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Table of Contents

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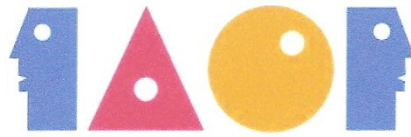
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KNOWLEDGE TRANSFER AMONG MNE'S SUBSIDIARIES: A CONCEPTUAL FRAMEWORK FOR KNOWLEDGE MANAGEMENT

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Abstract

This study emphasizes the successful knowledge transfer depends on the similarity in organizational characteristics. Using Asia-based subsidiaries of Agus, a German MNE, this study develops a conceptual framework of knowledge transfer to propose the relationship between organizational similarities and knowledge transfer. We find that the similarity of technological capability and strategic role to facilitate knowledge socialization; the similarity of organizational structure and culture to facilitate knowledge internalization; the similarity of technological capability to facilitate knowledge combination; and the similarity of technological capability and strategic role to facilitate knowledge externalization.

Keywords: Knowledge transfer; MNEs; Organization characteristics

Introduction

Subsidiaries of a MNE (Multinational Enterprises) can learn and benefit from each other (Tsai, 2002). Knowledge transfer among MNEs provides opportunities for mutual learning and peer cooperation, stimulating the creation of new knowledge and innovation (Tsai & Ghoshal, 1998). However, knowledge is often "sticky" and difficult to spread (Szulanski, 1996). How can a MNE subsidiary gain useful knowledge from other subsidiaries to enhance its innovation and performance? Prior research has suggested that MNE subsidiaries need to hold specialized knowledge and learn from other subsidiaries (Huber, 1991). The external access and internal capacity to learn from their peers is far more important when subsidiaries possess differential external access and internal capacity and various abilities to leverage and benefit from knowledge developed by other subsidiaries.

Although the organizational characteristics literature has highlighted the importance of the capacity to absorb knowledge, much less attention has been focused on the knowledge transfer among MNE subsidiaries. Not every subsidiary is willing to share the knowledge. Even though the knowledge is available, the subsidiary may not have the absorb capacity to apply it for its own use. Therefore, Gupta & Govindrajan (2000) argues that the value of knowledge transfer in MNEs depends on how subsidiaries provide access to new ideas and information of foreign markets that can be subsequently applied in other markets. Birkinshaw et al. (1998) argues that MNE subsidiaries not only hold specialized knowledge but also have the opportunity to learn from other subsidiaries.

The analysis of knowledge transfer from the integrated perspectives of intra-network (Gupta & Govindarajan, 2000), organizational structure and subsidiaries roles (Jarillo and Martinez, 1990) is overlooked. We conceptualize a systematic framework to capture knowledge transfer and investigate a subsidiary's access to knowledge by analyzing its organizational characteristics among MNE subsidiaries.

Literature Review

Knowledge Transfer Among MNE Subsidiaries

The increasing importance of organizational learning for creating competitive advantage has triggered the study of antecedents and consequences of knowledge transfer at intra and inter-subsidiaries. Knowledge transfer among MNEs refers to the process through which subsidiaries exchange, receive and influence the experience and knowledge of others. Since knowledge transfer requires the integration of differentiated knowledge, it manifests itself through changes in the knowledge bases or performance of recipients. Studies have also labeled knowledge transfer processes in alternative but related ways. For example, studies have considered knowledge sharing and socialization (Tsai, 2002), knowledge flows and combination (Gupta and Govindarajan, 2000), knowledge acquisition and internalization.

Contextual conditions may moderate the relationships between knowledge transfer and its antecedents and consequences. Inkpen and Tsang (2005) argue that transferring knowledge across different subsidiaries is complicated. Simonin (1999) has examined MNE inter-subsidiary can facilitates knowledge and expertise transfer from one part of the units to others through tight interactive relationship. Gupta and Govindarajan (2000) stresses that, in additional to capital and

product flows, knowledge flows across subsidiaries become specifically significant. Therefore, MNE inter-subsidiary across national borders has become more important to build durable competitive advantage and contribute to share experience, resources, and knowledge (Birkinshaw et al. 1998).

Antecedents of Knowledge Transfer

A considerable amount of research is emerging that considers organizational attributes, such organizational culture, size, geographical spans, as important antecedents of knowledge transfer (Birkinshaw et al., 1998). Szulanski (1996) indicates that organizational characteristics are the most important predictors of knowledge transfer among MNE subsidiaries. Although the list of organizational characteristics that are and can be included in analyses is virtually endless, many studies have assessed the roles of subsidiaries as well as organizational structure, culture and technological capability (Gupta and Govindarajan, 2000). Tsai (2002) proposes that some studies assessing the roles of MNE subsidiaries on knowledge transfer tend to find positive effects. However, other studies have found organizational culture and technological capability facilitates inter-organizational knowledge transfer. Accordingly, we classify antecedents of knowledge transfer among MNE subsidiaries into technological capability, organizational structure, organizational culture, and strategic roles (Inkpen and Tsang, 2005).

Methodology

Research Design

This article is based on a detailed case study of Agus. The main fieldwork was conducted semi-structured interviews with the most knowledgeable managers and informants. In order to provide a managerial perspective as well as a holistic organizational perspective, the researcher formally interviewed general manager and other key product or sales managers. The range of interviewees was to cover the different countries and management levels involved in the development and implementation processes (see Table 1).

The subsidiary of Taiwan was chosen since it connects most of the other subsidiaries who share identical industries and grows rapidly since its birth 7 years ago. First, the immediate aim is to identify key players in the context of KM regional share in the area of a regional-based subsidiaries network. Taking a rather different approach from the "contacting middle management" strategy, an e-mail was first sent to the country manager to express an interest in learning more about Agus intranet and KM experience. Then, after a preliminary study of the company is made, access issue will be proposed and negotiated.

Findings

The Similarity in Technological Capability and Strategic Role to Facilitate Knowledge Socialization

Knowledge socialization involves the sharing and integration of tacit knowledge between individuals. We use the term socialization to emphasize that tacit knowledge is exchanged and integrate through joint activities, such as being together, spending time, living in the same environment. Acquisition and supply of technology necessitates significant sharing of follow-up organizational guidance and practice to ensure that the technology is adequately exploited.

Table 1. The Information of Answerers

Country	Interviewee's title	Interview Method
Taiwan	General Manager, Marketing Manager, Product Manager	E-mail, Face-to-face, Phone
China	General Manager, Sales Manager	E-mail, Face-to-face, Phone
Japan	Sales Manager	E-mail, Fax
Malaysia	Product Manager, Sales Manager	E-mail, Fax, Phone
South Korea	Sales Manager	E-mail, Fax
Singapore	Project Manager, Sales Manager	E-mail, Fax, Phone
U.S.A.	Sales Manager	E-mail, Fax
Germany	Product Manager	E-mail, Fax

When a subsidiary closely linked with other MNE subsidiaries' technological capability, it will demand more procedural knowledge socialization from peer subsidiaries about how to integrate the transferred technology with the own value-adding process and how to organize aftermath operations and management to maximize technology-derived gains.

"We stress very much on information control, data management and workforce motivation so as to enhance managerial innovation, which links technological innovation to firm performance. In general, the profession is required from recruiting because we think product technology and manufacturing capability is important factor when we try to communicate with our clients and peer subs." (Country Manager)

The similarity in technological capability, the knowledge of product design concepts, product applications, and product improvements are also similarity among MNE subsidiaries. It will facilitate the subsidiary to understand and absorb them easily.

Furthermore, the similarity in strategic roles means that the extent of localization is similar among subsidiaries. It represents that

tacit knowledge about localization, such as how to cope with local governments, interpret and predict regulatory changes, reduce foreign exchange risks, and improve local adaptations is similar (Jarillo and Martinez, 1990).

"Our employees and managers are easy to communicate and interact with other subsidiaries on the similar strategic base. We have lots of chances to exchange and transfer ideas in employee rotation, cooperative projects, or brainstorming camps. (Project Manager, Singapore)

Proposition 1. The similarity in technological capability and strategic roles among subsidiaries is beneficial for knowledge socialization.

The Similarity in Organizational Structure and Organizational Culture to facilitate Knowledge Internalization

Knowledge internalization is the conversion of explicit knowledge into the organization's tacit knowledge. In internalization processes, the explicit knowledge may be embodied in action and practice, so that the individual acquiring the knowledge can re-experience what others go through (Nonaka & Takeuchi, 1995).

Organizational structure is important in leveraging technological architecture. Although intended to rationalize individual functions or units within an organization, structural elements have often had the unintended consequence of inhibiting collaboration and sharing of knowledge across internal organizational boundaries. It is important that organizational structures be designed for flexibility (as opposed to rigidity) so that they encourage sharing, collaboration and internalization across boundaries within the organization and across the supply chain (Nonaka & Konno, 1998).

"Tokyo and we (Taiwan) are similar in organizational design. The way we set the divisions and functions are almost the same. That's why our people and their people are easy to find the similar man to talk." (Country manager, Taiwan)

While the knowledge internalization between MNE subsidiaries is difficult, it is clear that the problems associated with knowledge transfer will increase with cultural distance. The transfer would encounter greater knowledge barriers regarding local political, cultural and societal norms in culturally distant countries (Hennart and Larimo, 1998). Consequently, the exchange of ideas and knowledge will be costlier between culturally distant members of the MNE network than between culturally close members.

"The 11 subsidiaries in Asia share information more closely since we have the same language. The feasible way in Taiwan is often workable in Singapore and Shanghai. We may be expected to exchange and knowledge better with others that are located in culturally more proximate countries." (Marketing Manager)

In other words, the similarity in organizational culture among MNE subsidiaries is positively associated with knowledge internalization (Nonaka & Takeuchi, 1995).

Proposition 2. The similarity in organizational structure and organizational culture among subsidiaries is beneficial for knowledge internalization.

The Similarity in Technological Capability to facilitate Knowledge Combination

Knowledge combination involves the conversion of explicit knowledge into a more complex set of explicit knowledge (Nonaka & Konno, 1998) through the systemization of concepts and conversion of knowledge. Individuals exchange and combine information through such media as documents, technology, manufacturing capability and computer networks. Traditional management information systems often result in the creation of combination knowledge.

Dixon (2000) puts more emphasis on technological capability in implementing knowledge management because it considers technological capability plays the role of an enabler for knowledge combination. The MNE subsidiary's knowledge management system is a combined form of its database and groupware intended for sharing, accumulating and diffusing knowledge.

"In addition, Agus set up a communication plaza---our A-google that mainly deals with the exchange of ideas take place everyday. One day, the partner from Singapore told us that applying to cable market is a success to them. And we realize that we can apply to the Kaohsiung port for the cable renew" (Marketing Manager)

As a result, the similarity in technological capability among MNE subsidiaries is beneficial for knowledge combination:

Proposition 3. The similarity in technological capability among subsidiaries is beneficial for knowledge combination.

The Similarity in Technological Capability and Strategic Role to Facilitate Knowledge Externalization

Externalization refers to a process where tacit knowledge is transformed into explicit Knowledge. Through the externalization process, tacit knowledge becomes specified, and metaphors, analogies, concepts, hypotheses and models take shape (Nonaka & Konno, 1998). Tacit knowledge is owned by management and employees of the subsidiary and hard to be expressed by the way of language or written words (Nonaka and Takeuchi, 1995). Although tacit knowledge is valuable and scarce for subsidiaries, it is difficult to learn since different customers, culture, governments, norms, and markets of every subsidiary would cause the barrier of communication among subsidiaries.

The similarity in technological capability among subsidiaries represents professional knowledge is similar among them. It can reduce the barrier and uncertainty of communication among subsidiaries when interacting to each other (Szulanski, 1996).

"Our technical personnel and all sales representatives in Asia are like to express and provide idea and experiences for members of other subsidiaries. You can see it in trade exhibition and conferences. Some ideas or skills about product application expressed in emails or phone chat" (Shanghai Country Manager)

Tacit knowledge of one subsidiary will be transformed directly and indirectly into transmittable and systematic knowledge which can be absorbed by other subsidiaries easily (Simonin, 1999).

If strategic role is similar among subsidiaries, it represents that the characteristic of local customers, some problems about local government they face, and the structure of local market are similar among subsidiaries.

"A product development process, crystallizing CEOs' thoughts and experts' know-how into a language and expressing, materializing the covert needs of customers. Agus always involves the creation of easy-to-share and easy-to-deliver knowledge by using our own languages." (Product Manager)

It also represents that the thoughts, concepts, and working manners of employees is similar among subsidiaries. On this premise, when a subsidiary interacts with other subsidiaries, the unspoken consensus and the frequency of communication among subsidiaries would be increased (Davenport & Prusak, 1998). Hence, management and employees of the subsidiary are willing to transform corporate tacit knowledge into explicit knowledge to make other subsidiaries consult and learn it conveniently. The above discussion leads to the following proposition:

Proposition 4. The similarity in technological capability and strategic roles among subsidiaries is beneficial for knowledge externalization.

Conclusion

The conceptual framework (see Figure1) proposes that antecedents---technology capability, organizational culture, organizational structure, and strategic role--- influence the knowledge transfer among MNE subsidiaries. The mechanism of knowledge transfer is comprised by knowledge combination, externalization, socialization and internalization (Nonaka and Takeuchi, 1995) among MNE subsidiaries as shown in Figure 1. at the end of this article.

Research on organizational knowledge transfer is burgeoning. Although conceptual and qualitative reviews of the literature on organizational knowledge transfer have been done (Inkpen and Tsang, 2005), no study has attempted to summarize a systematic framework to capture knowledge transfer and investigate a subsidiary's access to knowledge by analyzing its organizational characteristics among MNE subsidiaries.

We contributed to the existing literature on organizational knowledge transfer by reviewing and consolidating existing empirical research using exploratory study and in-depth case study. Specifically, our findings provide more fine-grained insights into the conceptual framework including four subsidiary characteristics --- techno-logical capability, structure, culture and strategic roles to examine the relationship between the similarity in subsidiary characteristics and various knowledge transfers. Moreover, in the field of know-ledge transfer, we fill the gap that the extent, frequency, and content of knowledge transfer (Huber 1991) should be elaborate by more details knowledge transfer activities. The four knowledge transfer modes containing knowledge socialization, knowledge internalization, knowledge combination, and knowledge externalization (Nonaka and Takeuchi,

1995) are well linked to the factors in similarities in organizational attributes.

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Knowledge Transfer Among MNE Subsidiaries

Figure1. Conceptual Framework
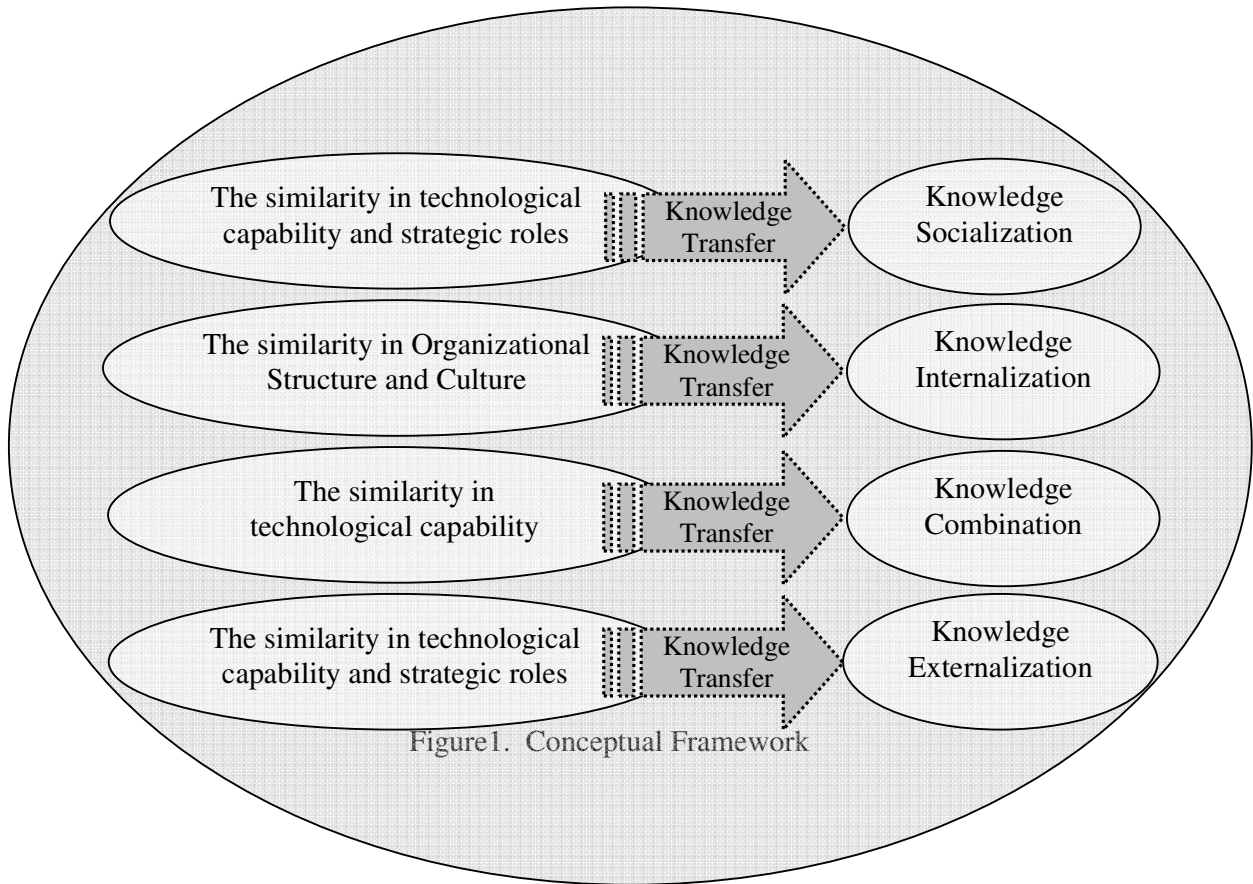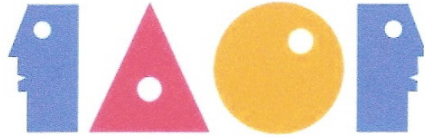
THE INFLUENCE OF HIGH-PERFORMANCE HUMAN RESOURCE PRACTICES ON ENTREPRENEURIAL PERFORMANCE: THE PERSPECTIVE OF ENTREPRENEURIAL THEORY

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Abstract

This study examines the effects of High Performance Human Resource Practices (HPHRPs) and entrepreneurship on the entrepreneurial performance of small- and medium-sized enterprises (SMEs). We build and test a causal model using data obtained from Taiwanese entrepreneurs and find supports for our hypotheses. The results indicate that HPHRPs in SMEs can encourage entrepreneurship among employees, which could positively enhance entrepreneurial performance. In addition, the entrepreneurship of SMEs positively affects entrepreneurial performance, and it partially mediates the relationship between HPHRPs and entrepreneurial performance. The implications and future research directions are discussed.

Keywords: high-performance human resource practices; entrepreneurship; entrepreneurial performance

Introduction

Since Taiwan joined the World Trade Organization (WTO) in 2002, its market has become increasingly open and dynamic. Enterprises are facing keen global competition, as the organizational environment in Taiwan has become more complex and dynamic and as the phenomenon of industries' exodus has become more obvious. In this regard, SMEs have played an important role in the economic development of Taiwan. They successfully helped the country stay afloat during the Asian financial crisis. Edralin (2010) has noted that in numerous large firms, the impact of globalization in the midst of a turbulent environment, coupled with their sheer size, bureaucracy, centralized control, and hierarchy, has gradually diminished their innovative, flexible, speedy, and risk-taking efforts. Hence, SMEs are considered the most entrepreneurial organizations as they seek greater risks and create both dramatic and destructive innovations in order to define and exploit market opportunities by utilizing existing technologies (Hayton 2003).

The HRM has been theorized and empirically demonstrated to have both discretionary HRM practices and tradi-

tional practices in organizations of all sizes (Hayton 2005). Discretionary HRM practices, such as incentive pay, employee suggestion schemes, and formal employee participation programs, are those, which encourage employee commitment, cooperation, and extra-role behaviors. In contrast, traditional HRM practices focus on conducting job analyses to identity the tasks, duties, and responsibilities that are needed to perform various jobs and then predicting the personal characteristics and behaviors that are needed for each specific position (Hayton 2003). With changes in the industrial environment and intensified industrial competition, the traditional HR practices only involve the administration of such recruiting, selection, training, and performance appraisal procedures; this function has been unable to cope with the current challenges and changes. Correspondingly, the role of human resource management (HRM) has been transformed from the supervision of the implementation of rules and regulations to being strategic business partner (Buckley and Monks 2004; Hailey, Famdale, and Truss 2005).

The strategic aspect of HRM, on the other hand, is instead focused on the design and implementation of a set of discretionary HRM practices that focus on a firm's human resource base towards accomplishing the firm's strategic goals and objectives (Tocher and Rutherford 2009). This transformation also enforces organization to establish a system and organizational environment that benefits more value-added activities, such as new product development and new market exploration. Chandler and McEovy (2000) indicate that implementing HRM practices that make employees focus on achieving the firm's strategy positively increase firm performance in both small and large firms. A large body of strategic HRM research suggests that high-performance human resource practices (HPHRPs), designed to enhance employees' competencies, motovation, and performance, is associated

with lower employee turnover rates, higher labor productivity, and better company performance (Liao et al. 2009).

HPHRPs should assess selective staffing, extensive skills training, broad career paths, promotion from within, guaranteed job security, result-oriented appraisal, extensive and open-ended rewards, broad job description, flexible job assignment, and encouragement of participation (Sun, Aryee, and Law 2007). Although HPHRPs seem relate to firm performance, little research has empirically explored the causal mechanisms through which these HR practices lead to greater firm performance (Sun, Aryee, and Law 2007; Collins and Smith 2006; Ferris et al. 1999). Therefore, there is a need to examine how HPHRPs affect firm per-romance in a rapidly changing environment. On the other hand, researchers hold different views regarding the form of HPHRPs (Datta, Guthrie, and Wright 2005). Thus, the goal of this study is to discuss whether enterprises that have implemented HPHRPs can truly motivate the entrepreneurship of employees in order to enhance entrepreneurial performance.

The Taiwanese government has continuously launched entrepreneurial policies and measures that have increased the number of new entrepreneurs in Taiwan yearly. By 2007, 97.63% of the enterprises in Taiwan were small- and medium-sized enterprises and the total number of SMEs in Taiwan exceeded 1.23 million. This means there is one entre-pruner for every 20 people in Taiwan. This also indicates that Taiwanese enterprises really prioritize entrepreneurship, which has played an important role in the economic development of Taiwan. However, Kuratko (2006) argued that the field of entrepreneurship was considered little more than an applied trade as opposed to an academic area of study. Despite the growing importance of entrepreneurial activities in Taiwan's SMEs, large-scale investigations on the

relationship between HPHRPs, entrepreneurship and entrepreneurial performance are scarce. This is the main reason why this study is focus on the entrepreneurship in SMEs.

The issues related with HPHRPs have been interesting to researchers of entrepreneurship (Terpstra and Olson 1993) because studies on HRM in SMEs in earlier years believed that such enterprises have fewer capabilities to manage their human capital However, Tocher and Rutherford (2009) believed that SMEs could eventually overcome their problems in HRM and gain com-putative advantages. Furthermore, Heneman, Tansky, and Camp (2000) believed that most studies on HRM focus on large and bureaucratic organizations. For SMEs, their limitations in terms of resources mean that their HRM activities are often rarely official and have limited scope of activities and complexity.

Needless to say, it is important for SMEs to gain competitive advantage through HRM because they do not have the resources to compete with large enterprises (Cardon and Stevens 2004). Furthermore, there is no consensus whether HR practices in SMEs will enhance entrepreneurial performance (Chandler and McEvoy 2000; Deshpande and Golhar 1994); thus, this subject is really worth examining. Therefore, this research has taken SMEs in Taiwan as the research objects in discussing the relationship between HPHRPs and entrepreneurial performance from the perspective of entrepreneurship.

Literature Review and Hypotheses

HPHRPs

According to the resource-based view (RBV), firms' internal resources that are rare, valuable, and inimitable can provide sources of sustainable competitive advantage and organizational effectiveness

(Barney, Wright, and Ketchen 2001). HRM practices that meet these criteria are such a source and thus enhance organizational performance (Ngo, Lau, and Foley 2008). In addition, HRM practices contribute a lot to accomplish firm objectives and to create value. Hence, an organization must invest in human resource to guarantee long-term success.

HPHRPs are one of the activities of strategic HRM that can provide multiple technical skills and knowledge for employees and increase their as well as the organization's flexibility in order to enhance organizational performance. Recruitment, training, development, and performance assessment are parts of strategic HRM practices. Evans and Davis (2005) pointed out that current studies conform to the viewpoints of HPWPs and high-performance management practices. When an organization focuses on HPWPs, it must regard its employees as its major assets. Continuous training in terms of knowledge, ability, and skill (KAS) enhancement of employees; broad pro-vision of information, motivation, and empowerment; expansion of opportunities for their participation; and the use of incentives will enable employees to have high flexibility and enhanced work abilities compared with those in other organizations (Shih, Chiang, and Hsu 2006).

Bamberger and Meshoulam (2000) highlighted three main human resource sub-systems: (1) people flow, including staffing, employee mobility, and training; (2) appraisal and rewards, including performance appraisal, compensation, and benefits; and (3) employment relations, including job design and participation. HPHRPs are a comprehensive factor of several HRM practices (Hartog and Verburg 2004) that increases KAS for the member of an organization. HPHRPs can foster employees' shared perceptions of a supportive organizational environment that motivates discretionary behaviors

contributing to organizational performance (Sun, Aryee and Law 2007). Therefore, sustaining organizational competitive advantage through HPHRPs has become a main focus of many organizations. In this regard, this study will further discuss the influence of HPHRPs on the operation of SMEs. It adopted the categorization of Bamberger and Meshoulam (2000) and Sun, Aryee, and Law (2007), which takes selection, broad training, work security, result-oriented performance assessment, broad work definition, incentive salaries, and participation as the measurement for integrating HPHRPs.

