visible employees on the retail floor and/or adding enhancing elements can also effectively combat the impact of wait and customer density expectations (Grewal et al., 2003). They hypothesized and tested to show that more visible employees at the service sites may reduce the wait expectations. Service providers consider the design of the service environment as the facilitator to the service encounter and productivity increasing (Lovelock & Wirtz, 2006). And based on Bitner's (1992), the servicescape consists of three dimensions. Of those three dimensions, ambient conditions are psychologically environmental affective actors which can catch customers' impression when entering service sites.

Spatial layout and functionality act as facilitator to enhance the service transaction. And sings, symbols, and artifacts are considered as communicators between what the service firms are able to guide the customers through the process of service delivery at a convenient way of time and effort reduction. Accordingly, the waiting time and effort may be perceived to be filled and pass faster when that waiting time of the service can be made engaged in distracting tasks that require their attention. Therefore, it is suggested that the design of the environment should be established on the basis of engagement in tasks. Hence, the following proposition then emerges:

Proposition 1: Servicescape is positively relates to service convenience.

Servicescape and Service Evaluation

Since services are more intangible, customers may be looking for more physical evidences; that is, the physical surroundings to assess the service before, during, and after the use of the service. By this, a number of authors argue that service consumers rely on a numerous clues that are implanted into the performance-based assessment (Berry, Wall, & Carbone, 2006). They continued that consumer's service evaluations are of performance; and three clues are reported to influence consumers' overall perception of an experience. Those clues are functional, mechanic, and humanistic. In addition, Zeithaml et al. (2013) identified two main elements of physical evidence - servicescapes and tangiblesto show how service consumers evaluate the services. Moreover, service causes the consumer to rely on some clues to make purchase decision and assess their satisfaction with the service during and after consumptions. Service consumers may refer to servicescape when using the services or making decisions to buy or not.

Previously, Parasuraman et al. (1985) credited with the inclusion of 'tangibles' dimension which designates the appearance of the physical facilities, equipment, personnel and communication material, which these comprise some of the most important aspects of servicescape (Reimer & Kuehn, 2005). Lovelock and Wirtz (2006) also said that spatial layout and functionality has affective impact on buying behavior, customer satisfaction, and the business performance of the service facility as consequence. Lovelock and Wirtz (2006) agreed that because services are more intangible and customers usually cannot evaluate how good it is, the customers therefore depend on the physical surroundings as key quality proxy to assess the service they intend to buy or use. Based on what have been discussed above, this study proposes a proposition as follow:

Proposition 2: Servicescape is positively relates to service evaluation.

Service Convenience and Service Evaluation

Based on the concepts of time and effort from previous studies, it is pro-

posed that the more convenient to receive the services at a shorter time and less effort, the more the service consumers feel satisfied and higher quality. Groth and Gilliland (2006) also reported that the affective reactions to the wait, service evaluation, and perceived wait time are the three most important outcome variables in the study of the wait experience; and this wait experience shows the existence of the feelings and emotions such as anger, frustration, and anxiety. It might not be perceived reasonable, but unpleasant if the wait is seemingly too long.

Many authors agreed that service efforts through the service encounter influence service outcome (Shieh & Wu, 2007); and this can be reasonably assumed that customers may perceive higher quality experience of the service while they see increasing effort from the service providers regardless of outcome. The customers then will be satisfied with this increased effort perceived during the service encounter. Hence, the service effort is a key actor which has influential affect on service quality. The result from the service convenience model reported that the service evaluation has been consistently found that waiting time affects the consumer satisfaction with the service. As aforementioned, satisfaction and quality can indicate consumers' assessment of a service. It can be assumed that the more convenient the service is received, the more the consumers are satisfied, and the higher the quality of the service will be likely. Moreover, it was found that unexpectedly high time and energy costs apparently influence

the customers' service assessment (Berry et al., 2002). However, because time and effort are often viewed as investment, benefit convenience does not affect the service evaluation. Ostrom and Iacobucci (1995) described that customer satisfaction/ dissatisfaction (CS/D) is a relative judgment which consists of qualities and the benefits received from a purchase as well as the cost and efforts spent by the consumers to obtain that purchase. Consequently, the above argument and discussion can be based on to the development of another proposition for this study as below:

Proposition 3: Service convenience is positively relates to service evaluation.

Conclusion

The results prove the evidence that the perception of time and efforts during the service delivery and consumption is important for both the service providers and receivers. Environmental cues and facilities, service providers' extra role behaviors and their shared perception of service practices, procedures and related service behaviors are reported to have influences on time and efforts during the service delivery and consumption, which led to the evaluation of the service in terms of quality and customer satisfaction. Service consumers will evaluate the service as higher quality when the time and efforts spent during the services delivery and consumptions are found lower or spent less at that time of service consumption. They also show a

higher level of satisfaction from the service convenience such as how convenient it is to make decision at the service site, how accessible the service is, what benefits they may receive, and how convenient the transaction can be made during the service consumption.

The literature reviews demonstrate various theories and findings related to service business, and those are found useful because when in a service business environment with tough competition, service providers should put much effort on understanding the time and efforts during the service encounter, while their employees' service behaviors are a bit beyond or impossible to control and created. Furthermore, service providers should be much concerned about the convenience of the service; they should try to reduce

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the time and effort spent during the service consumption. This conforms to the notion of lean service. People do not like to wait, so if you can reduce their waiting time, and lower their effort to receive the service, quality of the service will be experienced by the consumers, while they receive what they wish at less time and effort.

At last, we believe this study provides valuable insights into the customer's evaluation in the service delivery. As customers become more knowledgeable and demanding due to experience-seeking and modern technology, managers should map the whole physical surroundings of the service and service perceptions, and open up more time and efforts into service delivery.

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EXPLORING LUO-DONG HOME STAY AND TOURIST SATISFACTION

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Abstract

Revisiting willingness has been highlighted as an important research topic in competitive market of tourism destinations. Despite a good number of research on revisiting willingness and tourist satisfaction, it remains unclear why people undertake repeated visits and what kind of characteristics attract such visitors. This paper aims to investigate the relationship between tourist satisfaction and revisiting willingness. It is based on the questionnaire from the visitors. This survey provides the diversification of sightseeing and tourism by analyzing the questionnaire. There are 120 valid responses from the visitors. The visitors' data, such as personal background, feelings about home stay facilities, service quality, landscape, management and meals, were analyzed by SPSS version 12.0. The results of analysis indicated that there was a significant difference to visitors with different backgrounds. The tourist satisfaction and revisiting willingness proportionally interacted with each other as well.

Keywords: Tourism, Home Stay, Tourist Satisfaction, Revisiting Willingness

Introduction	changed in values
	disposable income
Research Motivation and Background	these days, all kind
Thanks to industrial and commer-	especially tourism
cial development in recent decades,	easily obtained. To
more and more people and families	an important indus

changed in values and increased their disposable income to spend on travel. With the booming of IT technology in these days, all kinds of information, especially tourism information, can be easily obtained. Tourism has become an important industry because it not only affects the development of coun-

try economy but also increases the country's revenues. Tourism also brings about local prosperity and increases a lot of job opportunities.

After Hsuehshan Tunnel, which is located on the Taipei-Yilan Freeway, opened on June 16, 2006, the journey time between Taipei and Yilan is cut down from two hours to just half an hour. Since both the domestic leisure travel and the transport convenience have increased, Luo-Dong's scenic recreational areas have been frequented more and more in recent years. Therefore, arrangement of accommodation before travel has become inevitably necessary. If travelers want to stop for the night, they always choose to stay at a hotel first. However, if it happens to be a holiday or tour peak season and a great deal of travelers flood to the resorts, there are not adequate hotels provided for them. That is, the supply of accommodation facilities often falls short of demand. In Taiwan, home stay has existed since 1981. At first, several local residents provided some of their rooms for the tourists to stop for the night. Such was the appearance of Taiwanese home stay in early days. The existence of Taiwanese home stay is just to meet the market demand. The development of home stay is to be first started at some popular scenic spots. The owners offer accommodation and local cultural feature services.

Obviously, the home stay industry has already become a newly developed Taiwan leisure industry. The government promulgated the law of "Home Stay Management Way", which substituted the original one and was used as the standard of guidance in 2001 for the purpose of promoting travel service quality. According to the Tourism Bureau survey, the number of Taiwan legal home stay was only 65 in February 2003, including 21 in Yilan County. Then in October 2008, the number of Taiwan legal home stay was 2601, including 381 in Yilan County. By October 2015, the latest statistics showed that the number of Taiwan legal home stay was already up to 5953, including 1141 in Yilan. Owing to the rapid growth of home stay, its management has also become very important.

Research Purposes

This study is aimed to investigate the tourists' requirements/expectations before lodging at home stay and their satisfaction with lodging at home stay at Luo-Dong, Yilan and to provide the results for the business owners with concrete and substantial suggestions for management improvement, and to make some contributions to Taiwan home stay.

Research Questions

(1) Is there is significantly difference in tourist satisfaction with Luo-Dong home stay among tourists with different socioeconomic backgrounds?

(2) Is there is significantly difference in tourists' requirements/expectations for Luo-Dong home stay among tourists with different socioeconomic backgrounds?

(3) Do tourist satisfaction and marketing attractions have significant

influence on tourists' revisiting willingness?

Literature Review

In recent years, social and economic prosperity and the government policy of two-day weekend have resulted in an expansion of domestic tourism. Meanwhile, the home stay is obviously booming in Taiwan, especially in Yilan. According to the statistics from the Tourism Bureau mentioned above, the number of Yilan home stay has amazingly increased. The Yilan's home stay proportion of the country's total legitimate ones is about 19.2%, ranked as the No. 2 location in Taiwan. Therefore, the most important issue faced by Yilan's home stay owners is to enhance the service quality, which is vital for customer satisfaction and willingness to revisit.

Recreational Behavior

According to Clawson and Knetsch (1969), there are five stages for the process of visitors' recreational behavior, the stage of expectations or plans made before a trip, the departure stage, the stage of destination on-site activities, return stage and recall stage. Visitors have different experiences in each stage, which are affected by different factors. In Driver and Toucher's study (1970), they think that humans, based on physical and psychological motivations, are driven to participate in recreational activities in pursuit of recreation experience. Recreational activities are goaloriented, which is only a means of achieving the purpose of recreational

experience. The recreational experience and the results obtained are related with the following three factors: (1) Prerequisite conditions, including external environment and tourists' characteristics (such as psychological, physical, socio-economic and other characteristics, past experiences and learning). Such prerequisite conditions will produce recreational motivations and then recreation behavior, and later lead to expected processing stage (such as recreation expectations, choice of recreational activities, time, cost, etc.). Therefore, recreational expectations in the expected processing stage and recreation choice will be affected by the factors of recreation motivation, past experience, social status, and so on. (2) An intermediate situation. including departure, the destination onsite activities and return stages. The stage of destination on-site activities means the period of from entering the recreational area to leaving there. During this time, the tourists' recreational activities will be varied because of their background, experience, motivation, expectations and attitudes. The on-site situation and performance at that time may lead to different levels of tourist satisfaction. (3) Goal achievement means that obtaining satisfactory experience is related with recall stage and stage of goal achievement.

According to the argument above, this study regards tourists' home stay as their recreational activity behavior, and the individual socio-economic background affects tourists' motivation of lodging and their expectations before lodging, and environmental characteristics cause different levels of satisfaction after lodging experience.

Recreation Experience

After the experience, the individual is subjected to external stimuli, arising through raw emotion and perception process. Psychological reactions can be divided into two kinds, internal and external stimuli. Driver and Toucher (1970) and Lawler (1973) mentioned the potential demand for recreation participation process through recreation obtained and its essence of rewards, such as stimulation, friendship, solitude, and so on. Individual old experience and environmental impact create recreation needs, motivations and expectations are formed gradually, and finally they lead to recreation behavior. When visitors have a variety of recreation experience that is mixed with past experience through a comprehensive analysis of the physiological and psychological feelings, there are feelings and experience obtained in the recreational activities that is socalled recreational experience. That is, recreation experience is a series of multi-stage process, and the experience will vary depending on the change of recreational course.

Tourist Satisfaction

Customer satisfaction, a business term, is a measure of how products and services supplied by a company meet or surpass customer expectations. According to Oliver (1999), satisfaction indicates that an experience from a consumer's feedback after using a product; it refers to a temporary, emotional response under the uncertain consuming. Normally, consumers will have expectations to the product before they consume, and they compared the actual performance of the product after using it to see the consistency level.

Factors Affecting Tourism

Ercan, Muzaffer, and Carlton (2003) summarized the factors that affect tourism. They classified eight kinds of factors as follows: natureloving, enhancing the family relationships, training experience, enjoying life, escaping, developing knowledge of history, enjoying luxury life, and showing off. Rodgers (1977) mentioned that the main factors affect tourism including age, gender, social class, upbringing and income. Torkildsen (1983) also mentioned that factors affecting tourism are a complex interactive relationship, such as gender, occupation, income, available resources and facilities.

Relationship between Tourist Satisfaction and Willingness to Revisit

Kozak (2002) stressed that tourists' willingness to revisit is very important to conduct and manage tourism as well as understand the demands of tourists. In short, the relationship between tourist satisfaction and willingness to revisit is positively related.

Methodology

In view of the development of the home stay at Luo-Dong and the sightseeing resources, it is important to upgrade tourist accommodation service quality and increase sight-seeing willingness. The research method is as follows:

- 1. By exploring the related literature, the questionnaire was designed in Chinese version.
- 2. The questionnaire was distributed to visitors at Luo-Dong home stays.
- 3. The data of the collected questionnaire were analyzed through SPSS version 12.0.
- 4. Based on the questionnaire survey and analysis, tourist satisfaction with Luo-Dong home stay, the tourist's revisiting willingness and the marketing attraction were explored.

Research Design

This study is mainly focused on the development of home stay at Luo-Dong, understanding the tourist satisfaction, the revisiting willingness and then their correlation by analyzing the data from the collected questionnaire.

This questionnaire was divided into four parts. The first part was mainly designed to know about tourists' background information; the second part, tourists' needs and expectations before lodging; the third part, tourists' satisfaction with home stay after lodging; the fourth part, customer orientation.

Instrument

By using the questionnaire, this study inquired into tourist satisfaction with home stay at Luo-Dong, revisiting willingness, marketing attractions, and social background. The questionnaire was first selected from the related literature as reference, and then revised to meet the demand of this study. It was designed in Chinese version to meet the visitor's demand. The questionnaire adopted five-point Likert scale: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, (5) strongly agree.

Results and Discussions

Data analysis from the effective questionnaires of 120 visitors is depicted as follows (see Table 1).

Gender and Satisfaction

The findings indicated that the majority of the subjects were females (63.2%), and that male subjects scored slightly higher (M=45.6) than females (M=42.3), which means the male subjects were more satisfied with Luo-Dong home stay than females.

Age and Satisfaction

The majority of the subjects were aged from 18 to 25. The results showed that the teenage subjects scored the highest (M=48.0), which means they were the most satisfied with Luo-Dong home stay.

Education and Satisfaction

The results showed that the majority of the subjects have college degree (53.7%) and that those who have graduate degree scored the highest (M=48.0), which means they were the most satisfied with Luo-Dong home stay.

Marital Status and Satisfaction

The results showed that married subjects (44.7%) scored slightly higher than unmarried ones (43.3%), which means that the married subjects were more satisfied with Luo-Dong home stay.

Occupation and Satisfaction

The results showed that the majority of the subjects were students (56.8%) and that technician subjects (M=46.1) scored slightly higher than the rest, which means they were more satisfied with Luo-Dong home stay than other subjects.

Monthly Income and Satisfaction

The results showed that the majority of the subjects were the ones whose average monthly income was between NT\$20001 and NT\$30000 (49.3%) and that the subjects who monthly income was between NT\$30001 and NT\$40000 scored the highest, which means that they were the most satisfied with Luo-Dong home stay.

Satisfaction Analysis

Tourist satisfaction with home stay near the Luo-Tung night market was analyzed by the two dimensions: Requirements and expectations before accommodation, and overall satisfaction after accommodation.

Analysis of Tourists' Requirements and Expectations before Accommodation

Among the fourteen items, providing a comfortable room is the most required and expected (mean=4.28); however, the explication personnel of the region guides is the least required and expected (mean= 3.28) (see Table 2).

Analysis of Tourist Satisfaction with Home Stay after Accommodation

Among the fourteen items, good service is the most satisfying (mean= 4.28); however, providing recreational activities is the least satisfying (mean= 3.15) (see Table 3).

In sum, the top five of tourist satisfaction with home stay after accommodation are offering good service, near the resorts, soundproof space, privacy of the room and staff's friendly attitude.

Whereas, the top five of tourist dissatisfaction with home stay after accommodation are providing recreational activities, the explication personnel of the region guides, safety equipment, providing featured meals, understanding local culture.

From the data analysis above, it is realized that visitors felt comfortable at Luo-Dong home stay because there were good service quality, private and soundproof rooms, transport convenience, and staff's warm and friendly attitude. However, the hygiene of restrooms was not satisfying; a lot of home stay didn't provide tour guidance, recreational activities, or safety equipment. They didn't offer free breakfast or introduce local culture to the tourist, either.

Revisiting Willingness

The results of the subjects' willingness to revisit Luo-Dong home stay was shown in Table 4. There were 45 subjects (37.5%) who are extremely willing to revisit Luo-Dong home stay, 68 subjects (56.7%) are willing to visit, 7 subjects (5.8%) whose answers are "so so,"

Variables	Descriptions	Number	Percent Mean
Candan	Male	44	36.8 45.6
Gender	Female	76	63.2 42.3
	12~19	49	40.6 48.0
	20~29	32	26.7 42.6
1 30	30~39	10	8.3 44.4
Age	40~49	7	5.8 42.8
	50~59	10	8.3 44.7
	Over 60	12	10.0 39.5
	Primary school	6	5.0 43.5
	Junior high	12	10.0 45.3
Education Level	Senior high	23	19.2 42.6
	College	64	53.7 44.5
	Graduate school	15	12.5 48.0
Manital Status	Single	91	756 43.3
Marital Status	Married	29	24.4 44.7
	Manufacturing industry	0	0 0
	Service industry	20	16.7 42.4
	Agriculture and forestry industry	6	5 42.0
Occupation	Soldier, public servant, and teacher	13	10.8 45.9
Occupation	Technician	2	10.8 46.1
	Unemployed	11	9.2 42.7
	Students	68	56.8 45.0
	Others	0	0 0
	Below NT\$20000	39	32.5 44.7
	NT\$20001-30000	59	49.3 42.9
M	NT\$30001-40000	6	5.0 46.4
Monunly Income	NT\$40001-50000	8	6.7 43.9
	NT\$50001-60000	11	9.2 43.0
	Over NT\$60001	8	6.7 43.5

Table 1. Demographic Profiles of Respondents & Means

	Statements	Mean	Ranking
1.	Providing a comfortable room	4.28	1
2.	Soundproof space	3.93	8
3.	The explication personnel of the region guides	3.28	14
4.	Good service	4.06	3
5.	Safety equipment	3.53	12
6.	Providing recreational activities	3.43	13
7.	Geographical location	3.97	7
8.	Privacy of the room	4.01	6
9.	Beautiful scenery	4.03	5
10.	Staff's friendly attitude	4.04	4
11.	Providing featured meals	3.67	11
12.	Near the resorts	3.78	9
13.	Easily accessible website information	4.13	2
14.	Understanding local culture	3.72	10

Table 2. Tourist Satisfaction with the Requirements and Expectations before Accommodation

	Statements	Mean	SD	Ranking
1.	Providing a comfortable room	3.95	.0.73	6
2.	Soundproof space	4.06	.0.84	3
3.	The explication personnel of the region guides	3.38	.0.63	13
4.	Good service	4.28	.0.86	1
5.	Safety equipment	3.49	.0.61	12
6.	Providing recreational activities	3.15	.0.36	14
7.	Geographical location	3.85	.0.84	9
8.	Privacy of the room	4.03	.0.69	4
9.	Beautiful scenery	3.89	.0.77	7
10.	Staff's friendly attitude	3.97	.0.86	5
11.	Providing featured meals	3.60	.0.71	11
12.	Near the resorts	4.17	.0.62	2
13.	Easily accessible website information	3.86	.0.78	8
14.	Understanding local culture	3.72	.0.75	10

Table 3. Tourist Satisfaction with Destination Attributes

Degrees of Willing- ness	Number		Percent	Mean
Extremely willing	45	37.5	42.3	
Willing	68	56.7	44.1	
So so	7	5.8	41.3	
Unwilling	0	0.0	0.0	
Extremely unwilling	0	0.0	0.0	
Total	120		100.0	42.6

Table 4. Tourists' Willingness to Revisit

and no subjects are unwilling to revisit.