HPHRPs and Entrepreneurship

HPHRPs are the bundle of HR practices that could improve employees' skills, their involvements in decision-making, and their motivation to do more efforts spontaneously (Appelbaum, Bailey, Berg, and Kalleber, 2000; Zhang and Jia, 2010). When employees have more experienced skills, they are embedded more knowledge and capability to engage in innovation (Branzei and Vertinsky, JBV, 2006). Furthermore, employees who are authorized discretions to deal with their daily jobs, are more possible to take responsibility and to explore new opportunities proactively (Zhang and Jia, 2010). When they are encouraged to identify new ways to doing business, they involved in more entrepreneurial activities and initiative (Schmelter, Mauer, Börsch, and Brettel, 2010).

To increase organizational capability for innovation, the organizations execute HPHRPs would use selective staffing to acquire high quality human capital who have valuable skills and experience and these employees have the more capabilities and express high potential to develop more new and initiative products (Zhang, Wan, and Jia, 2008). Furthermore, the organizations also implement several extensive training programs to enhance existing employees' capabilities to generate and renew

existing products and business (Gartner, Carter and Reynolds, 2010). These employee ability-enhancing practices would contribute to firm's involvement in entrepreneurial activities (Kroon, Voorde, and Timmers, 2012).

To enhance employees' propensity toward exploring new opportunities and trying new possibilities more proactively and spontaneously, organizations which execute HPHRPs view employees as co-intra-entrepreneurs and encourage employee's participation on decision makings (Wunderer, 2001). Organizations also clearly set the entrepreneurship-related activities as the result of performance appraisal (Zhang and Jia, 2010).

Furthermore, firms provide incentives and supports to help them implementing and realizing their entrepreneurial ideas. This employee motivation enhancing practices and empowering practices could facilitate employees' capabilities and willingness to engage in entrepreneurial behaviors (Kroon, Voorde, and Timmers, 2012; Bird, 1988; Kemelgor, 2002; Morris and Jones, 1993). In relation to this, the study pro-poses the following hypothesis:

H1: The use of high-performance human resource practices will be positively associated with entrepreneurship in SMEs.

HPHRPs and Entrepreneurial Performance

Recently, many studies on strategic HRM have started verifying the influence of HPHRPs on organizational performacne. These closely related practices can enhance the skill of the workforce, participation in decision making, incentives, and the creation of output (Appelbaum et al. 2000), which result in excellent performance and competitive advantages (Way 2002).

Sun, Aryee, and Law (2007) indicated that HPHRPs are combined with single practices, which together influence organizational performance. HPHRPs can increase the cognition of employees in supporting the organizational environment and encourage the prudent and free behavior of employees to achieve organizational performance. Akhtar, Ding, and Ge (2008) found from a research on Chinese enterprises that a group of HRM practices could affect product/service and financial performance. These practices include training, participation, result-oriented appraisals, and internal career opportunities. Shipton et al. (2005) pointed out that HRM practices and product innovation have a positive linkage. HRM practices that promote employee discretionary behavior, knowledge sharing, and organizational learning are found to be positively associated with entrepreneurial performance (Hayton 2003). Generally, HPHRPs can train, encourage, and promote the entrepreneurship of professional and management staff in the enterprise and will allow it to gain long-term competitive advantages. Therefore, this study proposes the following hypothesis:

H2: The use of high-performance human resource practices will be positively associated with entrepreneurial performance in SMEs.

Entrepreneurship and Entrepreneurial Performance

Entrepreneurship enables enterprises to successfully develop products and new markets and thus increase their competitiveness so that they can achieve excellent performance (Prahalad and Hamel 1994). In a complex and fluctuating environment, companies must have more entrepreneurship in order to find additional opportunities and thus maintain a high performance output (Hayton 2005). Birkinshaw (2000) pointed out that entrepreneurship is a function that refers to the creative method of the entrepreneur, which includes the development of new products and services, establishment of the supply chain, and new integration of the overall productivity. Furthermore, Miller (1983) proposed that the entrepreneurship of a company can be assessed by the risk-taking, innovativeness, and pro-activeness exhibited by management.

Organizational innovativeness implies the generation of new ideas, products, services or markets. Highly entrepreneurial firms are characterized by their willingness to innovate in order to rejuvenate market offerings and take risks to try out new and uncertain products, services, and markets (Wiklund and Shepherd 2005). A large proportion of research and development resources are provided by entrepreneurial firms to create breakthrough inventions by using new and pioneering technologies (Ahuja and Lampert 2001). Entrepreneurial firms require a culture where employees are encouraged to innovate, be proactive, and take risk, as well as establishing a set of polices and procedures that formally supports entrepreneurial behavior. Indeed, entrepreneurial SMEs are likely to adopt more innovative, strong entrepreneurial behavior to coordinate and exploit both tangible and intangible organizational resources (Ngui, Songan, and Hong 2008).

Synthesizing from various studies (Wiklund and Shepherd 2005; Ahuja and Lampert 2001; Ngui, Songan, and Hong 2008), innovation seems to be a common factor among all firms that could reasonably be described as entrepreneurial. Hence, innovation is the core of entrepreneurship, which refers to the introduction of new products, processes, and technologies that can affect the performance of the enterprise and provide a source of competitiveness (Chow 2006). Innovativeness represents the continuous development of the entrepreneur in the competitive market, which will ultimately benefit the sale of

products and growth and bring a positive boost to entrepreneurial performance (Barrett, Balloun, and Weinstein 2000; Zwell and Ressler 2000). Risk-taking means that the entrepreneur is willing to seize opportunities brought by the environment and to invest in certain resources; this is an indispensable factor in enhancing entrepreneurial performance (Keh, Foo, and Lim 2002). Entrepreneurial performance means an enterprise is willing to take risks and whether such risks are related with innovation and competitiveness (Lumpkin and Dess 2001). It is important that an enterprise has a venturesome attitude and is risk-tolerant in introducing new opportunities. Hayton (2003) indicated that entrepreneurial performance includes the influence of involvement on innovation and risk-taking. Pro-activeness represents the change in the environment predicted by entrepreneurs as they think about how to actively face and cope with it (Chow 2006).

As SMEs are faced with uncertainties in their business operations, pro-activeness will allow entrepreneurs to readjust their strategies because of the change in the environment in order to enhance entrepreneurial performance (Lumpkin and Dess 2001). Entrepreneurial performance indicates if an enterprise can take risks, innovate, and create new markets. In this regard, this study correspondingly presents the following hypothesis:

> *H3: The entrepreneurship of SMEs will be positively associated with entrepreneurial performance.*

The Mediating Influence of Entrepreneurship on HPHRPs and Entrepreneurial Performance

Baron (2003) believed that HRM could help entrepreneurs discover more risk management methods, and that the combination of entrepreneurship and HRM will allow the HR department to attract more attention and interest. Therefore, HRM practices and strategy is an important resource for long-term competitiveness (Lado and Wilson 1994). Entrepreneurship is the strategic element of the company, which includes the special HRM system used to support the internal entrepreneurial behavior and organizational results (Covin and Slevin 1991). Twomey and Harris (2000) stated that HRM practices (including training, performance management, incentives, and HR development) encourage entrepreneur-oriented behavior and entrepreneurship. They also believed that when the HRM system is combined with entrepreneurial force, it would create better organizational performance. Zwell and Ressler (2000) believed that the innovation of employees and entrepreneurship could create high performance for the organization.

Schuler (1986) believed that recruitment, selection, and training plans are designed to ensure that employees have the quality of innovation and risk-seeking, while performance appraisal and payment are designed to strengthen guidance and encourage the behavior of desire. Therefore, HRM will help the training of entrepreneurship for the organization. The manager of the enterprise is required to confirm the extent of entrepreneurship expected by the organization and decide the needs of HRM practices to achieve entrepreneurial performance (Morris and Jones 1993). As the business-operating environment of the enterprise has become more complex and dynamic, the enterprise should gain higher ability in taking risks through HRM, become more innovative, have more initiative, and have higher level of entrepreneurship to maintain continual high performance (Hayton 2005). Based on the references, this study presents the following hypothesis:

H4: The entrepreneurship of SMEs will mediate the relationship between high-performance human resource practices and entrepreneurial performance.

Research Methods

Sample and Data Collection

To ensure that the object of study has adopted HPHRPs, 800 SMEs that have won awards and subsidies from the SMEs department of Taiwan government, such as The National SME Award, The SME Innovation Research Award, The Rising Star Award, and so on, were selected. This study used questionnaires as the research method and the questionnaire design adopted the closed structural type. To increase the effectiveness of the questionnaire, we invited 2 academic specialists and 13 industrial personnel to discuss and revise the content of the questionnaire before it was released. When the design of the questionnaire was completed, we delivered it to entrepreneurs or general managers of the sample enterprises by mail. A total of 188 responses were received in March 2008, giving a response rate of 23.5%. Compared to survey-based HPWPs studies reviewed by Becker and Huselid (1998), which had response rates ranging from 6% to 28%, our response rate appears acceptable. Because of missing answers, the effective sample was finally reduced to 172, including 120 manufacturing companies, and 52 service enterprises.

With regard to the structure of samples, the distribution of samples and number of employees below 50 people (including 50) were the highest, covering 36.3%. With regard to types of industries, the manufacturing companies were the highest, at 48.5%. Most have a history of over 15 years, making up 61.4%. With regard to capital, those whose capital was below NT$50 million covered 55%. As for sales,

those whose sales were below NT$50 million were the highest, at 30.4%.

Measures

HPHRPs.

Following Bamberger and Meshoulam (2000) and Sun, Aryee, and Law (2007), we developed a 24-item scale to measure integrated HPHRP. These included the seven dimensions of selective staffing, extensive training, employment security, clear job description, result-oriented appraisal, incentive reward, and participation. Each item was answered using a 1–5 rating scale numbered from 1 = strongly disagree to 5 = strongly agree. A high score on this measure indicates a relatively intensive use of and investment in HPHRPs.

Entrepreneurship.

We use the 13-item scale validated by Miller (1983) to gauge entrepreneurship, capturing the firm's innovation (e.g. emphasis on long-term R&D), risk-taking (e.g. rewarding risk taking), and pro-activeness (e.g. challenging rather than responding to major competitors). A 5-point Likert scale was used (1 = strongly disagree and 5 = strongly agree). Higher scores indicate that the testee has higher features of innovativeness, risk-taking, and pro-activeness.

Entrepreneurial Performance.

Entrepreneurial performance reflects the ability of an enterprise to take risks, and shows whether it can innovate and compete. In addition, the target of entrepreneurial performance emphasizes the concept of new entry (Lumpkin and Dess 2001). This study will take the viewpoints of Yli-Renko, Autio, and Sapienza (2001) and Sarkar, Echambadi, and Harrison (2001) and will divide entrepreneurial performance into new product diversification and new market diversification. Ten items

for measurement are measured with the 5-point Likert scale. A higher score indicates that the testee has the diversification features of innovating existing products and services and developing new markets.

Questionnaire Development

Reliability Analysis.

The reliability of a construct refers to the consistency and stability of the questions. Table 1 lists Cronbach's α of the constructs. With the exception of incentive reward (Cronbach's α = 0.682), all other constructs have Cronbach's α above 0.7, which indicates high reliability (Nunnally 1978).

Validity Analysis.

1. Convergent validity: Table 1 displays the parameter estimates of the constructs and their *t*-values. All constructs have *t*-values greater than 2, revealing good convergent validity.

2. Discriminant validity: Anderson and Gerbing (1988) suggest the following procedure to test the discriminant validity of a variable. First, the constructs of a variable are set to be correlated and are referred to as the unconstrained model. Second, the unconstrained model is modified with one of the correlations set to 1.0, and is called the constrained model. A significant chi-square difference between the two models implies that the two constructs of the variable are significantly different and should not be merged as one construct. It can be noted that all chi-square differences between two constructs are significant ($\Delta\chi^2 \geq 10.83$, $p < 0.001$); therefore, the discriminant validities are verified.

Assessing Common Method Bias

Measures used in this study were gathered from the same source in the same questionnaire, which introduced the possible problem of common method bias. We used Harman's one-factor test to address this. A principal components factor analysis on items in the three variable measures was performed to examine if common method bias was a serious problem in the study. Factor analysis extracted 14 factors, with factor 1 accounting for only 21.12% of the variance. The results of this test offer some indication that common method variance (CMV) was not a problem in this study. Not a single factor, nor one general factor, emerged from the factor analysis to account for most of the covariance in the independent and criterion variables (Podsakoff and Organ 1986).

This study used the method suggested by Korsgaard and Roberson (1995) for CMV tests to divide the research mode zone into two models of one factor and multiple factors through confirmatory factor analysis. We estimated a one-factor model on which all 47 items were loaded. Second, we estimated a full measurement model that included a factor for each of our 12 key variables: selective staffing, extensive training, employment security, clear job description, result-oriented appraisal, incentive salary, employee participation, innovativeness, risk-taking, proactiveness, new product diversification and new market diversification. The verification result of the two models indicated that the fit statistics for the multiple factor model (CFI = 0.976, NFI = 0.85, root mean square error of approximation (RMSEA) = 0.049) are obviously better than the fit statistics for the one-factor model (CFI = 0.899, NFI = 0.85, RMSEA = 0.099). Therefore, we believe that CMV is not a pervasive problem in this study and that the relationships observed represent substantive rather than artefactual effects.

Table 1 Results of convergent validity and reliability analysis

Construct	α	X^2/df	GFI	AGFI	RMR	NFI	Estimate (λ)	t-Value
HPHRPs								
Selective staffing	0.858							
Extensive training	0.848							
Employment security	0.722							
Clear job description	0.813	1.134	0.893	0.861	0.031	0.875	0.578–0.756	6.347–10.999
Result-oriented appraisal	0.857							
Incentive reward	0.682							
Participation	0.774							
Entrepreneurship								
Innovativeness	0.839							
Risk-taking	0.850	1.149	0.934	0.899	0.034	0.936	0.627–0.849	8.731–13.291
Pro-activeness	0.840							
Entrepreneurial performance								
New market diversification	0.894	1.846	0.940	0.897	0.075	0.938	0.593–0.847	8.171–13.317
New product diversification	0.782							

Table 2 Descriptive statistics and correlation matrix of constructs

Constructs	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Selective staffing	3.99	0.64	1.00											
2. Extensive training	3.75	0.67	0.60*	1.00										
3. Employment security	3.63	0.79	0.46*	0.41*	1.00									
4. Clear job description	3.52	0.74	0.44*	0.50*	0.41*	1.00								
5. Result-oriented appraisal	3.57	0.68	0.47*	0.47*	0.43*	0.41*	1.00							
6. Incentive reward	3.71	0.72	0.46*	0.42*	0.35*	0.37*	0.53*	1.00						
7. Participation	3.62	0.66	0.58*	0.42*	0.40*	0.38*	0.53*	0.55*	1.00*					
8. Innovativeness	3.54	0.72	0.50*	0.40*	0.26*	0.33*	0.44*	0.52*	0.43*	1.00				
9. Risk-taking	3.09	0.78	0.48*	0.37*	0.26*	0.33*	0.39*	0.38*	0.34*	0.53*	1.00			
10. Pro-activeness	3.47	0.73	0.43*	0.44*	0.27*	0.33*	0.53*	0.52*	0.43*	0.63*	0.63*	1.00		
11. New market diversification	3.55	0.65	0.43*	0.48*	0.28*	0.39*	0.43*	0.47*	0.42*	0.51*	0.47*	0.62*	1.00	
12. New product diversification	3.24	0.78	0.43*	0.39*	0.30*	0.35*	0.45*	0.43*	0.35*	0.53*	0.48*	0.61*	0.40*	1.00

Note: *$p < 0.05$ level
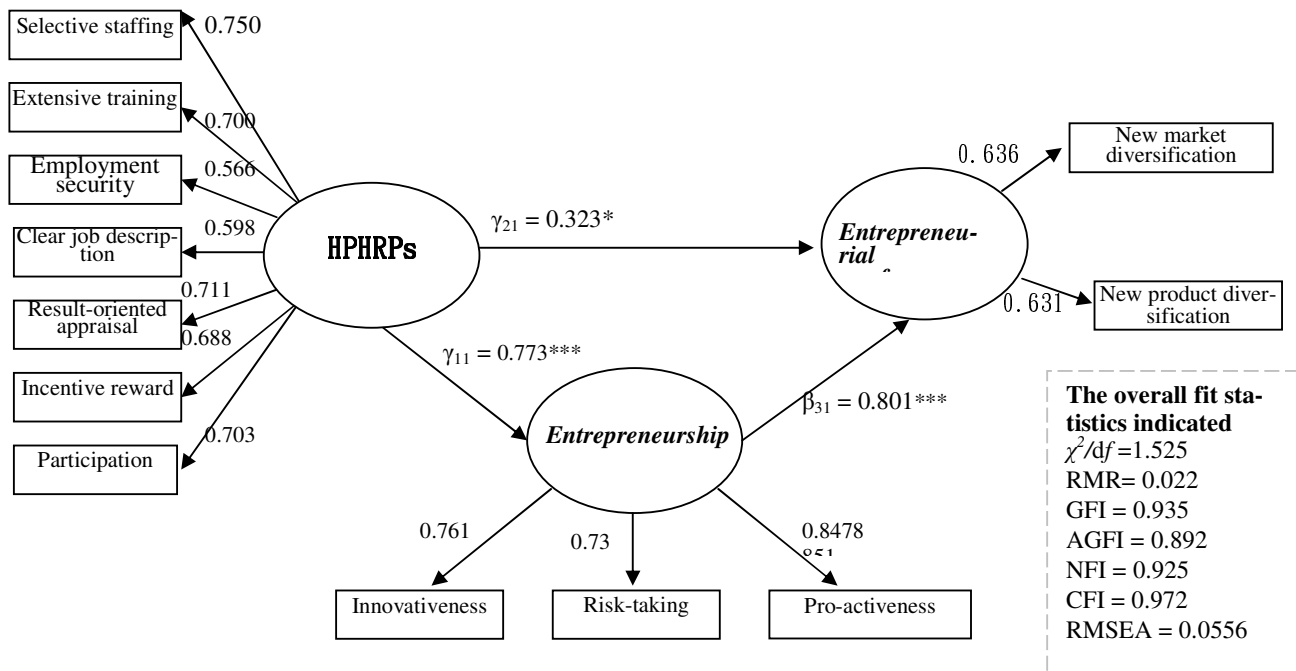
Figure 1 Parameter estimates for structural equation model
*p < 0.05 **p < 0.01 ***p < 0.001

Results and Analysis

Correlation Analysis

Table 2 displays the means and standard deviations of constructs and their correlations. The table shows that HPHRPs have positively correlated to entrepreneurship and entrepreneurial performance, which means that HPHRPs intensively promoted by an enterprise will lead to higher entrepreneurship, which will create higher entrepreneurial performance.

Testing the Hypothesized Structural Model

We estimated the structural model using AMOS 5.0. The overall fit statistics indicated a good fit of the model ($\chi^2(47)$ = 71.677, χ^2/df = 1.525, GFI = 0.935, CFI = 0.972, RMR = 0.022, RMSEA = 0.05). All fit indices for our structural model achieved or exceeded the usually recommended threshold values. We tested three

hypotheses. Figure 1 provides the standardized path coefficients and associated *t*-statistics of the model.

Figure 1 and Table 3 show that HPHRPs in SMEs have positive influence on entrepreneurship (γ_{11} = 0.773, p < 0.001); therefore H1 is supported. It shows that if SMEs could effectively utilize HPHRPs such as selection, training, performance appraisal, and incentive salary, it would encourage employee behaviour of innovation and risk-seeking (Twomey and Harris 2000). Entrepreneurship is a highly complex process and its influence covers the organization internally and externally. HPHRPs play an important role in increasing entrepreneurship (Hayton 2005). Therefore, enterprises with HPHRPs promote entrepreneurship of technical innovation and risk-seeking.

HPHRPs in SMEs have positive influence on entrepreneurial performance

($\gamma_{21} = 0.323$, $p < 0.05$); thus H2 is supported. It shows that employee training in SMEs will upgrade their abilities, while performance appraisal and incentive salary will further encourage employees to be involved in the corporate activities, which has integrated HPHRPs and will upgrade entrepreneurial performance for the enterprise (Hayton 2003). SMEs with HPHRPs will have significant positive influence on entrepreneurial performance ($\beta_{31} = 0.801$, $p < 0.001$); therefore H3 is supported.

In addition, research results indicate that HPHRPs in SMEs will have significant positive and direct effect on entrepreneurial performance ($\gamma_{21} = 0.323$, $p < 0.05$) and that they will indirectly affect entrepreneurial performance through entrepreneurship, with the indirect result being 0.619 ($\gamma_{11}\beta_{31} = 0.773 \times 0.801$) and the total effect being 0.942 (0.323 + 0.619). We also conducted the Sobel (1982) test to examine whether the indirect effect of the independent variable (i.e. HPHRPs) on the dependent variable (i.e. entrepreneurial performance) via the mediator (i.e. entrepreneurship) is significantly different from zero. Results indicated that Sobel test of the indirect effect of HPHRPs on entrepreneurial performance through entrepreneurship is significantly different ($p = 0.00005$, thus $p < 0.001$). This shows that SMEs with HPHRPs will train employees with entrepreneurship, which will lead to higher entrepreneurial performance. Therefore, H4 of this study is supported.

Discussion and Conclusions

This study has discussed the relationship between HPHRPs, entrepreneurship, and entrepreneurial performance of SMEs in Taiwan based on the strategic HRM concept. Previous studies on HRM practices in Taiwan have neglected SMEs, as they believed that SMEs could not confirm and manage issues related with HRM practices (Tocher and Rutherford 2009). Because of the change in organizational

environment in recent years, SMEs have begun to pay attention to HRM. As the long-term economic development in Taiwan is mainly based on SMEs, it is worth researching on this subject. When the organizational environment has become more complex and dynamic, entrepreneurship becomes an important factor for enterprises to achieve continual competitiveness. The importance of HPHRPs in encouraging entrepreneurship has been debated for a long time (Hayton 2005). Generally, research shows the results that there is a significant positive relationship between the implementation of HPHRPs and entrepreneurship. When enterprises implement HPHRPs, employee's entrepreneurial behaviors were encouraged toward technical innovation and risk-seeking. The demonstrations have provided sufficient proof that HPHRPs of SMEs in Taiwan can influence organizational entrepreneurship. Entrepreneurship is a dynamic process of objective orientation. An individual can determine market needs and new opportunities by combining creative thoughts, management ability, solid resources, and observation of the market environment to achieve the desired results. The HPHRPs can promote the achievement of targets and encourage cooperation among employees (Sun, Aryee, and Law 2007). Such behaviors will encourage employees to accept risks and uncertainties through incentive payment and other economic exchanges. In addition, HPHRPs can establish a cooperative and supporting environment that can encourage employees of the organization to learn through broad training and employee participation to upgrade their innovative abilities.

This study has also discovered that entrepreneurship can positively influence entrepreneurial performance, as enterprises with higher entrepreneurship will have higher entrepreneurial performance. It indicates that when the entrepreneur of the organization has higher ability to take risks and actively respond to the environment,

Table 3 MLEs of the path parameters

Paths/hypotheses	Direct effect	Indirect effect	Hypothesized relationship	Results
HPHRPs → Entrepreneurship (γ_{11})	0.773***		H1	Supported
HPHRPs → Entrepreneurial Performance (γ_{21})	0.323*		H2	Supported
Entrepreneurship → Entrepreneurial Performance (β_{31})	0.801***		H3	Supported
HPHRPs → Entrepreneurship → Entrepreneurial Performance ($\gamma_{11}\beta_{31}$)		0.619***	H4	Supported

Note: * $p < 0.05$ ($t > 1.96$); ** $p < 0.01$ ($t > 2.58$); ***$p < 0.001$ ($t > 3.29$)

the entrepreneur will recognize and be satisfied with their entrepreneurial behavior and results, which will have positive effect on entrepreneurial performance. The innovativeness of the entrepreneur can directly influence the design of company strategies (Shepherd and DeTienne 2005), which will show in the operational performance of the company. Generally, entrepreneurship will help the enterprise develop new products and new markets, increase the competitiveness for the enterprise and create excellent performance for the company (Narver and Slater 1990). This implies that an enterprise should focus on entrepreneurship and innovation and should choose the strategy of entrepreneurship to improve its entrepreneurial performance (Ireland et al. 2001).

The previous influence of HPHRPs on performance has been questioned (Shih, Chiang, and Hsu 2006). However, the results of this study indicate that SMEs that have adopted HPHRPs will have positive influence on entrepreneurial performance, which has heightened the need for SMEs in Taiwan to promote HPHRPs. According to the research of strategic HRM scholars (Arthur 1994; Hartog and Verburg 2004), HPHRPs such as selection, broad training, job security, clarification of job description, result-oriented performance appraisals, incentive salaries, and employee participation will help increase entrepreneurial performance. HRM practices can be strategically introduced to the organiza-

tion, which will upgrade and train suitable abilities and lead to better performance if they are implemented correctly. According to the resource-based view of Barney, Wright, and Ketchen (2001), the internal ability of a company can provide competitiveness and upgrade excellent performance. HR is an important core resource of a company, as people must implement the strategy of the company. Therefore, the organization should use HPHRPs to coordinate the activities of employees, train them on suitable abilities, and complete strategic tasks to increase entrepreneurial performance.

This study has proved that HPHRPs will influence entrepreneurial performance through entrepreneurship, which indicates that entrepreneurship is the strategic element for SMEs in Taiwan. The SMEs can support their internal entrepreneurial behavior by implementing HPHRPs to increase entrepreneurial performance and strengthen organizational competitiveness. Tocher and Rutherford (2009) believe that the HRM system will first influence employees' behavior and then influence the organizational performance. All these proposals have emphasized the importance of the mediating variables of HRM and organizational performance. However, studies on the relationship of the mediating variables between the HPHRPs and entrepreneurial performance in the past were rare.

This study has verified the results, and has exhibited the significant mediating effect of entrepreneurship between the HPHRPs and entrepreneurial performance. It has also indirectly cleared the prejudices of research on the relationship between HPHRPs and entrepreneurial performance. With regard to SMEs, the limitation of resources possibly means that HRM activities are rarely official, which can limit their scope and complexity (Welbourne and Katz 2002). This does not mean that effective HRM is not important to the success of an enterprise (Welbourne and Cyr 1999). In the last few years, traditional industries in Taiwan have been moved out, and face the impact of industrial upgrading and adjustment. The continual operation of SMEs cannot depend on the old management model that relies on the ability of the entrepreneur. With regard to management responsibilities in the future, it should consider participation, decision making, and implementation by professional HR managers, and should introduce modern strategic HRM concepts to undertake HPHRPs and adopt innovative and core competitive strategies to upgrade overall competitiveness for SMEs in Taiwan.

On the other hand, every measure of HPHRPs has a comprehensive effect, which means that all close linkage and interactive actions among HRM practices should be judged by system perception (Arthur 1994) to positively influence organizational performance. Although previous studies have shown that HRM practices can directly influence organizational performance, Shih, Chiang, and Hsu (2006) further discovered that the HRM practice system has higher influential effect on organizational performance than other HRM practices. Therefore, when an enterprise implements HPHRP, it should take the complete strategy of the enterprise into consideration instead of a single investment. It should continually implant it to promote entrepreneurship and increase entrepreneurial performance.

Although the applicability of HPHRPs in Asia and how they diverge or converge from the West have been examined, no conclusive results have been reached (Bae et al. 2003; Von Glinow, Drost, and Teagarden 2002). Recently, several studies have found a positive relationship between HPHRPs and firm performance (Hayton 2003; Shih, Chiang, and Hsu 2006; Sun, Aryee, and Law 2007), but Tsai's (2006) research results fail to provide support for the assertion. Hence, this has been a controversial issue, as HPHRPs will increase entrepreneurial performance. Although this study proved their relationship, it is suggested that researchers of strategic HRM further discover (1) why HPHRPs are linked to organizational performance (Collins and Smith 2006), (2) how to use the selection system to assess the entrepreneurship of employees, and (3) what training programs can effectively improve the skills of employees to increase their entrepreneurial performance, and how these training programs can be effectively conducted. Schuler (1989) proposed that incentive salaries can most effectively influence the behavior of employees. Therefore, SMEs should discuss how to introduce payment management and provide job security to employees to increase entrepreneurial performance.

Generally, SMEs should considerably invest in HPHRPs to allow employees to become valuable assets of the organization. Managers should also provide employees with broad training, clear job descriptions, reasonable performance appraisals, and incentive salaries. They should allow employees to participate in work design and respect the value of employees in the organization to prevent them from leaving.

From the perspective of practices, the entrepreneurship of an enterprise is a highly complex process that has multiple influences on the organization internally

and externally. HPHRPs play an important role in promoting entrepreneurship of the company. Effective HPHRPs provide more proactive, risk-taking, and innovative firms. Firms seeking to enhance their entrepreneurial level should give importance to promoting investment in HPHRPs (Kaya 2006). In this way, HRM is able to promote organizational innovation and risk-taking, which lie at the heart of an entrepreneurial culture. Hence, how to upgrade firm's entrepreneurship and HPHRPs is a very important and urgent issue for SMEs in Taiwan. Further, this study offers some recommendations for SMEs and government. With regard to SMEs, this study suggests that organizations use the long-term point of view to establish and judge entrepreneurship, actively develop HPHRPs, create a good company culture and environment, and train and support entrepreneurial behavior to encourage corporate entrepreneurship. Another, this study also suggests that the Taiwan government should play an active role to encourage the entrepreneurial conduct of people, and it should invest resources to actively support enterprises in developing entrepreneurship.

On the other hand, SMEs with limited financial abilities should properly utilize government resources, and they should strengthen their technical, market, and other relevant abilities by utilizing the government-supported projects that will allow the company to introduce more organizational abilities and will benefit the innovative activities of diversified new markets and products.

This study found some limitations during assessment. First, the understanding of researchers regarding the topic of employees in a company during their search for HPHRPs was limited, because the answers to the questionnaire were only from the research subject of entrepreneurs and general managers, which will increase the uniformity for the study. Second, we were

limited in measuring entrepreneurial performance because of our lack of financial data, because our research objects were SMEs, and Taiwan has no law requiring them to publicize their financial results. Some SMEs will even intentionally hide their financial data due to tax concerns.

Regarding the possibilities of SMEs promoting HPHRPs, the samples of this study were mainly manufacturers that have received awards and subsidies for SMEs from the management department of the Taiwan government. It is still a question for discussion whether the research result has covered all SMEs. Finally, it is suggested that the assessment of entrepreneurial performance in the future should adopt data that are more objective because objective performance data will allow readers to better understand the significance of HPHRPs in management. It can also use a longitudinal research to collect data to more effectively discuss the long-term effect of HPHRPs and entrepreneurship on entrepreneurial performance. In addition, future research that adopts the field experiment methodology is especially needed to test the causal influences of the HPHRPs on employee and organizational outcomes. Moreover, additional research could replicate this research in broader sampling contexts and extend the theoretical model by studying the effects of a larger set of variables. For example, besides firm's entrepreneurship, other strategic orientations (e.g. entrepreneurial capability, entrepreneurial motive, learning orientation, market orientation, and the personality of entrepreneurs) could be investigated.

In conclusion, we hope this study directs greater attention to the HPHRPs through which entrepreneurially oriented firms achieve improved entrepreneurial performance. This work offers a first attempt to advance understanding of the role of HRM practices in this process and could serve as a stepping stone for a better un-

derstanding of how firms can translate their entrepreneurship into stronger market and competitive positions.

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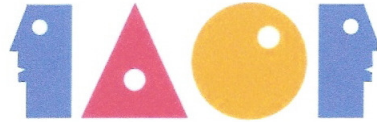
AN INVESTIGATION INTO THE DETERMINANTS OF POLITICAL SKILL UTILIZATION

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Abstract

Political skill is one kind of behavior and ability widely appears within organizations. This paper aims to investigate the factors influencing political skill utilization. In the study, the political skill consists of four dimensions: social astuteness, interpersonal influence, networking ability, and apparent sincerity. A 15-item political skill instrument was used to measure individual political skill utilization. The proposed factors influencing political skill utilizations include the gender, age, occupation, organization size and service seniority. Four hundred questionnaires were delivered to employees from four different occupations in Taiwan, and 244samples were analyzed. Research findings reveal that only occupation has significant influences on political skill utilization. The influences of gender, age, organization size and service seniority are not significant. Practical and research implications of the study are also discussed.

Key words: political skill utilization, influential factors, occupation

Introduction

Political skill referred to the exercise of influence through persuasion, manipulation, and negotiation in Organizations. It is one kind of behavior, character, and ability widely appears within organizations (Mintzberg, 1983; Treadway, Hochwarter, Kacmar, & Ferris, 2005). Political skill consists of social astuteness, interpersonal influence, networking ability, and apparent sincerity (Ferris, Treadway, Kolodinsky, Hochwarter, Kacmar, Douglas, & Frink, 2005).

In earlier research, scholars have explored the relationship between political skill and some latent variables. For example, Perrewé, Zellars, Rossi, Ferris, Kacmar, Liu, Zinko, & Hochwarter (2005) defined political skill as an ability of interpersonal control and explored the relationship between political skill and role overload. Treadway et al. (2005) used political skill as moderate and explored the correlation between political behavior and emotional behavior. Besides, in the discussion that focus on particular role, Blass & Ferris (2007) used political skill in the study of creating leader reputation of military staff; Andrews, Kacmar, & Harris (2009) explored the relation between political skill and organizational citizenship behavior in the government organization.

According to the prior research, however, we are unable to know that if political skill performs differently or in what way it performs in the segregated manifest variable. For example, do people with different gender using political skill differently? Or how people with different age use political skill in different way? Do different occupation, scale of organizations, and seniority influence the utilization of political skill? Scant attention has been paid to the factors influencing political utilization. Therefore, the main purpose of the study is to explore the determinant factors affecting political skill utilization.

Theoretical Background

A variety of definitions have been addressed in describing political skill. In early ages, the scholars who researched political skill thought that there are two parts in the exploration of political skill: social astuteness and interpersonal influence (Mintzberg, 1983; Pfeffer, 1981; Snyder, 1987). Besides, Bacharach & Lawler (1998) and Pfeffer (1981; 1992) have also proposed several viewpoints about political skill. They believe that in the manipulation of political skill, connec-

tions, friendship, network building, alliances, and coalition building are established by temporary alliances.

In recent years, Ferris et al. (2005) have concluded the concept in early literacy and established the four dimensions of political skill: social astuteness, interpersonal influence, networking ability, and apparent sincerity. Other scholars also follow the structure when researching in this field (e.g., Blass & Ferris, 2007; Blickle & Schnitzler, 2010; Ferris, Treadway, Perrewé, Brouer, Douglas, & Lux, 2007; Harvey, Wheeler, Harris, & Harris, 2007; Lvina, Johns, & Bobrova, 2009; Perrewé et al., 2005; Randel & Wu, 2011; Treadway et al., 2005). Because the four dimensions are commonly used in the literature, this study also describes political skill similarly. The specific description and definition of political skills are as follows.

Social astuteness (SA)

Ferris et al. (2005) explained that people with SA have a very strong ability to know accurately about themselves. They are able to understand the interaction between others and themselves in society or in an organization. A person with SA uses keen observation to know the organization environment and the people around him. He can also adapt to different occasions and situations, and is really good at interpersonal interaction. Pfeffer (1992) explained that SA is mainly used for personal advantages and the ability to empathize with others is only developed later. Needless to say, this dimension is the most important in the scoring of political skill because it is a supervisor's evaluation of employees, or peers' evaluation of the individual. From the preceding definition, we know that SA is the ability to observe the environment accurately with high alertness and sense advantages and disadvantages to behave appropriately.

Interpersonal influence (II)

Ferris et al. (2005) believe that II describes personal style. This kind of style is subtle, convincing, and can easily influence others. In many organizations, individuals often use II to achieve personal goals in different environments. Therefore, we know that II is a specific behavior or style of a person and it can influence and change others.

Networking ability (NA)

Pfeffer (1992) indicated that people with NA have a strong ability to develop and manipulate the network. People who have excellent NA easily create strong alliances of friendship to protect their resources, their property in the organization, and their ability to operate in the organization. Generally speaking, this kind of political skill includes features such as controlling, assigning, negotiating, and dealing with the crises and conflicts. Therefore, we can understand from the description that NA is an ability of alliance or negotiation. This ability can maintain or gain the advantages of personal status or resources.

Apparent sincerity (AS)

Jones (1990) explained that a person with this kind of political skill will behave like an actor and easily impress others by an image of honesty, sincerity, and integrity. This kind of behavior will not be considered as created or manipulated on purpose and will make it easy to gain a colleague's trust. This image can help achieve the actor's political goals (Ferris et al., 2005). Therefore, AS is an ability that is visible externally, can be observed directly, and can gain trust through the external image. For example, we can use this ability to shape and manage one's own image in others' view to gain their trust and value.

There are several studies exploring the relationship between political skill and some latent variables. Perrewé et al. (2005) explored the relationship between political skill and role overload. Treadway et al. (2005) used political skill as moderate and explored the correlation between political behavior and emotional behavior. Blass and Ferris (2007) used political skill in the study of creating leader reputation of military staff; Andrews et al. (2009) explored the relation between political skill and organizational citizenship behavior in the government organization. However, scant attention has been paid to the factors influencing political utilization. Therefore, the study aims to explore the determinant factors affecting political skill utilization.

Besides, An amount of studies have addressed that demographic variables (e.g., age, gender, educational level, professional experience, and company size) have to some extent a significant impact on individual decision-making and behavior (e.g., Forte, 2004; Lam & Shi, 2008; Trevino, Weaver & Reynolds, 2006). Therefore, this paper will investigate the relationships between some demographic variables and individual utilization of political skill. The following hypotheses are proposed:

H_1: *Political skill utilization will correlate significantly with gender.*
$H_{1.a}$: Social astuteness will correlate significantly with gender.
$H_{1.b}$: Interpersonal influence will correlate significantly with gender.
$H_{1.c}$: Networking ability will correlate significantly with gender.
$H_{1.d}$: Apparent sincerity will correlate significantly with gender.

H_2: *Political skill utilization will correlate significantly with age.*
$H_{2.a}$: Social astuteness will correlate significantly with age.

$H_{2.b}$: Interpersonal influence will correlate significantly with age.

$H_{2.c}$: Networking ability will correlate significantly with age.

$H_{2.d}$: Apparent sincerity will correlate significantly with age.

H_3 : Political skill utilization will correlate significantly with occupation.

$H_{3.a}$: Social astuteness will correlate significantly and positively with occupation.

$H_{3.b}$: Interpersonal influence will correlate significantly with occupation.

$H_{3.c}$: Networking ability will correlate significantly with occupation.

$H_{3.d}$: Apparent sincerity will correlate significantly with occupation.

H_4 : Political skill utilization will correlate significantly with organization size.

$H_{4.a}$: Social astuteness will correlate significantly with organization size.

$H_{4.b}$: Interpersonal influence will correlate significantly with organization size.

$H_{4.c}$: Networking ability will correlate significantly with organization size.

$H_{4.d}$: Apparent sincerity will correlate significantly with organization size.

H_5 : Political skill utilization will correlate significantly with service seniority.

$H_{5.a}$: Social astuteness will correlate significantly with service seniority.

$H_{5.b}$: Interpersonal influence will correlate significantly with service seniority.

$H_{5.c}$: Networking ability will correlate significantly with service seniority.

$H_{5.d}$: Apparent sincerity will correlate significantly with service seniority.

Research Methods

Measurement

To measure political skill utilization, this study developed a shorten version based on the 40-item political skill item pool that was created by Ferris, Berkson, Kaplan, Gilmore, Buckley, & Hochwarter (1999). The study adopted a 7-point Likert-type scale. Scale of 1 to 7 represents the degree from "strongly disagree" to "strongly agree."

Following the required procedures of item analysis, we performed factor analysis on 40-items PSIP and choose the factors, whose eigenvalue>1, and obtained a 15-item political skill instrument with 63.47% of the total variance explained. There are six items in **II** dimension (eigenvalue=13.67; ex. I am able to make most people feel comfortable and at ease around me.), five items in **NA** dimension (eigenvalue=1.58; ex. I am good at building relationships with influential people at work.), two items in **AS** dimension (eigenvalue=1.90; ex. I try to see others' points of view.), and two items in **SA** dimension (eigenvalue=1.25; ex. In social situations, it is clear to me just what to say and do.). The factor loadings are all above 0.7.

In addition, we evaluate the reliability. With regard to the index of reliability, Cronbach's α of all factors was 0.9153; NA(α=0.8740), AS (α=0.8207), SA (α=0.7134), and II (α=0.8607).

Data Collection

The sample consists of 400 participants from four different occupations in Taiwan. One hundred questionnaires were distributed to each occupation, and 261 of them were returned. Excluding 17 invalid questionnaires, a total of 244 effective questionnaires were collected. Effective response rate was 61%.

In addition to the political skill items, there were some demographic variables in the questionnaire, including two categories of gender, three ordinal scales of age, four

category scales of occupation and four ordinal scales of service seniority. There were four ordinal scales in organization size, which denotes the number of people.

Table 1. A Summary of the respondents

n=244		member	%			member	%
Gender	male	141	57.79	Org. Size	≤5 (people)	16	6.56
	female	103	42.21		6~15	81	33.20
Age	under 30(years old)	48	19.67		16~30	51	20.90
	31~50	177	72.54		above 30	96	34.34
	above 50	19	7.79	Seniority			
Occupation	Police Agencies	86	35.25		< 1 year	22	9.02
	Public Hospital	77	31.56		1~3 years	49	20.08
	Private Company A	34	13.93		4~6 years	36	14.75
	Private Company B	47	19.26		> 6 years	137	56.15

Table 2. The ANOVA test of political skill utilization

Total Score of Political Skill VS.	SS	DF	MS	F-value	P-value
Gender	298	1	298	3.340	0.069
Age	37.1	2	18.5	0.204	0.815
Occupation	1318	3	439	5.120*	0.002*
Seniority	348.7	3	116.2	1.295	0.277
Org. Size	205.3	3	68.4	0.757	0.519

("*" indicates that the number is significant in the test)

in the participant's own department. Table 1 shows a summary of the respondents.

Research Results and Discussion

To explore the relations between influential factors and political skill utilization, we tested research hypotheses using ANOVA. The result of the test is listed in table 2. The correlation between the total scored of political skill and occupation is significant. The correlations between score of political skill and other factors including gender, age, seniority, and organization size are not significant. Therefore, H_3 is supported; but H_1, H_2, H_4 and H_5 are not supported in the study regarding the significant factor, the occupation proportions of the samples are: police agencies, 35.25% (86 people); public hospital, 31.56% (77 people); and private companies, 33.19% (81 people, company A, 13.93%; and company B, 19.26%). In the total score of political skill, police agency has the highest score ($\bar{x}$=81.453) and public hospital has the second highest score. The third is taken by company A and the last by company B: Private company B ($\bar{x}$=75.979) and private company A ($\bar{x}$=74.206).

From Table 2, we know that there is only one determinant factor that influences political skill utilization. For occupation, the

demographic variables have significant correlation with four dimensions of political skill. As shown in Table 3, among all four dimensions, proposed influential factors have the most significant correlation with AS, followed by II, SA and NA.

Organizations with higher score are both the government agencies and those with lower score are both private companies. There are several reasons for the result. One of the reasons might be that in government agencies most of the tasks are routine and there are many limitations in administration than those in private companies. Government agencies are nonprofit organizations. They have to be responsible to the administrative authority and the society at the same time, so the regulations in government agencies are less flexible than the regulations in private companies.

In government agencies, every regulation must be obeyed. The employees are forced to assume responsibility by obeying administrative regulations. The workflow in government agencies is much clearer and there are experiences of senior employees are present for new employees to follow. In a paper by Ferris et al. (2007), it is also mentioned that all four dimensions are correlated with "development experience" and "responsibility." On the basis of this theory, government agencies are likely to get a higher score on these two dimensions, hence the result.

Although the variable "gender" has no significant correlation with total score of political skill, it has significant correlation in the items of "networking ability" of the four dimensions (male $\bar{x}=27.31$, female $\bar{x}=25.83$). The possible reason could be that in Taiwan culture, males are extrovert, and females are introvert. Therefore females'

score on networking ability are lower than males'. However, there is no strong evidence to prove that there is correlation among the four dimensions and variables such as age, seniority, and organization size.

Conclusions

A perspective shared by many academicians is that organizations are inherently political arenas. A proper use of political skill is very important in organizations to achieve success at work. The present study investigates the factors influencing political skill utilization. Research findings reveal that only occupation has significant influences on political skill utilization. The influences of gender, age, organization size and service seniority are not significant. Due to the lack of research on the related topic, the study can contribute the literature of political skill an understanding of the determinants of political skill utilization.

A limitation to the present study is that the method of development, establishment, and evaluation of the scale of this research is self-reported. The items of all dimensions are freely answered by subjects. The emotion and thoughts of subjects might influence the score of the political skill. According to the research results, the usage of political skill and occupations has significant correlation. This is an issue worth considering for further research. Because different occupation may have different job characteristics, further efforts can be put on the analysis of the relation between *"job characteristics"* and political skill. The results would be helpful for managing and adjusting organization environment or staff performance for the betterment of the organization.

Table 3. The ANOVA test of each political skill dimension

Gender VS.	SS	DF	MS	*F*-value	*P*-value
NA	3.607	1	3.607	6.230*	0.013*
AS	0.966	1	0.966	1.708	0.193
I I	0.362	1	0.362	0.651	0.421
SA	0.196	1	0.196	0.328	0.568
Age VS.	SS	DF	MS	F-value	*P*-value
NA	0.768	2	0.384	0.648	0.524
AS	0.255	2	0.127	0.223	0.800
I I	0.000	2	0.000	0.000	0.999
SA	0.114	2	0.057	0.095	0.909
Seniority VS.	SS	DF	MS	F-value	*P*-value
NA	0.970	3	0.323	0.544	0.653
AS	4.172	3	1.391	2.497	0.060
I I	2.527	3	0.842	1.528	0.208
SA	1.890	3	0.630	1.057	0.368
Occupation VS.	SS	DF	MS	*F*-value	*P*-value
NA	5.093	3	1.698	2.939*	0.034*
AS	11.205	3	3.735	7.079*	0.000*
I I	8.111	3	2.704	5.121*	0.002*
SA	5.604	3	1.868	3.216*	0.024*
Org. Size VS.	SS	DF	MS	*F*-value	*P*-value
NA	2.062	3	0.687	1.165	0.324
AS	2.893	3	0.964	1.715	0.164
I I	1.796	3	0.599	1.080	0.358
SA	1.214	3	0.405	0.675	0.568

("*" indicates that the number is significant in the test)

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APPLY MOSAIC PATTERN SHAPING IMAGES DESIGN INTO VISUAL ART COURSES

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Abstract

Incorporating Mosaic pattern shape structures into development of arts and humanities studies teaching activities, this study explored formation creation abilities of 6th-grade students. Experimental methods are two stages according to the course design, one is Mosaic pattern plane shaping design and the other is Mosaic 3D products shaping design. This research focuses on using pre-test and post-test results to discuss the effect of applying industrial design in national primary school art courses and the results of applying Mosaic pattern shaping images in products design. Findings of the study are as follows.

After incorporating Mosaic pattern shape structures into teaching activities in Arts and Humanities Studies. With the aforementioned in mind, using Mosaic pattern shape structures in teaching activities of Arts and Humanities of 6th-grade improves students' performance in shape creation. Thus, we suggest that students should prepare materials needed before their creation and that instructor should enhance students' proficiency in Mosaic pattern shape structures. Furthermore, the teaching activities can be incorporated into other teaching units to expand teaching activities and encourage students' critical thinking. Future studies may focus on how interactions among students influence their creation and compare their perception perspectives on using information technology and traditional media in paintings. This may shed light on how the use of information technology in arts and humanities studies is correlated with students' creativity performance.

Keywords: Mosaic, Shaping, Visual Arts, Design

Introduction

Mosaic graphics, also known as Mosaic patterns, Mosaic or Inlay pictures, first originated in Mesopotamia and has been more than 7,000 years.

Mosaic pattern shape structures, from point, line, and surface, many can be used in "Visual art" research in primary school "Arts and Humanities" area.

Research Motivation and Purpose

The research purposes are using mosaic products pattern shaping design into Visual art courses to examine the effect of elementary school children in shaping creation performance, the following are the purposes of this study. 1. Using mosaic pattern design in "Visual Arts" courses in primary school to examine the Visual composition of mosaic materials, pattern, and shape appearance. 2. Examining the problems encountered by students and solutions in the learning process, which confirmed on the creative teaching development, and converted to be the subject teaching plans of extensive teaching.

Question To Be Answered

How do six-grader students in primary school perform in shaping creation of Visual art while applying Mosaic pattern shaping images design application in Visual art courses?

Limitations To The Research

The author chose PSP and beads rather than original tile. Therefore, it is not to be discussed that if the students have abilities to deal with tile in Mosaic pattern.

Implementation

Students' thinking modes are influenced by surroundings a lot; therefore, it needs to be conducted with the help of guided modes for students to apply and differentiate lines, patterns and color matching. This research can take "Variability of form", "Interpretation of patterns", "Reconstruction and composition" and "Deconstruction" four nouns to be the guidance of patterns and lines structure, and enable students to understand patterns and lines performance in mosaics through the artist's work.

Through this course design, it trained basic design thinking and creativity of students, and the courses include design, analysis, judgment, production techniques, aesthetics and design concepts. On teaching presentation aspects, using hands-on activity and examples display as the main methods, specifically through the shaping training, the creativity and construction of originality of students, also fostering students' knowledge on the innovation of thinking.

Anticipated Result

The anticipated result of this research is that students can design a draft and manufacture a rough model based on the draft. After the rough model is tested, product manufacturing is carried out. It is anticipated that students can make 3D Mosaic pattern shaping images products by the design drafts.

Literature Review

On Mosaics

Art education should provide students with opportunities to explore their surroundings, to appreciate and remark on all kinds of art works, artifacts and natural scenes, to structure meanings through their senses and feelings, and to identify art. (Ministry of education, 2003)

Due to prevailing use of computer and Internet in recent years, infusing technology into art learning area becomes a

trend in Taiwan. A kind of Pixel Art, developed from computer icon, with aliasing emerges on the Internet. Quadrangles are building blocks of surface. After quadrangle are arranged and duplicated, art patterns are completed, and so do the mosaic pattern construct. Mosaic patterns are formed with squares, the smallest unit, to construct patterns with repeated and regular ways.

CPS and Creative

Collaborative Problem Solving (CPS) is an approach to understanding and helping children with behavioral challenges. Studies of the impact of CPS in the study can be broadly sorted into three categories; the influence on individuals' attitudes, the impact on individuals' behavior, the effects on groups, and trained participants showed significant improvement in regard to preference for ideation (Basadur, Taggar & Pringle, 1999).

Studies of the impact of CPS in the study can be broadly sorted into three categories; the influence on individuals' attitudes, the impact on individuals' behavior, and the effects on groups.

Creative problem solving usually begins with defining the problem. This may lead to a simple non-creative solution, or to finding a "textbook solution". The creative problem solving process, may also lead to the discovery of prior art and of creative solutions by others. The process, in these cases, may then be abandoned, if the discovered solution is "good enough" (Wikipedia, 2013).

Creative thinking is an essential life skill. It is a rational process that enables people to successfully produce novel and useful responses to open-ended challenges and opportunities. Creative thinking involves specific cognitive, meta-cognitive, and affective skills. Once internalized, these skills can be readily applied to all areas of life (Basadur, Taggar & Pringle, 2006).

Thus, CPS and Creative at the same time as a teaching strategy used in parallel in the field of Arts and Humanities, teaching can be attempted. The author has an attempt to apply CPS and Creative thinking for this research.

Inquiry on Art Education in Elementary School

After collecting art and manual-work curriculum guidelines, the researcher found that before 1998, design and manufacturing courses only appeared in art and manual-work related courses. Following are some basic principles:

"Art and manual-work education" Guiding students to solve aesthetic problems.