Conclusions and Suggestions

The conclusions and suggestions are explained as follows:

Since the Luo-Dong home stay industry has been booming recently, home stay owners should improve their management and upgrade the service quality to attract more tourists. The environmental attributes have much influence on the tourist's willingness to revisit the same home stay. Therefore, if the home stay owner can meet tourists' requirements, their accommodation satisfaction will be promoted. The results showed that service directly influenced the tourist satisfaction.

Whether home stay owners offered local culture service or not, the soundproof space of the home stay directly affected the tourist satisfaction. However, whether they provided any recreational activities or tour guidance had no influence on the home stay satisfaction.

According to the above results, this study puts forth the following suggestions.

- (1) The home stay owner should value the tourist's accommodation and upgrade the service quality to promote tourist satisfaction.
- (2) The home stay owner can combine local culture, recreational activities and tour guidance service to attract more visitors.
- (3) The home stay satisfaction is affected by safety equipment, therefore the home stay owner should reinforce the necessary facilities.
- (4) The home stay visitors at Luo-Dong value good service and comfortable space, so the home stay owner should make efforts to meet their requirements.

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INNOVATIVE THINKING OF FOOD SAFETY MANAGEMENT FOR TRADITIONAL BAKING INDUSTRY IN TAIWAN -YU JAN SHIN THE BUTTER SHORTBREAD

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Abstract

Yu Jan Shin, a pastry baking business in Taiwan, has been operated for a half century and proud of the products with high production quality. Nonetheless, it unprecedentedly dropped into the food safety issue in 2014. The 1% miss of fried shallot spice incident has the enterprise immediately became the topic of public discussion in the media report. After the 10 - day return storm and the crisis of financial bankruptcy, Chen Yu - Hsien, the second - generation manager and the chairman & general manager, led the family management team to rapidly recover the normal business operation of retail sales. How do they grow together and face the food safety issue together, turn peril into safety to present the magnificence of butter shortbread in Dajia, and round off the incident by going through the food safety issue without doing "face losing" things? This study contributes to provide several models, which are worth learning for the financial management, and corporate social responsibility in the crisis management, of the case company, in spite that it is a small family business.

Key words: baking industry, family business, food safety management, crisis management, enterprise value

Research Background

In such an era, when various information industries of information, network, computer, video, and electronic media are advanced, global disasters or major events are immediately delivered to the world. Such crisis incidents test the response and management abilities of local governments, enterprise organizations, or institutions. In face of technology replacing tradition and machinery substituting labor in baking industry, it is necessary to invest in time and efforts for continuously maintaining the competitiveness. The engagement of industries in the baking market results in the fierce competition. The factors of increasing raw material costs, inadequate labor force, increasing wages, and prosperity fluctuation have food - related businesses encounter great difficulties. High business costs and low product price are not common phenomena. Increasing store rental and indirect costs are also the operation dilemma for businesses. The emergence lifestyles of e - generation enhance the changes of consumer habits. Furthermore, the enhancing consumer awareness of environmental protection and health has the request for products constantly improving from production process to innovative technology R&D and broadening to those strict regulations and rules that need to be followed. In the changeable and complicated global business environment, crisis management has become the essential management skill for enterprises and professional managers as well as the professional knowledge for public relation practitioners. Especially, an enterprise in Taiwan, where consumer rights and corporate image are emphasized, faces various possible crises, which are closely related to sustainable management. In this case, under the internal and external environmental pressure, a corporate manager has to present the idea of crisis management. Enterprises have established public relation practitioners and crisis management team in past years to face crises and cope with crisis issues in order to predict and prevent crises in possible ranges and rapidly propose coping strategies and regularly simulate various crises to train internal employees' coping capacity.

In consideration of consumers' concern of food safety resulted from the requirement for self - health awareness and the lifestyle to eat healthily, consumers' crisis awareness is constantly enhanced and the request for food safety sanitation and the sources become a concerned issue of the public. Relative to consumers selecting food for personal preference and health considerations, food safety is also emphasized. Accordingly, this study intends to discuss the food safety management in traditional baking industry in Taiwan.

Literature Review

Definition of Crisis

Karl (1982) proposed four characteristics for crises, covering the inclusion of an important turning point to result in different incident development, making certain decisions, at least a major value being threatened, and

being determined under time pressure (Chu, 2002). Ler - binger (1997) pointed out crises as the potential threats to the future profitability, growth, and even survival of a company, with the characteristics of a manager being aware of threats and believing that such threats would hinder the development of the company, an organization being aware that the situation would get worse and be irreparable when no action is adopted, and the sudden encounter of an organization (Chu, 2002). Fearn - Banks (1996) defined that crises were the major event which could result in potential negative effects on an organization or an industry; such an incident could influence the organization's publicity, product, service, or reputation to impact the normal operation and even threat the survival (Coombs, 1999). Huang et al. (2009) considered that crises presented the properties of stage, threat, uncertainty, and urgency. Liu (2004) divided the characteristics of crises into incident suddenness, time management urgency, institutional threats, management chance, and universality.

Crisis Management

Crisis management, referring to the management of crises and the reduction of damage, aims to avoid or reduce the negative results of crises and protect institutions, personnel, or enterprises from being damaged. Fink (1986) defined crisis management as the continuous and dynamic management process, which focused on proactive management and discontinuous learning mechanism. Fink (1986) indicated that effective crisis management should contain prediction of crises, establishment of crisis responses, early discovery of crises, keeping away from crises, face of crises, and good interaction with media. Huang (2004) divided crisis management into the detection of crisis message, preparation and prevention of crises, control and management of crisis damage, recovery from crisis, and afterward review and learning. Wu (2002) regarded crisis management as a critical issue for an organization after the occurrence of crises, and an enterprise's crisis management ability as the test of the sustainable management. The factors in frequent crisis incidents and the expanding influence on an organization contain 1.the report of mass media accelerating the spread and impact of crises (Cohn, 2000), 2.the advance of technology hastening increasing crises and risks (including human operating losses and technology risks) in an organization (Covello, 1992), 3.globalization resulting in organizational changes, including the risks of business expansion, merge, restructuring, lay - off, and even close - down (Augustine, 2000), 4.increasing requirements and monitoring of the public for the government, political figures, and various organizations reducing personal mental and moral acceptance of risks (Ogrizek & Guillery, 1999), 5.promoting public rights to strive for personal equity and express dissatisfaction to governmental departments or enterprises through lawyers and legislators for the deserved welfare, and 6.the advance of Internet allowing crisis incidents instantly spreading to the world and causing challenges in crisis communication and management (DiFonzo& Bordia, 2000).

Food Safety

Food safety refers to food for human health (Chang, 2011). Chen (2011) defined it as to guarantee the safety of food, without poisonous or harmful materials, ensure food being produced, processed, stored, and sold in proper environments, and reduce pollution at different stages so as to guarantee consumers' physical health. Grunert (2005) regarded food safety as a primary consideration in food policies to affect consumers' choice of food. Food policies could be combined with other factors, such as the safety of microorganism and animal diseases (Mad Cow Disease and Foot - and - mouth Disease). The use of food additives, chemical pesticide, chemical, preservative, and hormone in vegetables, fruits, and processed food in the agricultural intensification process was the major food safety issue (De Jonge, Van Trijp, Goddard & Frewer, 2008; Mergenthaler, Weinberger & Qaim, 2009). In addition to freshness, flavor, and nutrition, sanitation and safety were also the factors in food quality (Wu, 2010). In either media or academic circles, food safety has attracted more concerns, and the risk of food pollution has become globalized. Meanwhile, consumers pay more attention to the sources of food materials, safety, and authenticity. Such potential risks in food safety or food sanitation problems have food - related value and choice become complex.

Research Methodology

With Case Study, a special enterprise was selected as the subject for collecting data and analyzing problems according to the antecedents. Yin (1994) regarded Case Study as an empirical survey applied to unobvious limits between research phenomenon and real environments. The characteristics covered to deal with specific issues or variables and relied on multiple data sources to explain the research phenomenon. The studied subject about food safety issues in traditional baking industry in Taiwan is a specific phenomenon in baking industry. Research on such a phenomenon is rare currently. The content, to some degree, is the pioneering. The collected data through Case Study could present the causal relation and critical factors in details. According to the key incident, the food manufacturer and the employees of Yu Jan Shin are proceeded the pre - designed structural interview in order to present the participants' responses to the same question.

Case Description

When the food safety issue of Ting Hsin oil emerged, the highlighted media reports in Mainland China, and even European and American countries resisted to food safety in Taiwan, Dajia Yu Jan Shin, famous of butter shortbread, actively and rapidly started the strict "quality safety mechanism" for self - examination on September 5th. The continuous incident of cooking oil made of cooked waste resulted in media reports boiling in the entire island. To reduce consumers' doubts, 8 lard oil made products were automatically taken off shelves for the prevention on September 13th; the product materials were publicly explained on September 14th, including (1)egg and milk vegetarian products (about 98.7% sales volume): natural butter (Anchor butter imported from New Zealand) +flour +sugar+others, (2)"fried shallot" products, and (3)non - vegetarian with fried shallot products (about 1.3% sales volume): lard oil (Cheng - Yi pure lard oil, non - lard oil)+fried shallot (Cheng Agricultural Product Store) - Fangfu (pure lard oil+green onion)+other materials; it automatically reported to Health Bureau of Taichung City Government on the same day that the used Cheng's fried shallot seemed to have cross infection during production. Health Bureau immediately went for the investigation. The owner explained on the media that total six lard - oil used products "seemed" to be polluted, while the famous product "butter shortbread" was not influenced as it used butter. Since food safety is a key factor in the industry, it is the most important product quality for the business management of Yu Jan Shin. The annual food sanitation education intends to build correct food sanitation concepts of the personnel. What is more, the constant examination and communication to continuously improve problems reduce the damage caused by bad sanitation down to the lowest.

Apple Daily real - time reported on September 15th that Chang Guann Co. recycled cooling oil made of cooked waste to produce bad - quality lard oil and was suspected to import animal feed oil from Hong Kong to produce edible oil. It resulted in the second food safety crisis. Food and Drug Administration further announced several problematic products with the list up to 183 items after the investigation; Yu Jan Shin was also influenced. Several media further reported the latest list of products using Fangfu lard oil and Chang Guann oil; Cheng's fried shallot also appeared in the list. Chen, the chairman of Yu Jan Shin, stated that Cheng's oil was confidential in the past 20 - year cooperation and was surprised with the cross pollution. After receiving Cheng's information, the products with fried shallot were taken off shelves and stopped production and automatically reported to the sanitation unit. Chen emphasized that the egg and milk vegetarian products, e.g. butter shortbread, were made with Anchor butter from New Zealand, without lard oil and fried shallot, that consumers could be confident. The owner of Cheng Agricultural Product Store indicated that he asked Fangfu to offer evidence of not using Chang Guann's cooling oil made of cooked; unexpectedly, the uncleaned pipes were suspected to mix such oil with the pure lard oil. The products were therefore taken off shelves, and total 68 buckets of oil were recycled by Fangfu. In the food safety crisis management process of fried shallot, Yu Jan Shin automatically reported to the sanitation unit promptly and practically and "sincerely" used the self - produced lard - oil fried shallot for the products on October 8th, and the products were 98.7% made with "Anchor natural butter from New Zealand" on October 18th. Among the annual 195 tons purchase, self - made lard oil and fried shallot were merely used in few products. The information

was announced on the official website of the company.

Effects Of Media On Food Safety Issues

Although the media reports provided consumers with more space and rights to know in the fried shallot incident, the audience measurement guided random exposure of extreme or unproven information. It was wondered if the incident parties were objectively concerned, whether larger unnecessary social panic and turbulence were induced, and how journalists were regulated. Business Today reported on Volume 935 that Yu Jan Shin family business was proud of not doing "face losing" things, but it was criticized because of Chang Guann oil incident in the previous September. Not only did the owner become the public target, the employees also became the focus. The management team described the experience in the incident that the media reports in Taiwan revealed lots of inciting speeches and threats to the parties and continuously expanded the issue to have the public be threatened in the uneasy environment.

In short, the public has to pay for the generation and management of social incidents. Consequently, people should be responsible for taking the lessons and avoiding the reoccurrence in order to share the healthy society and economic prosperity.

Crisis Management Inspiration And Enterprise Value

Yu Jan Shin, operated for a half century, is a famous bakery in Dajia because of the carefulness from the materials to the production of pastry. Unfortunately, the old bakery suffered from the recycled oil issue. To avoid similar crises in the future and to step toward excellence with quality, not only does the management team have to make efforts, the customers also expect to continuously share the famous pastry in Taiwan. To follow the family property, the "butter shortbread" has to sincerely use "natural butter". The natural butter shortbread, which was 5 times higher price than those with artificial butter, seemed to be a fool decision; however, it was a wise and far - sighted action and established the "sincerity" and "responsibility" of Yu Jan Shin (Yu Jan Shin, 2014). The enterprise value appeared on the employees being able to unite and fight with managers to resolve crises with a happy ending. In sum, going through the fried shallot incident was a major disaster for Yu Jan Shin in the five decades. Although it was satisfactorily rounded off, the management team, especially the chief executives, developed the abilities after the impact. However, there were still recovery, including the reconstruction of morale and the reengineering of overall quality. Starting from a stall in front of the temple, it experienced the deserted dilemma to an old brand with the annual revenue up to several hundred million dollars in the half century. The consumers do not simply buy the flavor of butter shortbread, but the emotion between both parties generates from none to some, from main streets to alleys, and from implicit to explicit,

Date	Incident	Management	Effects on businesses	Relevant personnel to
				incident
September 5	Chang Guann oil polluted	The government examined the oil sources	Confirmed the safety	Purchase and produc- tion de- partment
September 13	Cheng Yi lard oil suspected to use animal feed oil	Taken off shelves and stopped pro- duction for the prevention	Retail sales closed and stopped production	All staff
September 14	Cheng's fried shallot	Automatically reported to Health Bureau of Tai- chung City Gov- ernment, and used Cheng's fried shallot was suspected of cross infection during production.	Lard - oil - made products were urgently taken off shelves, in- cluding cheese sesame pastry, green - bean cake, oil - skin skewed meat, skewed meat bean cake, salty cake	Health Bu- reau of Tai- chung City Government
September 15	Started return and refund	Both on - site and communication	Return and refund	All staff and customers
October 8	Secure infor- mation an- nouncement	Sincerely self - produced	Lard - oil fried shallot	consumers
October 18	Secure infor- mation an- nouncement	Oil use	98.7% Anchor natural butter from New Zealand	consumers

Table 1. Major fried shallot crisis incidents

Data source: Self - organized in this study from YU Jan Shin (2014a
covering priceless customer loyalty and integrating managers' sincere concerns about products. Unexpectedly, the food safety issue resulted in the brand experiencing great test. After the training day of "double compensation", it was concerned how the chairman led the family management team to the stable and quality business. It is believed that there must be something left at somewhere people had been through. The fried shallot incident had the management team and the customers perceive "heartfelt" in between; and, the company actively informed the consumer for return but was refused by the customer and received the comfort to prevent the finance from dilemma. The brand director Chen Yu - min pointed out the double control of production after the fried shallot incident, including:

- Control of raw materials: Lard oil and fried shallot were self - produced, the suppliers were requested to provide traceability of pork, and the preservation and use safety of goods were whole day controlled.
- (2) Regular and irregular visit and inspection of suppliers: To ensure the stability and security of material quality.
- (3) Introduction of monitoring system in all plant: The production personnel, machine, materials, environments, and operation were 24 hour controlled and would be completed in July, 2016.

- (4) Reinforcement of food safety center: The self - inspection center was established with expanded function and permanently cooperated with professors in food department in Hung Kuang University (the past inspection system completely depended on the government - approved SGS system).
- (5) Strict request for traceability from suppliers: It was expected that the customers could realize the material source of each product for consumers' safety and health.

Reviewing the return of fried shallot, it could be reflected that although Yu Jan Shin was a small - scale enterprise, the manpower in the return process was orderly arranged and the financial management was smoothly operated. With the practice of management system, the return process from the opening of receipts, the check of products, and the flexible mobility of personnel could be rounded off within 10 days. Such a management model led several models for learning management in the incident.

Conclusion

Yu Jan Shin learned the lessons (1) of how to interact with media and (2) that an enterprise should be well managed and be the optimal state, from the experience in the fried shallot incident. In the incident, if it was not the ordinary practice of systems and management, it would have to introduce expert guidance, like Nomura Research Institute, and actively apply the governmental resources to build the solid business. Moreover, the family management team collaboratively resolved crises day and night to recover the business within few days from the major food safety disaster. The fried shallot incident was not purposively caused, the sincere and active behaviors appeared great difference from the evasion and cheating of other enterprises for the food safety crisis management and the managers sought nothing but profits. A lot of enterprises therefore were ruined and could not survive; but, Yu Jan Shin relatively provided the optimal model.

Yu Jan Shin replaced traditional lark - oil shortbread with natural butter. which not only made the famous "butter shortbread", but also famed of the hometown of butter shortbread. During the time, the management team was not afraid of failure, learned from doing and did from learning, and continuously researched and innovated to accumulate decades of baking experiences. The insistence on raw materials and quality created fresh brand image on the consumers. Butter shortbread is not simply made with real materials, but the delicious flavor reveals culturally inherited pastry in Taiwan. The customers could perceive the steady business of Yu Jan Shin to support the employees with "heartfelt" in the crisis. The enterprise value of Yu Jan Shin was presented from the employees sending the owner flowers, the employees uniting to fight for the dilemma, and the customers showing trust and consideration.

Yu Jan Shin is a traditionally small family business. In the food safety issue, it is commendable to receive support from the customers and the employees and presents several models for managers in other enterprises. Under the firm business basis in traditional pastry industry, how to avoid disasters and expand excellent quality management is important for the sustainability of family business.

Reviewing the fried shallot incident, even the famous old store is harmed (Yu Jan Shin website, 2015). However, several unscrupulous enterprises have not been punished. It is doubted whether people could get rid of the fear of edible oil. Several causal relations and effects on the food safety issue are worth considering.

- (1) What are the regulations and the monitoring function of governmental units and social groups?
- (2) Consumer demands for cheap goods result in enterprises misusing or abusing food ingredients. In this case, should consumer attitudes be changed?
- (3) How to have an enterprise practice the business idea, rather than being a slogan?
- (4) How to awake corporate managers rooting and practicing business ethics?
- (5) An enterprise encountering crises tests the management team. It is the key in the organizational

management going through the dilemma.

To sum up, sincere Yu Jan Shin focuses on the cake art, combines history, culture, and local characteristics, builds the brand on products, services, activities, buildings, journals, and

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stores, applies humanities and history to inherit the family business, expects to concern the society, deeply manages the brand to improve the localization to international vision, copes with the Internet information in the practical action of global village, and stabilizes the international food stage.

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CORPORATE SOCIAL RESPONSIBILITY BASED BUSINESS PER-FORMANCE EVALUATION SYSTEM

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Abstract

This study established a performance evaluation system based on CSR through coordinating, conducting and analyzing interviews with professionals from industry, academia, government, and CSR promotion organizations. This study focuses on the seven cores of ISO 26000: organizational governance, human rights, labor practices, environment, fairness, consumer issues, and community involvement and development. This evaluation system encourages enterprises to prioritize regulatory compliance, and to practice CSR by designing indexes. Enterprises can refer to this study as an evaluation index to assess their operational performance in terms of CSR. Additionally, this study lets enterprises consider how they can move beyond simply focusing on profits to achieve sustainable management while performing CSR related tasks.