Enriching children's aesthetic knowledge through application of art.

Applying art and combining living technology to foster aesthetic literacy and improve quality of life.

Teaching materials are mainly objects that beautify environment or are purposeful to children. For example, practical, fun daily tools, artifacts, and the color or style of display.

Enhancing children's imagination, thinking, planning and problem-solving abilities through art creation and art work appreciation.

Teaching focuses on procedures and methods of planning, designing drafts and working drawing.

The education reformation launched in 2003. According to Grade 1-9 Curriculum Guidelines the objectives of Arts and Humanities domain in elementary schools

include "exploration and discovery", "expression and creation" and "aesthetics and analysis". Following are the themes of above-mentioned topics:

Discovery and Expression: Students should be able to explore themselves, enrich their perception of life, use media available to perform art, and to improve physical and spiritual life.

Aesthetics and Comprehension: Students should be able to recognize numerous art values, styles and cultural contexts through aesthetics and cultural activities, to treasure artifacts and art works and engage in multi-culture art activities actively.

Practice and Application: Students should be able to understand links between art and life, and better their understanding toward environment through art activities; to know art industry, expand their aesthetic horizon, respect and understand art creation, and implement these concepts in daily life.

Cheung (2006) sustains that Uddin and others at Trinity University of United States (Uddin et al, 2001) in the International Engineering Education Symposium pointed out when emerging knowledge in teaching, it should be imported based on the concept development and qualitative analysis, met the prerequisites knowledge according to the appropriate level and focused on the conveying as a whole and integration of related concepts and so on.

Teaching plan of main contents include: plan name, designer, target object, learning area, teaching time, ability index, teaching methods, teaching tools, lesson plans, teaching activities description and guiding steps, evaluation and reference resources. Students' study guide and assistant in the traditional way of teaching is teacher-centered, mostly taught by teachers facing front in the classroom. Students can discuss with peers, or adjust the learn-

ing unit and progress in accordance with their interests and ability, they can even select and decide the teaching content with teachers. Teachers role transform the way teaching students what they had learned and the restrict knowledge in the textbooks into instructor assist students to find and acquire knowledge.

Huang (1997) mentioned three principles on integrating curriculum:
Knowledge integration.
Integration of students' experiences.
Social integration.

American scholars Krug and Cohen-Evron propose four curriculum integration positions and practices in art education.

Chen (1975) sustains that children draw their painting in various manner while they are growing. From scribbling to comprehension, images and patterns, colors and lines, and space and shading have direct impact on children.

German art educator Josef spike said "art education is to inspire feelings toward shapes, colors, harmony and aesthetics while promotes us to have more contact with art. Shaping education is the multiple developments of observing, experiencing, performance abilities and productivity…" .

Shaping Construction Principles

On shaping meaning aspect, shaping is through the sense organs, and outline of the object type in the world, converted to meaningful and full consciousness structure entities.

Shaping Definition.

Activities that transform visual perceptual shaping into concrete structure. (1) Dividing Shaping in terms of Formation:

a. Natural Form: often coincides with me-chanics, aesthetics, such as eggs, river banks.

b. Artificial Form: like the concrete shape and abstract shape; representational style with geometric concept notation; for ex-ample, cars often use streamlined to reduce air resistance; an abstract shape, evolved from concrete shape; for example India Arabic numerals, original amount like concept by corner to mind that evolved to the present figure.

(2) Shaping Elements:
a. Form: Presented in three-dimension.
b. Color: Without color, shaping is only a concept.
c. Space: Consisted of hollowness and emptiness.
(3) The Composition of Shaping:
a. Point: It is the smallest visual unit in space, which can concentrate human's vision.
b. Curve: It is presented in length and is visually continuous.
c. Surface: In plane space, it has contour line, which determines its shape.
d. Solid: It is the expression of volume and weight.

Components of Shaping.

(1) Conceptual Elements
Broadly speaking, Shaping is to receive the states and contours of objects through senses and transform them into entities and solid structure. On the other hand, activi-ties that implement visibility operation and tangibility operation through vision are called Shaping.

Narrowly speaking, Shaping is the visual language represented by symbols that are composed of lines.

Visual language of Shaping pertains to visual art area in Arts and Humanities in primary school curriculum. In industrial design, visual language belongs to product image. Therefore, the introduction of in-

dustrial design into Arts and Humanities domain is the main purpose of this re-search.

(2)Visual Elements
Visual elements of the shape are generally divided into balance, proportion, rhythm, contrast, harmonic, and so on, for the inte-gration of mind and matter.

Composition of Shaping.

Composition of Shaping described as follows:
(1) Line Constructing Shaping.
(2) Lines Arrangement Shaping.
(3) Hallowed Shaping.
(4) Overlapping Shaping.
(5) Radiating Shaping.
(6) Cross Arrangement Shaping.
(7) Free Arrangement Shaping.
(8) Mixed Arrangement Shaping.

Form and Aesthetics of Industrial Design.

In Industrial design aesthetic, the main classifications of aesthetic are: the product aesthetics, shaping aesthetics, de-scribed as follows.

(1) Product Aesthetics
Nowadays, people are pursuing delicate life so designing draws more and more attention. Product design focuses not only on functions and prices but also on styling and spirit. Modern men yearn for beautiful things to express themselves and improve quality of life. For this very reason, aes-thetics and aesthetic expression become more and more significant in designing.

(2) Shaping Aesthetics
Shaping aesthetics assure the visual com-fort of products. There are three reasons why it is important:
a. Exploring factors that influence visual comfort of products and comparing these factors with aesthetics theories and princi-ples of shaping construction.
b. Discussing features and comfort of products in terms of product design.

c. Establishing benchmarks for visual comfort of product design.

Research Methods and Design

Research Process and Teaching Method

Research Process.

"Problem-solving" and "design and creation" become the mainstream in craft design of visual art education. While teachers are teaching "design and creation", students are solving problems. The process of design is to search for solution. This process, which is a major step in this research, provides students with structural thinking and a problem-solving model.

Creative Teaching in Design and Creation.

Hoping that through the creative thinking process, students can design and manufacture product by thinking creatively. However, students' creative thinking skills are guided to be supported by way of learning. Based on nine-year integrated curriculum for "Visual art courses" ability index and the teaching materials which are suitable for research objects, this research designed teaching modules. Discussing the confronted difficulties in practical teaching of "design and manufacturing", developing suggestions to deal with them and using the collecting data to modify the feasibility of teaching design model in return by records from student activities, worksheets, interviews, questionnaires, and teacher's observation.

The Development of Research Projects.

After teaching plans were developed, the author implemented every teaching steps of self-designed course. The course curriculum of this research is divided into 17 weeks, from creative thinking of design draft, the plane mosaic pattern design, to 3D mosaic shaping tiling.

Research Object.

The fifth and sixth graders taught by the author are main research object in this study, using two visual art courses every week to teach and manufacture. Project mosaic related works by PowerPoint, and use "Q&A" to test the understanding of students on mosaic in classroom, and invite students to talk about ideas, after teaching activities, there will be a worksheet to assess the learning results from students.

Mosaic Product Shaping Design

When author taught in the classroom, the first encountered problem is: the stereotypes impression of mosaic on TV which means the dealing on the part of the screen to be unseen, and before that students had no preparation experience of design and manufacturing. Therefore, the teaching materials better come from student's daily life experience, so the mirrors and beads are used. According to the teaching activity design, the following two stages, Mosaic pattern plane shaping design and mosaic 3D shaping design, are implemented. 3D shaping designs are the drawing of design draft, mold manufacturing, mold modifying, solid production, processing, the final product display.

Encountered Difficulties and Solution by Students

By students' works, the design of mosaic mirror backplane and pattern shaping are in high homogeneity, in other words, the works among peers are similar; therefore, the design focus on beautifying in order to differentiate works. The reasons why the design are in high homogeneity, understood through interviewing, are because mostly the design shaping ideas come from images by surrounding media, such as idols, singers and cartoon pictures;

Table 1. *Questionnaire 1: Pre-test Learning Assessment*

	Strongly Agree	Agree	Acceptable	Disagree	Strongly Disagree
1. I know what mosaic is.	60%	12%	10%	7%	11%
2. I know that mosaic is an art form that can be created.	55%	12%	20%	6%	7%
3. I know what materials can be used to make a mosaic.	29%	30%	21%	7%	13%
4. I used to imagine that I could try and do mosaics.	32%	9%	23%	10%	26%
5. I know that mosaic can be formed with points.	15%	13%	44%	15%	13%
6. I know that mosaic can formed with lines.	10%	26%	25%	11%	34%
7. I know that mosaic can be formed with surfaces.	10%	22%	20%	19%	29%
8. I know where to see mosaic works.	31%	15%	19%	9%	26%
9. If the teacher is going to give a class on mosaic design, I would love to learn about it.	36%	22%	27%	11%	4%
10. I will be really looking forward to creating a mosaic myself.	48%	4%	21%	11%	15%

the other is from the effect and imitation among peers. However, in the process of product design, whether it is practical, functional, or decorative, etc, are able to work with the learning objectives of "Arts and Humanities" area; therefore, students will also be able to reach learning objectives in this area.

Findings and Discussion

Data Collection Process and Analysis

This study use qualitative data, analyze the product, classify photographs, interview in order to choose appropriate data to render teaching study.

This research used triangulation of information, triangulation of investigator to prove the accuracy. On the triangulation of information, the author tested the reaction from students in class, the students' works, questionnaires and student inter

view. Information were collected in different ways and at different time, and also reached the consistency of data. On the triangulation of investigator, the author analyzed and discussed the data, teaching results, and students' works in order to reach the consistency in analyzing point of view.

Learning Questionnaire Research

Pre-test Learning Questionnaire.

Before teaching, this study begins using a questionnaire to test the students' knowledge of mosaic; the test is divided into five phases, if problems match completely, check on the "agree" column; on the contrary, if it does not meet, check on the "disagree". Before the test, questionnaire rules have been explained to the students, and asked whether they understand the meaning of five represented options, students can answer completely.

Table 2. *Questionnaire 2: Post-test Learning Evaluation*

	Strongly Agree	Agree	Acceptable	Disagree	Strongly Disagree
1. I have a better understanding of mosaic after the class on it.	62%	17%	21%	0%	0%
2. I have a better understanding of mosaic after seeing mosaic works.	60%	23%	10%	7%	0%
3. It is useful for doing mosaics after seeing works related to mosaics.	45%	19%	21%	15%	0%
4. I am very satisfied with my first mosaic work.	21%	17%	45%	4%	13%
5. I enjoy making mosaic very much.	21%	21%	24%	10%	24%
6. I find it quite interesting making mosaics.	29%	17%	33%	17%	4%
7. I really want to create other kinds of mosaics.	41%	13%	21%	8%	17%
8. I think that I can design other interesting mosaic patterns.	42%	25%	25%	4%	4%
9. I think that a design drawing is not necessary for making mosaics.	17%	17%	24%	21%	21%
10. I think that making a design drawing does not help much in creating mosaics.	13%	4%	37%	13%	33%

Learning From The Questionnaire Results.

Key findings, 75% of students know what Mosaic is. of students show high interests in learning Mosaic pattern. 55% of students have little confidence in this course.

Post-test Learning Questionnaire.

In the student's learning process, questionnaire is a way to test students' learning, assisted with worksheets in the learning process; and after learning of validation, questionnaires are usedto understand students' comprehension whether is different or not.

Collaborative Research and Discussion.

This research focused on the fostering of students' learning ability and the display of learning result. Therefore, apart from students' works, teachers' collaborative research is also the research focus. Because teachers are usually busy with class works and the administrative business, this research conducted in a questionnaire way, naming students' works by random number, choosing one second students' works attached in questionnaire for school teachers to fill in the questionnaire.

Key findings, after teaching, 83% of students have clearer concept in Mosaic. 67% of students are inspired and want to develop more Mosaic works.

At first, students were not familiar with the material, so it took a few weeks of each stage to complete. After the last completed designing draft, most of the students can learned that designing a piece requires great concentration and patience. At this point, students really had the ability to design independently, but whether they

<div align="center">Table 3. *Questionnaire of Collaborative Research*</div>

	Male	Female
1. Your gender:	25%	75%

	Yes	No
2. Do you have experience teaching courses in arts and humanities domain?	29%	71%
3. Do you attend events associated with arts and humanities (visual arts, music, etc) when you are off work?	56%	44%
4. Do you attend courses associated with arts and humanities (visual arts, music, etc) when you are off work?	38%	62%
5. Do you know that the Kang Hsuan Educational Publishing Group offers a textbook for the course on architectural drafting?	13%	87%

<div align="center">Table 4. *Part One*</div>

	Strongly Agree	Agree	Acceptable	Disagree	Strongly Disagree
1. Do you consider these works good enough to show sixth graders' creativity?	13%	74%	0%	13%	0%
2. You consider these works praiseworthy in general.	25%	69%	6%	0%	0%
3. You think that these works need enhancement.	0%	31%	44%	25%	0%
4. You think that there is room for improvement for these works.	0%	21%	58%	21%	0%
5. You think that these works are not enough to represent students' changes in their learning ability?	0%	25%	31%	44%	0%
6. You think that these works are good enough to be included as part of teaching examples in your instruction?	6%	69%	19%	6%	0%
7. You think that these works are creative.	6%	75%	19%	0%	0%

<div align="center">Table 5. *Part Two*</div>

	Strongly Agree	Agree	Acceptable	Disagree	Strongly Disagree
1. Do you consider these works good enough to show sixth graders' creativity?	15%	47%	38%	0%	0%
					(continued)
2. You consider these works praiseworthy in general.	23%	39%	23%	15%	0%
3. You think that these works need enhancement.	8%	46%	31%	15%	0%
4. You think that there is room for improvement for these works.	23%	47%	15%	15%	0%

	Strongly Agree	Agree	Acceptable	Disagree	Strongly Disagree
5. You think that these works are not enough to represent students' changes in their learning ability?	8%	15%	23%	46%	8%
6. You think that these works are good enough to be included as part of teaching examples in your instruction?	15%	54%	31%	0%	0%
7. You think that these works are creative.	15%	62%	15%	8%	0%
8. You think that it is innovative to teach the six graders draft drawing.	23%	31%	38%	8%	0%
9. You think that the six graders have the ability to draw a draft.	8%	77%	15%	0%	0%
10. You think that it is appropriate to teach the six graders draft drawing.	8%	77%	0%	15%	0%

Verification by Experts and Scholars.

Table 6. *Questionnaire of Expert and Scholar Verification*

	Male	Female
1. Your gender:	38%	62%

2. Your job: College Professor	College Assistant Professor	Associate Professor	Lecturer	Art Designer	Art or Design area teacher
0%	15%	15%	0%	55%	15%

	Yes	No
3. Do you know that the Kang Hsuan Educational Publishing Group offers a textbook for the course on architectural drafting?	46%	54%

Table 7. *Part One*

	Strongly Agree	Agree	Acceptable	Disagree	Strongly Disagree
1. Do you consider these works good enough to show sixth graders' creativity?	8%	54%	23%	15%	0%
2. You consider these works praiseworthy in general.	38%	47%	15%	0%	0%
3. You think that these works need enhancement.	0%	15%	38%	47%	0%
4. You think that there is room for improvement for these works.	0%	30%	31%	31%	8%
5. You think that these works are not enough to represent students' changes in their learning ability?	0%	46%	8%	38%	8%

	Strongly Agree	Agree	Acceptable	Disagree	Strongly Disagree
6. You think that these works are good enough to be included as part of teaching examples in your instruction?	8%	53%	31%	8%	0%
7. You think that these works are creative.	23%	46%	23%	8%	0%

Table 8. Part Two

	Strongly Agree	Agree	Acceptable	Disagree	Strongly Disagree
1. Do you consider these works good enough to show sixth graders' creativity?	15%	47%	38%	0%	0%
2. You consider these works praiseworthy in general.	23%	39%	23%	15%	0%
3. You think that these works need enhancement.	8%	46%	31%	15%	0%
4. You think that there is room for improvement for these works.	23%	47%	15%	15%	0%
5. You think that these works are not enough to represent students' changes in their learning ability?	8%	15%	23%	46%	8%
6. You think that these works are good enough to be included as part of teaching examples in your instruction?	15%	54%	31%	0%	0%
7. You think that these works are creative.	15%	62%	15%	8%	0%
8. You think that it is innovative to teach the sixth graders draft drawing.	23%	31%	38%	8%	0%
9. You think that the sixth graders have the ability to draw a draft.	8%	77%	15%	0%	0%
10. You think that it is appropriate to teach the sixth graders draft drawing.	8%	77%	0%	15%	0%

had the ability to manufacture is the second phase of the teaching content. Therefore, they make a Mosaic pattern shaping images design product last semester as practice, the following semester, mosaic 3D shaping design and manufacturing is more important for student.

Key findings, In Part One, 75% of teachers think that the students are creative. 19% of teachers agree that these works are good enough. In the future, they'll apply relevant teaching strategies in their teaching.

In Part Two, 92% of teachers think that the students show creativity in their works. 94% of teachers agree this curricu

lum enhance learners' designing abilities. Key findings, 62% of experts and scholars agree the research present students' creativity in their works. 54% of experts and scholars agree this curriculum improve learners' abilities. 83% of experts and scholars agree it is innovative to teach students draw drafts.

Conclusions and Recommendations

Study conclusions

Mosaic Plane Design Works.

Up to 15 weeks, the outcome is rich. There are 200 pieces of works in total. Plane design was conducted by introducing various patterns and the concept of.

Figure 1. Mosaic Plane Design Works 1
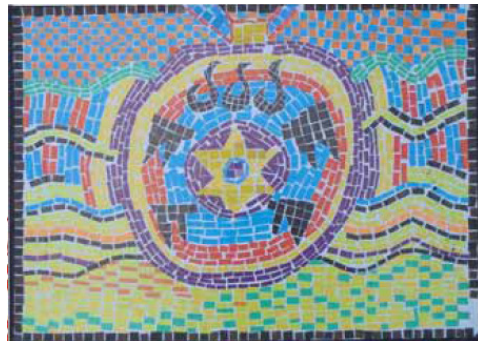
Figure 2. Mosaic Plane Design Works 2

Figure 3. Mosaic Plane Design Works 3

pattern segmentation. There, students were able to carry out mosaic plane creation. Table1 and Table 2 show the evidence that they have higher interests in Mosaic style Some students are motivated and are willing to create more works. This result proves the inspiration and promotion in affective domain.

Mosaic 3D Design Creation.

Considering environmental protection, we use PSP that school already stored. As a material for basic shaping design, using existing shape to modify, cut, reconnect, and then creating a new form, students' diverse thinking shown.

This stage, PSP is used as mosaic materials to go well with the EPS. By peer cooperation, the different colors of PSP are cutting into small one square centimeter squares as a basic material for Mosaic creation.

Figure 5. Mosaic 3D Design Creation
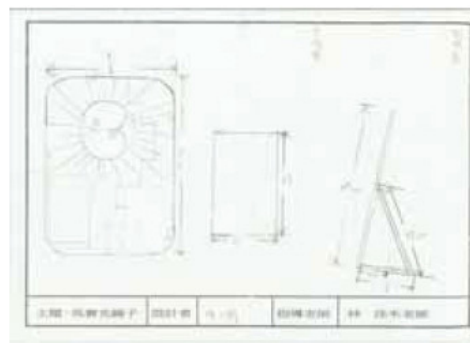
Figure 6. Mosaic Mirror Design Creation
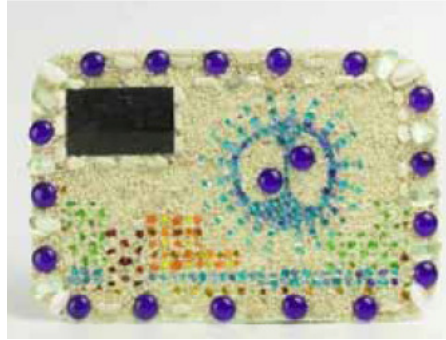
Figure 7. Mosaic Mirror Design Creation

By team work, the students discuss different ways of cooperation and share the experiences on manufacturing, which enables them to play the spirit of cooperation and adherence to principles set out in classrooms.

Mosaic Mirror Design Creation.

Mosaic mirror was the last work. In the process of draft drawing, students have to focus on application of concepts in the design, reach accuracy and keep original. Initially, they do not understand requirements of design draft and symbols. After two weeks of practicing and revision, most kids can finish the draft in good level.

In terms of scale, the six graders learned relevant course in mathematics. Importing simple proportion in design is not only the fun part for students, but also the practice of curriculum integration. To help the slow learner, author invite superior student to be an assistant. You can see a young expert encourage slow learner to complete the work.

After design draft was checked, the manufacturing part comes. The author required students to design out of the same size of proportion, using carton to make mold. There are some works failed during the process because the backplane can't

bear the weight or incline too much; therefore, must modify design draft, by this action, learning to estimate gravity location, and also understanding why author required restrict in design draft drawing.

Recommendations For Future Research

We suggest that students should prepare materials needed before their creation and that instructor should enhance students' proficiency in Mosaic pattern shape structures. Furthermore, the teaching activities can be incorporated into other teaching units to expand teaching activities and encourage students' critical thinking. Future studies may focus on how interactions among students influence their creation and compare their perception perspectives on using information technology and traditional media in paintings. This may shed light on how the use of information technology in arts and humanities studies is correlated with students' creativity performance.

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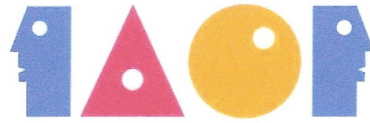
THE MODERATING EFFECT OF WORKLOAD ON ORIENTATED
SERVICE AND RELATIONSHIP QUALITY

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Abstract

In recent years, the rise of services sectors has generated more and more interests on employees' service-oriented. The purpose of this paper is to explore the moderating effect of workload between the orientated service and relationship quality. The population in the study is a world famous conglomerate of chained restaurants. Based on the sample from 260 employees - customers dyads in Taiwan, results show that there has the positive relation between service oriented and relationship quality. The service oriented has positive influence on relationship quality. Further, the results provide evidence that workload has moderating effect on service oriented and relationship quality. The findings suggest that the degree of workload could affect employees' perception of other management practice, thus expand the width of their roles and further enhance the presence of service oriented toward customers.

Keywords: orientated service, relationship quality, workload

Introduction

The trend of people's eating has changed from indoor to outdoor due to the change of people's life style. For this reason the catering industry in Taiwan has burgeoned since. When the time US developed first chain restaurant system in 1858, the concept of "franchise" has then become a significant trend of business management. In 1984, McDonald was successfully entered Taiwan's catering market by its fast-food franchise model. Moreover, for promoting organization's competence, catering business practitioners not only need to pay attention to the changes of customers needs but also need to be aware of the unique style of the product features, the restaurant modification and marketing. In addition, catering business practitioners also need to understand future trend of the business, in order to be on top among the competitors. Moreover, practitioners also need to constantly invent new products to attract customers along with customer - oriented service in order to obtain customers' trust and keep a good relationship with customers (Nicholls, Gilbert, & Roslow, 1998).

Restaurant employees often suffer in excessive working hours, days and workloads. With insufficient rest or days off employees feel pressurized and depressed easily and thus make them exhausted for work (Frank, 2004). Therefore this paper will conduct some amount of questionnaires for understudying whether the phenomenon mentioned above will affect service quality and relationship with customers. The questionnaire will be conducted in restaurant by the questions of whether the customer-oriented service will be affected and interfered by heavy workloads. The result will be served as an index for the catering business practitioners, for the understanding of the importance of service quality versus degree of employees' work loads, and for the improvement / enhancement of employee performance in keeping a good relationship with customers.

Literature Review

Orientated Service

Customer oriented service was first introduced by the scholars of Schneider, Parkington and Buxton in 1980. They found that customers accepting the service delved by employees was influenced how they were served. Many scholars believe that, the higher the will to serve from employees, the higher the satisfaction customers felt. In their point of view, service should be viewed as a product, and the product quality is determined by how the employees reacted, emotion control, and attitude toward working. Employee and customer interaction is the core value of the service system. When employees are contacting with customers, their behavior will affect customers directly. The related service-quality studies in the past show that the integrity, unity, dedication, reliability, responsibility and good manner coming from employees are essential to a good service quality. Service orientation goes through passion, manner and sincerity to the customers. Service orientation is also learned from the combination of employees' ability, willingness to learn, motivation and attitude. Since service relies heavily on employees and customers' interactions, choosing high service oriented employees is the key factor for catering business to survive and success (Hogan, Hogan and Busch, 1984).

Relationship Quality

Relationship is emotional feel connecting from one person to the other, and focusing relationship in customers and employees is a key for the industry to be

successful. There is something that satisfies customers and makes them to keep coming back (Lin, 2003). Relationship quality is a connection between the customer and the enterprise, this relationship on the level will depend on the extent to meet customer needs (Hennig, Thurau & Klee, 1997).The quality of relationship between employees and customers decides the possibility of customers returning for the service.

Relationship quality is a combination of a group of intangible value, reflecting the overall strength of the relationship, as well as the relationship between people that meet the needs and expectations based on the buyers and sellers of past experiences, to affect both sides trading results (Crosby, Kenneth & Deborah, 1990; Levitt, 1983).

When a customer is satisfied with the sales staff, in the minds of customers will form a positive, good experience; and for the trust that customers formed during the experience, the reduction of customer uncertainty enforces customers to expect future positive result of service, and thus the relationship between customer and employees are strengthened (Walker & Stanton, 2001).

Workload

Workload means an individual must complete a lot of work within a certain time. Excessive workload and long working hours in the long run will cause employees unable to cope with time and mental/physical depressions (Rose, Murphy, Byard, & Nikzad, 2002; Houkes, Janssen, Jonge, & Bakker, 2003).Frank (2004) divided the workload into two parts of quality and quantity. Quantity means work cannot be completed within a limited time due to a heavy load; quality means that workers feel that they cannot achieve work standards, or feel the performance stan-

dards cannot be reached. Workload can also be viewed as a measurement of work performance and the extent of the various working pressure (Jung & Jung, 2001; Chang & Chen, 2006).

Relationship among Service Oriented, Relationship Quality and Workload

The rise of the service industry and customer satisfaction has gradually formed a great importance to the concept of service orientation (Yan, Lin & Dai, 2004; Saura, Contrí, Taulet & Velázquez, 2005). Service- oriented policies and training will have a direct impact to the staff's attitude and behavior toward to customers. The customer perception of the service-oriented attitude and behavior from the employees will be reflected to the companies to provide better services. The trust of better services customers formed will slowly increase the possibility of the development of a positive impact for the company and then for the higher relationship quality between the company and the customers (Beatson & Gudergan, 2008).

In addition, if customers are satisfied with the service, they formed deep confidence that reduces the degree of distrust (Frazier, 1983). Hence quality of service is one the basis for customer satisfaction. In order for catering service organizations to have more efficient competitions, it is necessary to better understand the nature of the service relationship from the customer side (Gwinner, Gremler and Bitner, 1998). Moreover, the workload can also be considered as a measuring indicator of job requirements (Karasek, 1979). Also some research of pressure confirms that workload is the greatest pressure source (Gilboa Shirom, Fried, & Cooper, 2008; Cooper et al., 2001; Lu, 1997). Research conducted by Shen and Wang (2007) confirmed that work the pressure will interfere with the work morale on the job performance

Hypotheses

Based on the previous research mentioned above, we test the following hypotheses:

H_1：There has the positive relation between service oriented and relationship quality

H_2：The service oriented has positive influence on relationship quality

H_3：Workload has moderation effect on service oriented and relationship quality

Research Methods

Structure of Research

Measures Properties.

The company to help our survey is a world famous conglomerate of chained restaurants. The conglomerate has several restaurants located in Taiwan. The questionnaire is conducted and sent to restaurant employees and their customers. In this questionnaire, employees will need to do self- evaluation by filling a survey from their awareness, and customers (we pick 10) will fill forms of service oriented and relationship quality from the service, based on their actual feelings. 26 employees and 260 customers will take this questionnaire. We will get permission from the unit supervisor before questionnaire is conducted. Currently the scale we adopt is Likert's five-point scale, in aiming to avoid ambiguous or misrepresented answers.

Measurement for the Service Oriented.

The questions of variation are based on the method of classification that created by Saura et al. (2005); Schrode, Wulf and Schumacher (2003). In this construct, the evaluation for the service oriented is divided by three dimensions: service encounter, service system and human resource management. There will have 11 questions in the measurement for the questionnaire.

Measurement for Relationship Quality.

Questions of variation in this measurement are based on Lytle et al. (1998) created by Saura et al. (2005) and Schroder, Wulf and Schumacher (2003). The measurement consists of three dimensions and they are trust, satisfaction and promise. Totally six item options are designed and made for the measurement.

Table 1. Effects of service oriented on relationship quality-workload as moderating factor

dependent variable	Independent variable	Path coefficient	Std error	t-value	P-value
workload	relationship quality	.85	.22	2.98	.004
service oriented *workload	relationship quality	.97	.12	3.26	.001
service oriented	relationship quality	1.23	0.11	10.89	.001

Notes: n =260(two-tailed test) *p<.05
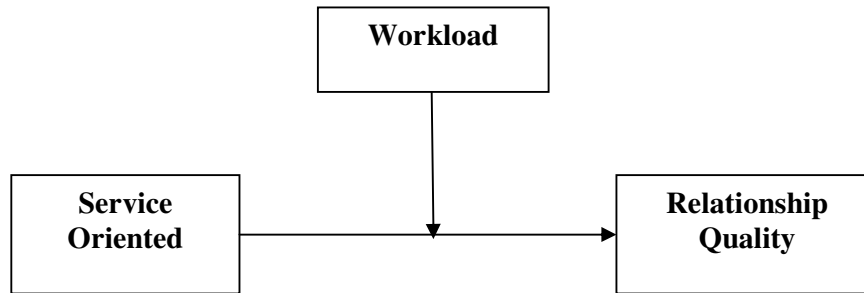
Figure 1: Structure of research diagram

Measurement for Workload.

The questions of variation made in this research are based on Quantitative Workload Inventory scale by Spector and Jex (1998). There will be 5 questions in the questionnaire was designed to measure the speed of job and the feeling from the employees.

Results of Hypotheses Testing

In proposed model, the evaluation index as follow: CMIN=34.88, DF=41, CMIN/DF=4.36, GFI=0.91＞0.9, AGFI= 0.90＞0.9, RMSEA=0.01＜0.05, this model had a good-fitness. The result for regression analysis was shown the high correlation between service oriented and relationship quality (correlation coefficient=0.94), hypothesis H_1 was supported. As hypothesized, a positive relationship between effect of service oriented and relationship quality is confirmed (path coefficient =1.23，t =10.89). Therefore, H_2 is supported. As predicted, a significantly moderating effect of workload on service oriented and relationship quality is accepted (path coefficient =0.97，t =3.26). Therefore, H_3 is supported, was shown on Table 1.

Conclusion

Service-oriented behavior is very important for consumer behavior; consumers are not just shopping, but also care about the feelings of the services (Schrode, Wulf & Schumacher, 2003). So, how to enhance the customer experience, relationship, fueling consumer behavior of the customer were became the key point. Enterprise can try to strengthen personnel service manners to enhance politeness and affinity; also can supervise each employee to implement the standard operation procedures and consistency of customer service. Another way, through staff training and educating will help employees to have the empathy to serve customers. Besides, after customer dining, enterprise can provide feedback form and asked guests if anything need to improve, take the initiative to observe the customer and provide service appropriate. In addition, the industry offers a variety of products, and improves the quality of the meals and services to improve the restaurant overall service.

Finally, company should also consider the assessment of employees working configuration, too heavy workload will affect the quality of service, customers feeling, and the consumer's willingness to consumption again. At the same time, increase the percentage of staff turnover,

customer complaints and affects the brand image negatively. Therefore, the company should focus on how to allocate work to strengthen the education and training of employees properly, in order to enhance interaction with customers, as a manager should think about it.

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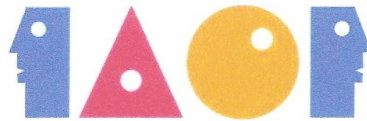
AN INVESTIGATION ON THE CORRELATION AND INFLUENCE BETWEEN PRODUCT FORM FEATURES AND THE PURCHASE INTENTIONS OF CONSUMERS

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Abstract

This study was aimed to investigate the correlation between the product form features of wooden bookshelves and the purchase intentions of consumers. Pearson correlation coefficient was employed to test the relationship between product form features and purchase intentions, and linear regression analysis was used to analyze the influence of product form features on the purchase intentions of consumers. The research result showed that: 1. Integrity, order, visual balance, rhythm, and size and proportion were significantly positively correlated with the purchase intentions of consumers. Size and proportion was the most profoundly correlated with the purchase intentions of consumers. 2. Integrity, order, rhythm, and size and proportion all significantly influenced the purchase intentions of consumers, indicating that integrity, order, rhythm, and size and proportion are all influential factors when consumers purchase wooden bookshelves, so enterprises should pay attentions to the factors when they develop new products. 3. Although visual balance did not significantly influence the purchase intentions of consumers, they were correlated according to the test of Pearson's correlation coefficient. However, the influence was not much, so it did not reach any significance. The result of this study was expected to be a reference for the design department and marketing department of furniture products in order to advance the development of new furniture products of enterprises.

Keywords: product form feature; purchase intentions of consumers; linear regression analysis

Background and Motives

The demand of consumers changes rapidly, and product form is one of the critical influential factors when consumers make purchase decisions. Kotler and Keller (2006) mentioned that product design provides the most potential channels of differentiation and positioning for products and services, and design is an important factor which usually brings an enterprise competitive predominance.

However, the identification that product forms generated in the mind of consumers is a critical factor in their purchase decisions (Lin, 1996). Hence, this study was aimed to understand the feeling of consumers about the product form features of wooden bookshelves in order to provide a reference for product designers and marketing practitioners.

Research Purposes

1. Investigating the relationship between product form features and the purchase intentions of consumers.

2. Investigating the influence of product form features on the purchase intentions of consumers.

Research Limitations

In this study, the relationship between product form features and the purchase intentions of consumers was investigated in order to understand the purchase intentions of Taiwanese consumers for product form features. The product form design was aimed at wooden bookshelves in this study, which is the limitation of this study. In addition, the consumers of the furniture hypermarkets in Taiwan were regarded as the research objects in this study.

Literature Review

Product Form Features

The aesthetic features of products may influence consumers for many years, and the products seem to become a part of sensory environments (Bloch, 1995). Bowman (1990) brought up five product form elements: point, line, color, texture, and shape. Furthermore, Chiu (1987) generalized three form elements, including shape, color, and material. In terms of research on product form elements, Wang (2009) mentioned that Tjalve classified form features into integrity, order, visual balance, rhythm, size and proportion, etc. Integrity integrates fractional frameworks with detailed components. Order simplifies and tidily allocates complicated product components. Visual balance includes two types of balance, respectively symmetrical balance and asymmetrical balance.

Rhythm applies the combinations of quantities, arrangements, size, shapes, and colors to creations. A so-called golden ratio is an aesthetic size or proportion.

In summary, for product form features, integrity, order, visual balance, rhythm, and size and proportion, which were generalized by Tjalve, mentioned by Wang (2009), were employed as the operational definitions of variables and the principles for measuring questionnaires in this study.

The Purchase Intentions of Consumers

Kolter (2000) argued that consumers integrate their individual factors in the psychological functioning progress to guide their purchase decisions and behavior. Engel, Blackwell and Kollat (1993) defined the behavior of consumers as "human expressions and behavior for obtaining and using goods, including the procedures of behavioral decisions." Moreover, Kotler (1997) defined the be-

havior of consumers as human experience in purchasing and using products and services. In terms of purchase intention, Schiffman and Kanuk (2000) regarded the possibility for consumers to purchase a product as a yardstick. Boyd and Mason (1999) measured the purchase intentions of consumers by means of the length of time that they purchase a product. Hence, if enterprises intend to increase the purchase intentions of consumers, it is critical for them to understand the influential factors in the purchase intentions of consumers in terms of product form features.

According to the aforementioned arguments, Schiffman and Kanuk's (2000) definition of the purchase intentions of consumers, that is, the possibility of purchasing a product is the tendency for consumers to select the product, was employed in this study as the operational definition of variables and the principle for measuring questionnaires in this study.

Research Methodology

Research Design

Research Framework: The research framework of this study is displayed by Figure 1.

Research Hypotheses

Baxter (1995) addressed that when consumers do not consider functions, brands, and prices as important purchase factors, the value of the appearance of a product becomes a critical purchase factor when consumers purchase the product. It is thus obvious that product form features and the purchase intentions of consumers are inseparable. Consequently, the following hypotheses were established in this study.

H_1: Product form features and the purchase intentions of consumers are positively related.

H_1-1: Integrity and the purchase intentions of consumers are positively related.

H_1-2: Order and the purchase intention of consumers are positively related.

H_1-3: Visual balance and the purchase intentions of consumers are positively related.

H_1-4: Rhythm and the purchase intentions of consumers are positively related.

H_1-5: Size and proportion as well as the purchase intentions of consumers are positively related.

H_2: Product form features influence the purchase intentions of consumers.

H_2-1: Integrity influences the purchase intentions of consumers.

H_2-2: Order influences the purchase intentions of consumers.

H_2-3: Visual balance influences the purchase intentions of consumers.

H_2-4: Rhythm influences the purchase intentions of consumers.

H_2-5: Size and proportion influences the purchase intentions of consumers.

Research Objects

The consumers of the furniture hypermarkets in Yunlin and Chiayi were regarded as the research objects in this study for the convenience of sampling. In total, two hundreds and forty copies of questionnaires were delivered and
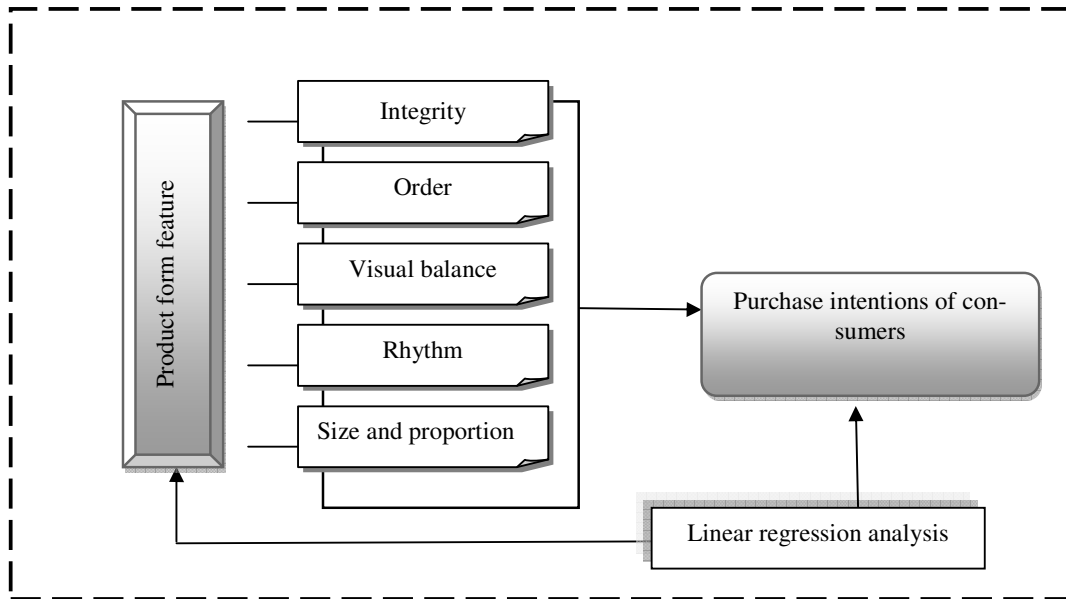
Figure 1. The Research Framework Of This Study

Table 1 Reliability Analysis

Item	Cronbach's α
Integrity	0.823
Order	0.875
Visual balance	0.810
Rhythm	0.838
Size and proportion	0.868
Purchase intentions of consumers	0.822

retrieved between February and April in 2013 for the analysis and investigation.

Questionnaire Design and Implementation

Relevant literature was employed as the operational definition of variables and the principle for measuring questionnaires, and questionnaire survey was adopted in this study as the main research tool for collecting data. Thirty copies of the questionnaire were pre-tested and appropriately modified. In this study, the Cronbach's α of each dimension was higher than 0.7, as shown in Table 1.

In accordance with the standard suggested by Nunnally (1995), when Cronbach's α is higher than 0.7, the reliability

of a research questionnaire is good. Hence, the questionnaire was formally delivered.

The questionnaire included three parts. The first part was the background information of each participant, including sex, age, education, and income. The second part was the opinion of each participant about product form features. The third part was the opinion of each participant about the purchase intentions resulting from product form features. Moreover, a Likert five point scale was used to measure the opinions of consumers on product form features and the purchase intentions.

Research Statistics and Analyses

Descriptive Statistic and Analysis Results

In terms of sample structure, there were totally 240 participants, respectively 138 males, accounting for 57% of the samples, and 102 females, accounting for 43% of the samples. For age, 80 people were between 30 and 39 years old, accounting for the maximum, and 20 people were under 20 years old, accounting for the minimum. In terms of education, 132 participants graduated from a university, accounting for 55% of the samples, which was the maximum. There were 66 people having an income between 20,000 and 29,999, accounting for the maximum, while there were only 12 people having an income above 60,000, accounting for 5% of the samples.

Pearson's Correlation Test for Integrity, Order, Visual Balance, Rhythm, Size and Proportion, and the Purchase Intentions of Consumers

Pearson correlation analysis was employed in this study to verify the correlation (Table 2.). According to the test, the correlation coefficient between integrity, order, visual balance, rhythm, and size and

proportion as well as the purchase intentions of consumers was $p < .01$, indicating a significantly positive correlation. The correlation coefficient between size and proportion as well as the purchase intentions of consumers, namely .520, was the highest whereas the coefficient of visual balance, namely .287, was the lowest. Consequently, Hypotheses H_1-1, H_1-2, H_1-3, H_1-4, and H_1-5 were supported.

The Linear Regression Analysis of Integrity, Order, Visual Balance, Rhythm, Size and Proportion, and the Purchase Intentions of Consumers

In accordance with Table 3, adj-$R^2 = .316$. It is thus known that a linear relationship existed between integrity, order, visual balance, rhythm, size and proportion as well as the purchase intentions of consumers. The Durbin-Watson value in Table 3 was employed to judge whether residuals were distributed randomly or not. If the D-W value is close to 2, there is not any serial correlation. According to the test result, D-W = 1.733. Obviously, there was not any serial correlation.

The F test result in Table 4 ANOVA showed that significance = 0.000 < 0.05, indicating that among integrity, order, visual balance, rhythm, and size and proportion, at least one variable influences the purchase intentions of consumers. According to the t-test of regression coefficients in Table 5, the significance of visual balance = .485 > 0.05. Apparently visual balance did not significantly influence the purchase intentions of consumers. The significance of integrity, order, rhythm, and size and proportion was <0.05, indicating that all of them significantly influence the purchase intentions of consumers.

Table 2. Pearson Correlation Of Integrity, Order, Visual Balance, Rhythm, Size And Proportion And Purchase Intentions Of Consumers

		Integrity	Order	Visual balance	Rhythm	Size and proportion	Purchase intentions of consumers
Integrity	Pearson Correlation	1					
	Sig. (2-tailed)	.					
Order	Pearson Correlation	.061	1				
	Sig. (2-tailed)	.343	.				
Visual balance	Pearson Correlation	.434(**)	.063	1			
	Sig. (2-tailed)	.000	.328	.			
Rhythm	Pearson Correlation	.337(**)	.169(**)	.309(**)	1		
	Sig. (2-tailed)	.000	.009	.000	.		
Size and proportion	Pearson Correlation	.288(**)	.397(**)	.387(**)	.488(**)	1	.
	Sig. (2-tailed)	.000	.000	.000	.000	.	
Purchase intentions of consumers	Pearson Correlation	.304(**)	.301(**)	.287(**)	.405(**)	.520(**)	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.

** Correlation is significant at the 0.01 level (2-tailed).

Table 3. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.575	.330	.316	.34713	1.733

Predictors: (Constant), Size and Proportion, Integrity, Order, Visual Balance, Rhythm
Dependent Variable: Purchase Intentions of Consumers

Table 4. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.910	5	2.782	23.086	.000
	Residual	28.197	234	.121		
	Total	42.107	239			

Predictors: (Constant), Size and Proportion, Integrity, Order, Visual Balance, Rhythm
Dependent Variable: Purchase Intentions of Consumers

Table 5. Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.508	.210		11.961	.000		
	Integrity	.078	.038	.125	2.044	.042	.764	1.310
	Order	.083	.038	.130	2.221	.027	.832	1.202
	Visual Balance	.029	.042	.044	.699	.485	.727	1.376
	Rhythm	.080	.031	.164	2.588	.010	.716	1.396
	Size and Proportion	.128	.026	.335	4.846	.000	.598	1.672

Dependent Variable: Purchase Intentions of Consumers

In the collinearity test, VIF <10, indicating that there is not significant collinearity in integrity, order, visual balance, rhythm, and size and proportion. Thus, Hypotheses H$_2$-1, H$_2$-2, H$_2$-4, H$_2$-5 were supported. In addition, Hypothesis H$_2$-3 was not supported. Although there was not significant influence between visual balance and the purchase intentions of consumers, they were correlated in the

Pearson correlation test.

It is just that the influence was not much, so it did not reach any significance.

Conclusions and Suggestions

In this study, the product form features of wooden bookshelves and the purchase intentions of consumers were combined to investigate the correlation between product form features and the purchase intentions of consumers in hopes of providing a reference for furniture design departments and marketing departments in order to advance the development of new furniture products of enterprises. The research results showed the following.

1.   Integrity, order, visual balance, rhythm, and size and proportion were significantly positively correlated with the purchase intentions of consumers. Size and proportion and the purchase intentions of consumers were the most profoundly correlated.

2.   Integrity, order, rhythm, and size and proportion all significantly influenced the purchase intentions of consumers, indicating that integrity, order, rhythm, and size and proportion are all influential factors when consumers purchase wooden bookshelves, so enterprises should pay attention to them when developing new products.

3.   Although visual balance did not significantly influence the purchase intentions of consumers, they were correlated in the Pearson correlation test. However, the influence was not profound, so it did not reach any significance.

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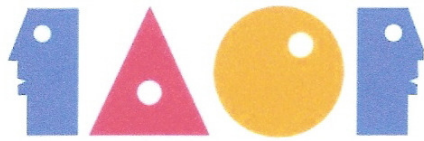
MEASURING MANAGERIAL EFFICIENCY OF SECURITIES INVESTMENT TRUST FIRMS UNDER TAIWANESE FINANCIAL HOLDING COMPANIES: AN APPLICATION OF THE TWO-STAGE DEA APPROACH

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Abstract

This study was conducted between 2010 and 2011 on the investment trust firms that were subsidiaries of Taiwanese financial holding companies. The Super SBM Efficiency model was adopted to solve the problem of indistinguishableness of management performance if a number of efficiency scores turned out to be 1 at the same time when other types of models were applied. The outcome showed that by using a two-stage DEA management efficiency matrix, it was possible to analyze the high-efficiency group and the low-efficiency group effectively. Yuanta Securities Investment Trust was a leader in the high-efficiency group during the said period while Shin Kong Securities Investment Trust trailed behind due to low efficiency. These empirical results from the study can serve as references for the managers of investment trust firms when determining management directions and decisions.

Keywords: Super SBM Efficiency, investment trust firm, two-stage DEA, management efficiency matrix

Introduction

As of Jan. 2013, there were 16 financial holding companies in Taiwan, namely Huan Nan Financial Holdings, Fubon Financial, Cathay Financial Holdings, China Development Financial, SinoPac Holdings, Chinatrust Financial Holding Co., Ltd., First Financial Holdings, E.SUN Financial Holding Co., Ltd., Yuanta Financial Holding Co., Ltd., Mega Holdings, Taishin Financial Holding Co., Ltd., Shin Kong

Financial Holding Co., Ltd., JihSun Holdings, Waterland Financial Holdings, Taiwan Financial Holdings, and Taiwan Co-operative Holdings. Financial holding company mergers are by no mean easy tasks. The integration management after a merger not only signifies the commencement of fusion of organizational cultures but also means creation of value from the merger has to begin. An investment trust firm in a financial holding system is usually a subsidiary of the smallest scale. The aim of this study is to find out whether such investment trust firms are able to improve their management efficiency by utilizing the business channels of the bank, life insurance company and securities firm in the same system after a merger or if their management efficiency actually deteriorates as a consequence of the increased diversity of operations or the hugeness of the organization.

Data Envelopment Analysis (DEA) has been used extensively in many studies conducted on the management efficiency of financial businesses (Chen, Chiu, and Huang, 2010; Tsai, Wu and Wang, 2011; Ling, Yen & Yang, 2012). To overcome the lack of management-elated information when using one-stage DEA, Seiford and Zhu (1999) applied two-stage DEA for the first time to analyze the profitability and market capacity of the top 55 banks in the US. Taiwanese scholars have also done the same, such as the study on the profit efficiency and market efficiency of 14 financial holding companies in Taiwan (Lo and Lu, 2006; Sheu, Lo, and Lin, 2006) and the one on the management performance of 24 Taiwanese property insurance companies in different phases (Huang and Kao, 2005). In both studies, the conventional CCR or BCC model was adopted to figure out the efficiency scores. In doing so, the efficiency score of a number of decision-making units (DMUs) often turns out to be 1 at the same time and the performance of all these DMUs is thus rated first place. It becomes impossible to determine the dif-

ference in management performance. Related literature also indicates that using DEA to analyze the management efficiency of investment trust firms is insufficient. These are the reasons behind the attempt of this study to examine the management performance of the investment trust firms of Taiwanese financial holding companies through a different approach.

To reflect the management-related information in the production process, this study chooses a two-stage DEA approach to analyze the management performance of the investment trust firms of Taiwanese financial holding companies. The objectives of this study are as follows.

First, to apply two-stage DEA to assess and compare the management efficiency of each investment trust firm and use the Super SBM Efficiency model to solve the problem of indistinguishableness of management performance when a number of efficiency scores turn out to be 1 at the same time.

Second, to establish a management efficiency matrix to identify the leading group with high efficiency and the trailing group with low efficiency and discuss them separately.

Review of Literature

The financial holding companies in Taiwan have been formed one after another since 2001. In a financial holding system, the securities investment trust operation (hereinafter referred to as the investment trust firm) plays a role that is related to the bank, the securities firm, and the life insurance company. It releases fund products, manages the marketing channels of the financial holding company, and also makes direct sales, thus becoming an indispensible link in the financial holding company. After the government lifted the restriction on representation and sales for foreign funds, investment trust firms,

in addition to raising capital for their own funds, have been able to also include domestic representation and marketing for foreign funds as part of their business, thus reaching a new milestone.

However, due to the limited market size and high homogeneity of the services and products offered, competition is tough. Therefore, improvement of competitive edges, development of leadership in this industry, appropriate use of the channels and resources (bank, securities firm and life insurance company) of the financial holding system, and perfection of cross selling skills have become decisive factors in the competition among investment trust firms.

Besides DEA, there are other ways to evaluate performance or assess efficiency, such as the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Multiple Objective Programming (MOP), Grey Relational Analysis (GRA), and so forth. Berger, Hunter and Timme (1993) recommended DEA models for evaluation of the performance of financial institutions. So far, financial institution management efficiency studies have mostly been conducted on banks, such as the one on 34 commercial banks in Taiwan during the 1995-1996 period to assess the efficiency scores and productivity, using deposits, number of employees, assets as the input variables and loans, investments and non-interest income as the output variables and coming up with the finding of private banks being more efficient than public banks (Chen & Yeh, 2000).