Keywords: Corporate social responsibility, ISO 26000, performance evaluation

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Introduction

Corporate social responsibility (CSR) is a form of corporate selfregulation that is integrated into business models. CSR integrates business operations and values, whereby company policies and actions reflect the interests of all stakeholders, including investors, customers, employees, the community and the environment. Corporates have recently been encouraged prioritize financial, environmental, and social dimensions related to CSR. This issue is not only integral to sustainable management, but also significantly influences corporate survival. Manufacturing enterprises are expected to commit very basic CSR, under which all products are manufactured according to quality and safety standards to ensure consumer safety during product use (Wu and Lai 2006, Coolloud 2012).

During CSR promotion many corporates have realized that CSR serves as a powerful driver to reduce tension between labor and management, coordinates commercial activities and resource environments, and creates a friendly society (Isaksson 2005; Helms and Hervani 2010). Many industries or individual enterprises attempt to establish friendly enterprises, industries, and global supply chains by establishing and practicing self-disciplined regulations to form a sustainable development mechanism for enterprises responsible for humans, society, and the environment (Gold et al. 2010, Marín et al. 2012).

The implementation of CSR has enabled the international community to

gradually establish methods to promote and measure corporate social responsibility using various rating frameworks and indexes, including: The Universal Declaration of Human Rights, Sullivan Principles, SA8000, International Labor Organization, ISO14000, United Nations Global Compact, GRI Sustainability Reporting Guidelines, Account Ability, and the OECD Guidelines for Multinational Enterprises (The eight major global CSR norms, 2012). In the enterprise operation measuring model based on CSR, ISO 26000 guides businesses and organizations regarding how to realize socially responsible operations. ISO 26000 helps clarify social responsibility, helps businesses and organizations translate principles into effective actions, and shares global best practices relating to social responsibility. This study is based on the seven core themes of ISO 26000 (Organizational governance, human rights, labor practices, the environment, fair operating practices, consumer issues, community involvement and development), and fuses them with other international generic indicators of corporate social responsibility. The establishment of corporate social responsibility in a business performance based measurement model can provide a reference for the future assessment of corporate social responsibility practices.

Corporate Social Responsibility

Numerous scholars and businesses agree that corporate social responsibility (CSR) is increasingly important, but no full and internationally recognized definition of CSR exists. CSR is a form of corporate self-

regulation integrated into a business model, and integrates business operations and values, whereby company policies and actions reflect the interests of all stakeholders, including investors, customers, employees, the community and the environment (Wikipedia 2012). Frederick (1992) defined corporate social responsibility as the process through which various individuals, organizations, institutions, environment and community leaders affect enterprise operations, and the damage caused by the commitment of an enterprise to restore and repair the compensation responsibility to make social a balanced and sustained robust operation.

The International Organization of Employers (IOE) defines corporate social responsibility as the voluntary integration by a company of social and environmental concerns into its business operations and stakeholder interactions. The World Business Council for Sustainable Development (WBCSD) defines corporate social responsibility as corporate commitment to continued compliance with ethical norms, to contribute to economic development and improve quality of life for employees and their families, the local community, and society in general.

Promotional of corporate social responsibility by the international community is very positive, and many international organizations, governmental or non-governmental organizations, academics, and so on, have started formulating relevant corporate social responsibility programs, standards, guidelines and specifications. Currently the main international norms are the eight global standards for CSR, namely: Global Compact, International Labor Organization, ILO, The OECD Guidelines for Multinational Enterprises, Sullivan Principles, ISO 26000 Guidance on Social Responsibility, Social Accountability 8000, Account Ability 1000, AA1000, Sustainability Reporting Guidelines (the eight major global CSR norms 2012).

ISO26000

ISO 26000 provides guidance on how businesses and organizations can operate in a socially responsible way. This standard thus helps define social responsibility, helps businesses and organizations translate principles into effective actions, and shares global best practices regarding social responsibility. ISO26000 defines corporate social responsibility as when the social and environmental impact of enterprise operations reflects responsible enterprise behavior that meets social interests and sustainable developments requirements, and is based on moral behavior. Furthermore, socially responsible corporations must comply with laws and the government intergenerational contract, and must be fully integrated into corporate activities.

The main contents of ISO26000 include: 1. Social responsibility-related terms and definitions; 2. Social responsibility background 3. Principles and practices related to social responsibility 4. Core subjects and issues of social responsibility 5. Fulfillment of community responsibility 6. Processing of stakeholder issues 7. Communication of social responsibility information.

In ISO26000, to fulfill social responsibility a corporate must consider seven principles and seven core subjects (as shown in Fig. 1). The principles of social responsibility are based on seven principles, as follows.

- Accountability: An organization should be accountable for its social, economic and environmental impacts, including when that organization decides whether intentional or unintentional events cause significant consequences. Organizational decisions and stakeholder actions have significant impacts.
- Transparency: An organization should be transparent in decisions and activities that impact stakeholders, society, the economy and the environment.
- Ethical behavior: An organization should always behave ethically, and should stress honesty, equity and integrity.
- Stakeholders: An organization should respect, consider and respond to stakeholder interests.
- Rule of law: An organization should always respect the rule of law.
- International norms: An organization should pursue sustainable development and contribute to society by complying with relevant international standards.

Human rights: An organization should respect human rights and recognize both their importance and universality.

The seven core subjects related to ISO26000 include the following.

- Organizational governance: An organization should establish and implement decisions that consider regulations and requirements.
- Human rights: An organization should use its influence to respect and support human rights, and thus encourage respect for human rights to spread through their organizational supply chains and local communities.
- Labour practices: An organization should establish and implement labor-related programs, including not just within the organization itself but also in the work places of contractor employees.
- The environment: An organization should employ integrated methods to reduce adverse environmental impacts and improve its environmental performance.
- Fair operating practices: An organization should exhibit moral conduct in its negotiations with other agencies.
- Consumer issues: An organization should behave responsibly to customers, products and services for matters relating.



Figure 1. ISO 26000 seven core subjects, the seven principles of social responsibility and the integration of seven main chapters

Community involvement and development: An organization should build relationships with local communities.

Research Framework

This study is based on the seven core subjects of ISO 26000: organizational governance, human rights, labour practices, the environment, fair operating practices, consumer issues, community involvement and development, and simultaneously refers to other international CSR standards and norms related subject matter, the establishment of which can assist the development of the corporate social responsibility model. Figure 2 shows the research structure.

This study proposes the following three-step procedure for establishing an evaluation model for the CSR: initial model construction; modification of the initial model; and construction of the evaluation model.

Step 1. Initial model construction. Explore the literature through grouping the first stage together to establish a preliminary performance evaluation, which comprises two levels: the first layer possesses seven dimensions, the second layer is a performance index



Figure 2. Research structure of ISO 26000-based corporate social responsibility

comprising 41 parts, used as a corporate social construct to measure the performance evaluation model based on its initial structure.

Step 2. Modify the initial model. For practicality and applicability, before evaluating relative importance, it is necessary to integrate experienced perspectives from government officers, industry managers, and scholars through expert questionnaires and advisories to construct and modify the initial indicators during the first step.

Step 3. Construct the evaluation model. The correspondence relationships between the second level strategic subjects and third level measurement indicators were further clarified using the analytical network process (ANP) proposed by Saaty (2003) for pairwise comparisons. Model Building

Construction of evaluation criteria

This study refers to the relevant literature, and then integrates the seven general principles for industry based on the ISO 26000 core theme of performance evaluation indicator establishment; it comprises organizational governance, human rights, labour practices, the environment, fair operating practices, consumer issues, community involvement and development Corporate social responsibility assessment indicators are established based on seven dimensions, as follows.

Organizational governance: both forprofit and non-profit organizations must fulfill special requirements in their enterprise governance, and specifically must adopt formal governance, organizational structures and processes based on development, and informal governance that maintains organizational culture and values. In this study the organizational governance aspect considers general principles, the establishment of a general reference to key issues related to the development of a practical index for measuring social responsibility and its incorporation into a concrete description of organizational governance corporate bear responsibility programs to reach aspects goal. Notably, successful organizations must remain conservative, be well managed, and observe the law.

- Human rights: The definition of human rights transcends the law or cultural traditions, and rests on ethics, legal standards and intellectual property rights. An organization must be responsible within its sphere of influence, and policies must be based on respect for human rights, and must eliminate unlawful discrimination or rights violations. In this study, enterprises fulfill their human rights obligations through respecting all individuals equally and caring for the disadvantaged.
- Labour practices: To create a stable employment environment, enterprises must pay fair wages and otherwise compensate their workers. Fulfillment of this obligation forms part of an organization's primary economic and social contribution, namely to respect the rule of law,

labor practices and social justice as a precondition to give labor body science, psychology given due care and security, improve living standards, and indirectly reduce social problems. This dimension outlines practices enterprises should follow in relation to labor to help employees feel that happiness is the ultimate goal.

- The environment: As the world population growth and increased consumption, resource depletion, climate change, ecological damage, and numerous other problems threaten the health, safety, and social wellbeing of mankind, these problems due to the global environmental dimension close relationship, to address persistent and viable solution must cooperate with each other to be slowed. For enterprises to achieve sustainable development, they must improve human environment, the facet fusion ISO 14000 series of standards, and the establishment of enterprises in various proportions reflect specific assessment data on environmental improvement targets, reaching the green protective earth life and make resources endless goals.
- Fair operating practices: Fair operating practices for enterprises and other organizations relevant to the transaction process of ethical conduct, and fair competitive environment can stimulate innovation, improve efficiency, and even decrease product or service prices, thus benefiting the long-term competitive environment, a fair and competitive good-

ness external to the organization impact will achieve sustained and balanced economic and social status. Fair practices within the organization can support organizational philosophy, and actively contribute to the execution of social responsibility, as demonstrated by positive] organizational leadership, reached with stakeholders "to establish mutual assistance, reciprocal working relationship."

- Consumer issues: ISO 26000 content was used to build consumer related issues, with reference to the United Nations in 1985 having passed the "UN Guidelines for Consumer Protection," which considered this aspect of consumer safety evaluation index, and considered information, choice, responsiveness, provision of compensation, education, privacy, and other preventive measures to devise a system to protect the basic needs of consumers and offer consumers a high standard of living, based on the principle "treat customers, to win their trust".
- Community involvement and development: Community development is a social, political, economic and cultural characteristic of the interaction results, so the organization if the proposed contribution to community development, will assume responsibility for community welfare, including developing and implementing strategies to improve social welfare and assist the development of organizations in environments that are very beneficial, thus achieving the target " commu-

nity participation benefits enterprise development"

Factor control and correction

The preliminary factors were based on extensive literature review. The preliminary factors were then presented to selected experts, including government officers, industry managers, and scholars, for evaluation and incremental modification. The factor modification process followed the procedures proposed by Yang and Huang (2011). Experts first reviewed all factors, and individual factors were confirmed as appropriate if over 90 percent of the selected experts checked "appropriate." However, factors that failed to reach the 90 percent threshold were deleted, while those that received evaluations between 80 to 90 percent were marked "appropriate", but presented with suggestions from the reviewer regarding revisions. The modification process yielded 35 factors, which were further classified into seven dimensions (See Table 1).

Model Development

After seeking expert advice and making appropriate revisions, the assessed features were divided into two levels. The first level contains seven dimensions, while the second level contains 35 factors. These seven dimensions thus are related to one other. The relation of the dimension level is network structure. To analyze the network relationship, this study used analytic network process (ANP) to weight the importance of each dimension and indictor. The ANP approach is a good alternative for evaluating interrelation-

ships among dimensions and indicators (Saaty 1996; Yang et al. 2009; Yang and Huang 2011). Twenty experts, including government officers, industry managers, and scholars used their professional experience to weight each dimension and factor. The Super Decision software was used for parameter estimation. Table 1 lists the results.

Discussion

This study integrated seven aspects and found data on 35 analytical indexes, and used this information to build a CSR performance evaluation model. This study ranked the seven aspects of corporate social responsibility performance evaluation as follows: fair operating practices (0.1806), organizational governance (0.1701), labor practices (0.1684), human rights (0.1391), the environment (0.1269), consumer issues (0.1260), community involvement and development (0.0888).Clearly, following fair operational practices allows enterprises to enhance their overall performance and organizational governance, and thus the implementation of social responsibility can significantly impact corporations. This analysis demonstrated high correlation between emphasis and consistency for the current self-assessment of corporate social responsibility.

Regarding the terms included in the performance evaluation index, the top five indicators in the impact assessment model for corporate social responsibility performance were as follow. Avoid the use of suppliers that utilize illegal labor or illegal materials (5.9%): Recently, there have been cases of enterprises selecting sweatshops or suppliers of fake goods as suppliers, resulting in scandals that can seriously tarnish their corporate image. Such cases can even result in consumer boycotts. Therefore, enterprises must increase their emphasis on high quality, and resist the use of illegal labor or illegal suppliers to maintain good corporate brand image.

Proportion of suppliers that implement principles of fairness and justice (5.7%): Enterprises that select suppliers and manufacturers based on principles of fairness and justice can avoid hidden traps that might affect quality and delivery costs. Supplier that operate in this manner will pay more attention to quality or service delivery. corporate labor protection, and inclusion of labor considerations when setting workplace health and hygiene standards will reduce the risk of occupational injury. If employers respect the physical and spiritual needs of labor, they can effectively improve enterprise identity.

Organization operations accord with legal norms (4.9%): globalization means organizations must be familiar with the different standards and legal norms faced by businesses operating in different countries. Companies must develop their organizational and operational policies accordingly, to avoid unnecessary fines or legal sanctions, thus reducing their operational risk and ensuring their profits are legitimate.

Core subject	key measurable indicators	Indicator weight	Subject
	Organization operations accord with legal norms	0.2896	0.0493
Organizational	Full disclosure of financial reports to shareholders, together with notification of significant opera- tional changes	0.2229	0.0379
governance	Dedicated units responsible for corporate social responsibility planning and implementation	0.1952	0.0332
(0.1701)	Provide employees with the means to implement important social responsibility principles	0.1475	0.0251
	corporate tax paid and payable tax rate gap	0.1448	0.0246
	Ensure consistent treatment of workers within a given area, including equal opportunities and absence of illegal discrimination	0.4000	0.0556
Human rights	Labor workplace health and hygiene considerations have been set	0.4000	0.0556
(0.1391)	Labor unions function autonomously and effectively	0.2000	0.0279
	[Labor Conference are held annually]	0.2000	0.0278
	Average work injury frequently is quarterly or less	0.2294	0.0386
	The organization implements measures to improve the level of construction education and industri- al safety	0.2024	0.0341
Labour practic-	Ratio of formal to informal employees	0.1669	0.0281
es (0.1684)	Proportion of disadvantaged workers to total employees	0.1490	0.0240
(0.1084)	[Disadvantaged workers .÷ All workers×100%]	0.1480	0.0249
	Individual salary expectations and their gap with actual pay	0.1266	0.0213
	Enterprises provide vocational training	0.1266	0.0213
	Investment to reduce environmental pollution	0.2405	0.0217
	[Total annual investment ÷ Total annual revenue×100%]	0.2495	0.0317
	Advance environmental considerations in policy development	0.2261	0.0287
	Production volume and proportion of waste	0 1422	0.0182
The environ-	[Total waste ÷ Total production×100%]	0.1455	0.0182
(0.1269)	Extent of 3R implementation in processes	0.1422	0.0100
(0.120))	[Reduce, Reuse, Recycle]	0.1433	0.0182
	Percentage of recyclable or remanufactured material in products	0.1248	0.0158
	Percentage of total waste that comprises recyclable materials	0.1100	0.01.40
	[Recyclable Materials ÷ Total waste×100%]	0.1130	0.0143
	Avoid the use of suppliers that utilize illegal labor or illegal materials	0.3289	0.0594
Fair operating	Proportion of suppliers that implement principles of fairness and justice	0.01.67	
practices	[Suppliers who follow fair business practices] ÷ Total number of suppliers×100%]	0.3165	0.0572
(0.1806)	Establish working procedures to prevent price fixing	0.2029	0.0366
	Percentage of products that infringe patents	0.1517	0.0274
	Honestly label product ingredients and content	0.2258	0.0285
G	No disclosure, distribution, or sale of consumer personal information	0.2047	0.0258
Consumer	Products or services should be designed to prevent the release of hazardous materials or chemicals	0.1841	0.0232
(0.1260)	Consumers should be educated in proper product use to provide a complete description.	0.1296	0.0163
(0.1200)	Ensure timely responses to consumer complaints	0.1279	0.0161
	Provision of a channel for responding to consumer complaints	0.1279	0.0161
Community	Annual subsidies provided to disadvantaged groups	0.2590	0.0230
involvement	Enterprises to participate or assist local in community activities	0.0400	0.0000
and develop-	[Annual number of times participating in local community activities]	0.2499	0.0222
ment (0.0888)	Number of communities or individuals with which the organization establishes an ongoing rela- tionship of providing assistance.	0.1971	0.0175

Table 1. Corporate Social Responsibility Performance Indicators model

Annual number of educational and cultural activities	0.1500	0.0133
activities specifically related to community activities (ex: official leave)	0.1440	0.0128

Note: all samples have undergone rigorous consistency tests (C.R. ≤ 0.1)

These results indicate that corporate care for workplace human rights, anti-discrimination, protection of worker health and safety at work that are more seriously, Besides compliance with the relevant legal requirements, this section also aims to provide more assistance to disadvantaged groups. On the production side, the emphasis is on environmental protection during production, but importance is also attached to supplier selection, which allows implementation of the work environment. Therefore, the more that supplier selection complies with the principles of fairness and justice, the more significant the positive impact on enterprises.

Ensure consistent treatment of workers within a given area, including equal opportunities and absence of illegal discrimination (5.6%): Respect for labor rights, equal treatment of workers, and the creation of an equal opportunity environment without unlawful discrimination is important to making an enterprise well-respected, and can also improve internal stability.

Labor workplace health and hygiene considerations have been set (5.6%): Establishment of a healthy work environment is a basic obligation.

Case Study

In order to verify the established evaluation model, this study selects three different types of enterprises as empirical objects: bank, manufacturing and service. The result of CSR assessment will be the reference for developing strategies or action plans in the future. This work uses an expert group to empirically analyze the three companies, including entrepreneurs involved in industry and related researchers. Company performance is assessed on a 5-point Likert scale, ranging from 5 for "excellent" to 1 for "very poor." The final weighted scores of bank, manufacturing, and service are calculated using weighted measurement indicators. Table 4 lists evaluation results. According to the results of assessment, bank has more excellent performance in the organizational governance, labor practices and consumer issues of seven core subjects and community involvement and development is relatively poor performance. These results indicate that work norms and guidelines of the inner workings of the bank set and compliance, employee care, and supporting measures to protect the lives and safety of the worker is quite well. For external consumer issues respect, bank explains the content of financial products, reward and risk honestly allowing consumers to get a higher property protection. In addition, bank builds a good two-way communication for consumer in order to provide quick response for consumer advices and complaints. In the poor performance of community involvement and development, the most important task is to set up independent ad hoc group of corporate social

		Score			Weighted score		
Core subject	key measurable indicators	Bank	Manufac- turing	Service	Bank	Manufac- turing	Service
	Organization operations accord with legal norms	5.000	4.000	4.333	1.448	1.158	1.255
	Full disclosure of financial reports to shareholders, together with notifica- tion of significant operational changes	5.000	4.667	4.333	1.115	1.040	0.966
Organizational governance	Dedicated units responsible for corporate social responsibility planning and implementation	5.000	3.667	3.333	0.976	0.716	0.651
	Provide employees with the means to implement important social respon- sibility principles	2.667	4.000	4.667	0.393	0.590	0.688
	corporate tax paid and payable tax rate gap	2.667	4.333	5.000	0.386	0.627	0.724
	Ensure consistent treatment of workers within a given area, including equal opportunities and absence of illegal discrimination	3.667	3.000	4.333	1.467	1.200	1.733
Human rights	Labor workplace health and hygiene considerations have been set	4.000	5.000	5.000	1.600	2.000	2.000
Tunian Tights	Labor unions function autonomously and effectively						
	[Labor Conference are held annually]	4.000	4.667	3.667	0.800	0.933	0.733
	Average work injury frequently is quarterly or less	5.000	4.667	2.000	1.147	1.071	0.459
	The organization implements measures to improve the level of construc- tion education and industrial safety	1.333	1.667	4.333	0.270	0.337	0.877
Labour practic-	Ratio of formal to informal employees	4.000	4.000	3.333	0.668	0.668	0.556
es	Proportion of disadvantaged workers to total employees [Disadvantaged workers.÷ All workers×100%]	4.667	3.667	3.000	0.691	0.543	0.444
	Individual salary expectations and their gap with actual pay	2 667	4 3 3 3	3 000	0.338	0 549	0.380
	Enterprises provide vocational training	4.333	2.667	4.667	0.549	0.338	0.591
	Investment to reduce environmental pollution						
	[Total annual investment ÷ Total annual revenue×100%]	3.333	3.667	3.667	0.832	0.915	0.915
	Advance environmental considerations in policy development	2.667	4.000	3.333	0.603	0.904	0.754
	Production volume and proportion of waste	3.333	3.667	1.667	0.478	0.525	0.239
The environ-	Extent of 2P implementation in processor						ł
ment	[Reduce, Reuse, Recycle]	3.667	4.000	3.000	0.525	0.573	0.430
	Percentage of recyclable or remanufactured material in products	3.000	2.000	3.000	0.374	0.250	0.374
	Percentage of total waste that comprises recyclable materials						
	[Recyclable Materials ÷ Total waste×100%]	3.333	4.000	3.667	0.377	0.452	0.414
	Avoid the use of suppliers that utilize illegal labor or illegal materials	4.000	4.333	3.667	1.316	1.425	1.206
	Proportion of suppliers that implement principles of fairness and justice						
Fair operating	[Suppliers who follow fair business practices] ÷ Total number of suppli-	3.000	5.000	2.333	0.950	1.583	0.738
practices	ers×100%]						
	Establish working procedures to prevent price fixing	4.333	4.667	3.667	0.879	0.947	0.744
	Percentage of products that infringe patents	4.333	4.000	4.333	0.657	0.607	0.657
	Honestly label product ingredients and content	4.667	4.000	3.667	1.054	0.903	0.828
	No disclosure, distribution, or sale of consumer personal information	4.667	4.667	3.333	0.955	0.955	0.682
Consumer	Products or services should be designed to prevent the release of hazard-	4.333	3.667	4.333	0.798	0.675	0.798
Consumer issues	Consumers should be educated in proper product use to provide a com-	4.333	4.333	4.667	0.562	0.562	0.605
	Ensure timely responses to consumer complaints	4 3 3 3	4 3 3 3	3 667	0.554	0.554	0.469
	Provision of a channel for responding to consumer complaints	4 2 2 2	1 667	1 222	0.554	0 597	0.554
-	Annual subsidias provided to disadvente and groups	4.555	4.00/	4.333	0.554	0.050	1 205
Community	Entermises to porticipate or ossist local in a survey its activitie	3.000	3.667	5.000	0.///	0.950	1.295
and develop-	[Annual number of times participating in local community activities]	2.667	1.667	5.000	0.666	0.417	1.250

Table 2. The empirical results of the three enterprises

ment	Number of communities or individuals with which the organization establishes an ongoing relationship of providing assistance.			5.000	0.460	0.591	0.986
	Annual number of educational and cultural activities	2.000	2.000	5.000	0.300	0.300	0.750
	activities specifically related to community activities (ex: official leave)	2.333	2.333	5.000	0.336	0.336	0.720



Figure 3. The performance of enterprise bank, manufacturing and service

responsibility, to encourage active participation and Practice.

In manufacturing, fair operating practices and the environment are more excellent in core subjects and community involvement and development is relatively poor performance. In Fair operating practices, pay attention to patents and intellectual property rights, establish business processes to prevent price-fixing, and develop cooperation between manufacturers and material suppliers. In the environment, develop recyclable or reconstituted material, environmental protection material or packaging materials, and reduce environmental pollution process. In the Community involvement and development, enterprises should develop incentives for community involvement

of employees, increase employee awareness of community contributions, and cooperate with other enterprise in community and local community development groups to improve the performance.

In service, community involvement and development is more excellent in core subjects and the environment and fair operating practices are relatively poor performance. In community involvement and development, services emphasis on peopleoriented business philosophy combined with the practice to show good effectiveness of the services. In the poor performance of the environment and fair operating practices, this study recommends continuing efforts to reduce carbon emissions targets and measures

to develop a practice of environmental awareness to continually improve the overall environmental performance.

Conclusion

This study refers to the relevant literature and relevant norms of international CSR, and considers the general characteristics and principles of individual industries. Then, following asking expert advice to existing norms regarding CSR, this study establishes an evaluation framework and measurable index, and then analyzes it using the ANP approach, to evaluate projects and assign weightings, and thus provide relevant evidence on actual cases of corporate social responsibility performance through application of the proposed evaluation model.

This study found that enterprises generally believed that, in terms of importance, the three most important aspects of corporate social responsibility were: Fair operating practices (18.06%), organizational governance (17.01%), labor practices (16.84%). These three aspects thus were selected

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Wu, P.J. and Lai, H.F. : The concept of corporate social responsibility – theory and practice. Journal of GreTai Securities Market, Vol. 122, (2006) 31-42. as most important by over 50% of the sampled enterprises. The corporate social responsibility evaluation model thus should measure these three aspects of corporate social responsibility performance as key items. Less important aspects were human rights (13.91%), the environment (12.69%) and consumer issues (12.60%). However, even these three less important aspects are still significant. On the contrary, community participation and development aspects together accounted for only 8.88%, and thus were far less significant than the other six aspects. Most enterprises thus should focus their efforts to become socially responsible on the six aspects identified as most significant.

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COST OPTIMIZATION STRATEGY FOR EFFICIENCY IMPROVEMENT

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Abstract

The data envelopment analysis (DEA) evaluation technique computes the relative efficiencies of all decision-making units (DMUs) by finding a set of optimal weights for each DMU that can maximize its efficiency. This technique also provides inefficient DMUs directions for efficiency improvement. However, DEA does not consider the cost required for efficiency improvement. In practice, the costs of reducing input and increasing output are different. Therefore, exploring how to integrate the improvement cost into the efficiency improvement plan is a valuable topic worth investigating. This study reveals that as long as the input items and set of weights for the output and input items remain the

same, a DMU with output items $Y' = (y_1/\theta, y_2/\theta, ..., y_s/\theta)$ is an efficient frontier DMU. A new strategy for improving DMU efficiencies with minimal cost is proposed. Mathematical theorems are developed to demonstrate the feasibility of the proposed strategy. Finally, numerical examples are used to illustrate the proposed strategy and compare it with the DEA efficiency improvement plan. The results reveal that the proposed strategy for efficiency improvement is superior to that of the DEA-CCR model. Moreover, the study provides not only a theoretical explanation but also practical reasons for efficiency improvement.

Keywords: Data envelopment analysis, efficiency improvement, optimization

Introduction

Charnes *et al.* (1978) developed the data envelopment analysis (DEA) evaluation model, which can compute the relative efficiencies of decision-making units (DMUs) with multiple input and output factors under the assumption of constant returns of scale. This model is called the DEA-CCR model and includes input- and output-oriented models. The basic function of the input-oriented CCR model is to construct *n* similar DMUs (each with *m* input factors and *s* output factors) to evaluate the relative efficiency of the k^{th} DMU and maximize the ratio of the weighted sum of outputs to the weighted sum of inputs. The output-oriented CCR model mainly minimizes the ratio of the weighted sum of units to the weighted sum of outputs.

The CCR model is subjected to the condition that similar ratios for every DMU be less than or equal to unity. The mathematical equation of the DEA-CCR input-oriented model is represented as follows (Charnes *et al.*, 1978):

$$Max. \theta_{k} = \frac{\sum_{i=1}^{s} u_{rk} y_{rk}}{\sum_{i=1}^{m} v_{ik} x_{ik}}$$

s.t.
$$\frac{\sum_{i=1}^{s} u_{rk} y_{rj}}{\sum_{i=1}^{m} v_{ik} x_{ij}} \le 1, \ j = 1, 2, ..., n. \ (1)$$
$$u_{rk}, v_{ik} \ge \varepsilon > 0$$

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where:

 θ_k : the relative efficiency of the k^{th} DMU, k = 1, 2, ..., n y_{rk} : r^{th} output of the k^{th} DMU x_{ik} : i^{th} input of the k^{th} DMU y_{rj} : r^{th} output of the j^{th} DMU x_{ij} : i^{th} input of the j^{th} DMU u_{rk} : weight for r^{th} output of the k^{th} DMU v_{ik} : weight for i^{th} input of the k^{th} DMU ε : a small positive real number generally set to 10^{-4} or 10^{-6}

This model restricts the ratio of the weighted sum of outputs to the weighted sum of inputs to unity, and the values of the weights are set as unknown variables. When computing the relative efficiency θ_k of DMU_k, the values of weights were chosen to maximize θ_k . A DMU is considered "relatively efficient" if θ_k equals unity and "relatively inefficient" if θ_k is less than unity. Equation (1) is difficult to compute and can provide multiple solutions because the objective function and constraints in equation (1) are fractions. By setting the denominator of the objective function to unity, equation (1) can be transformed into a linear-programming model as follows (Charnes *et al.*, 1978):

$$Max. \ \theta_{k} = \sum_{r=1}^{3} u_{rk} y_{rk}$$
s.t.
$$\sum_{i=1}^{m} v_{ik} x_{ik} = 1$$

$$\sum_{r=1}^{s} u_{rk} y_{rj} - \sum_{i=1}^{m} v_{ik} x_{ij} \le 0, \ j = 1, 2, ..., n.$$

$$u_{rk}, v_{ik} \ge \varepsilon > 0$$

$$(2)$$

The DEA evaluation technique can evaluate the efficiencies of DMUs with multiple inputs and outputs and is flexible in practical application. The DEA technique has been applied for performance evaluation problems in numerous fields (Bao *et al.*, 2011; Charnes *et al.*, 1978, 1981; Chen, 2009; Hwang and Chang, 2003; Kao *et al.*, 2003).

One crucial reason for the widespread use of the DEA technique is that it not only computes the relative efficiencies of all DMUs but also provides inefficient DMUs direc-

tions for efficiency improvement. In general, the directions for efficiency improvement for inefficient DMUs are as follows: (a) increase the amount of output, and (b) decrease the amount of input. Since Charnes *et al.* (1978) proposed the DEA-CCR model, numerous researchers have investigated the model and attempted to discover optimal methods for efficiency improvement. Alirezaee and Mir-Hassani (2006) proposed a layer DEA model for measuring and improving the efficiencies of DMUs in the presence of outlier data. Jahanshahloo *et al.* (2004) defined a fuzzy comparison of fuzzy numbers and proposed a slack-based measure fuzzy DEA model for evaluating and ranking all DMUs. Navabakhsh *et al.* (2007) introduced a model for evaluating the outputs of DMUs by using interval data in DEA and proposed directions for efficiency improvement. Kiatpathomchai *et al.* (2009) investigated the technical efficiency improvement of rice farming in southern Thailand. Alirezaee and Afsharian (2009) introduced an efficiency improvement algorithm and a selective and gradual method for efficiency improvement of DEA models.

The aforementioned studies on planning the efficiency improvement of inefficient DMUs are based on their projections to the production frontier. However, it is possible that each inefficient DMU projects to several points with different coordinates at the frontier. Therefore, the cost required for reaching the frontier may differ. In such a situation, decision makers should consider minimizing the cost to attain the efficiency improvement goal.

In practical applications, the cost required for improving efficiency is crucial and worth investigating because each input and output factor requires a different unit cost. To the best of our knowledge, only a few studies have investigated the economic cost for increasing output or reducing input (Mohammadi *et al.*, 2011). Therefore, based on the existing efficiency improvement technique, the present study recommends an efficiency improvement strategy that mainly considers the cost required for improving efficiency.

The paper is divided into five sections. First, the research background and importance of the study are explained in section 1. Second, a survey on the basic theory underlying the DEA model and its dual model that is used for efficiency improvement is introduced in section 2. Furthermore, the development of the proposed strategy is discussed in detail in section 3. Three theorems are derived as the fundamental theory for the

proposed efficiency improvement strategy. In section 4, numerical examples are used to illustrate the proposed strategy. Finally, conclusions and suggestions are discussed in section 5.

DEA Evaluation Technique

The DEA-CCR model has two versions based on the objective of evaluation; the input- and output-oriented models (Charnes et al., 1978). The input-oriented model is described as equations (1) and (2). Boussofiane et al. (1991) reported that the objective of improvement for inefficient DMUs can be attained using the solution of the dual problem. The dual problem of equation (2) can be represented as follows (Boussofiane et al.,

$$Min. \ h_{k} = \theta_{k} - \varepsilon \left(\sum_{i=1}^{m} s_{i}^{*} + \sum_{r=1}^{s} s_{r}^{*}\right)$$

$$s.t. \qquad \sum_{j=1}^{n} y_{rj} \lambda_{j} \cdot s_{r}^{*} = y_{rk}, r = 1, 2, ..., s.$$

$$1991): \qquad \theta_{k} x_{ik} \cdot \sum_{j=1}^{n} x_{ij} \lambda_{j} - s_{i}^{-} = 0, i = 1, 2, ..., m.$$

$$\lambda_{j}, s_{r}^{+}, s_{i}^{-} \ge 0$$

$$\theta_{k} \ free$$

$$(3)$$

where s_i^- represent a slack variable and s_r^+ represent a surplus variable.

The improvement plan for inefficient DMUs can be obtained from equation (3) as follows:

$$y_{rk}^* = y_{rk} + s_r^{+*}$$

 $x_{ik}^{*} = \theta_k^{*} x_{ik} - s_i^{-*}$ (4)

The DEA-CCR output-oriented model can be described as follows (Charnes et al., 1978):

Min.
$$\eta_k = \sum_{i=1}^m v_{ik} x_{ik}$$

s.t. $\sum_{r=1}^s u_{rk} y_{rk} = 1$
 $\sum_{i=1}^m v_{ik} x_{ij} - \sum_{r=1}^s u_{rk} y_{rj} \ge 0, j = 1, 2, ..., n.$
 $u_{rk}, v_{ik} \ge \varepsilon > 0$

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The dual problem of equation (5) can be represented as follows (Boussofiane *et al.*, 1991):

Max.
$$g_{k} = \eta_{k} + \varepsilon \left(\sum_{i=1}^{m} p_{i}^{-} + \sum_{r=1}^{s} p_{r}^{+}\right)$$

s.t. $\sum_{j=1}^{n} x_{ij}\lambda_{j} + p_{i}^{-} = x_{ik}, i = 1, 2, ..., m.$
 $\eta_{k}y_{rk} - \sum_{j=1}^{n} y_{rj}\lambda_{j} + p_{r}^{+} = 0, r = 1, 2, ..., s.$
 $\lambda_{j}, p_{r}^{+}, p_{i}^{-} \ge 0$
 $\eta_{k} free$
(6)

where p_i^- represents a slack variable and p_r^+ represents a surplus variable.

The improvement plan for inefficient DMUs can be obtained from equation (6) as follows:

$$y_{rk}^{*} = \eta_{k}^{*} y_{rk} + p_{r}^{*} x_{ik}^{*} = x_{ik} - p_{i}^{-*}$$
(7)

As mentioned in the previous sections, the DEA evaluation technique can evaluate the relative efficiencies of DMUs and provide directions for efficiency improvement. However, these improvement plans do not consider the cost factor. To provide an optimal efficiency improvement strategy for DMUs, several crucial theorems are formulated as follows:

Theorem 1: Let the efficiency value of DMU_k be θ_k , and the set of weights for output and input factors be $U = (u_{1k}, u_{2k}, ..., u_{sk})$ and $V = (v_{1k}, v_{2k}, ..., v_{mk})$, respectively. Then, as long as the input factors $X = (x_{1k}, x_{2k}, ..., x_{mk})$ remain the same, a DMU with output factors $Y' = (y_{1k}/\theta_k, y_{2k}/\theta_k, ..., y_{sk}/\theta_k)$ must be an efficient frontier DMU.

Proof:

Let the values of input and output factors of DMU_k be $X = (x_{1k}, x_{2k}, ..., x_{mk})$ and $Y = (y_{1k}, y_{2k}, ..., y_{sk})$, respectively. According to equation (2), the set of weights for input and output factors are $V = (v_{1k}, v_{2k}, ..., v_{mk})$ and $U = (u_{1k}, u_{2k}, ..., u_{sk})$, respectively. The efficiency value of DMU_k, θ_k , is as follows:

 $\theta_k = (u_{1k}y_{1k} + u_{2k}y_{2k} + \ldots + u_{sk}y_{sk})/(v_{1k}x_{1k} + v_{2k}x_{2k} + \ldots + v_{mk}x_{mk}).$ Through simple calculation, it is evident that

 $(u_{1k}y_{1k}/\theta_k + u_{2k}y_{2k}/\theta_k + \dots + u_{sk}y_{sk}/\theta_k)/(v_{1k}x_{1k} + v_{2k}x_{2k} + \dots + v_{mk}x_{mk}) = 1.$

Therefore, a DMU with input factors $X = (x_{1k}, x_{2k}, ..., x_{mk})$ and output factors $Y' = (y_{1k}/\theta_k, y_{2k}/\theta_k, ..., y_{sk}/\theta_k)$ must be an efficient DMU on the frontier.

Q.E.D.

The proof of Theorem 1 indicates that for a DMU_k whose input and output factors are $X = (x_{1k}, x_{2k}, ..., x_{mk})$ and $Y = (y_{1k}, y_{2k}, ..., y_{sk})$, the objective value η_k of an output-oriented DEA-CCR model is

 $\eta_k = (v_{1k}x_{1k} + v_{2k}x_{2k} + \ldots + v_{mk}x_{mk})/(u_{1k}y_{1k} + u_{2k}y_{2k} + \ldots + u_{sk}y_{sk}).$

Through simple calculation, it is evident that

 $(v_{1k}x_{1k}/\eta_k + v_{2k}x_{2k}/\eta_k + \dots + v_{mk}x_{mk}/\eta_k)/(u_{1k}y_{1k} + u_{2k}y_{2k} + \dots + u_{sk}y_{sk}) = 1.$

It is apparent that as long as the output factors $Y = (y_{1k}, y_{2k}, ..., y_{sk})$ remain the same, a DMU with input factors $X' = (x_{1k}/\eta_k, x_{2k}/\eta_k, ..., x_{mk}/\eta_k)$ must be an efficient frontier DMU.

Theorem 1 indicates that once the set of weights is decided and the values of input factors remain the same, DMU_k can be made an efficient DMU by simply increasing the value of each output factor from y_{rk} to y_{rk}/θ_k . Conversely, if the values of output factors remain the same, the value of each input factor can simply be reduced from x_{ik} to x_{ik}/η_k to make the DMU with these new values of input and output factors efficient. This indicates that for improving the efficiency of inefficient DMUs, the values of some output factors

must be increased or those of some input factors must be reduced, similar to the traditional DEA model. However, such improvement actions inevitably require a particular cost. Therefore, analyzing the minimal cost required for improving the efficiency of inefficient DMUs is the major concern of this study. The following theorem describes the key assumptions of this concept.

Theorem 2: Assume that the costs required for increasing the values of output factors of all DMUs are $C = (c_1, c_2,...,c_s)$, and the set of weights for output factors of DMU_k, $U = (u_{1k}, u_{2k},..., u_{sk})$, are known. Let the amount of increase in each output factor be M_{rk} , r = 1, 2,...,s, from the input-oriented DEA-CCR model. The minimal cost required for making DMU_k efficient can be computed using the following linear equation model.

Min.
$$TC = \sum_{r=1}^{s} c_r M_{rk}$$

s.t. $\sum_{r=1}^{s} u_{rk} (y_{rk} + M_{rk}) = 1$ (8)
 $M_{rk} \ge 0$

Proof:

The proof of Theorem 1 indicates that as long as the values of input factors $X = (x_{1k}, x_{2k}, ..., x_{mk})$ remain the same, a DMU with output factors $Y = (y_{1k}/\theta_k, y_{2k}/\theta_k, ..., y_{sk}/\theta_k)$ must be an efficient frontier DMU. The mathematical equation for the efficiency of an efficient frontier DMU_k can be written as

$$u_{1k}(y_{1k}/\theta_k) + u_{2k}(y_{2k}/\theta_k) + \ldots + u_{sk}(y_{sk}/\theta_k) = 1.$$

Replacing y_{rk}/θ_k with $y_{rk} + M_{rk}$ makes DMU_k with output factors $Y'' = (y_{1k}+M_{1k}, y_{2k}+M_{2k},..., y_{sk}+M_{sk})$ efficient. This replacement entails solving the following equation:

$$u_{1k}(y_{1k}+M_{1k})+u_{2k}(y_{2k}+M_{2k})+\ldots+u_{sk}(y_{sk}+M_{sk})=1$$

The preceding equation contains *s* unknown variables; hence, it might provide multiple solutions. Therefore, the solution of equation (8) is optimal for increasing M_{rk} , which is required for minimizing the cost of increasing the efficiency of DMU_k.