Chen, Cook and Zhu (2010) assessed the performance of 37 Taiwanese commercial banks between 2004 and 2006, using number of employees, deposits and fixed assets as the input variables and loans and non-interest income as the output variables, and concluded that banks operating under financial holding companies had better management performance

than independent ones. Tsai, Wu and Wang (2011) analyzed the management and profit efficiency of banks in China during the 2004- 2006 period and discovered that larger and older banks were more superior than smaller and newer banks in these areas. In securities firm management efficiency studies, CCR or BCC and the Malmquist index are commonly adopted.

Studies have indicated that the management efficiency of securities firms is generally poor and tends to worsen year after year (Lee & Wang, 2007; Liao, 2012). In all the above, conventional one-stage DEA models were applied and how the input items were distributed among the output items was hidden in the black box. The internal process was neglected (Färe & Grosskopf, 2000).

Seiford and Zhu (1999) were the first the use a two-stage DEA model in their analysis of the profitability and market capacity of the top 55 banks in the US. In the stage one, employees, assets and shareholders' equity were defined as the input items and income and profit the output items to measure profitability. In the stage two, the out items of the first stage were defined as the input items (income and profit) and market value, total return on investment and earning per share as the output items to assess market capacity. The chief contribution of this study is the separation of the production process in banking business into profitability and market capacity and the analysis of management efficiency in each stage that compensate for the lack of management-related information when one-stage DEA models are applied. Hwang and Kao (2005) adopted two-stage DEA to analyze the management performance of 24 Taiwanese property insurance companies in different phases, using market capacity to assess marketing performance and profitability to measure investment performance. Lo and Lu (2006) used two-stage DEA to study the 14 financial holding companies in

Taiwan in 2003 and discovered that larger financial holding companies had better management performance than smaller ones, while those with life insurance business as their main operation outperformed the ones with banking and securities business as their main operation in management.

Due to the restriction that efficiency scores cannot be greater than 1 when using conventional DEA, some scholars started to adopt the Super SBM model and the Malmquist index to discuss market and operating efficiency in the financial holding industry, and at the same time apply the matrix formed with the market and operational efficiency scores arrived at to analyze the results of competition in different phases (Yen, Yang, Lin and Lee, 2012; Lin Yen and Yang, 2012). The outcome, showing clearly the high-efficiency group and the low efficiency group, can serve as a reference for the management when determining management directions and making decisions.

Research Design

Conducted in 2011, this study covers the investment trust firms of all the 16 financial holding companies in Taiwan, including Hua Nan Securities Investment Trust, Fubon Securities Investment Services, Cathay Securities Investment Trust, KGI Securities Investment Trust, SinoPac Securities Investment Trust, First Securities Investment Trust, Yuanta Securities Investment Trust, Mega International Investment Trust, Taishin Securities Investment Trust, and Shin Kong Securities Investment Trust. The samples have been obtained from the database of the Taiwan Economic Journal (TEJ) and the public websites of the financial holding companies. The framework of two-stage DEA and the variables are defined as follows:

Framework of Two-stage DEA

After a review of related literature, fixed assets, operating expenses and number of employees are applied as the input items and fund size and beneficiaries as the output items in stage one for operating capacity measurement. In stage two, the output items in stage one are applied as the input items (fund size and beneficiaries) and shareholders' equity and sales per employee as the output items for profitability measurement (Seiford & Zhu, 1999; Lin et al., 2012; Yen et al., 2012). The two-stage DEA framework is as shown in Figure 1.

Selection and Definition of Variables

In most existing literature, the input and output items in financial services are usually determined with the intermediate approach and the production approach (Bonin, Hasan & Wachtel, 2005; Lin et al., 2012; Yen et al., 2012). In this study, however, investment trust firms are considered intermediates that provide financial services or help convert financial resources, not producers; therefore, the input and output items are determined accordingly.

The increase of each input or output item will reduce the discriminating power of DEA. Hence, the numbers of input and output items and the number of DMUs must be maintained at a certain proportion for the analytic results of the DEA model to be valid. It is a rule of thumb that the number of units to be evaluated has to be at least twice the total number of input and output items (Bowlin, 1987; Golany & Roll, 1989). In this study, there are 3 input items and 2 output items in stage one and 2 input items and 2 output items in stage two, while the number of units to be evaluated is 10. The proportioning complies with the rule of thumb, therefore. The variables in this study are defined as shown in Table 1.
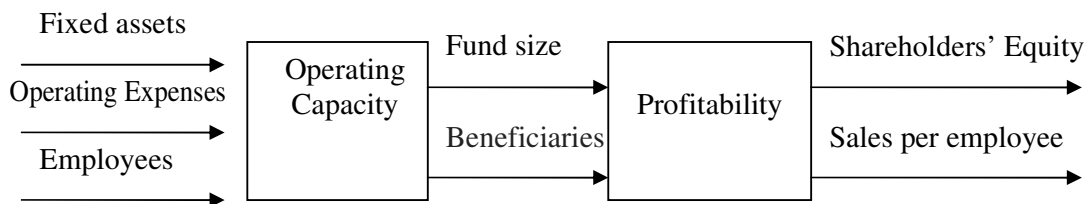
Figure 1.   The frame work of two-stage DEA

Table 1. Definitions of inputs and outputs

Variable	Definition	Unit
Fixed assets	Assets, such as land, houses, and equipment, for long-term business operations	NT$ million
Operating Expenses	The principal service and material expenses, not including personnel costs	NT$ million
Employees	The total employees hired annually.	Persons
Fund size	The total funds under the management of a securities investment trust firm	NT$ million
Beneficiaries	The total beneficiaries of the fund under the management of a securities investment trust firm	Persons
Shareholders' Equity	Total assets – liabilities.	NT$ million
Sales per employee	Revenue / employee.	NT$ million

Table 2. Correlation coefficients of operating capacity

	Operating expenses	Employee	Fixed assets	Fund Size	Beneficiaries
Operating expenses	1				
Employees	0.9217	1			
Fixed assets	0.2072	0.3331	1		
Fund Size	0.6457	0.6273	0.5156	1	
Beneficiaries	0.021	0.1426	0.3411	0.4234	1

Table 3. Correlation coefficients of profitability

	Fund Size	Beneficiaries	Shareholders' Equity	Sales per employee
Fund Size	1			
Beneficiaries	0.4234	1		
Shareholders' Equity	0.5116	0.15	1	
Sales per employee	0.6583	0.057	0.636	1

The Super SBM Efficiency Model

The study uses Tone's (2002) Super SBM Efficiency model to improve the situation in which efficiency scores are simultaneously 1. There are two Super SBM Efficiency models, one for Constant Return to Scale (CRS) and the other for Various Returns to Scale (VRS).

The following is the Super SBM model for CRS.

$$\delta^+ = Min\delta = \frac{\frac{1}{m}\sum_{i=1}^{m}\frac{\overline{x_i}}{x_{i0}}}{\frac{1}{s}\sum_{r=1}^{s}\frac{\overline{y_r}}{y_{r0}}}$$

$$s.t \ \overline{x} \geq \sum_{j=1,\leq\neq0}^{s}\lambda_j x_j$$

$$\overline{y} \geq \sum_{j=1,\leq\neq0}^{n}\lambda_j y_j$$

(1)

$$\overline{x} \geq x_0, \ \overline{y} \geq y_0$$

$$\overline{y} \geq 0, \ \lambda \geq 0$$

The Super SBM model in Formula (1) is converted into linear programming for the convenience of finding the solution:

$$\tau^* = Min\tau = \frac{1}{m}\sum_{i=1}^{m}\frac{\overline{x_i}}{x_{i0}}$$

$$s.t \ 1 = \frac{1}{s}\sum_{r=1}^{s}\frac{\overline{y_r}}{y_{r0}} \quad (2)$$

$$\overline{x} \geq \sum_{j=1,\leq0}^{n}\Lambda_j x_j$$

$$\overline{y} \geq \sum_{j=1,\leq0}^{n}\Lambda_j y_j$$

$$\overline{x} \geq tx_0, \ \overline{y} \geq ty_0$$

$$\Lambda \geq 0, \ \overline{y} \geq 0, \ t \geq 0$$

If the Super SBM model is modified into the model for VRS, the model will be as follows:

$$\delta^+ = Min\delta = \frac{\frac{1}{m}\sum_{i=1}^{m}\frac{\overline{x_i}}{x_{i0}}}{\frac{1}{s}\sum_{r=1}^{s}\frac{\overline{y_r}}{y_{r0}}}$$

$$s.t \ \overline{x} \geq \sum_{j=1,\leq\neq0}^{s}\lambda_j x_j$$

$$\overline{y} \geq \sum_{j=1,\neq0}^{n}\lambda_j y_j$$

(3)

$$\sum_{j=1,\neq0}^{n}\lambda_j y_j = 1$$

$$\overline{x} \geq x_0, \ \overline{y} \geq y_0$$

$$\overline{y} \geq 0, \ \lambda \geq 0$$

DEA models can be divided into two types, namely input-oriented and output-oriented. In this study, it is considered that from the perspective of managers, the financial industry expects to obtain more output under current input, so the Super SBM model based on the slacks of input-oriented VRS is employed in this study to evaluate the operating efficiency of each securities investment trust firm.

Empirical Results and Analysis

In this study, DEA Solver software is adopted to analyze the management performance of the investment trust firms. Initially, a Super SBM change-in-input model is used to establish the management performance value of each investment trust firm. Then a management matrix is applied to observe the changes in each investment trust firm.

Huang (1993) believed that there isotonicity should exist between the input items and the output items. In other words, increasing an input item should not cause any output item to decrease. Therefore, correlation analysis is conducted first is this study. The correlation coefficients in Tables 2. and 3. indicate that the relations between the operating capacity in stage one and the profitability in stage two and between all the input items and output items are positive, complying with the requirement that isotonicity should exist between the input and output items.

Empirical Results of Super SBM

Table 4. shows that the operating efficiency score and profit efficiency score of each investment trust firm during the 2010-2011 period. When the efficiency score is larger than 1, the larger the score, the better the management efficiency is. The financial holding companies with an operating efficiency score larger than 1 in 2010 include KGI, Cathay, Hua Nan,

Yuanta, Mega, First, and Fubon; those with a profit efficiency score large than 1 are Taishin, KGI, Cathay, SinoPac, Yuanta, and Fubon. The ones having both the operating and profit efficiency scores larger than 1 are KGI, Cathay, Yuanta, and Fubon. The companies with an operating efficiency score larger than 1 in 2011 include Taishin, KGI, Cathay, Shin Kong, Yuanta, Mega, and First; those having a profit efficiency score larger than 1 are Taishin, SinoPac, Hua Nan, Yuanta, Mega, First, and Fubon. Meanwhile, the ones with both the operating efficiency and profit efficiency scores larger than 1 are Taishin, Yuanta, Mega, and First.

Two-stage DEA Management Matrix

In order to understand better the performance of the 10 investment trust firms, this study defines the operating efficiency scores as the cross axle and profit efficiency scores as the vertical axle to form the management efficiency matrix. The management matrix in Figure 2 shows that KGI, Cathay, Yuanta, and Fubon are the four investment trust firms in the leading group with the best operating performance and profit efficiency, with Cathay being the most outstanding. Meanwhile, it also indicates Shin King as the one with the worst operating efficiency and profit efficiency and therefore trailing behind.

The management matrix in Figure 3 shows that Taishin, Yuanta, Mega, and First score over 1 in operating and profit efficiency and are therefore the best performers. Among them, Yuanta appears to have been the most outstanding, being part of the high-efficiency leading group in two consecutive years. The figure indicates that there was no low-efficiency trailing group in 2011.

Table 4. The Operating Efficiency and Profit Efficiency Scores

| DMU | 2010 | | | | 2011 | | | |
| | Operating Efficiency | | Profit Efficiency | | Operating Efficiency | | Profit Efficiency | |
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
TS	0.5556571	9	8.3549709	1	1.606707	3	2.7681125	2
KG	2.7422598	3	2.0069394	2	2.85847	2	0.8336375	8
CA	6.9710095	2	1.0054401	3	3.0855179	1	0.6598334	9
SP	0.3620416	10	1	5	0.4346727	10	1.3284188	5
SK	0.6440909	8	0.3867817	8	1.0127904	6	0.3666141	10
HN	1.5517056	4	0.1267111	10	0.6175179	9	1.1147242	6
YT	1	6	1	5	1	7	1	7
MG	1.4471981	5	0.5036834	7	1.5083368	4	1.8454096	4
FI	1	6	0.2748635	9	1.167285	5	3.3133504	1
FB	19.286365	1	1.0011879	4	0.7400071	8	1.9805914	3

Note: TS (Taishin Securities Investment Trust); KG (KGI Securities Investment Trust); CA (Cathay Securities Investment Trust); SP (SinoPac Securities Investment Trust); SK (Shin Kong Securities Investment Trust);HN (Hua Nan Investment Trust); YT (Yuanta Securities Investment Trust); MG(MEGA International Investment Trust); FI (First Securities Investment Trust); FB (Fubon Securities Investment Service).
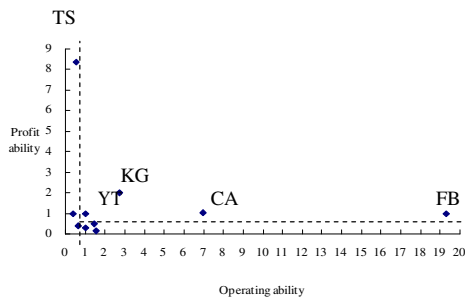
Figure 2. The 2010 management matrix of two-stage DEA
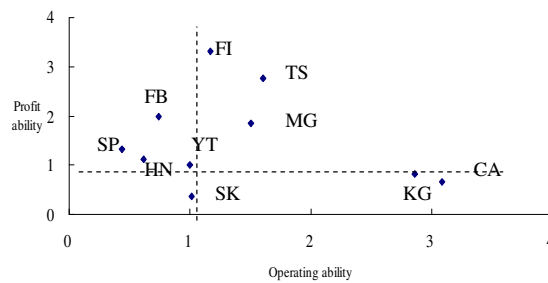
Figure 3. The 2011 management matrix of two-stage DEA

Conclusion

Since the relative efficiency estimated with DEA is the result of calculation based on the input items from each DMU and the output items, even a smaller-scale investment trust firm can top the list in management efficiency. Take Fubon and Taishin for example. They may not be the largest in scale, yet their management efficiency apparently stands out. In addition, by using a two-stage DEA management matrix, it is possible to observe the changes in the investment trust firms and the ones with similar management practices and characteristics will fall in the same group. The leading group and trailing group in 2010 and 2011 are exhibited with a two-dimensional plan. Yuanta Securities Investment Trust apparently was the leader in the high-efficiency group during that period, indicating that the other branches of the financial holding company were

able to provide effective support by helping the investment trust operation market the funds and serve its clients. The synergy generated from the formation of the financial holding company was there. On the contrary, Shin Kong Securities Investment Trust, despite its massive assets, failed to manage business effectively and trailed behind in 2010 as a result of its low efficiency. In the future, it should fully utilize the advantages of the channels of the financial holding company to boost its management efficiency.

This study uses a two-stage DEA method to conduct in-depth analysis of the management performance of investment trust firms of Taiwanese financial holding companies. The Super SBM Efficiency model is also adopted to solve the problem of indistinguishableness of management performance if a number of efficiency scores turn out to be 1 at the same time when other types of models are applied. The two-stage DEA management efficiency matrix clearly shows the high-efficiency group and the low-efficiency group, making it possible to establish the changes in the industry and the operating efficiency and profit efficiency scores and, based on these results, offer suggestions to each firm with regard to efficiency improvement. It is also recommended that each financial holding company must pay attention to changes in the external environment all the time and adjust its resource allocation accordingly in order to boost its competitiveness.

Study Limitations and Suggestions for Future Studies

Some financial holding companies have not yet gone public and this makes it difficult to obtain related data. In future studies, this limitation must be eliminated. The data on all financial holding companies must be examined to improve the accuracy of the results of analysis of the entire financial holding industry. Meanwhile, other input and output variables may also

be included in order to cover the changes taking place in this industry.

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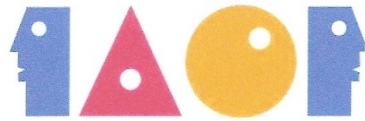
APPLICATION OF TOLERANCE METHOD TO THE TFT-LCD DESIGN

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Abstract

In the past few years, the TFT-LCD industry has become the driving force of the whole photonics market of Taiwan. As manufacturers establish new generations of TFT-LCD product lines, the key competitive advantages of this industry have shifted from mass-production to a low cost, diverse product and application mix and technological leadership. The objective of this research is to directly applied tolerance methods in product design and attempted to derive the appropriate material specification window to reduce costs. First, the propagation of error method was applied to compare two study cases and to find the critical items. Second, the Monte Carlo simulation was used to replace the target materials and the process capability was calculated to verify whether the resulting quality level met the design goals. Finally, the Taguchi method was used to double check the new design quality, and material costs were successfully reduced. This paper examines various tolerance design methods to reduce material costs. The methodology can not only be applied to new projects, but also be used to solve some of the design revision problems faced in smaller projects, so that the products can immediately achieve better performance.

Key Words: Tolerance Design, Propagation of Error, Monte Carlo Simulation, Taguchi Method

Introduction

In a competitive market, balancing product quality and cost is a challenging problem that every business needs to address, especially in the TFT-LCD industry (Hung et al., 2011). Generally, achieving higher product quality leads to higher costs. During manufacturing processes, tolerance, also known as the width between low and high manufacturing specifications, are parameters used to control quality due to the existence of variations in manufacturing. Tolerance has been an im-

portant factor in manufacturing processes since the idea of interchangeable parts was practically implemented. To achieve high quality, small tolerance is usually enforced, thus increasing operating difficulties. On the other hand, selecting broad tolerance ranges could violate the functionality requirements and lead to significant losses. It is difficult to manufacture a component with narrow tolerance band compared to a wider tolerance band. Narrow tolerance band require better material, machine tool, control mechanism, workman skills, extra processing time, measuring instruments and involvement of management (Yang and Naikan, 2003). This will definitely cost more compared to wider band manufacturing tolerances. Wider band tolerances will be cheaper, but there will be more number of rejections during quality checks, assembly, and problems during operation. Therefore, a systematic approach for tolerance design is important in today's manufacturing systems (Buranathiti, 2007). Although a manufacturing system that applies tolerance design could achieve high quality and lead to reduced operating costs, the performance may be lower in the product design phase. Brenda Reichelderfer of ITT Industries reported on their benchmarking survey of many leading companies, and stated that "design directly influences more than 70% of the product life cycle cost; companies with high product development effectiveness have earnings three times the average earnings; and companies with high product development effectiveness have revenue growth two times the average revenue growth." He also observed that "40% of product development costs are wasted!" (Phadke, 2010). Understanding the impact of variations in manufacturing on product performance and cost is thus critical in product development.

Industrial needs have driven a demand for increased design and drafting skills in the industrial technology discipline, especially when it comes to toler-

ance. It is now widely accepted that over 70% of final production costs are incurred during design (Boothroyd et al., 1994). Therefore, it is important for industrial technologists to realize how the design process affects the overall product cost when they are preparing process plans for a particular product. In particular, it is very important to understand the tolerance and identify the process mean based on the tolerance given by the designer. Consequently, the most critical stage of the overall design process is usually to identify the specification tolerance. Tight tolerance specifications lead to increased manufacturing costs, but broad tolerance specifications could cause the product assembly to fall short of its functional requirements. Finding the appropriate tolerance is thus the key to the movement from design to manufacturing with low cost and high quality (Li & Chen, 2001). Tolerance design is a means to manage the combination of the tolerance of each design parameter to achieve a criterion. Two schemes for the tolerance design are considered. The first scheme is to determine an optimal combination of the input tolerances to meet a specifically desired tolerance. The second scheme is to determine an optimal combination of the input tolerances to minimize the cost of quality (Buranathiti, 2007).

There are several methods proven worthwhile for tolerance design such as worst case tolerance analysis, root sum square method, statistical tolerance analysis, cost-based tolerance analysis, Monte Carlo analysis and Taguchi methods (Yang and El-Haik, 2003; Staudter et al., 2009). Nowadays some researchers even applied the method of tolerance design in non-manufacturing process (Narahari et al., 2000; Garg et al., 2004; Pan and Chen, 2012).

Review of Literature

Propagation of error (POE)

In formulating the tolerances of a product, sometimes an estimate is needed of the error of a quantity that is a function of several random variables. A simple example is stacking tolerance. Giving the standard deviations of three objects that are to be stacked, we want to know what the standard deviation of the resulting stack height is. Suppose object i has height X_i with standard deviation σ_i. Using a generalization of Function 1 with $a1 = a2 = a3 = 1$, the stack height $U = X1 + X2 + X3$ has a standard deviation of

$$\sqrt{\sigma^2 + \sigma^2 + \sigma^2} \; .$$

Propagation of Error is defined as the effects on a function due to a variable's uncertainty. It is a derived statistical formula designed to combine uncertainties from multiple variables. The purpose of POE is to provide an accurate measurement of uncertainty. Table 1 shows some example expressions, in which Function 4 is the general case of POE. The general expression is obtained from the first order terms of a Taylor series expansion.

Thus, it is only an approximation when the function is nonlinear (Nelson, 1992). The POE method has been applied extensively in many fields of research (Lee & Park, 2001; Xiong et al., 2002; Ferrero & Salicone, 2004; Anderson & Whitcomb, 2007). In this paper, the case company applied POE, and especially Function 4, to determine the reasonable tolerance.

Monte Carlo Simulation

Monte Carlo techniques, first developed by Metropolis and Ulam (1949), are statistical numerical methods that are applied to the simulation of random processes. Monte Carlo methods have been used in a wide variety of fields to solve problems spanning from the analysis of sub-atomic quantum physics to the devel-

opment of galaxies. An important feature of the Monte Carlo models is that they can be applied to both material and device simulations. A particularly attractive feature of this method is that it allows the simulation of physical processes, which cannot always be observed or reduced directly from laboratory experiments (Akarsu & Özbaş, 2005).

The Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of random numbers as inputs. It also assumes that components are combined in a random manner. This method is often used when the model is complex, nonlinear, or involves more than just a couple uncertain parameters. A key strength of Monte Carlo simulation is that it is simple and fast. Moreover, it appeals to a broad range of users who can describe a system using a set of basic math components, and yet do not understand how all the individual elements, when working simultaneously, can provide solution points to develop market insights. Second, the increasing speed of computers had made developing approximations faster than working out a complex math solution, which ma y still need sophisticated and time-consuming computer programming in order to run multiple case studies (James & Whiteside II, 2008). In analyzing the tolerance of a product, the Monte Carlo simulation is just one of many methods for analyzing uncertainty propagation, where the goal is to determine how random variation, lack of knowledge, or error affects the sensitivity, performance, or reliability of the system that is being modeled. In addition, unlike the Root Sum Square (RSS) method, Monte Carlo simulation does not need to have a normal distribution, and can be

Table 1. Approximate Variances of Various Functions

	Function	Approximate Variances
1.	$U = a_1 X_1 + a_2 X_2$	$\sigma_U^2 = a_1^2 \sigma_1^2 + a_2^2 \sigma_2^2$
2.	$U = a X_1^{b_1} X_2^{b_2}$	$\sigma_U^2 = U^2 \left[\left(\dfrac{b_1 \sigma_1}{X_1} \right)^2 + \left(\dfrac{b_2 \sigma_2}{X_2} \right)^2 \right]$
3.	$U = a \log_b (X_1)$	$\sigma_U^2 = \left(\dfrac{a}{\ln(b)} \right)^2 \left(\dfrac{\sigma_1}{X_1} \right)^2$
4.	$U = f(X_1, X_2, X_3, \Lambda)$	$\sigma_U^2 = \Sigma \left(\dfrac{\partial f}{\partial X_i} \right)^2 \sigma_i^2$

Table 2 Process capability (Cpk) implications

Process	Cpk	Spec range	Ppm defective
Not capable	<1	± 3 Sigma	2700
Capable	1.33	± 4 Sigma	63.5
Very capable	1.67	± 5 Sigma	0.6
Six Sigma	2	± 6 Sigma	0.002
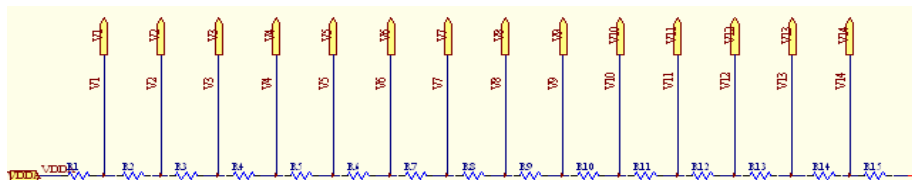
Figure 1 Gamma Wiring Diagram

used to visualize different distributions. In practice, which tolerance analysis method e.g. the number of tolerances, accessibility of the process data, what should be analyzed, and so on. The Monte Carlo method is often used in Design for Six Sigma (DFSS) to analyze the sensitivity of a prototype system, and to predict yields and/or process capability index of Cp and Cpk values. CPK is a quantitative measure of how much variation there is in the product or process with respect to the requirements/specifications (Table 2).

In a Six Sigma environment, capability metrics for Y (output), such as CP, CPK and DPPM are usually computed for the purposes of verifying achieving the goals or not in the final stage of improvement. A product design should ideally have a small degree of sensitivity to proc-

ess variation, so that its performance remains well within specification limits (Scibilia, 2009). In this paper, the case company used Minitab software to quickly generate a very large number of simulated values, along with the integrated statistical and graphic capabilities, making this a very powerful tool for Monte Carlo simulation methods.

Taguchi Method

Taguchi method provides a way of thinking that emphasizes a philosophy of freely using the methods of design of experiments to solve engineering problems (Li et al., 1998). Genichi Taguchi refers to experimental design as "off- line quality control" because it is a method of ensuring good performance in the design stage of products or processes (NIST/ SEMATECH, 2010). Taguchi developed procedures that apply orthogonal arrays of statistically designed experiments to efficiently obtain the best model with the fewest possible experiments. These methods utilize two-, three-, and mixed- level fractional factorial designs. However, most Taguchi procedures have been applied to analyzing only linear systems under the assumption of the addition of individual factor effects (Tong et al., 1997). The advantage of using the Taguchi method is in the reduction of both production cost and time, and it can also minimize the effects of uncertainties or variations in design parameters (Phadke, 1989).