Q.E.D.

Theorem 3: Assume that the costs required for reducing the values of input factors of all DMUs are $P = (p_1, p_2, ..., p_m)$, and the set of weights for input factors of DMU_k, $V = (v_{1k}, v_{2k},...,v_{mk})$, are known. Let the amount of reduction in each input factor be Q_{ik} , i = 1, 2,...,m, from the output-oriented DEA-CCR model. The minimal cost model for making DMU_k efficient can be computed using the following model.

Min.
$$TC = \sum_{i=1}^{m} p_i Q_{ik}$$

s.t. $\sum_{i=1}^{m} v_{ik} (x_{ik} - Q_{ik}) = 1$ (9)
 $Q_{ik} \ge 0$

Proof:

The proof is omitted because it is similar to the proof of Theorem 2.

Numerical Example Results and Discussion

In this section, numerical examples are used to illustrate the proposed strategy. Selected data from Wang *et al.* (2007) are used as examples where the costs required for increasing the output factors are assigned arbitrarily. For simplicity, first, assume that the DMUs contain multiple output factors and only one input factor with a value equal to unity (Table 1). This problem can be treated similarly to that in which DMUs contain only output factors. Assume that the unit costs required for increasing output factors are $$20, $100, and $150 for y_1, y_2, and y_3$, respectively.

DMUs Containing Only Output Factors

The relative efficiency and set of weights for DMUs are computed using equation (2) and by setting $\varepsilon = 0.0001$ (Table 1). The results are listed in Table 2. Table 2 indicates that DMU 10 is the most inefficient DMU. The DEA-CCR model provides directions for increasing the efficiency of DMU 10 (equations (4) and (7)). Using equations (6) and (7), the optimal increase in the three output factors of DMU 10 can be computed as follows:

 $\eta_{10} = 4.179490 \approx 4.18$ $p_1^- = p_1^+ = p_2^+ = p_3^+ = 0$

and

$$\Delta y_{1,10} = y_{1,10}^* - y_{1,10} = 4.18 * 1.91 - 1.91 = 6.0738$$

$$\Delta y_{2,10} = y_{2,10}^* - y_{2,10} = 4.18 * 1.35 - 1.35 = 4.293$$

$$\Delta y_{3,10} = y_{3,10}^* - y_{3,10} = 4.18 * 1.25 - 1.25 = 3.975$$

The cost required for improving the efficiency of DMU 10 is as follows:

Total cost = 6.0738 * 20 + 4.293 * 100 + 3.975 * 150 = 1147.026

Consider the cost of efficiency improvement. Using equation (8), the minimal cost and optimal increase for each output factor of DMU 10 are computed as follows:

 $M_{1,10}^* = 13.63444$ $M_{2,10}^* = 0$ $M_{3,10}^* = 0$ $TC^* = 272.6889 < 1147.026$

If the unit cost required for increasing the output factor y_1 is changed from \$20 to \$200, the total cost required by the DEA-CCR model is as follows:

Total cost = 6.0738 * 200 + 4.293 * 100 + 3.975 * 150 = 2240.31

			0	
DMU -		Input		
	<i>y</i> ₁ (teaching)	<i>y</i> ₂ (research)	<i>y₃</i> (service)	<i>X</i> 1
1	8.01	7.24	4.80	1
2	7.73	7.16	4.88	1
3	6.79	10.16	3.38	1
4	7.10	2.44	2.30	1
5	8.43	2.04	5.84	1
6	4.37	4.85	7.85	1

Table 1. Selected data from Wang *et al.* (2007)

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7	9.88	2.09	2.32	1
8	4.62	7.48	2.43	1
9	3.39	1.45	2.41	1
10	1.91	1.35	1.25	1
11	2.08	2.22	1.28	1
12	4.00	1.34	1.24	1
13	1.84	1.66	1.55	1
14	1.84	3.40	1.59	1
15	3.03	4.61	1.88	1

The cost required by the proposed strategy is as follows:

 $M_{1,10}^* = 0$ $M_{2,10}^* = 0$ $M_{3,10}^* = 9.144255$ $TC^* = 1371.638 < 2240.31$

Thus, it can be easily verified that DMU 10 becomes efficient through both improvement strategies. However, the proposed strategy provides a relatively economic method for improving the efficiency of DMUs.DMUs Containing Both Input and Output Factors

For DMUs containing both input and output factors, the costs required for efficiency improvement are a major concern. Data from Wang *et al.* (2007) are again used as an example to illustrate the proposed strategy (Table 3).

Table 2. Relative efficiencies and weights for DMUs

DMU	heta	u_1	u_2	U3	v_1	
1	1	0.0905	0.0379	0.0001	1	
2	0.993	0.0318	0.0512	0.0781	1	
3	1	0.0905	0.0379	0.0001	1	
4	0.756	0.0894	0.0146	0.0370	1	
5	1	0.0558	0.0212	0.0832	1	

6	1	0.0001	0.0001	0.1273	1
7	1	0.0894	0.0146	0.0370	1
8	0.736	0.0001	0.0983	0.0001	1
9	0.421	0.0558	0.0212	0.0832	1
10	0.239	0.0558	0.0212	0.0832	1
11	0.280	0.0318	0.0512	0.0781	1
12	0.423	0.0894	0.0146	0.0370	1
13	0.267	0.0558	0.0212	0.0832	1
14	0.373	0.0001	0.0705	0.0838	1
15	0.483	0.0001	0.0705	0.0838	1

Assume that the unit costs required for increasing the values of the output factors y_1 , y_2 , and y_3 are \$60, \$70, and \$80 million, respectively. In addition, the unit prices required for reducing the values of the input factors x_1 , x_2 , and x_3 are \$250, \$400, and \$550, respectively. The relative efficiency and weights for each DMU are computed using equation (5), the output-oriented CCR model. The results are listed in Table 4.

The minimal cost required for improving the efficiency of inefficient DMUs can be computed using equation (9). For example, the minimal cost required for improving the efficiency of DMU 1 is computed as follows:

$$Q_{11} = 204.3009, Q_{21} = 0, Q_{31} = 0, \text{ and } TC = 52096.72$$

The total costs required for improving the efficiencies of all inefficient DMUs are listed in Table 5.

To compare the proposed model with the DEA-CCR model, equation (8) is used to compute the total cost required for improving the efficiencies of inefficient DMUs by

DM		Output			Input	
U	<i>y</i> ₁ (teaching)	<i>y</i> ₂ (research)	<i>y₃</i> (service)	<i>x</i> ¹ (person-nel)	x_2 (space)	<i>x</i> ³ (facility)
1	8.01	7.24	4.80	4375.0	410.3	379.5
2	7.73	7.16	4.88	4389.2	479.4	575.5

Table 3.Complete data from Wang et al. (2007)

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3	6.79	10.16	3.38	4819.0	541.6	518.5
4	7.10	2.44	2.30	4301.0	179.6	224.7
5	8.43	2.04	5.84	4137.6	255.6	362.3
6	4.37	4.85	7.85	4967.1	273.1	275.0
7	9.88	2.09	2.32	2856.8	87.9	160.1
8	4.62	7.48	2.43	2692.7	46.7	312.1
9	3.39	1.45	2.41	2934.9	132.1	277.4
10	1.91	1.35	1.25	1620.9	71.7	100.0
11	2.08	2.22	1.28	1608.0	102.2	117.5
12	4.00	1.34	1.24	2402.7	101.7	136.7
13	1.84	1.66	1.55	1839.7	114.5	254.0
14	1.84	3.40	1.59	1836.9	155.5	204.8
15	3.03	4.61	1.88	1890.6	173.4	295.0

Table 4. Relative efficiencies and weights of inputs and outputs for all DMUs

DMU	η	u_1	u_2	И3	<i>v</i> ₁	<i>V</i> 2	<i>V</i> 3
1	1.0433	0.0339	0.0292	0.1076	0.0002	0.0001	0.0002
2	1.0824	0.0318	0.0288	0.1123	0.0002	0.0001	0.0001
3	1.2804	0.0375	0.0733	0.0001	0.0001	0.0001	0.0014
4	1.5385	0.0473	0.1771	0.1010	0.0001	0.0001	0.0049
5	1	0.0235	0.0001	0.1373	0.0002	0.0001	0.0001
6	1	0.0001	0.0399	0.1027	0.0002	0.0001	0.0001
7	1	0.1012	0.0001	0.0001	0.0003	0.0001	0.0001
8	1	0.0001	0.1336	0.0001	0.0004	0.0001	0.0001
9	1.576	0.0535	0.0001	0.3397	0.0003	0.0051	0.0001
10	1.415	0.0970	0.4385	0.1781	0.0001	0.0001	0.0125
11	1.174	0.0714	0.3038	0.1384	0.0001	0.0001	0.0085
12	1.636	0.0819	0.3588	0.1546	0.0001	0.0001	0.0101
13	1.559	0.1065	0.1048	0.4065	0.0008	0.0001	0.0001
14	1.260	0.0001	0.1318	0.3470	0.0007	0.0001	0.0001
15	1.034	0.0688	0.0665	0.2581	0.0005	0.0001	0.0001

DMU	Q_{l}	Q_2	Q_3	Total Cost
1	204.30	0	0	52,096.7
2	370.03	0	0	94,356.8
3	0	0	195.33	107,432.5
4	0	0	110.96	61,030.1
9	0	113.33	0	45,331.6
10	0	0	33.30	18,315.8
11	0	0	20.39	11,217.0
12	0	0	62.76	34,518.0
13	675.66	0	0	172,293.3
14	389.72	0	0	99,378.4
15	65.40	0	0	16,678.0

Table 5. Total cost required for improving the efficiencies of DMUs by reducing inputs

 Table 6. Total cost required for improving the efficiencies of DMUs

 by increasing outputs

DMU	M_1	M_2	<i>M</i> ₃	Total Cost
1	0	0	0.00000178	142.69
2	0	0	0.00004472	3,577.54
3	0	0.00001185	0	829.82
4	0	0.00001163	0	814.26
9	0	0	0.0000035	27.72
10	0	0.00000019	0	13.04
11	0	0.00000678	0	474.70
12	0	0.00000390	0	273.13
13	0	0	0.00000558	446.75
14	0	0	0.00000002	1.61
15	0	0	0.00000019	15.38

DMU	Q_1	Q_2	Q_3	M_1	M_2	<i>M</i> ₃	Total Cost
1	0	259.2	0	0.347097	0.313731	0.207998	59,530,510.00
2	0	310.3	132.0	0.636310	0.589390	0.401707	111,769,177.28
3	238.5	459.4	0	1.904038	2.849047	0.970792	391,582,289.54
4	706.0	61.4	0	3.822484	1.313642	1.238269	420,566,622.07
9	0	0	106.7	1.949945	1.407194	1.386244	326,458,471.94
10	167.6	14.3	0	0.791739	0.559606	0.518154	128,176,675.01
11	265.4	60.7	0	0.361910	0.386269	0.222714	66,661,130.11
12	219.6	31.4	0	2.544568	0.852430	0.788816	275,516,941.34
13	0	31.5	95.8	1.027734	0.927195	0.865754	195,893,291.54
14	0	105.6	20.9	0.933908	0.881474	0.412219	150,768,886.15
15	0	128.6	92.3	0.103114	0.156883	0.063978	22,389,080.70

Table 7. Total cost required for improving the efficiencies of DMUsby using the DEA-CCR model

increasing their outputs, and the results are listed in Table 6. Finally, the DEA-CCR model is used to compute the

Discussion

The results indicate that the total cost required for efficiency improvement using the proposed strategy is lesser than that required for efficiency improvement using the DEA-CCR model. Using the DEA-CCR model, decision makers incur approximately 1,000 times the cost incurred when using the proposed strategy. Thus, by considering the cost required for increasing outputs or reducing inputs, the total cost required for improving the efficiencies of all inefficient DMUs, and the results are listed in Table 7. proposed strategy provides an optimal plan for efficiency improvement. The numerical examples illustrate that the present study provides not only a theoretical explanation but also practical reasons for efficiency improvement.

Conclusions

Performance evaluation aims to distinguish efficient DMUs among a set of DMUs and provide inefficient DMUs directions for efficiency improvement. In the presence of only one improvement plan, the cost may not be

a considered factor. However, it is a crucial element in the presence of several improvement plans. The DEA evaluation technique can compute the relative efficiencies of all DMUs and provides useful directions for efficiency improvement for inefficient DMUs. However, the technique does not consider the cost required for efficiency improvement. In practice, the cost of reducing input and increasing output typically differs for each input and output item. Therefore, evaluating how to integrate the improvement cost into the efficiency improvement plan is a valuable topic worth investigating.

The present study proposes an efficiency improvement strategy that considers the cost factor. Mathematical theorems are developed to demonstrate the feasibility of the strategy. Using the proposed strategy, decision makers can reduce the inputs or increase the outputs at minimal costs. The results of the numerical examples reveal that the proposed strategy can not only improve the efficiencies of inefficient DMUs but also achieve the objective with minimal cost. This study provides not only a theoretical explanation but also practical reasons for efficiency improvement.

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THE EXPLORATION OF INFLUENCES BY AQUACULTURE LAND USE ON INDUSTRY TRANSFORMATION, DISASTER PREVENTION AND MANAGEMENT POLICY

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> > Abstract

The research aims at understanding aquaculture land use and causes of changes in such usage against the backdrop of government's policies regarding industry transformation and disaster prevention and management. The results shed light on preventive and adaptive measures in response to the occurrence of natural disasters, based on which relevant policies can be established. In terms of methodology, judgmental sampling was adopted to select 10 interviewees covering the three categories of subject: government officials, elected local representative and local business owners. According to the in-depth interviews, aquaculture's economic benefits outweigh that of the solar farm, and local livelihood shows a strong dependence on aquaculture. Financial reasons are mainly to blame for the industry not taking on the transformation advocated by government policies. This research believes that any disaster prevention should begin with public awareness of extreme weather, while entrusting local groups to initiate the change of aquaculture land for other economic activities.

Key Words: Industry Transformation, Aquaculture, Land use, Disaster Prevention, Policy Management

Introduction

Originally a down-faulted basin on the southwest of Taiwan, Pingtung Plain was slowly transformed by the sedimentation of the Kaoping River, Laonung River and Ailiao River into an alluvial fan as it is today. Based on soil composition and drainage capacity it can be classified into four sedimentary areas. Starting from the Chaochou Fault, lie from east to west the alluvial fan, the spring belt, the flood plain and the low-lying swampland. Each area supports the flourishing of various industries suited for its unique natural environment. Located on the coast southwest to the plain, Linbian Township and Jiadong Township belong to the low-lying swampland and enjoy a tropical monsoon climate marked by the frequent occurrence of convectional rain and cyclones (Shih, 2001). As a

result, precipitation here is characterized by heavy downpours over a short period of time. In 1970s aquaculture started to take root, boosting the local economy by enabling good margins and resulting in job creation. The booming industry of fish farming won Pingtung County the title of "Aquaculture Kingdom". The success, however, has come at a cost, as ubiquitous fish farms put the environment under serious stress.

Land subsidence and flooding are two of the worst consequence from aquaculture's overexploitation of the land. Linbian River that runs across the border of the two townships is known for its rapids and propensity for changing course during rainy seasons. To make matters worse, falling water tables caused by groundwater overabstraction increase the area's susceptibility to deluge, especially in the case of riverbank-breaking during extensive rainfall in the typhoon seasons.

To prevent the worsening of land subsidence and flooding, central and local government had embankments built along the sides of Linbian River. However, a sequence of typhoons from 2001 onward, including Haitang, Bilis, Sepat, Kalmaegi and Fung-wong, still caused serious flood damages to both townships. The worst of them all was Typhoon Morakot in 2009, which saw Wenfeng village, the centre of land subsidence in Lianbian Township, inundated by floodwater as high as 3.6 meters. Other parts of the township were also hit by water rising over 1 meter high. Morakot flooding has exposed the vulnerability of existing disaster prevention policy in the face of extreme weather conditions.

Studies on disasters in the past decades have shown that natural disasters are beyond human control (Wong and Zhao, 2000). Human activities in the post-industrial area left a profound impact on the climate, increasing both the intensity and frequency of meteorological events. In many places of the world extreme weather is occurring more frequently (Easterling et al., 2000 ; Folland et al., 2001; Groisman et al., 2005) and the resultant natural disaster often becomes a cataclysmic event with intertwining social, political and economical impacts (Mitchell et al., 1989; Albala-Bertrand, 1993; Cutter, 1994). Marked with unpredictability and uncontrollability, natural disasters' relentless occurrence and everincreasing scale now demand as much a new sense of awareness as renewed adaptive measures (Bolin, 1985; Davidson and Baun, 1986).

In the aftermath of Typhoon Morakot, different levels of governmental offices in Taiwan began to target local industry transformation as one of the key preparations for future natural disasters, in addition to sole dependence on civil engineering. The Aqua Solar Farm, born out of this initiative, was intended to turn fish farms in Pingtung County under the guidance of the county government into solar farms. The project is designed to run alongside other traditional disaster preventions, such as river sediment clearing and replenishing local land with new earth, to mitigate the threat of flooding and enhance public safety. Moreover, the **Reconstruct Information Center was** established to promote the awareness that disaster prevention cannot be

achieved single-handedly by the government, as local industry, public cooperation and infrastructure are all crucial to its effectiveness and implementation (Britton, 1990; Cliffe, 1995).

To sum up, this research explored aquaculture land use in the target area with a special focus on fish farming. Changes in the use of aquatic farm lands were seen as the indicators for an owner's adaptive behaviors and environmental awareness. Via interviews an in-depth investigation with a bottom-up approach gathered insights into how aquaculture busienss owners in Linbian and Jiadong townships employ their farm land and how well they understand the vulnerability, capacity and resilience of their properties (Dolan & Walker, 2006). The research also looked at the effects of disaster prevention and management policies on the area's aquaculture land use in order to understand reasons for land use changes. The aim is to assist government's efforts in making and modifying industry development and disaster management policies.

Literature of Review

With increased intensity and frequency extreme weather casts an everincreasing impact on human societies (Kunkel et al., 1999). To tackles them IPCC (2007) proposed the approaches of mitigation and adaption. While the former suggests minimizing human interference on climate system, the latter stresses the understanding of each land's unique vulnerability in order to customize different adaptive measures. The relation between adaptation and environmental vulnerability depends on the interaction of ecological, social and political factors. An area's vulnerability and its resident's ability to adapt to new environmental challenges are both susceptible to environmental impact or interruptions (climate change) and the mounting environmental pressure (for instance, land use) (Engle and Lemos, 2010). The change of land use reflects the most direct of human responses to environmental changes, and is simultaneously subject to many temporal-spatial factors (Rindfuss et al., 2002). A poor employment of land invokes various disasters, leaving a negative impact on surface runoff. The most effective way to adapt to disaster brought upon by extreme weathers is via the change of land use (Fohrer et al., 2001; Camorani et al., 2005; Wan and Yang, 2007;

Smith, 1996 ; Hewitt, 1997).

The development of aquaculture along Taiwan's coastlines has left a profound impact both environmentally and socio-economically. With its farreaching and growing influences, aquaculture is threatening the balance of the local eco-system and the usability of land (Chua, 1992), and worse of all the existential safety of communities over a large area (Ericson et al., 2006; Saito et al., 2007; Syvitski et al., 2009, Higgins et al., 2013). Facing these potential risks, it is necessary for the coastal area management (CAM) (Chua, 1992) to initiate alternative ways of land use based on comprehensive analyses covering the aspects of natural conditions, socio- economical concerns and policies.

Adapting to extreme weather involves a variety of issues, ranging from demographics, economics, natural resources exploitation and dependence, policy to local cultures (Malone, 2009). Research has shown that regulations to prevent and manage disaster should meet the demands of industries, cultures and financial concerns. It is necessary to establish a favorable environment to gather public support for adaptive measures or upgrades of existing practices (Burton, 1997; Pielke, 1999; Bryan et al., 2008). From the indigenous tribe's culture perspective, Gregory et al. (1997) studied the community's perception of disasters and their adaptive behavior and confirmed the significant influence of tribal tradition on the collective awareness of disasters and responding adaptation. Current adaptive behaviors mostly focus on tackling problems that already existed (Smit and Wandel, 2006) and lack the readiness for tackling future crises. Moreover, any adjustment is subject to the limitations of social, economical and political factors, and has to take into account varying settings and levels of social acceptance (Adger et al., 2005; Smit and Wandel, 2006). Introducing new measures is likely to have personal, social and national ramifications and such burdens should be shared among the individual, the community and the country (Adger et al., 2003).

A cataclysmic event requires a tremendous ability to adjust and has a far-reaching influence on the majority of the population (Bell et al.,1996). In this research the target area has repeatedly been hit by the peril of flooding, forcing the residents to face the mounting environmental pressure. As extreme weather becomes a more commonplace event, disaster prevention and management focus more on the long-term prospect of climate change (Burton, 1997). However, most of such policies still consider extreme weather conditions as a rarity or mere exception. This oversight or miscalculation risks undermining the results of disaster risk reduction and management (Gaillard, 2010).

Disaster adaptation is closely related to the public's environmental awareness and life experience, while subject to influences from individuals, communities, local cultures and characteristics (Adger et al., 2009). In addition to civil engineering, flood prevention should also include the management of public opinions, local knowledge and community networks (Rahman, 1996), using residents' environmental awareness and adaptive behavior as the foundation of customized policies that address local lifestyle and consensus.

Methodology

Fieldwork and qualitative interview (focus interview) were combined as two research methods to explore the effects of government policies on local industry's land use (Chua, 1992). Interview content was first established by gathering data of the government's industry and disaster prevention policies. The focuses of our interviews with government officials and local representatives were set on industry development and risk perception (Gregory et al., 1997), consulting the conclusions from Adger et al. (2003, 2005).

Government officials covered government authorities, elected local representatives, policy execution units and heads of local authorities, were selected as being the most representative using judgmental sampling. This group consisted of 8 interviewees. The purposes of their interviews are to pinpoint the goals of current policies and problems their implementation encountered. The other group covered industry representatives from local aquaculture production and sales teams as well as agriculture/fishery associations. The sample consisted of 10, with 2 of them now switching to solar power generation.

The interviews helped explain how aquaculture farmers adjust their business models either by changing or not changing their land use. The respective themes for these two group interviews are as follow:

- 1. Governmental authorities:
 - 1) difficulties in policy implementation
 - 2) degree of local cooperation
 - 3) Investment and costeffectiveness

- 2. Industry representatives
 - 1) land use and industry transformation
 - degree of support for official disaster management responses and policies
 - 3) risk and disaster adjustments

No.	Office/Company	Interview Date	Interview Location	
A1	Jiadong Township Office	2011/11/21	Jiadong Township Office	
A2	Pingtung County Council	2011/11/21	Council Member Service Centre	
A3	Linbian Township Representative Council	2012/02/09	Linbian Township Repre- sentative Council	
A4	Linbian Township Representative Council	2012/02/09	Linbian Township Representative Council	
A5	Linbian Township Office	2012/03/03	Community Centre	
A6	The Seventh River Man- agement Office	2012/05/14	The Seventh River Manage- ment Office	
A7	Pingtung County Gov- ernment	2012/05/14	Pingtung County Government	
A8	Pingtung County Government	2012/05/14	Pingtung County Government	
B1	Private aquaculture business	2011/12/10	Private residence	
B2	Private aquaculture business	2011/12/29	Private fishery	
B3	Private aquaculture business	2012/01/02	Linbian literature and history workshop	

Table 1. List of Interviewees

B4	Yin Fun So aquaculture working group	2012/01/02	Yin Fun So aquaculture working group
В5	Yin Fun So aquaculture working group	2012/01/02	Yin Fun So aquaculture working group
B6	Yin Fun So aquaculture working group	2012/01/02	Yin Fun So aquaculture working group
B7	Private aquaculture business	2012/02/08	Private fishery
B8	Private aquaculture business	2012/02/08	Community centre
B9	Solar farm	2012/02/09	Private residence
B10	Solar farm	2012/03/03	Community centre

Table 2. Follow-up interview questions

Interviews with government officials and elected representatives		
Outline	Related Questions	
Obstacles to policy implementation	1. What are the reasons for implementing the industry transformation policy?	
	 What in your opinion are the obstacles to the policy ? What do you think are the reasons for such obstacles? During policy implementation, what kind of assistance or supporting measures did government proivde? 	
Local cooperation	 Do you think that local residents or groups welcome the policy of industry transformation? What do you think are the reasons for their acceptance of or resistance to the policy? What in you opinion are the factors affecting local co- operation with the policy? 	

Investment and its cost-effectiveness	 How much do you think will the total of investment in industry transformation be? What are the immediate and permeant benefits you think will come from industry transformation? Do you believe local residents will enjoy these bene- fits? 	
Interviews with local industry representatives		
Outline Related Questions		
Land Use and Indus- try Transformation	 Do you think it is necessary to promote the change of land use and industry transformation in the area? Why? Do you think the development of local economy can benefit from the policies of land use and industry trans- formation? Why? What do you think will be the reasons for the failure or success of the policies regarding land use and industry transformation? 	
Responses to Disas- ter Management Pol- icy and Civil Coop- eration	 Do you find government policies regarding land use and industry transformation acceptable? Why? Do you think there have been sufficient supporting measures during the implementation of such policies? If not, what measures do you think are needed? Do you find the variety of benefits brought forth by current policies to be enough? Why? 	
Disaster adjustments	 Will you give up your current way of land use if flood- ing happens again? Why? What kind of measures will you choose to adapt in the face of extreme weather conditions in the future? What do you think the government should do to help the public prepare for the possibility of extreme weath- er in the future? 	

Here summarizes the research process. Fieldwork was carried out to observe the development of aquaculture in the target area and the industry's adjustments to its environment and the threat of natural disasters. After discussing with locals, the suitable interviewees were chosen. Subsequently, interviews with local aquaculture representatives and solar farm owners asked their opinions of and familiarity with government policies regarding aquaculture and disaster prevention. The impact of policies on land use was one of the key subjects. Finally, government officials were interviewed to compare these policies' official interpretation with their local perception. The divergence of policy understanding between the government and the industry help shed light on the major obstacles to policy execution.

Data Analysis

In the aftermath of Typhoon Morakot, with the intent to facilitate a transformation of the industry, the government introduced the Aqua Solar Farm project. As an ancillary policy to the solar project, flood prevention was carried out via clearing the riverbed sediments of Linbian River and replenishing the area's soil with fresh earth moved in from the elsewhere. Both Linbian and Jiatung townships underwent post-flooding restoration. The solar project aimed at reducing local dependence on aquaculture was met with mixed responses from industry representatives.

From a policy's point of view, solar farming is meant to provide fish

farmers a new business model and a new way of land use. In the long run the project aims to turn the area into a solar energy zone that attracts companies, creates jobs and slows the speed of land subsidence caused by aquaculture. The change of land use is its primary and ultimate goal. For the project to achieve all these requires local consensus. Currently the biggest obstacle the solar project is facing comes from local resistance, as aquaculture farmers in our interviews suggested:

- "There is no consensus on changing to aqua solar farms, despite official backing. Some like the idea, some simply don't." ----A8
- "Solar farms can help aquaculture transform and improve its image. In future there can be a solar power station set up locally to attract more companies to take part. We should publicize the news and progress of solar farms to promote local tourism."——A5
- 3. "Here are good conditions for aquaculture— a very favorable environment for the industry. The market price of grouper is still high, and from Jiadong to Fangliao the grouper farms cover the area of over 1000 hectares."—
 —A7

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On the feasibility of the solar project, industry representatives disagreed with the officials. They saw it as fundamentally flawed for lacking the infrastructural support of an extensive power grid network. Provided by Taiwan Power company; the grids offers only partial coverage of the region, raising the doubts over unfair disadvantages for those left out, as well as its ability to have a real impact on transforming local economy. Moreover, the buy-in rate for the solar power was published by Bureau of Energy, Ministry of Economic Affairs to be 12.9722 NTD per kWh for the bulk purchase of 10 to 200 KW. The heavy subsidy has long stirred up suspicions of its long-term sustainability. Elected representatives also argued that the solar policy lacks a real connection with the farm land. These doubts make it hard for aquaculture business owners to embrace solar farm, especially when they suspect it not to last. As their interviews point out:

 "Now they are pushing the solar project, and keep saying with solar panels installed, you don't have to do anything and can expect approximately 30 thousand NTD a month. I object the idea of solar farm, because the installation, if said to last the proposed 20 years — enough time for a child to grow up — will occupy the land, meaning no need for cultivation and care. Growing up like this leaves a child with no attachment to the land, no sweet memories of a childhood in the countryside that would entice one to return one day after leaving home for a work and life in the city."— —A2

- 2. "Solar farms just began in Linbian and Jiatung... a policy to run for 20 years. Lots of people think it has a dim prospect, don't believe it would last, and still on the watch out. 12.9 per kWh sold to the government and then the government charges 3 and more per kWh — hardly a sustainable investment. Over the long run, it is likely to collapse."—A3
- 3. "Taking on the solar project is assumed to have future benefits, though only a very few agree" — A3
- 4. "The profits from solar farming, as said earlier, could become fewer and fewer and the real benefits were not felt by local people. If you wanna try out and turn your fields into solar farms, do so your-

self and leave us others alone..." —___A4

The interviews with aquaculture farmers suggested that solar farming is less profitable and this is one of the reasons for its limited popularity. Fish farming is still considered a more costeffective way of land use, therefore hard to be replaced by its solar counterpart. The few solar project participants were on board mostly because their old fish farming businesses were no longer viable after natural disasters. The solar project gave them another way to re-employ the land and another source of income in the place of aquaculture. They were, however, not with doubts. Current solar farm owners also expressed doubts over the policy on its onset, most of them concerning the sustainability of subsidy and land ownership when the lease ends. In general, the opinions were tainted with a distrust of the policy, as seen below in some of the interview quotes:

- "energy generation... to be frank makes the land less cost-effective. The main reason is governments do not want fish farming to continue."—B2
- "Lots of people who went into aqua solar farming now said that they want to quit. A heavy finan-

cial loss caused by flooding is one of reasons. The cost-effectiveness is another. In the past investing 1 million in aquaculture probably yielded 100 thousand in profit, but in solar farm it takes double the investment amount to get the same profit. Fish farming is at least a steady income, and does not cost so much. Profit is the main reason for people to shun the idea of solar farm." ----B2

3. "the advantages (of solar farm) wouldn't last. That is, the subsidy is meant to benefit only a small group of people. 13 dollars for a kWh! The current tariff is just over 2 dollars per kWh. Taiwan Power Company covers the difference, simply using government

money!__B2

4. "The same land used for fish farming earns several times more than solar farms. Who would choose solar over fish then? People who joined the solar project are those who have already decided to disinvest in aquaculture, thinking to give up. And along comes the solar project that offers an easy income from the land they

already own.]-B3

"farming fish here is our accustomed way of live. We don't know what else we could do if giving up this. We can only con-

tinue, otherwise what else? _____

B4

 "Solar farm? Look out here, the whole stretch, there is none. Not a single piece of land. No one wants

- "Solar farm? People should give up fish farming. As for solar farm, it's gibberish ... bullshit farm, none of the applications was granted." ----B6
- "land is sinking further every year and flooding worsens year after year. Morakot flooding washed away almost all the local industry. If we are to continue fish farming, the conditions would only get worse. The solar project might be able to usher in changes."—B9
- 9. "Another round of solar project was proposed, to double the number or then double it again. No idea how much. The problem is as i mentioned earlier is the solar electricity purchase price. The government loses money buying it, passing the bill to everyone. This does not make sense. Also, I

want my land back in 20 years for my grandchildren if they want to

farm..." ——B9

10. "Our land here has sunken but the news is the solar project brought

in new constructions already... J

——B10

11. "The government could simply stopping buying the electricity by saying they couldn't afford it!"

——B10

Embankment construction, soil refilling and river beds deepening are the three tasks that policy execution units, elected representatives and industry representatives all agree not to be forgone. However, each party has a different priority. The region's elected and industry representatives held the belief that a proper construction of embankments along the coasts and riversides should enable fish farming to continue. Morakot flooding, as they pointed out, was down to insufficient river sediments clearing and the government's rigid soil refilling regulations. As a result, the flood-prevention capacity of existing embankments was compromised. According to local fish farm owners, participation in the solar

project is less important than the construction of coastal and riverside embankments. They held the opinion that despite sinking water tables due to groundwater over-extraction, wellconstructed embankments alone should offer the area sufficient protection against the threat of flooding. They tended to believe the severity of Marokot flooding had more to do with the collapsed embankments. Man-made safety structure that failed to prevent disasters were blamed rather than heavy downpour, as the interviewees expressed below:

 "With embankments collapsed there is little use of pumping out water... After flooding the most urgent things the county and township to do are restoring em-

- "Coastal embankments exist for a long time and continue to be a problem. The banks along the coast and the rivers, plus drainage system, are the most important. With all these done properly, aquaculture should be able to continue." — A2
- " In the case of Linbian River, it is a must to clear the sediments! Without lowering the riverbed on-

ly leads to greater dangers. The earth dug out from the river can be a gift from nature to those sunken areas. Those subsiding lands cost fishermen a lot if they want to refill the soil, raising it up. Those with money have already done so by piling new earth on their lands. Government can use the opportunity to use river sediment as the re-filling material..."—A3

- 4. "With strong pipelines and good drainage systems there won't be any more problem. In the past decades there was no problem, with more fish farms running and higher yields which then promote more fish farming." ----B5
- "Most villagers thought this flood was an accident— a man-made one. Here we don't get flooded and this time it was due to the collapse of banks."—B6
- "Of course everyone fears a typhoon, especially after being hit like this. Without a proper construction of the embankments, the deepening of river beds, this fear won't go away. The shadow of previous disaster makes everyone fearful."——B6
- 7. " I wish the government to build tough embankments along Linbi-

an rive. This is important."—— B6

- 8. "If Linbian River embankments are built well, then we don't have to worry. It's hard to prepare for a serious disaster, but the river has to be cleaned. All the things washed down from upstream will properly need 10 years to clean out. It should be cleaned every year. It wasn't last time."——B7
- 9. "Should the government secure the river embankments properly, I believe this incident won't happen again. Most outside people blame land subsidence here, but it wasn't like that. Our water pumping stations work well and other facilities too. If there is no accident like the big hole letting water gush in, the village faces no real danger of flooding. The higher the river banks, the safer we are." — B8
- 10. "To be honest, government in tackling flooding was... how to put it... very passive. Why didn't they do more to prevent disasters? They only started reviewing what could have been done after things

had happened. _----B8

 "Morakot flooding was manmade! It was no doubt a natural disaster, but it was human error that leads to the collapse of river banks." ——B10

12. "...this Morakot flooding was so severe because of human factors. Without artificial reasons, there should have been no flood this time."—B10

Contrary to the opinions of the area's elected and industry representatives, the policy execution units believed that embankments, soil replenishing and watercourse deepening only address the symptoms. They are rescue measures rather than the solutions to the real cause of flooding and that is groundwater over-exploitation. Flood prevention should start with the transformation of the industry and land use in order to reduce excessive groundwater abstraction. As for the poor result of river bed clearing, they believed it is partly to do with the illegal groundwater extracting pipes placed illegally inside the drainage system. In their opinion, even if coastal and riverside embankments are raised and thickened, with local industry going on as usual and a lack of risk awareness, flooding is bound to recur. The official responses were as follow:

1. "We wish they (fish farmers) to avoid extensive investment, oth-

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erwise, when the next one comes, like Morakot, the loss would be even greater. Industry should adopt some sort of adjustments." —____A6

- "Out of hundreds of pipes only 20 or so are working normally. The drainage channel is not working its 100% capacity. Look at that pipe over there, going directly across the gate, not even concealed. This is the government's negligence." ----A6
- 3. "Linbian River has a high flood prevention standard— one to last for 100 years. In comparison, most of the regional rivers have a flood prevention standard of 50 years. It is very wrong to believe like most people are saying here that well-maintained embankments are enough to prevent flooding, despite the situation of falling water tables." ——A7
- "We always said that even the best facility has its limits. It not possible to rule out the possibility of flooding even with good construction." ——A8
- 5. "It is likely that the area is no longer suited for aquaculture. Climate change probably makes it less suitable or China has become a better place for fish farming.

Just like the manufacturing industry before."——A8

6. "Like in the drainage channel in Linbian, there used to be hundred of pipes, affecting flood water being discharged. We ask the owners to remove the pipes, and they refused. Some people are like this and should be taught. The same situation happens now in Jiantung too! The drainage channel is stuck with the pipes that trapped mud and block water discharge. They blame the government for flooding, and insist it is in their right to leave their pipes inside the chan-

nel..." ——A8

Linbian and Jiatung townships have been hit by a multitude of floods over the years. The mounting environmental pressure has forced residents to take adaptive precautions themselves, such as elevating their



Figure 1. Elevating houses

houses (See Figures 1 & 2) and keeping valuables away from the ground floor. In the wake of Typhoon Morakot, fish farmers, solar farm owners and elected representatives grumbled about the construction speed and quality of the banks, the incomplete river beds clearing and the progress of soil refilling. Most of the blame was put on central government's inadequate disaster prevention efforts. Land subsidence was not perceived by farmers as the leading cause of flooding, as the collapsed embankments became the top culprit.

Backed by such perception, they also did not see the need of altering their current business model and land usage. This reflects how hard it is for

Figure 2. Keeping valuables away from the ground floor

people to give up their accustomed way of living even after disasters. Environmental awareness and adaptive behaviors, deeply under the influence of local industry culture, are hard to come by. Adjustments were made without challenging or overturning the established industry model. For instance, in the aftermath of Morakot local farmers in the target area built a higher wall fencing around the fish ponds (Fig.3) can be seen as a unique way to adapt without abandoning the old trade. The solar project does not seem to provide enough incentives for fish farmers to see it as a viable alternative to aquaculture. Few exceptions were those who lost their livelihood of fish farming in the disaster and chose solar farming for the fact that they were unable or un



Figure 3. The elevated walls around fish ponds after Typhoon Morakot

willing to continue their previous business. More responses from other interviewees show are Table 3 below.

Conclusion

Typhoon Morakot has exposed the inadequacy of traditional flood prevention, such as embankment construction, river course deepening and refilling soil, in the face of extreme weather conditions. Both central and local government have realized that in addition to these measures, in the areas suffering serious land subsidence, such as in Linbian and Jiatung townships, changes in land usage are necessary. The solar project was launched with the aims to gradually reduce the dominance of aquaculture by introducing a more sustainable and environmentally friendly business model that keeps disaster prevention in mind.

Implication

Environmental awareness and adaptive behaviors are bound to and shaped by local culture and economy (Gregory et al, 1997). As seen in this studied area, aquaculture is the leading industry that dominates local land use and economy. It plays a central role in local landscape and livelihood. The interviews with aquaculture business owners showed that the solar project had little effect on changing their mind and way of land use. This reflected the tight control of traditional economic activity on local land use (Adger et al., 2005; Smit and Wandel, 2006; Adger et al., 2009). The project only became a preferred option to those who had lost their fish farming businesses in flooding and were in need of another source of income. Their change of land use also came as a post-disaster adaptation. This also suggested a less than effective communication between officials and the public, which failed to convince the area's aquaculture industry to change course to take part in the well-intended disaster mitigation project (Britton, 1990; Cliffe, 1995). It is however unsurprising for a policy failing short of local businesses' expectations and financial interests to gather sufficient public support for the needed industry

Policy Implementing units and civil opinion groups		
Outline	Extracts from interviews	
Obstacles	 They mostly blamed blocked waterways for flooding, instead of ground water extraction (A5). Even when solar farm is up and running local people still think higher embankments are more important. However, based on the current situation, I think it is crucial to clea river sediments (A6). The general public want civil engineering — something they can see (A6). Everyone was concerned about embankment construction and kept on asking whether there would be any flooding after completion. The thing they don't know is that building banks is no guarantee of complete safety (A7). Even the best facilities have limitations (A8). 	
Local cooperation with Government Policy	 The way of aquaculture is fixed. It is hard to make changes espe- cially when earning nothing already (A2). Profits from aquaculture are a lot better than other businesses. No chance for people to give it up easily (A3). Aquaculture is several times more profitable than solar farm. Tell me why I should give up fish for solar power (A4). The profits from fishponds are diminishing but everyone still wants to bet on them (A5). As long as the lease of land provides a steady income, there are still people willing to take part in the solar farm project (A5). 	