Tolerance Design deals with the problems of how and when to specify tightened tolerances for a product or a process so that quality and perform-ance/productivity are enhanced. Every product or process has a number —perhaps a large number — of components. It is a natural impulse to believe that the quality and performance of any item can easily be improved by merely tightening up on some or all of its tolerance requirements. However, it is necessary to realize that tolerance design—the

selection of critical tolerances and the re-specification of those critical tolerances—is not a task to be undertaken without careful thought (NIST/SEMATECH, 2010).

The Taguchi method has been widely-used for quality improvement in many practical business applications (Bilen et al., 2001; Khoei et al., 2002; Steiner et al., 2005), and many companies around the world have saved hundreds of millions of dollars by using it in diverse industries, such as automobiles, xerography, tele-communications, electronics, software, and so on. In this paper, the case company used the Taguchi method to calculate the coefficient table to confirm the important component design factors.

Case Study

The case company was established in 1998, and it specializes in the manufacturing of TFT-LCD products. When it was first established, the company built up a clear operating concept of being dedicated to the R&D, manufacturing and sale of low-radiation, low power consumption, compact TFT-LCD. Its customers include leading electronics companies both in Taiwan and overseas. In the case company, the resistor specification, in another word the allowable error margin, is very small and the resulting register component price is very high. Currently, the Gamma resistor specifications are selected at 1% allowable error in the TFT-LCD system design.

If some of the resistor specifications can allow a larger margin of error and still retain the original tolerance specifications of Gamma voltage, the cost of resistor components may be reduced. In light of this, the case company formed a tolerance design project team with the aim of reducing the cost of the product.

Tolerance Design Process

In this paper, the case company adopts an effective process for tolerance design, using these five steps (Sleeper, 2003):

1. Define tolerance for Y
2. Develop transfer function
3. Compile variation data on X
4. Predict variation of Y
5. Optimize system

Research Results

Step 1: Define tolerance for Y

The project focused on TFT-LCD monitors and selected one of the firm's 19-inch products as the focal item. The Gamma wiring diagram for this monitor is shown in Figure1. There are fifteen resistor components in the system. Therefore, fifteen voltages and the 14 critical output parameters of the power supply for analog circuit - VDDA were considered manipulating. Every resistor has its own individual specifications, but they all have 1% allowable error. Each voltage also has its own specifications.

Step 2: Develop transfer function

Depend on the Gamma wiring diagram (Figure1), the transfer functions are as shown below.

$$Y_1 = V_1 = VDDA * \frac{R_{t1}}{R_{total}}$$

$$Y_2 = V_2 = VDDA * \frac{R_{t2}}{R_{total}}$$

M

$$Y_{13} = V_{13} = VDDA * \frac{R_{t13}}{R_{total}}$$

$$Y_{14} = V_{14} = VDDA * \frac{R_{t14}}{R_{total}}$$

where

$$R_{total} = R_1 + R_2 + ... + R_{14} + R_{15} = \sum_{i=1}^{15} R_i$$

$$R_{t1} = \sum_{i=1}^{15} R_i - R_1$$

$$R_{t2} = \sum_{i=1}^{15} R_i - \sum_{j=1}^{2} R_j$$

M

$$R_{t13} = \sum_{i=1}^{15} R_i - \sum_{j=1}^{13} R_j$$

$$R_{t14} = \sum_{i=1}^{15} R_i - \sum_{j=1}^{14} R_j$$

Step 3: Compile variation data on X

In order to understand the current status, the project team first selected ten sample products at random and measured the actual voltages, for VDDA from V1 to V14, with the results shown in Table 3. They also selected ten samples (error: 1%) at random and measured the actual resistor values, with the results shown in Table 4. Due to restrictions on component specifications, some of the values did not produce the 5% error for the resistors. With regard to the target 19- inch product, the suppliers could provide 5% resistor error for only R6, R7 and R12. The team also selected ten samples at random and measured the actual resistor values, and the results are shown in Table 5.

Before using the POE method to analyze the data, the team conducted a normality test including VDDA, R1-R15 (error: 1%), and R6, R7, R12 (error: 5%) using the Minitab software. The test results are shown in Table 6, and the data all followed a normal distribution. Then the POE method was used to calculate the contribution to variance of the above transfer functions. Case 1: R1-R15 with 1% error; Case 2: only R6, R7 and R12 with 5% error; the others with 1% error.

Table 3. Gamma Voltage Parameter Results

Parameter	VDDA	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14
mean	13.476	13.251	12.563	10.157	9.413	8.955	7.865	6.669	6.471	5.747	4.357	3.760	2.945	0.664	0.194
stDev.	0.477	0.046	0.442	0.362	0.330	0.327	0.027	0.208	0.213	0.020	0.014	0.011	0.011	0.002	0.002

Table 4. Gamma Resistor Parameter Results (Error: 1%)

Parameter	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
mean	20.618	63.373	220.690	68.174	42.272	99.989	110.180	18.249	66.596	126.930	54.977	74.872	210.010	43.300	17.816
stDev.	0.049	0.136	0.415	0.119	0.089	0.127	0.315	0.062	0.255	0.411	0.185	0.162	0.663	0.037	0.062

Table 5. Gamma Resistor Parameter Results (Error: 5%)

Parameter	R6	R7	R12
mean	100.220	110.030	74.905
stDev.	0.262	0.356	0.292

Table 6. The Normality Test Results

Normality test item	VDDA	R1 (1%)	R2 (1%)	R3 (1%)	R4 (1%)	R5 (1%)	R6 (1%)	R7 (1%)	R8 (1%)	R9 (1%)	R10 (1%)	R11 (1%)	R12 (1%)	R13 (1%)	R14 (1%)	R15 (1%)
p-value	0.614	0.217	0.416	0.611	0.120	0.668	0.895	0.082	0.705	0.247	0.333	0.900	0.813	0.131	0.840	0.662
Conclusion	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal
Normality test item	--	--	--	--	--	--	R6 (5%)	R7 (5%)	--	--	--	--	R12 (5%)	--	--	--
p-value	--	--	--	--	--	--	0.059	0.281	--	--	--	--	0.543	--	--	--
Conclusion	--	--	--	--	--	--	normal	normal	--	--	--	--	normal	--	--	--

Table 7. The Results of Contribution to Variance (%) for POE

	Contribution to Variance(%).																											
Item	V1		V2		V3		V4		V5		V6		V7		V8		V9		V10		V11		V12		V13		V14	
	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	5%	1%	5%	1%	1%	1%	1%	1%	1%	1%	1%	1%	5%	1%	1%	1%	1%
VDDA	100.0	100.0	99.9	99.9	98.5	98.5	98.1	98.0	97.8	97.6	96.7	96.2	94.6	93.9	94.3	93.4	92.2	91.4	87.4	86.1	83.7	82.0	75.3	74.9	86.5	86.0	50.4	50.2
R1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R2	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
R3	0.0	0.0	0.0	0.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.8	0.8	0.5	0.4
R4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
R5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.3	0.1	0.3	0.1	0.3	0.1	0.3	0.1	0.3	0.1	0.3	0.1	0.3	0.1	0.3	0.1	0.3	0.0	0.2
R7	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.5	0.6	0.5	0.6	0.5	0.6	0.5	0.6	0.4	0.5	0.4	0.5	0.4	0.6	0.3	0.3
R8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2
R10	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.4	0.4	0.9	0.9	0.9	1.0	1.5	1.5	0.8	0.8	0.7	0.7	0.7	0.7	0.8	0.8	0.4	0.4
R11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.7	0.7	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1
R12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.2	0.1	0.4	0.1	0.2	0.5	0.7	0.5	1.7	0.8	2.4	0.1	0.3	0.1	0.4	0.1	0.2
R13	0.0	0.0	0.0	0.0	0.2	0.2	0.4	0.4	0.6	0.6	1.1	1.1	2.3	2.2	2.3	2.5	3.8	3.8	8.7	8.6	12.7	12.5	21.9	21.8	2.0	2.0	1.2	1.1
R14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	2.3	2.3	0.0	0.0
R15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	6.4	6.3	46.8	46.7

The results are shown in Table 7, and they reveal that that the contributions to variance for V1-V14 do not have a very large impact on the results, and that the major factor is VDDA and the minor factors are R13, R15. Based on the POE output results, we can change the tolerance specification from 1% error to 5% error for R6, R7 and R12.
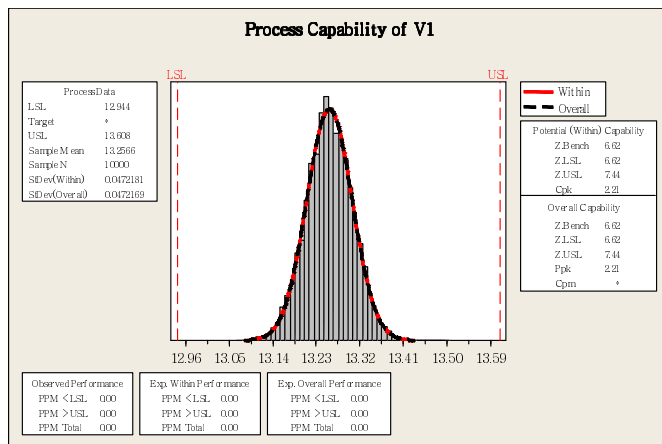
Zlt=6.62, Cpk=2.21

Figure 2. Process capability of V1

Table 8. The Results of the Zlt and Cpk analysis for Monte Carlo Simulation Data

Output	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14
Zlt	6.62	6.62	6.65	6.65	6.60	6.50	6.44	6.38	6.27	6.14	5.90	5.77	*	*
Cpk	2.21	2.22	2.22	2.22	2.20	2.17	2.15	2.13	2.09	2.05	1.97	1.92	6.44	17.01

Table 9. Taguchi coefficient table for output voltages

Taguchi coefficient table.			
Output	S	R-Sq(adj)	important factor
V1	0.0000016602	100.00%	VDDA
V2	0.0000067065	100.00%	VDDA
V3	0.0000237489	100.00%	VDDA
V4	0.0000289105	100.00%	VDDA
V5	0.0000321498	100.00%	VDDA
V6	0.0000386900	100.00%	VDDA
V7	0.0000460650	100.00%	VDDA
V8	0.0000455764	100.00%	VDDA
V9	0.0000503847	100.00%	VDDA
V10	0.0000596494	100.00%	VDDA
V11	0.0000637123	100.00%	VDDA
V12	0.0000681763	100.00%	VDDA
V13	0.0000836252	100.00%	VDDA
V14	0.0000867300	99.98%	VDDA

Step 4: Predict variation of Y

In order to verify the above design decisions, the team used a Monte Carlo restrictions on component specifications, some of the values did not produce the 5% error for the resistors. The case company could not gain the more cost reduction, it may search for new suppliers to design and manufacturing. This case study illustrates how a design may be fully optimized, thus the case company decided to continue implementing tolerance design.

Discussion

The final results still retained the original tolerance specifications (Cpks were over 1.67) and achieved the cost reduction of resistor components. Due to projects over the long run.

Conclusion

Increasing competitive pressure from global markets and technological developments have resulted in the continual demand for organization improvement methodologies in operations management, especially with regard to the TFT-LCD design. As manufacturers establish the new generation TFT-LCD production lines, the key competitive advantages of this industry vary from mass-production to low cost, diverse product and application mix and technology leadership.

This paper examines various tolerance design methods to reduce material costs, which are part of the tools used in the DFSS (Design for Six Sigma) methodology. The DFSS methodology can not only be applied to new projects, but also be used to solve some of the design revision problems faced in smaller projects, so that the products can immediately achieve better performance simulation to iteratively evaluate the transfer functions using 10,000 random data as inputs. They then

implemented capability analyses for the outputs from V1 to V14. For example, Figure 2. shows the process capability of V1, and the total results are shown in Table 8. The Zlt results were over the 4.5 level and the Cpk were over 1.67, thus indicating a high level of process performance. They therefore used the 5% error specification for the R6, R7 and R12 resistors, while the voltage outputs of V1-V14 still sufficed for the design requirements. Finally, the team applied the Taguchi method to reconfirm the findings, and the Taguchi coefficient table (shown in Table 9) indicates that the most important factor is VDDA, supporting the findings of POE.

Step 5: Optimize system

From the analysis results, we know that the initial Gamma circuit had an over quality design (Cpk>1.67). The case company could thus change the resister design specifications for R6, R7 and R12 from 1% error to 5% error. By doing that the firm's 19- inch focal product can achieve a cost down benefit of $ 0.219 for each product, which is nearly 10% of the product cost.

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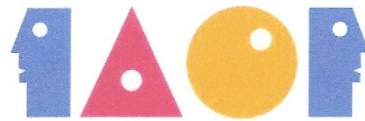
EFFECTS OF PSYCHOLOGICAL EMPOWERMENT ON ORGANIZATIONAL CITIZENSHIP BEHAVIOR IN LIFE INSURANCE INDUSTRY

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Abstract

Employees are required to actively execute altruistic behaviors beyond the posts, rather than focus on the productivity, in the increasing competition so as to develop the potential of the organization; while managers stress on employees' organizational citizenship behavior. This study tends to discuss the effects of psychological empowerment on organizational citizenship behavior. Total 400 copies of questionnaires are distributed to the southern cashiers of a life insurance company, ten employees in each cashier. Within 255 collected copies, 16 invalid ones are deducted that total 239 valid copies are retrieved, with the retrieval rate 59.75%.

Descriptive statistics, correlation analysis, reliability analysis, and regression analysis are applied to the data analysis, in which positive correlations and positive effects between perception of psychological empowerment and organizational citizenship behavior are found. The results show that an enterprise should understand the employees' perception of psychological empowerment to further affect the organizational citizenship behavior.

Key words: Psychological Empowerment, Organizational Citizenship Behavior, Regression Analysis

Introduction

Organizational citizenship behavior could provide managers with management information and present major contribution to the organizational operation. It could enhance cooperative behaviors to increase the capacity and solve problems among employees, allow managers applying the time to planning and production, promote team morale and courteous attitudes through altruistic behaviors, reduce time for conflict management, and promote employees' civil morality. By voluntarily participating in meetings, the coordination among team members could be achieved to enhance the team efficiency and efficacy, present sportsmanship, and be willing to bear new responsibilities or learn new skills to promote the ability of the organization adapting to the environment (Podaskoff ＆ MacKenzie, 2000). Podaskoff & MacKenzie (1994) discovered the

critical effects of organizational citizenship behavior on the achievement of organizational objectives. Managers should identify and cultivate healthy organizational citizenship behavior and monitor the employees' quality of work and life in order to develop more positive functions of organizational citizenship behavior.

Literature Review

The idea of empowerment, originated in ideology in 1960s and self-help social movement in 1970s, aimed to explore community psychology, mental health, and social work. After 1980s, empowerment was broadly utilized and discussed in organizational behavior and management, such as businesses, education, psychology, social work and boomed in late 1990s. Revised from Thomas & Velthouse's (1990) perception of psychological empowerment, Spreitzer (1995) remained the dimensions of meaning, competence, and impact and changed option into self-determination.

Present research on psychological empowerment and in-role performance mainly related to job satisfaction (Thomas & Tymon, 1994; Spreitzer et. al., 1997; Eylon & Bamberger, 2000) and job satisfaction and performance (Spreitzer, 1997), and appeared directly positive effects on job performance (Tuuli & Rowlinson, 2009). Research on psychological empowerment and extra-role organizational citizenship behavior was comparatively few, such as Bradley et al. (2006), who pointed out the positive effects of psychological empowerment on organizational citizenship behavior. Ahearne, Mathieu & Rapp (2005) indicated the relations between psychological empowerment and organizational citizenship behavior. Tyler (1999) considered that perception of psychological empowerment could enhance individual identity of an organization, resulting in the power to assist in the organization. When an organization established condi-

tions to enhance individual value in the organization, social identity and exchange motivation should result in employees' direct citizen behaviors towards the organization (Brief & Motowidlo, 1986) that promoting organizational value and maintaining individual status were regarded as the employee value (Masterson, Lewis, Goldman & Taylor, 2000). Alge et al. (2006) found out the positive effects of psychological empowerment on organizational citizenship behavior. Singh, 2000; Zeithaml, Berry & Parasuraman (1988) discovered the special relations between psychological empowerment and organizational citizenship behavior in service departments.

Research Methods

Research Subject

A life insurance company in Taiwan is selected as the research subject. 400 copies of questionnaires are delivered and mailed to the employees in 40 southern cashiers, ten employees in each cashier. Deducting 16 invalid ones from the collected 255 copies, total 239 valid copies are retrieved, with the retrieval rate 59.75%.

Operational Definitions

Psychological Empowerment.

Spreitzer (1995) defined psychological empowerment as an individual experiences in intrinsic motivation, which were built on the perception of work role; i.e. the psychological status of an employee perceiving the empowerment from the supervisor. Spriziter's cognitive models of meaning, competence, self-determination, and impact are used as the dimensions for measuring psychological empowerment. Total 12 questions are covered, for which Likert's 5-point scale is utilized for extremely disagree to extremely agree with

the scores 1-5. The high scores present the higher psychological empowerment.

Organizational Citizenship Behavior.

According to the definition of Williams & Anderson (1991), organizational citizenship behavior is divided into organizational citizenship behavior - organization, (such as conscientiousness, sportsmanship, and civic virtue) and organizational citizenship behavior-individuals (such as courtesy, altruism). The former refers to the behaviors of employees making efforts to the organizational benefits; the latter indicates that the employees are willing to actively help people and concern other colleagues, with which the organization indirectly makes profits.

Referring to the viewpoints of Bradley et al. (2006) and Podsakoff et al. (1990), organizational citizenship behavior is divided into the dimensions of conscientiousness, sportsmanship, civic virtue, courtesy and altruism. Total 23 questions are measured with Likert's 7-point scale for never to always with the scores 1-7. The higher scores present the higher organizational citizenship behavior.

Research Results

Descriptive Statistics

According to the 239 valid copies of questionnaire from the southern cashiers of a life insurance company, the analysis results showed that 1.females (199 people, about 83.3％) were more than males (40 people, about 16.73％), 2.the majority was in the age group of 41-50 (90 people, about 37.7％), and the least group aged 61 and above (3 people, about 1.3％), 3.most of them presented the educational background of senior high schools (135 people, about 56.5％), and the least of them of graduate schools (2 people, about 0.8％), and 4.most of them showed the average

monthly income 20001-40000 NT dollars (99 people, about 41.4％), and the least of them made more than 100000 NT dollars per month (10 people, about 4.2％).

Reliability Analysis

Nunnally (1978) indicated that the reliability α higher than 0.7 presented favorable consistency. The reliability analysis of this study (239 valid samples) appeared Cronbach´s α of psychological empowerment and organizational citizenship behavior higher than 0.72, showing the reasonable attributes in the dimensions. The Cronbach´s α of psychological empowerment and organizational citizenship behavior appeared 0.872 and 0.922, respectively, in this study.

Correlation Analysis Among Variables

To test the correlations among the research variables, Pearson's correlation was applied to discussing the relations between psychological empowerment and organizational citizenship behavior. The mean, the standard deviation, and the correlation coefficient are shown in Table 1.

The descriptive statistical values of the research variables, including mean, standard deviation, and the correlations among sub-dimension are shown in Table 1. The mean of psychological empowerment appears 3.71 and organizational citizenship behavior 5.73, presenting the participants perceived higher organizational citizenship behavior than psychological empowerment. The positive correlations between psychological empowerment and organizational citizenship behavior revealed that the higher psychological empowerment perceived by the employees in the southern cashiers of the life insurance company, the higher organizational citizenship behavior they appeared. employees' perception of psychological empowerment therefore should be emphasized in

Table 1. Mean, standard deviation, and the correlation coefficients of sub-dimensions

Variable	M	S.D	PE1	PE2	PE3	PE4	OCB1	OCB2	OCB3	OCB4	OCB5
PE	3.71	0.54									
OCB	5.73	0.52									
PE1	4.00	0.60	1								
PE2	4.01	0.59	0505 (**)	1							
PE3	3.88	0.76	0.458 (**)	0.494 (**)	1						
PE4	2.94	0.94	0.306 (**)	0.261 (**)	0.354 (**)	1					
OCB1	6.00	0.54	0.704 (**)	0.640 (**)	0.430 (**)	0.294 (**)	1				
OCB2	5.69	0.64	0.395 (**)	0.466 (**)	0.660 (**)	0.521 (**)	0.604 (**)	1			
OCB3	5.46	0.70	0.586 (**)	0.358 (**)	0.416 (**)	0.689 (**)	0.551 (**)	0.650 (**)	1		
OCB4	5.97	0.55	0.628 (**)	0.768 (**)	0.666 (**)	0.323 (**)	0.716 (**)	0.640 (**)	0.573 (**)	1	
OCB5	5.41	0.72	0.415 (**)	0.379 (**)	0.705 (**)	0.714 (**)	0.452 (**)	0.698 (**)	0.647 (**)	0.575 (**)	1

Note 1: * P<0.05   ** p<0.01   *** p<0.001

order to enhance organizational citizenship behavior.

Regression Analysis of Psychological Empowerment towards Organizational Citizenship Behavior

From Table 2, meaning and competence in psychological empowerment showed significantly positive effects on conscientiousness in organizational citizenship behavior; competence, self-determination, and impact presented remarkably positive effects on sportsmanship; meaning, and impact revealed notably positive effects on civic virtue; meaning, competence, and self-determination appeared significantly positive effects on courtesy; and, self-determination and impact showed remarkably positive effects on altruism. Apparently, the higher perception of psychological empowerment could better positively affect organizational citizenship behavior.

Conclusion and Suggestions

Conclusion

This study aims to discuss the effects of psychological empowerment on organizational citizenship behavior. In addition to individual characteristics of employees in the southern cashiers of the life insurance company, the correlations among variables and the effects of psychological empowerment on organizational citizenship behavior are understood. Based on the research findings, suggestions are proposed for the reference of life insurance industry and the direction for further research.

Table 2. Regression Analysis of Psychological Empowerment towards Organizational Citizenship Behavior

Dependent variable		Organizational Citizenship Behavior				
		Conscientiousness	Sportsmanship	Civic Virtue	Courtesy	Altruism
Independent variable		B	B	B	B	B
Constant term		2.949***	2.830***	2.444***	2.434***	2.311***
Psychological Empowerment	Meaning	0.501***	0.009	0.403***	0.232***	0.031
	Competence	0.376***	0.146***	-0.100	0.494***	-0.031
	Self-Determination	-0.001	0.473***	0.041	0.311***	0.519***
	Impact	0.043	0.313***	0.554***	0.013	0.529***
R		0.778	0.740	0.794	0.858	0.863
R^2		0.606	0.547	0.631	0.737	0.745
Adjusted R^2		0.599	0.539	0.625	0.732	0.741
F		89.951	70.607	99.959	163.762	170.826
P		0.000***	0.000***	0.000***	0.000***	0.000***

Note: * $p<0.05$ Significant ** $p<0.01$ Very significant *** for $p<0.001$ Extremely significant

The research results present the positive effects of psychological empowerment on organizational citizenship behavior. Such a result conforms to the research results of Spreitzer (1996), Bradley et al. (2006), Singh (2000), Zeithaml, Berry & Parasuraman (1988), Tyler (1999), Ahearne, Mathieu & Rapp (2005), and Alge et al. (2006). Katz (1964) emphasized extra-role behavior as willingness, cooperation, innovation, respect for systems, self-training, and good manners (Cheng, 2003) and indicated that the smooth operation of an organization did not simply depend on the employees completing the in-role job requested by the organization, but presenting innovative and autonomic behaviors beyond the requirements in the roles. The employees therefore could perceive the meaningful job and show ability on completing the tasks. Besides, being able to participate in decision-making allowed the employees perceiving the power of influencing the work that they would be willing to retain in the organization, make efforts to achieve the organizational performance or execute the innovation and willingness behaviors.

Todd & Angelo (2007) considered that organizational citizenship behavior could be the implementation of active outcomes or the avoidance of negative results. Robinson & Morrison (1995) pointed out OCB as a social exchange between employees and the organization that the employees would work more meaningfully and appear extra-role behaviors, like altruistic behaviors, when perceiving the efforts being identified by the organization. The win-win situation between the employees and the organization would therefore be achieved. Based on the idea of reciprocation, Organ (1990) mentioned that organizational employees were likely to reciprocate with civic behaviors when they perceived the supervisors often presenting positive assistance on them. The mutually dependent employees and supervisors in life insurance industry should better understand the meaning so as to create significant performance.

Suggestions

According to the employee characteristics, more females engage in life insurance industry than males do, more of them appear the education background of senior high schools, and the majority of them are in the age group of 41-50. Enhancing male employees, promoting the quality, and increasing the participation of young people should be considered in the recruitment in order to balance the human resource structure. Furthermore, the research findings show the positive correlations and positive effects between psychological empowerment and organizational citizenship behavior that the following suggestions are proposed for life insurance industry.

In such an era when there are numerous cashiers in life insurance industry, managers should enhance the employees' perception of psychological empowerment with ability to deal with affairs, make work more meaningful, provide better services, and understand the real demands of customers for better revenue. In this case, when promoting the awareness of a company through the marketing of Internet, newspaper and magazines, the employees' perception of psychological empowerment should also be taken into account so as to enhance the enthusiasm for the company.

Aquino & Bommer (2003) discovered that OCB could enhance the social attraction of employees in the sectors, as the positive behaviors in the organization, and allow the employees acquiring better networking with colleagues and friends. Leaders in life insurance industry therefore are suggested to really understand the work ability and intention of employees, play the role of a coach to interact and dialogue with the employees, and make correct behaviors by realizing the intention and ability. Moreover, leaders should spend time on understanding the members' situations for making proper decisions to enhance the team performance, reinforce the employee development and growth and team execution. In addition to the revenue, extra-role behaviors should also be emphasized.