Table 3. Extracts from Other Interviews

Investment and Cost Effectiveness	 Government must invest substantially to prevent flooding. After all, aquaculture is highly profitable (A3). Land acquisition will already cost government who knows how much (A4). I am not sure about the specifics, but I do know it will cost a lot (A5). Solar energy industry can bring in many peripheral benefits (A5). Government has already invested heavily in river course clearing, embankments and water pumping station (A6).
	Local industry representatives
Outlines	Extracts from interviews
Land Use and Industry Trans- formation	 The county major has been promoting solar farm vigorously and once mentioned the subsidy of 1 million per hectare for solar ener- gy. But the promise eventually fizzled out (B1). Taiwan Sugar Corporation started extracting ground water before aquaculture did. Instead of blaming them, we fish farmers were asked to stop (B2). Only those whose land is no longer fit for aquaculture would accept solar farm as an alternative (B3). Only aquaculture can boost local economy. Solar farm is of no use (B4). I will continue aquaculture until running out of money. I have no idea what to do other than rearing fish (B7).
Responses to dis- aster management policy	 Riverbed clearing is a must A lack of comprehensive planning makes no one know how to cooperate (B1). Lots of subsidies were promised after flooding. There was a plan encouraging reconstruction to plant some trees here and some grass over there. Totally useless (B2). Instead of solar farming, more subsidies are more practical (B6). With better embankment and pumping stations, there won't be flooding and fish farm can continue (B8). The lease of land for solar power is not bad. Fish farmers get a good deal from letting out the land to be turned into solar farm but there are lots of restrictions (B9).

Disaster adjust- ments	1. 2. 3. 4. 5.	Elevate the ponds and switch to the types of fish that mature faster if continuing auqaculture (B2). Rear fish in separate batches and don't focus on just grouper like before (B4). Lift the ponds, thicken the banks and continue aquaculture as usual (B5). Just carry on like before. I made no changes (B7). Rearing different fish — which costs less than elevating the ponds
	5.	Rearing different fish — which costs less than elevating the ponds (B8)

transformation (Burton, 1997; Pielke, 1998; Bryan et al., 2008).

To sum up, when old business is able to run as usual, even a wellintended policy has little success in convincing aquaculture farmers to voluntarily change course. To address such resistance, this research believes that public education through local organizations holds the key. Local residents should learn the dire fact of extreme weather, possible ways to prevent and alleviate the damages of natural disasters, as well as the true intent of government policy in protecting lives and properties. Communicating via civil groups and associations that have a close bind with local people and land is more effective in evoking environmental awareness rooted in local lifestyle and experience lifestyle and promote a wider acceptance (Rahman,

1996). Second, there should be consistent policies. For instance, the aqua solar farm project asks for a 20-year lease for the land but guarantees no buy-in price for the solar energy. This affect participants' confidence in the project and its wider popularity in the area. In addition, there was another policy that affect fish farmer's willingness. Coinciding the solar project, in June 2010 Ministry for Economic Affairs listed grouper as one of the key exports in the Early Harvest list, when negotiating the Economic Cooperation Framework Agreement (ECFA) with China. This policy that encourages the farming of groupers for export undermined the appeal of solar farming and put aquaculture business owners in a difficult spot.

Future Direction

The conclusions were based on our interviews with several parties involved, including policy execution units, elected local representative, aquaculture farmers and participants in the solar project, and provided a reference for future policies and implementation regarding local industry adjustments. As it set out to compare the different viewpoints between fish farmers and policy implementers, the research is limited in its inclusion of

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other industries than aquaculture. Future research can focus on residents not in the aquaculture business to understand their environmental awareness and adaptive measures facing the area's environmental pressure. This helps render a more comprehensive picture of the area's public attitudes and opinions to enable a better design and implementation of disaster prevention and management policy.

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RESEARCHING THE ENTRY-MODE OF LED TAIWANESE OEM FIRM BY FOREIGN INVESTMENT

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Abstract

The purpose of this study is to aid the LED OEM firms solving the foreign investment (FI) entry mode selection problem. This study combines the concepts of factor analysis, analytic hierarchy process (AHP), genetic algorithm (GA) and fuzzy integral to construct the entry mode selection approach.

The research findings are: (1) In the different investment entry modes, there is a pretty large difference of evaluation focus while the investors select their entry modes. (2) For example, Taiwanese LED OEM firms entering to mainland China, the merge and acquisitions is the priority consideration, and the following is the strategic alliances. This research is shown that if the stock share holding is unlimited, the high stock share holding investing mode is priority selected by Taiwanese LED OEM firms. (3) In the different investment modes, the aspects of "Capital and Risk" and "Technology Ability" have the consist effect of the entry mode selection.

Keywords: Foreign investment, factor analysis, analytic hierarchy process (AHP), genetic algorithm, fuzzy integral

Introduction wan, the revenues of LED OEM industry generated approximately NT\$ 6.4 billion (US\$ 820.4 million) in 2010 Recently, the LED OEM industry plays a critical role throughout the and NT\$ 377.5 billion (US\$ 8.33 bilworld economy. For example, in Tailion) in 2012; its growth rate from

2010 to 2012 was 2,132.64% (MOEA, 2013).

Simultaneously, the funding is the key point of LED OEM firms as usually spend several million dollars on research and development (R & D) projects that is in the majority of capital. As facing growing international competition, many Taiwanese LED OEM firms have begun to invest heavily in R & D to develop innovative products or processes.

Additionally, LED OEM firms currently face the challenge of highlevel entry-barrier, long-developing period and high failure rate. Most of them are small and medium enterprises which main revenues come from manufacturing and selling that lacks the availability of investment capital. Thus, LED OEM firms can refer to the models of the cooperation among universities, research institutes, LED OEM firms and other related industrial companies becomes one of major strategy in their business operations. By taking variety activities, such as development, produce, marketing cooperation and integrated resources, of oversea investment modes. LED OEM firms not only can manifest advantages in LED OEM industry's value chain, but also can enhance the competitiveness of industry. Foreign investment (FI) is one of important method to pursuit the cooperation in LED OEM firms. When LED OEM firms attempt FI, it is important to know how to acquire external resources to complement or integrate simultaneously and also assure the obscurity of internal expertise and knowledge. Furthermore, LED OEM

firms will also search for the decision criterion that affect oversea investment strategies, weigh the importance of the decision and then establish the optimal entry mode. These are the actions of enterprise will take into consideration first.

As we know, LED OEM industry has high-level entry barrier, long time for development, high investment cost for R & D and high risk of failure. Only the successful development of products will bring huge rewards for enterprises. Recently, most of LED OEM firms in Taiwan are small and medium enterprises (SMEs) and their main revenues come from manufacture and sales. Therefore, their fund-raising channels are not enough and it lacks the availability of investment capital in long time R & D cost. Thus, Taiwanese LED OEM firms can make reference to the development modes of oversea LED OEM enterprises. They can cooperate with overseas research center and through different investment entry modes to undertake some business activities as R & D, production, marketing cooperation or resource integrating and so on. This will improve the competitive capacity in value chain of Taiwanese LED OEM industry. Nevertheless, not only acquiring or integrating external resource but also ensuring internal knowledge and professional technique are not embezzled at the same time, that is, the most important issue for Taiwanese LED OEM firms. Thus, finding influential factors for making the decision of FI is priority. Measuring their importance then establish the most suitable entry mode for

LED OEM industry should be considered for enterprises.

Although studies in the past most lie in the entry modes of oversea investment as well as their influential factors, they viewed these influential factors as independent variables. They discussed the related and influential degree of these research variables and choices of modes; yet, rarely considered the interaction of these factors. Therefore, it is critical for an expert decision-maker to set up an oversea investment entry strategic mode that has many principles and plans in a complex environment.

In the previous related researches of FI entry modes, most influential factors have been seen as independent variables. Those variables are used to discuss the influential relationship while choosing variables or modes, but the relationship between factors are seldom to be considered. For this reason, how the expert decision-maker of LED OEM firms can choose the appropriate one among the kinds of FI entry modes is an important issue.

This study searches for the key factors that influence the oversea investment strategies from relevant literatures in the past. Furthermore, we use these key factors to establish a strategic model of oversea investment entry modes for LED OEM industry in Taiwan. This strategic model can be a reference for LED OEM firms to imitate when firms implement the investment strategies of globalization. Therefore, this study searched the related literatures from the past and found the key point of making FI decision by the LED OEM firms. Then this study applied the fuzzy hierarchy integral to these factors and established the decision model of FI entry modes of Taiwan LED OEM industry.

Furthermore, the decision model can be a reference for LED OEM firms while they make the decision of overseas investment strategic. Czinkota and Ronkainen (2002) contended the enterprises have active motives to invest oversea in seven kinds of advantages, including: (1) profit advantage, (2) unique product attributes, (3) skill advantage, (4) commitment of management, (5) benefits from tax, (6)exclusive information and (7) economies of scale. They also documented that five kinds of pressures, such as approaching customers, diminishing sales of domestic market, saturated domestic market, competitive pressure and overproduction, have passive motives to invest oversea.

Dalton and Serapio (1999) indicated the motives which American international companies do development and research abroad, including: (1) responding the demands of product design and development of the host country market, (2) developing new products for the host country, (3) investing more sources to support the production, sales and service of the headquarter in the host country, (4) recruiting workers of development department, (5) developing new science and techniques, (6) tracking the developing situation of oversea tech-

niques and (7) attending joint venture and collaboration. Moreover, Tsai and Erickson (2006) argued that the strategic motives of early competitive advantages in LED OEM industry depend on creating leverage effect of free cash flows from enterprise and research activities. From the perspective of strategic motives, market-oriented investment strategy positively affects the investment performance of the firm (Appiah-adu and Ranchhod, 1998). However, the skill-oriented enterprises are inclined to invest in oversea subsidiaries to acquire the location advantages of techniques and knowledge (Pearce and Papanastassiou, 1996; Shan and Song, 1997). The study documents that the way LED OEM firms obtain their techniques is influenced by their ability, skills and environments (Cho and Yu, 2000). Firms which have the excellent ability of research and development will prefer collaboration or independent development. Notably, firms which have excellent ability of research and development are inclined to have more control to remain the advantages of capability for differentiation. The purpose of keeping high control is to avoid the risks of spilling out knowledge and techniques from the firms (Agarwal and Ramaswami, 1992).

From the perspective of location advantage, firms develop in high potential market will bring in longterm profits, achieve economics of scale, and the opportunity of low marginal production cost. Even if the effect of economics of scale is not significant, firms prefer establishing long-term opportunity of investment (Agarwal and Ramaswami, 1992; Robertson and Gatignon, 1998). Moreover, some scholars attribute these influential factors to country risks of host country (Richards and DeCarolis, 2003). The environmental risks of host country will cause the investment risks of firms, and obstruct the willingness for firms to invest in the host country. Finally, firms will not choose to invest in the host country (Agarwal and Ramaswami, 1992; Cho and Yu, 2000). While the law and restrictions are against the development of firms in the host country, firms abandon their original option. To receive the legitimacy of operation, firms will adopt the operation model that accords with the law of the host country to lower the degree of influence (Dalton and Serapio, 1999; Yiu and Makino, 2002; Shenkar and Luo, 2004). Regardless, the host country offer beneficial investment laws for firms, such as deferred tax, tax holidays, government subsidy, to support the execution of country industry policies. These benefits of laws make firms choose different kinds of oversea entry modes (Brouthers, 2002; Shih, 2006). Isbasoiu (2006) suggested that cluster industry plays an important role in economic development and life quality in a cluster. Cluster industry is composed of a number of organizations; thus, it shares supplies, dealers or techniques together in specific geographic location. Through the formal and informal network relationship of LED OEM cluster, knowledge and technique are prompted to transfer and exchange naturally (Deeds, DeCarolis and Coombs, 2000). In addition, Allansdottir, Bonaccorsi, Gambardella, Mariani, Orsenigo, Pammolli and Riccaboni (2002) mentioned that the viewpoints

and attitudes of the public will affect the industry operation, such as returns and the condition of management.

From the perspective of ownership advantages, the studies in the past integrate the scale of firms, international experiences and capability of differentiation as variables of ownership advantages. Ekeledo and Sivakumar (2004) considered that firms which had relatively larger size than the competitors in the host country were inclined to choose oversea investment entry modes of sole proprietorship. Compared with small-size firms, firms have enough firm size gain more stable and easily well-established operation network systems. Compared with small-sized firms, large-size firms usually have the ability to provide more advantageous knowledge (Coombs, Mudambi and Deeds, 2006). Firms which have abundant international experiences possess high value and exclusivity. These firms prefer using high ownership to enter other countries, and think less about contracts or partial ownership (Agarwal and Ramaswami, 1992; Shih, 2006). Furthermore, Deeds and Hill (1996) assumed that the speed of product differentiation was the key to success for new high-tech firms. That is, the higher the speed of the product differentiation is, the more competitive advantages the new firms have. The competitive advantages include cash input in early period, an increase of product visibility, acquirement of legitimacy and market share.

1. Synthesizing the categories of entry modes by researchers mentioned

above, this study simplifies the research processes regarding the completion of this research and considering current LED OEM developing situations. The foreign entry modes of LED OEM industry indicated by Chen and Luo (2004) are not only effectively represent the measuring purpose in different assessment criteria, but also can reduce the complexity of assessment factors in the entry modes and their alternatives.

2. Considering the questionnaires release and the reply willing of respondent, the entry modes indicated by Chen and Luo (2004) are: (1) joint venture, (2) minority holding strategic alliance, (3) joint R & D, (4) joint production, (5) joint marketing and promotion, (6) enhancing partner relationship for provider, (7) R & D contract and (8) licensing agreement are simplified and rearranged to four entry modes of "joint venture," "strategic alliance," "merger and acquisition," and "cooperation contract." They are the alternatives in this study.

3. The research samples are the Taiwanese LED OEM firms' experts who are willing to or investing now in Mainland China and will be interviewed simultaneously.

Zadeh (1965) introduced fuzzy set theory to illustrate the fuzzy phenomena which human activities met. Through uncertain elements of membership of fuzzy sets, we can transfer human behaviors and conceptual languages into fuzzy numbers. These fuzzy numbers can be calculated and ranked (Laarhoven and Pedrycz, 1983).

In addition, Mikhailov and Singh (1999) did a comparative study which was aimed at traditional crisp value and fuzzy interval, and found out that performing of the effect of the ranking of advantage by fuzzy measures is better than crisp value. Especially, in a complex multi-criteria scenario, an expert decision-maker has too much information to analyze and evaluate; thus, he or she easily make decisions inconsistently. Chen et al. (2006) used four different types of membership functions to represent weighted linguistic variables by different professional abilities of expert decision-makers. Furthermore, they represented the measurement of linguistic variables by three distinct types of membership functions; moreover, they quantify linguistic variables. Chen and Klein (1997) introduced the defuzzying method to calculate the crisp value by the relation of referential rectangle and triangle fuzzy numbers.

Fuzzy measure views the performances of criteria as the candidate fuzzy sets and can be used to determine the degrees which are involved to the performances of criteria in the memberships of fuzzy sets. The value of fuzzy measure involves the connotative weights of performances of criteria, that is the fuzzy measure takes dependent interaction effects among those criteria into consideration. Eliminating the assumption which the probability of all sets is 1, fuzzy measure transfers the additive probability into nonadditive fuzzy measures. λ -fuzzy measure, so-called Sugeno measure (Sugeno, 1974), can fulfill λ additive axiom, decreasing the difficulty in defining fuzzy measure. The constrained parameter, λ , of λ -fuzzy measure indicates the additivity among elements. Comparing with other fuzzy numbers, λ -fuzzy measure is easily and extensively applied to determine the value of fuzzy measure (Chen and Wang, 2001; Lee and Leekwang, 1995). When the expert decision-maker evaluates the alternatives, more numbers of criteria have more sophisticated calculation of λ -fuzzy measure. Furthermore, Lee and Leekwang (1995) employed genetic algorithm (GA) to develop a means that can calculate the value of λ -fuzzy measure without complete information. Chou (2007) provides GA computer program to obtain the optimal value of λ by the software of Matlab R2007a. On the other hand, Takahagi (2000) normalized the λ -fuzzy measure for it to be easily explained the value of fuzzy measure.

Case Implementation

Constructing the Hierarchical Selection of FI Entry Modes for Taiwanese LED OEM Firms

To carry out this study the Delphi's Technique which included literature review to screen and category the assessment criteria was used. The questionnaires were issued according to the experts who are specialists in the LED related fields, and with name on Collection of Taiwan LED OEM Industry (2010). Total amount of delivering questionnaires is 200, recovering the valid samples count 155 questionnaires; the valid questionnaire rate is 77.5%. The valid questionnaires contained 41 expert decision-makers who actually have experience of makingdecision policy of FI, and 144 persons who have experience of FI but they did not have experience to making decision for FI. The statistics test results suggests that no matter who have FI experience or not, the participants in this test did not show significant difference on recognition and importance of 31 assessment criteria. At the same time. the results shows that different operations are affected the selection of assessment criteria through the view of experts. Almost of possible principles should be involved, thus there is unnecessary to omit the criteria. The Kaiser -Meyer-Olkin's measure adequacy based on the sampling size reached to 0.892. This indicates that 31 assessment criteria are appropriated to conduct the factor analysis.

Accordingly, this study did not reduce any assessment criteria and also did not preset any situation of factor structure. Then using orthogonal rotation of principal axis factors to analyze factors and using oblique rotation to find the relationship among all of factors. Finally, this study selects the same components of variation and excludes the errors of measure effects from 31 assessment criteria to find the significant possibility of six-divided-factor and named it, and then this study establishes the factor structure for the assessment criteria. Based on the adjusted results of factor analysis from each assessment criteria, this study establishes the assessment hierarchy of FI entry modes for Taiwanese firms.

Evaluation of FI Entry Mode for Taiwanese LED OEM Firms

This study evaluated how importance and effect of making the decision for four major FI entry modes of LED OEM firms based on each assessment aspect and criterion. The experts in investing LED OEM industry were requested to fill out the questionnaire and its assessment scale from 1 to 5. This questionnaire was issued for 10 firms who with name on Collection of Taiwan LED Industry 2010. Total amount of delivering questionnaire is 13, recovering the valid sample counts 10 questionnaires; the valid questionnaire rate is 79.92%.

This study according to each expert who has experience in LED OEM fields, familiar with LED OEM industry, has influence of making decision and all respondents determine what they belong to the linguistic models to decide the triangular fuzzy numbers while they fill out the questionnaires (see Table 1).

Under different alternatives, the aggregated assessment values of criteria and weighted values of assessment criteria in each evaluative aspect for all expert decision-makers are calculated.

Conclusions

The conclusions are drawn above, we could find out that some Taiwanese LED OEM firms which tend to invest or have already invested in Mainland China, the different assessment criteria affect final results while the enterprises making a decision. Some key points are summarized as follows.

The assessment key point of "Environment of Host Country" is mainly indicated to "Tax Preference" and "Public Acceptance and Attitude for LED OEM Products." However, the target, content, form and extent of tax preference are different between foreign and domestic enterprises in Mainland China. Thus, different entry modes may cause big difference of tax preferences. If Taiwanese LED OEM firms have considered about investing in Mainland China, it had the best to understand the local rules and regulations of tax to avoid loss. The other important thing is "Public Acceptance of LED OEM Products" for Chinese. It can be the indicator of market scale for domestic demand. The higher acceptance is the more business opportunities for the future. According to the strategic motivation of investment for LED OEM enterprises, they have choice to determine whether take highstake investment or not. The assessment key point of "Enterprise Capacity" was mainly indicated to "Characteristic of Executives," "Enterprise-Scale," "R&D Capacity" and "Number of Patent." Operation in the beginning of LED OEM industry exist many uncertain factors, strategies and management groups have to adjust anytime in order to face any variation of market. Talents of management and excellent techniques are extremely important for new enterprises, and they may be the key points for company's development for the future. Simultaneously, highstake investment may improve highcontrol of business operation in Chinese LED OEM market if the enterprises have enough resources and huge scale for their own. For this reason, they could own much profit and also reduce the risk of technology diffusion. Nowadays, almost of the products (or medicines) produced by Chinese LED OEM firms were lack of patents. If Taiwanese LED OEM enterprises own powerful capacity of R&D and numbers of valid patents, the bargain power and core competition can be improved while they tend to enter LED OEM market of China. "Development Priorities Fits Original Industry" and "Using the Local Environment for R&D" are the main points of assessment for "Industrial Development." Mainland China has the largest resource and market of Chinese herbal medicine. and which also be a key point of longterm development for Chinese LED OEM industry. Therefore, so many Taiwanese LED OEM firms of health food in order to acquire stable resource and numerous markets, they start investing China market. From the aspect of entry mode, some enterprises establish branch-company and others license their products for marketing. In addition, LED OEM industry is a circle with knowledge and technology intensive. If infrastructures, such as water and electricity, medical treatment, education, transportation ... etc. of host country are perfect, it will improve knowledge exchange and technology transfer smoothly. Nevertheless, China is so vast that resources can not be distributed equally for each region. Thus, Taiwanese enterprises must to do objectively complete evaluating the advantage and disadvantage of every area before they invest in Chinese market;
otherwise, unpredictable factors will impact normal operation of their company.

"Diversity Channel for Capital" and "Scale of Market Demand" are the key points of assessment for "Capital and Risk" aspect. Currently, the capital invests into Chinese LED OEM industry is almost own funds and bank loan, Venture Capital (VC) (or Risk Investment in China) acquired from stock market was less. If a company hope to earn much money just leans on product sale, they may get failure and can not afford the long-term cost of R&D. Furthermore, the initial public offerings (IPO) have many limitations in China, so fund-raising in local region is restricted. The capital market is not complete and perfect cause the influence of selecting the entry mode, the more equity investment may be more difficult to exit the market. The other big problem for investing in China that is local enterprises are used to using product payment for operation funds. Therefore, the risk of Chinese debts is rising for overdue bills, bad debts and difficulty to received account. Therefore, whether the capital channel is diversity or not that enterprise should consider it. For the entry mode of high degree of involvement, if exit mechanism for capital is not perfect, the operation will be hard when enterprises face the huge losing of capital and can not stop lose immediately.

The assessment point of "Technology and Capacity" was mainly indicated to "Technical Uncertainty" and "Capacity of Commodity and Technical Reality." Comparing with Chinese LED OEM industry, Taiwan's LED OEM firms with advantage capacity of technology integration and process improvement but China's LED OEM firms are specialized in R&D. In the aspect of LED OEM industry, knowledge intensive and setting priority of R&D is general. If someone does not have enough ability to do research and development, adopt industrial division and strategic alliance may be a good way to avoid knowledge and technology diffusion while they are investing but on the other hand may not. And then "Capacity of Technical and Commodity Reality" is a foundation which can create profits for the future. "Latest Industry News" is emphasized "Establishment of Overseas Technical Information Center." Because the key feature of LED OEM industry is high knowledge-intensive, the acquirement and accumulation of knowledge is essential. Now, China makes much effort to accumulate LED OEM knowledge. Not only making LED OEM as one of the five major high-tech area, but also cultivating LED OEM talents actively and offering more incentive to encourage overseas specialist returned. These measures improve effectiveness to establish the LED OEM information database. Therefore, the foundation of technical center in local area can make easily to track the newest development of Chinese LED OEM industry for any kind of entry mode. It also can help Taiwanese's company to develop their LED OEM industry.

For the following research, we can try our best to acquire different kinds of opinion from foreign LED

OEM firms which have already invested in China or expand the number of samples for other invested area (included developed countries, the nation with unique mode of development and emerging countries which have significant potential). To assess the evaluation by applying the structure of this study

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should be able to obtain more information of investment and stringent results. If other research methods can be applied to verify the result, such as fuzzy AHP or fuzzy ANP, it may make much better and complete applications of assessment structure for this study.

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Figure 1. Hierarchical Evaluation Structure of Fuzzy Integral for FI Entry Modes for Taiwanese LED OEM Firms

	Expert 1	Ex- pert2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Expert 9	Expert 10
Assessment Linguistic Model	LM_{C1}	LM _{C1}	LM_{C2}	LM _{C3}	LM _{C3}	LM _{C1}	LM_{C2}	LM _{C2}	LM _{C2}	LM_{C1}
Weight Linguistic Model	LM_{G1}	LM_{G1}	LM _{G3}	LM_{G4}	LM_{G4}	LM _{G1}	LM_{G2}	LM _{G3}	LM _{G3}	LM _{G1}

Table 1. Linguistic Models for the Experts

Appendix I, II Linguistic Models

1. Linguistic Model for the Grade of Importance of Foreign Investment Entrymode Selection of LED OEM Firms



Figure A.2.1 Linguistic Model, LM_{G1}, for the Grade of Importance of Foreign Investment Entry-mode Selection of LED OEM Firms

Verbal Expres	sion	Membership Function			
Very Low	$\mu_{\scriptscriptstyle Very\ Low}(g)$	$f = \begin{cases} 0; & g \le 0, \\ (0.2 - g)/0.2; & 0 \le g \le 0.2, \\ 0; & g \ge 0.2. \end{cases}$			
Low	$\mu_{Low}(g) = \begin{cases} 0 \\ 0 \\ 0 \\ 0 \end{cases}$	0; $g \le 0.2$, $(g - 0.2/0.1; 0.2 \le g \le 0.3,$ $(0.4 - g)/0.1; 0.3 \le g \le 0.4,$ 0; $g \ge 0.4.$			
Fair	$\mu_{Fair}(g) = \begin{cases} (g) \\ $	0; $g \le 0.4$, $(g - 0.4/0.1; 0.4 \le g \le 0.5,$ $(0.6 - g)/0.1; 0.5 \le g \le 0.6,$ $(0; g \ge 0.9).$			
High	$\mu_{High}(g) = \begin{cases} \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\$	$\begin{array}{ll} 0; & g \leq 0.6, \\ (g-0.6/0.1; & 0.6 \leq g \leq 0.7, \\ (0.8-g)/0.1; & 0.7 \leq g \leq 0.8, \\ & 0; & g \geq 0.8. \end{array}$			
Very High	$\mu_{\scriptscriptstyle Very\ High}(g)$	$0 = \begin{cases} 0; & g \le 0.8, \\ (g - 0.8/0.2; & 0.8 \le g \le 1.0, \\ 1; & g = 1.0. \end{cases}$			

Table A.2.1 Five Possible Fuzzy Ratings and Meanings for Model $LM_{\rm G1}$



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Verbal Expres	sion Membership Function
Very Low	$\mu_{Very \ Low}(g) = \begin{cases} 0; & g \le 0\\ (0.25 - g)/0.25; & 0 \le g \le 0.25,\\ 0; & g \ge 0.25. \end{cases}$
Low	$\mu_{Low}(g) = \begin{cases} 0; & g \le 0.2, \\ (g - 0.2/0.1; & 0.2 \le g \le 0.3, \\ (0.4 - g)/0.1; & 0.3 \le g \le 0.4, \\ 0; & g \ge 0.4. \end{cases}$
Fair	$\mu_{Fair}(g) = \begin{cases} 0; & g \le 0.35, \\ (g - 0.35/0.15; & 0.35 \le g \le 0.5, \\ (0.65 - g)/0.15; & 0.5 \le g \le 0.65, \\ 0; & g \ge 0.65. \end{cases}$
High	$\mu_{High}(g) = \begin{cases} 0; & g \le 0.6, \\ (g - 0.6/0.1; & 0.6 \le g \le 0.7, \\ (0.8 - g)/0.1; & 0.7 \le g \le 0.8, \\ 0; & g \ge 0.8. \end{cases}$
Very High	$\mu_{Very\ High}(g) = \begin{cases} 0; & g \le 0.75, \\ (g - 0.75/0.25; & 0.75 \le g \le 1.0, \\ 1; & g = 1.0. \end{cases}$



Verbal Exp	ession Me	Membership Function		
Very Low	$\mu_{Very\ Low}(g) = \begin{cases} 0\\ (0.35 - g)\\ 0 \end{cases}$	$g \le 0,$ $g)/0.35; 0 \le g \le 0.35,$ $g \ge 0.35.$		
Low	$\mu_{Low}(g) = \begin{cases} 0; \\ (g - 0.15/0, \\ (0.45 - g)/0 \\ 0; \end{cases}$	$g \le 0.15,$ 15; $0.15 \le g \le 0.3,$ 0.15; $0.3 \le g \le 0.45,$ $g \ge 0.45.$		
Fair	$\mu_{Fair}(g) = \begin{cases} 0; \\ (g - 0.25/0.2) \\ (0.75 - g)/0 \\ 0; \end{cases}$	$g \le 0.25,$ 25; $0.25 \le g \le 0.5,$.25; $0.5 \le g \le 0.75,$ $g \ge 0.75.$		
High	$\mu_{High}(g) = \begin{cases} 0; \\ (g - 0.55/0), \\ (0.85 - g)/0, \\ 0; \end{cases}$	$g \le 0.55,$ 15; $0.55 \le g \le 0.7,$ 0.15; $0.7 \le g \le 0.85,$ $g \ge 0.85.$		
Very High	$\mu_{Very High}(g) = \begin{cases} 0\\ (g - 0.6)\\ 1 \end{cases}$	$g \le 0.65, \\ 5/0.35; 0.65 \le g \le 1.0, \\ g = 1.0.$		



Figure A 4 Linguistic Model, LM_{G4}, for the Grade of Importance of Foreign Investment Entry-mode Selection of LED OEM Firms

Verbal Exp	ression	Membership Function
Very Low	$\mu_{\scriptscriptstyle Very\ Low}(g)$	$f = \begin{cases} 0; & g \le 0, \\ (0.55 - g) / 0.55; & 0 \le g \le 0.55, \\ 0; & g \ge 0.55. \end{cases}$
Low	$\mu_{Low}(g) = \begin{cases} (g) \\ ($	0; $g \le 0.05$, $(g - 0.05/0.25; 0.05 \le g \le 0.3,$ $(0.6 - g)/0.3; 0.3 \le g \le 0.6,$ 0; $g \ge 0.6.$
Fair	$\mu_{Fair}(g) = \begin{cases} (g) \\ $	$\begin{array}{ll} 0; & g \leq 0.05 \\ g - 0.05 / 0.45; & 0.05 \leq g \leq 0.5, \\ 0.95 - g) / 0.45; & 0.5 \leq g \leq 0.95, \\ 0; & g \geq 0.95. \end{array}$
High	$\mu_{High}(g) = \begin{cases} 0 \\ 0 \\ 0 \end{cases}$	$\begin{array}{ll} 0; & g \leq 0.6, \\ (g-0.4/0.3; & 0.4 \leq g \leq 0.7, \\ (0.95-g)/0.25; & 0.7 \leq g \leq 0.95, \\ 0; & g \geq 0.95. \end{array}$
Very High	$\mu_{\textit{Very High}}(g)$	$0 = \begin{cases} 0; & g \le 0.45, \\ (g - 0.45/0.55; & 0.45 \le g \le 1.0, \\ 1; & g = 1.0. \end{cases}$

Table A2. 4 Five Possible Fuzzy Ratings and Meanings for Model $LM_{\rm G4}$

2. Linguistic Model for the Measurement of Foreign Investment Entry-mode Selection of LED OEM Firms



Figure A2.5 Linguistic Model, LM_{C1}, for Foreign Investment Entry-mode Selection of Bio-tech Firms

Verbal Exp	ression	Membership Function		
Very Poor	$\mu_{Very Poor}(x) = \begin{cases} (x) \\ ($	0; (0.25 - x)/(0.25; 0;	$x \le 0,$ $0 \le x \le 0.25,$ $x \ge 0.25.$	
Poor	$\mu_{Poor}(x) = \begin{cases} (x-0) \\ (0.4-1) \end{cases}$	$\begin{array}{ccc} 0; & x \le 0 \\ 0.2/0.1; & 0.2 \le x \\ -x)/0.1; & 0.3 \le \\ 0; & x \ge 0 \end{array}$	0.2, $x \le 0.3,$ $x \le 0.4,$ 0.4.	
Fair	$\mu_{Fair}(x) = \begin{cases} (x-0) \\ (0.65) \end{cases}$	$\begin{array}{cccc} 0; & x \\ 0.35/0.15; & 0.35 \\ -x)/0.15; & 0.5 \\ 0; & x \end{array}$	$\leq 0.35,$ $5 \leq x \leq 0.5,$ $1 \leq x \leq 0.65,$ $\geq 0.65.$	
Good	$\mu_{Good}(x) = \begin{cases} (x - x) \\ (0.8 - x) \\ (0.8 - x) \end{cases}$	$\begin{array}{ccc} 0; & x \leq \\ 0.6/0.1; & 0.6 \leq \\ -x)/0.1; & 0.7 \leq \\ 0; & x \geq \end{array}$	$\leq 0.6,$ $x \leq 0.7,$ $\leq x \leq 0.8,$ $\geq 0.8.$	
Very Good	$\mu_{Very\ Good}\left(x\right) = \begin{cases} \end{cases}$	0; (x - 0.75 / 0.25; 1;	$x \le 0.75,$ $0.75 \le x \le 1.0,$ x = 1.0.	

Table A2.5 Five Possible Fuzzy Ratings and Meanings for Model LM_{C1}



Figure A 6 Linguistic Model, LM_{C2}, for Foreign Investment Entry-mode Selection of Bio-tech Firms

Verbal Express	ion Membership Function
Very Poor	$\mu_{Very\ Poor}(x) = \begin{cases} 0; & x \le 0, \\ (0.3 - x)/0.3; & 0 \le x \le 0.3, \\ 0; & x \ge 0.3. \end{cases}$
Poor	$\mu_{Poor}(x) = \begin{cases} 0; & x \le 0.15, \\ (x - 0.15/0.15; & 0.15 \le x \le 0.3, \\ (0.45 - x)/0.15; & 0.3 \le x \le 0.45, \\ 0; & x \ge 0.45. \end{cases}$
Fair	$\mu_{Fair}(x) = \begin{cases} 0; & x \le 0.3, \\ (x - 0.3/0.2; & 0.3 \le x \le 0.5, \\ (0.7 - x)/0.2; & 0.5 \le x \le 0.7, \\ 0; & x \ge 0.7. \end{cases}$
Good	$\mu_{Good}(x) = \begin{cases} 0; & x \le 0.55, \\ (x - 0.55 / 0.15; & 0.55 \le x \le 0.7, \\ (0.85 - x) / 0.15; & 0.7 \le x \le 0.85, \\ 0; & x \ge 0.85. \end{cases}$
Very Good	$\mu_{Very\ Good}(g) = \begin{cases} 0; & x \le 0.7, \\ (x - 0.7/0.3; & 0.7 \le x \le 1.0, \\ 1; & x = 1.0. \end{cases}$

Table A2.6 Five Possible Fuzzy Ratings and Meanings for Model LM_{C2}

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Verbal Expre	ssion Membership Function
Very Poor	$\mu_{Very\ Poor}(x) = \begin{cases} 0; & x \le 0, \\ (0.55 - x)/0.55; & 0 \le x \le 0.55, \\ 0; & x \ge 0.55. \end{cases}$
Poor	$\mu_{Poor}(x) = \begin{cases} 0; & x \le 0.05, \\ (x - 0.05/0.25; & 0.05 \le x \le 0.3, \\ (0.6 - x)/0.3; & 0.3 \le x \le 0.6, \\ 0; & x \ge 0.6. \end{cases}$
Fair	$\mu_{Fair}(x) = \begin{cases} 0; & x \le 0.05, \\ (x - 0.5/0.45; & 0.05 \le x \le 0.5, \\ (0.95 - x)/0.45; & 0.5 \le x \le 0.95, \\ 0; & x \ge 0.95. \end{cases}$
Good	$\mu_{Good}(x) = \begin{cases} 0; & x \le 0.6, \\ (x - 0.4/0.3; & 0.4 \le x \le 0.7, \\ (0.95 - x)/0.25; & 0.7 \le x \le 0.95, \\ 0; & x \ge 0.95. \end{cases}$
Very Good	$\mu_{Very\ Good}(x) = \begin{cases} 0; & x \le 0.45, \\ (x - 0.45/0.55; & 0.45 \le x \le 1.0, \\ 1; & x = 1.0. \end{cases}$

Table A2.7 Five Possible Fuzzy Ratings and Meanings for Model LM_{C3}

Appendix III

The following procedure is an example to determine the left and right spreads of L-R fuzzy number at α -level. Other fuzzy numbers can use similar procedures to determine their left and right spreads (Chen, 1994). Suppose an L-R fuzzy number is defined as:

 $\forall x \in R$:

$$\mu_{\tilde{X}}(x) = \begin{cases} 0, & a_{\tilde{X}} \leq 0, \\ F_{L}[(m_{\tilde{X}} - x)/(m_{\tilde{X}} - a_{\tilde{X}})], & a_{\tilde{X}} \leq x \leq m_{\tilde{X}}, \\ F_{R}[(x - m_{\tilde{X}})/(b_{\tilde{X}} - m_{\tilde{X}})], & m_{\tilde{X}} \leq x \leq b_{\tilde{X}}, \\ 0, & x \geq b_{\tilde{X}}. \end{cases}$$
(A3.1)

with scales $m_{\tilde{X}} - a_{\tilde{X}} > 0$, $b_{\tilde{X}} - m_{\tilde{X}} > 0$. The height of \tilde{X} at $m_{\tilde{X}}$ in x-axis is a real

number, and $a_{\tilde{\chi}}$, $b_{\tilde{\chi}}$ are called the left and right spreads at α -level ($\alpha = 0$), respectively. Figure A3.1 shows the fuzzy number of Eq. (A3.1) and their left and right spreads at an arbitrary α -level.

In Figure A1, an arbitrary α -level of F_L can be written as

$$F_{L}(\frac{m_{\tilde{X}} - x}{m_{\tilde{X}} - a_{\tilde{X}}}) = \alpha, \ \alpha \in [0, \ 1].$$
(A3.2)

By taking the inverse of this function we obtain

$$\frac{m_{\tilde{X}}-x}{m_{\tilde{X}}-a_{\tilde{X}}}=F_L^{-1}(\alpha),$$

or
$$x = m_{\tilde{X}} - F_L^{-1}(\alpha)(m_{\tilde{X}} - a_{\tilde{X}}).$$

Similarly, for F_R ,

$$F_{R}\left(\frac{x-m_{\tilde{\chi}}}{b_{\tilde{\chi}}-m_{\tilde{\chi}}}\right) = \alpha, \qquad \alpha = [0, 1].$$

By taking the inverse of this function, we obtain

$$\frac{x - m_{\tilde{X}}}{b_{\tilde{X}} - m_{\tilde{X}}} = F_R^{-1}(\alpha),$$

or $x = m_{\tilde{X}} + F_R^{-1}(\alpha)(b_{\tilde{X}} - m_{\tilde{X}}).$ (A3.3)

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Figure A3.1 The left and right spreads of fuzzy number \tilde{X} at α -level

Hence, the interval of \widetilde{X} at the α -level is given by

$$X_{\alpha} = [a_{\tilde{X}}(\alpha), \ b_{\tilde{X}}(\alpha)]$$

= $[m_{\tilde{X}} - F_{L}^{-1}(\alpha)(m_{\tilde{X}} - a_{\tilde{X}}), \ m_{\tilde{X}} + F_{R}^{-1}(\alpha)(b_{\tilde{X}} - m_{\tilde{X}})].$ (A3.4)