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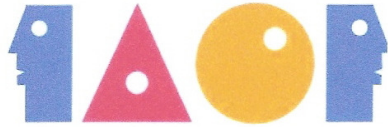
NOVEL INVESTMENT STRATEGIES IN STOCK MARKET: THE APPLICATION OF EXTENTICS AND GREY THEORY

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Abstract

The purpose of this research is to devise the selection and transaction mechanisms for stock trading, which could assist investors in making investment decisions. To establish the optimum trading model, this research analyzed financial statements using Extentics to identify companies with superior financial status as investment targets, and forecasted the potential fluctuations in stock prices using the grey theory. The result indicates that applying the investment strategies proposed by this research to the financially excellent companies is the most profitable. Regarding the companies which have good and moderate financial indicators, the transaction mechanism using the grey theory is not the most significant; however, the investment losses to those companies can effectively be controlled within a small range. Therefore, the trading model developed by this research can maximize the investor profits when investing in companies with excellent financial performance, and be effective in investment risk control when investing companies with moderate financial performance.

Key Words: Investment and financial management, Extentics, grey theory

Introduction

Among numerous financial products, investment in stock markets is preferable to general investors because the return on stock investment is better than other financial products. However, high investment returns implies high risks; investors must be more careful. To reduce risk, financial experts suggest not to put all our eggs into one basket. However, putting eggs into excessive numbers of baskets can dilute capital, reducing profit margins. Therefore, determining the level of capital dispersion is a crucial element for comprehensive and optimum investment strategies. The pur-

pose of investment is to pursue higher returns on capital. Recently, because of the abundance of innovative financial products, investors face more variables of uncertainty and incompleteness of information when making investment decisions. To assist investors in investment decision-making, this research proposes an innovative strategy for stock market investment, shielding investment decisions from the influence of individual subjective consciousness. This research uses the Extentics and the grey theory to build an investment decision-making framework that provides investors with comprehensive investment information.

Financial statements are the official financial reports that enterprises provide for outsiders, which present the financial conditions on a given date, the operating performance during a given period, and other financial information. There are four major financial statements that general business entities should reveal quarterly: balance sheets, income statements, statements of change in owner's equity, and cash flow statements. The information in financial statements explains the conditions and results of business operations. For investors, financial statements are essential information in decision making (Bernstein & Wild, 2000). Investors must integrate various analytical methods and techniques to decode the high value-added financial information implied in financial reports to make successful investment decisions. Financial ratio analysis simplifies complicated financial information, which uses percentages, ratios, or fractions to interpret accounting terms within a given period, allowing statement users to obtain correct and clear information, and further to grasp the relationship and trends of companies via the change in financial ratios (Hong & Li, 2003). Generally, investors can analyze corporate financial ratios using the twenty financial analysis ratios in the five dimensions published by Taiwan Stock Exchange Corporation (TSEC),

including the capital structure of listed/OTC companies, liquidity ratios, activity ratios, profitability ratios, and cash flow, as presented in Table 1.

In the nineteenth century, Munehisa Honma was the first person to apply the Sakata strategy to the futures exchange market of Japanese rice. Then, following traders further incorporated the price and volume of real market transactions in developing a candlestick charting theory (Hong & Lu, 2005; Du, 2006). The current technical analysis primarily uses professional methods to organize the opening and closing prices and the highest and lowest strike prices for a given day, presenting the analytical result via shapes, figures, indices, and numbers. Investors can use the information to forecast potential stock prices and assess the trends in stock prices. Technical indicators refers to time series data calculated by stock price, volume, and advance/decline numbers using various equations, which can reflect possible changes in individual stock prices and indices. Technical indicators can be categorized into the three groups of price, volume, and market psychology, as presented in Table 2.

The financial ratios and technical indicators commonly used in actual stock-selection operations are defined as the matter element in the Extentics; after systematic analysis, the information can be used by investors as a stock-selection strategy. Finally, we propose a "grey prediction theory" for predicting potential trends in stock price fluctuations. By constructing and validating a grey model, we help investors grasp the optimal timing for trading stocks. To verify the feasibility of the trading pattern proposed in this research, we compare this trading pattern with the technical analysis techniques used by professional security practitioners as indicated in the survey results. The aim of this research is to construct a rational and robust investment decision-support system

for pursuing a better return on investment, allowing investors to maximize profits.

Mathematical Methodology

Extentics

The Extension set and incompatibility problem introduced by Wen Tsai began the new science of extension engineering, the origin of the extension method. Extension engineering proposed an ideological framework for contradictory problems. The theory can reflect the related exchange relationships among subjects, characteristics, and vectors through the structure and exchange of matter-elements (Tsai, 1983). When humans resolve practical problems, they encounter many contradictions. The level of contradiction between problems can be quantified into a given vector based on the correlation of the subjects and characteristics of each matter-element, to align with the statement of high/low scales of correlation between each matter-element. Both numerical and non-numerical contradictory values among matter-elements are quantified into numerical values and applied to real axes using the Extentics, describing the numerical relationship using correlation functions (Tsai & Lin, 2001; Xie, 1998). The practical method is detailed below.

The distance between points is defined in classical mathematics. Namely,

$$\rho(x, y) = |x - y| \qquad (1)$$

To highlight the relationship between points and intervals in the extension correlations, the concept of distance is extended. Assuming that x is a given point in a real field $(-\infty, +\infty)$, $X_0 = <a,b>$ suggests a given interval in the real field. The distance between point x and interval X_0 can be presented as follows:

$$\rho(x, X_0) = \left| x - \frac{a+b}{2} \right| - \frac{b-a}{2} \qquad (2)$$

If point x is located outside interval X_0, $\rho(x,X_0)$ is positive, and if point x is located inside interval X_0, $\rho(x,X_0)$ is negative.

In real problems, we consider not only the positional relationship between point and interval, but also the positional relationship between intervals, and between one point and two intervals. The term *rank value* is used to describe the positional relationship between one point and two intervals.

Assuming that $X_0 = <a,b>$, $X = <c,d>$, and $X_0 \subset X$, $D(x, X_0, X)$ is the rank value of point x to intervals X_0 and X. The equation is presented as follows:

Table 1. Twenty financial analysis ratios in the five dimensions of financial analysis

Financial dimension	Financial Analysis ratios
Capital structure	Debt ratio, long-term capital ratio
Liquidity ratios	Current ratio, quick ratio, times interest earned
Activity ratios	Receivables turnover, average collection period, inventory turnover, average days of sales, fixed asset turnover, total asset turnover
Profitability ratios	Return on assets, return on equity, operating income to paid-in capital, profit before tax to paid-in capital, net profit margin, earnings per share
Cash flow	Cash flow ratio, cash flow adequacy ratio, cash flow reinvestment ratio

Source: Taiwan Stock Exchange Corporation (TSEC)

Table 2. Seventeen technical indicators for stock market analysis

Dimension	Technical indicators
Price	Moving average, BIAS, moving average convergence and divergence, relative strength index, stochastic index, directional movement index, momentum index, parabolic SAR, William overbought/oversold index
Volume	On balance volume, volume ratio, turnover value index, counterclockwise curve
Market psychology	Psychological line, overbought-oversold index, advance decline line, advance decline ratio

Table 3. The constituent stocks of TSEC Taiwanese technology index

Inotera	Pegatron	Chimei	TSMC	UMC
ASUS	Winbond	ASE	Compal	Tatung
Inventec	Quanta	Macronix	VIA	CMC
Qisda	SPIL	Ability	Acer	Realtek
Gigabyte	MSI	WPG	Chicony	Advantech
Clevo	D-Link	NTC	AUO	MiTAC
Synnex	Faraday	Elan	Novatek	MediaTek
Liteon	HannStar	Transcend	HTC	PTI
Wistron	Richtek	Kinsus	*	*

$$D(x, X_0, X) = \begin{cases} \rho(x, X) - \rho(x, X_0) & x \notin X \\ -\dfrac{|a-b|}{2} & x \in X_0 \end{cases} \quad (3)$$

Establishing correlation functions can assist us in understanding the depth in the level of correlation of matters of concern and issues currently under discussion. The following is the correlation function through the concept of distances and rank values.

$$K(x) = \frac{\rho(x, X_0)}{D(x, X_0, X)} \quad (4)$$

In a given field $U \in (-\infty, +\infty)$ and a given interval $X \subset U$, the simple functions $K(x)$ and $x \in U$ are correla

tion functions, which is the extension set $\bar{X}_0 = \{(x, y) | x \in U, y = K(x)\}$.

For example, when given $X_0 = <3,5>$, and $X = <1,9>$, the meaning of $D(2, X_0, X)$ and $D(6, X_0, X)$ are presented in Fig. 1 (Tsai, 1983).

The correlation functions are calculated below:

$$K(2) = \frac{\rho(2,X_0)}{D(2,X_0,X)} = \frac{\left|2-\frac{3+5}{2}\right|-\frac{1}{2}(5-3)}{\left|2-\frac{1+9}{2}\right|-\frac{1}{2}(9-1)-\left|2-\frac{3+5}{2}\right|+\frac{1}{2}(5-3)} = -\frac{1}{2}$$

$$K(4) = \frac{\rho(4,X_0)}{D(4,X_0,X)} = \frac{\frac{1}{2}(5-3)-\left|4-\frac{3+5}{2}\right|}{\frac{|3-5|}{2}} = 1$$

$$K(6) = \frac{\rho(6,X_0)}{D(6,X_0,X)} = \frac{\left|6-\frac{3+5}{2}\right|-\frac{1}{2}(5-3)}{\left|6-\frac{1+9}{2}\right|-\frac{1}{2}(9-1)-\left|6-\frac{3+5}{2}\right|+\frac{1}{2}(5-3)} = -\frac{1}{4}$$

The correlation functions of points 2 and 6 are -1/2 and -1/4, respectively. Because point 4 is the middle of interval X_0, the correlation function is one, reaching the maximum value.

Figure 2 shows the diagram of correlation functions on which the correlation degrees of points 0, 1, 3, 5, 7, 8, 9, and 10 are also calculated. The correlation functions of these points are -3/2, −1, 0, 0, -1/2, -3/4, −1, and -5/4, respectively; indicating that the closer the point to interval X_0, the larger the correlation degree is.

Grey System Theory

In data prediction, black represents incomplete information, white means complete information, and grey suggests the intermediate zone between complete and incomplete information. The grey system theory is used to discuss ambiguous information. Professor Deng (1982) proposed the grey system theory in 1982, which was the inception of this new discipline. Deng used the small sample size, inadequate information, and uncertain system of partially known and unknown information as his research subject, extracting valuable information from the formation and development of partially known information, which can evolve into regular correct descriptions and effective surveillance (Wen, 2004). After the birth of grey theory, its applications were widely spread in various scientific researches which contribute greatly in human society. The importance and development of grey theory was elaborately described by Liu (Liu, 2007)

In order to enhance the forecasting precision, authors improved the original GM(1,1) by incorporating the idea of Bernoulli differential model. The improved GM(1,1) is called nonlinear grey Bernoulli model (NGBM).

(a)

(b)

Figure 1. The meaning of $D(2,<3,5>,<1,9>)$ and $D(6,<3,5>,<1,9>)$ [4]
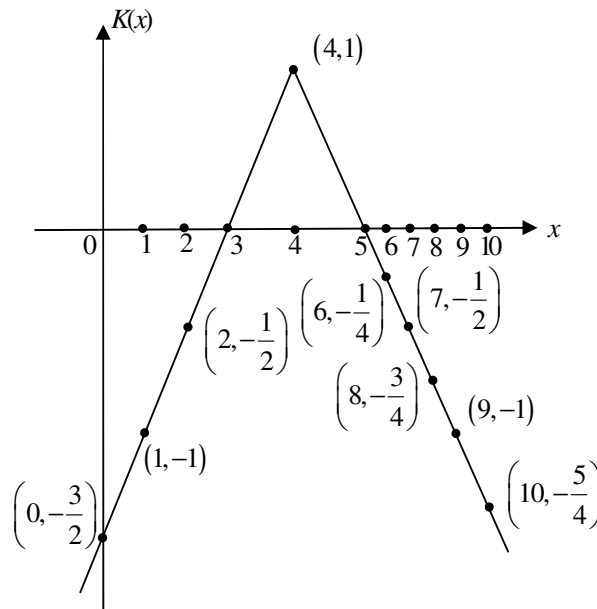
Figure 2. The schematic diagram of the correlation functions

The NGBM features the simple inference process of the GM(1,1) model, and requires only four data entries to construct the model; thereby reducing the forecast error of the GM(1,1), and promoting the forecast accuracy for nonlinear data (Chen, Chen & Chen, 2008; Chen, Shin & Wu, 2010). The derivation process of NGBM is explained as follows:

(1) Raw sequences are defined using the data:

$$X^{(0)} = (x^{(0)}(1), x^{(0)}(2), L, x^{(0)}(n)) . \quad (5)$$

(2) The raw sequences are added using accumulated generation operation (AGO), of which purpose is to be fitted by exponential functions:

$$X^{(1)} = (x^{(1)}(1), x^{(1)}(2), L, x^{(1)}(n)) \quad (6)$$

where $x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i)$, $k = 1, 2, L, n$

(3) The NGBM differential and difference equations are established using the Bernoulli differential equation.

$$\frac{dX^{(1)}}{dt} + aX^{(1)}(t) = b\left[X^{(1)}\right]^{\gamma} . \quad (7)$$

In the equation, a is the development coefficient, b is the grey control coefficient, and γ is a real number not equal to unity.

Using the definition of discretization
$$\frac{dX^{(1)}}{dt} \cong \frac{x^{(1)}(k + \Delta t) - x^{(1)}(k)}{\Delta t} . \quad (8)$$

By setting $\Delta t = 1$,
$$\frac{dX^{(1)}}{dt} \cong X^{(1)}(k+1) - X^{(1)}(k) = X^{(0)}(k) \quad (9)$$

and let $X^{(1)} \approx Z^{(1)}$.
In the equations,

$$Z^{(1)}(k) = \alpha X^{(1)}(k) + (1 - \alpha)Z^{(1)}(k-1), k = 2 \sim n \quad (10)$$

Generally, α is set to be 0.5.
Therefore, the difference equation can be rearranged as follows:

$$X^{(0)}(k) + aZ^{(1)}(k) = b\left[Z^{(1)}(k)\right]^{\gamma}, k = 2 \sim n \tag{11}$$

(4) Parameters a and b are solved using the least squares method. Putting the raw data in the difference equation:

$$X^{(0)}(2) + aZ^{(1)}(2) = b\left[Z^{(1)}(2)\right]^{\gamma}$$

$$X^{(0)}(3) + aZ^{(1)}(3) = b\left[Z^{(1)}(3)\right]^{\gamma}$$

$$\text{M}$$

$$X^{(0)}(n) + aZ^{(1)}(n) = b\left[Z^{(1)}(n)\right]^{\gamma}$$

Rearrange above set of equations and transform them into matrix form $Y = B\theta$. Of which,

$$Y = [X^{(0)}(2)\ \ X^{(0)}(3)\ \ \text{L}\ \ X^{(0)}(n)]^{T}$$

$$B = \begin{bmatrix} -\frac{1}{2}[X^{(1)}(1)+X^{(1)}(2)] & \left(-\frac{1}{2}[X^{(1)}(1)+X^{(1)}(2)]\right)^{\gamma} \\ -\frac{1}{2}[X^{(1)}(2)+X^{(1)}(3)] & \left(-\frac{1}{2}[X^{(1)}(2)+X^{(1)}(3)]\right)^{\gamma} \\ \text{M} & \text{M} \\ -\frac{1}{2}[X^{(1)}(n-1)+X^{(1)}(n)] & \left(-\frac{1}{2}[X^{(1)}(n-1)+X^{(1)}(n)]\right)^{\gamma} \end{bmatrix}$$

Y is the raw data sequence, B is the data matrix, and θ is the parameter list. Using the least squares method:

$$\theta = \left(B^{T}B\right)^{-1}B^{T}Y \tag{12}$$

The expansion equation of parameters a and b can be expressed as follows:

$$a = \frac{\sum_{k=2}^{m}\left[z^{(1)}(k)\right]^{n+1}\sum_{k=2}^{m}\left\{x^{(0)}(k)\left[z^{(1)}(k)\right]^{n}\right\} - \sum_{k=2}^{m}\left[z^{(1)}(k)\right]^{2n}\sum_{k=2}^{m}x^{(0)}(k)z^{(1)}(k)}{\sum_{k=2}^{m}\left[z^{(1)}(k)\right]^{2n}\sum_{k=2}^{m}\left[z^{(1)}(k)\right]^{2} - \left(\sum_{k=2}^{m}\left[z^{(1)}(k)\right]^{n+1}\right)^{2}} \tag{13}$$

$$b = \frac{\sum_{k=2}^{m}\left\{x^{(0)}(k)\left[z^{(1)}(k)\right]^{n}\right\}\sum_{k=2}^{m}\left[z^{(1)}(k)\right]^{2} - \sum_{k=2}^{m}\left\{x^{(0)}(k)z^{(1)}(k)\right\}\sum_{k=2}^{m}\left[z^{(1)}(k)\right]^{n+1}}{\sum_{k=2}^{m}\left[z^{(1)}(k)\right]^{2n}\sum_{k=2}^{m}\left[z^{(1)}(k)\right]^{2} - \left(\sum_{k=2}^{m}\left[z^{(1)}(k)\right]^{n+1}\right)^{2}} \tag{14}$$

(5) The accumulated forecast equation using the NGBM can be expressed as follows:

$$\hat{X}^{(1)}(k+1) = \left[(X^{(0)}(1)^{(1-\gamma)} - \frac{b}{a})e^{-a(1-\gamma)k} + \frac{b}{a}\right]^{\left(\frac{1}{1-\gamma}\right)}, \gamma \neq 1, k = 1 \sim n \tag{15}$$

In the equation, when $\gamma = 0$, it is reduced to the GM(1,1), which is shown below.

$$\hat{X}^{(1)}(k+1) = \left[(X^{(0)}(1) - \frac{b}{a})e^{-ak} + \frac{b}{a}\right], k = 1 \sim n \tag{16}$$

When $\gamma = 1$, the equation does not exist as $\left(\frac{1}{1-\gamma}\right)$ approaches to infinity.

(6) As in the GM(1,1), inverse accumulated generating operation (IAGO) is conducted on the forecast value obtained by the previous equation to calculate the actual forecast value:

$$\hat{X}^{(0)}(k) = \hat{X}^{(1)}(k) - \hat{X}^{(1)}(k-1) \tag{17}$$

Investment Strategy

Data Collection

The sample of this research was recruited from the constituent stocks of the TSEC Taiwan Technology Index published. The Taiwan Technology Index is compiled by TSEC and the Financial Times Stock Exchange (FTSE) Index Company of the U.K., which selects the constituent information technology stocks of the FTSE Global Classification System from the 150 constituent stocks of FTSE TWSE Taiwan 50 Index and the FTSE TWSE Taiwan Mid-Cap 100 Index. These blue-chip stocks have passed the free float and transaction liquidity tests, providing the cost effectiveness of market transactions. For investors, these blue-chip stocks can disperse investment risks, eliminating the trouble of stock selection. A total of 43

listed companies were selected from the Taiwan Technology Index, as shown in Table 3.

The Stock Selection Model

This research used the Extentics to analyze and arrange the constituent stocks of the TSEC Taiwan Technology Index, selecting the optimal investment target. The Extentics can elaborately handle any different and contradictory matter-element problems; however, a primary issue of complexity is the assessment of values that need to be processed in advance. First, based on the data collected and successful trial data generated by the process, we classified the quality levels of different and contradictory matter-element problems into several categories, such as $A+$, A, B, C, and D. Then, we defined the data range according to the database or expert opinion, conducting indicator assessment by putting the matter-element problem indicators into each level set for assessment. Finally, we compared the correlation between the indicator and each level set. The larger the degree of correlation, the better the degree of conformation with the level set. The concrete assessment procedures are presented as follows:

(1) Confirm the classical region of the element-matter model

$$R_{0j} = \left(N_{0j}, C, V_{0j}\right) = \begin{bmatrix} N_{0j} & c_1 & V_{0j1} \\ & c_2 & V_{0j2} \\ & L & L \\ & c_n & V_{0jn} \end{bmatrix}$$

$$= \begin{bmatrix} N_{0j} & c_1 & \left(a_{0j1}, b_{0j1}\right) \\ & c_2 & \left(a_{0j2}, b_{0j2}\right) \\ & L & L \\ & c_n & \left(a_{0jn}, b_{0jn}\right) \end{bmatrix}$$

(18)

In the equation, N_{0j} indicates j number of quality, $c_i = (1, 2, L, n)$ indicates the characteristic of quality level N_{0j}, and V_{0ji}

is the vector range of N_{0j} regarding characteristic c_i. Among these, the upper and lower limits of vector range V_{0ji} are a_{0ji} and b_{0ji}, respectively; that is, the data range of the corresponding characteristics of each quality level is set as the classical region.

(2) Confirming the joint field of the matter-element model

$$R_P = \left(P, C, V_p\right) = \begin{bmatrix} P & c_1 & V_{P1} \\ & c_2 & V_{P2} \\ & L & L \\ & c_n & V_{Pn} \end{bmatrix}$$

$$= \begin{bmatrix} N_{0j} & c_1 & \left(a_{P1}, b_{P1}\right) \\ & c_2 & \left(a_{P2}, b_{P2}\right) \\ & L & L \\ & c_n & \left(a_{Pn}, b_{Pn}\right) \end{bmatrix}$$

(19)

In the equation, P means the set of subjects for assessment, and V_{Pi} is the vector range determined by P regarding c_i; of which, the upper and lower limits of the vector range V_{Pi} are a_{Pi} and b_{Pi}, respectively, which is the joint field of P.

(3) Confirming the matter-elements for assessment

Regarding the subjects for assessment, this research used matter-elements to present the result of test data and analysis; that is, the subject matter-element for assessment.

$$R = \begin{bmatrix} p_0 & c_1 & v_1 \\ & c_2 & v_2 \\ & L & L \\ & c_n & v_n \end{bmatrix}$$

(20)

In the equation, P_0 means the subject for assessment, and v_i means the P_0 vector regarding c_i.

(4) Confirming the correlation between the subject for assessment and quality levels

The definition of distance can be applied to calculate the correlation coefficient of subjects for assessment, in terms of the concerned quality level (a given classical region of the matter-element model). According to the definition of distance, this research inferred that:

$$\rho(v_i, V_{0ji}) = \left| v_i - \frac{1}{2}(a_{0ji} + b_{0ji}) \right| - \frac{1}{2}(b_{0ji} - a_{0ji}) \ , i = 1, 2, L \ , n$$
(21)

$$\rho(v_i, V_{pi}) = \left| v_i - \frac{1}{2}(a_{pi} + b_{pi}) \right| - \frac{1}{2}(b_{pi} - a_{pi}) \ , i = 1, 2, L \ , n$$
(22)

The correlation coefficient of each level of the subject for assessment can be calculated using the following equation:

$$K_j(v_i) = \begin{cases} \dfrac{-\rho(v_i, V_{0ij})}{|V_{0ij}|} , & v_i \in V_{0ij} \\ \dfrac{\rho(v_i, V_{0ij})}{\rho(v_i, V_{pj}) - \rho(v_i, V_{0ij})}, & v_i \notin V_{0ij} \end{cases}$$
(23)

(5) Calculating the correlation of subject for assessment P_0 and level j

$$K_j(p) = \sum_{i=1}^{n} K_j(v_i)$$
（24）

$K_j(p)$ is the correlation coefficient of the subject for assessment P_0 and level j.

(6) Assessing quality level

If $K_{j0}(p_0) = \max\limits_{j_0 \in \{1,2,L \ ,m\}} K_{j0}(P_0)$, objective P_0 is optimal.

The Establishment of Matter Element Models

This research adopted the financial statements of 43 research companies published in the third quarter of 2010. The 20 financial analysis ratio indices of the five dimensions served as the matter-elements of the extension engineering theory, which can be seen in Table 4. The calculation methods of the upper and lower limits of the joint field depend on the financial ratios of each industry. The lower limit is the minimal value of all the financial ratios of the industry, and the upper limit is the maximum value; the upper and lower limits are increased and reduced by a factor of 0.01, respectively. The reason for increasing the upper limit and reducing the lower limit is because the matter-element value might be equivalent to the boundary value of the joint field if the maximum and minimum cannot be obtained directly, leading to difficulties in calculating correlation coefficients. The range of the joint field can be divided into several classical regions, as shown in Table 5.

This research divided financial indices into several categories based on the requirements of this study. Regarding debt ratio, collection days of receivable, and average days of sales, 0 to 20 % denotes excellent; 21 to 40 % denotes good; 41 to 60 % denotes moderate; 61 to 80 % denotes poor; and 81 to 100% denotes poorest. The opposite relationship was used for the rest of the financial ratios: 81 to 100 % denotes excellent, 61 to 80 % denotes good, 41 to 60 % denotes moderate, and so on. Classical regions were established based on the five intervals.

The model variables are the 20 financial analysis indices of the five dimensions published by TSEC. However, this research could select stocks after calculating the correlation functions because the gap of the financial indices of some stocks were too large, resulting in oversized gaps between the upper and lower limits of the joint field. Moreover, most of the stocks were located in extreme regions when classifying classical regions. Therefore, the researchers of this study decided to remove most financial indices. A total of seven financial ratios were ultimately selected: debt ratio, total assets turnover,

Table 4. The matter elements of the financial analysis ratio indices of TSEC Taiwan Technology Index stocks

Financial analysis ratios	Kinsus	Macronix	Advantech	Synnex	Novatek	Winbond	Acer
Debt ratio (%)	17.55	16.46	25.55	37.13	43.87	45.74	60.67
Long-term capital ratio (%)	263.95	247.81	535.72	2993.36	1357.52	126.89	6817
Current ratio (%)	316.18	375.84	137.52	93.1	185.06	105.43	119.32
Quick ratio (%)	276.41	329.88	96.28	67.87	160.08	68.8	99.42
Time interest earned (%)	187.96	2547.04	1945.22	26.53	102.76	8.78	50.51
Receivable turnover(times)	5.27	4.8	4.71	5.7	2.79	6.81	3.95
Average collection period (days)	69.26	76.04	77.49	64.04	130.82	53.60	92.41
Inventory turnover (times)	6.23	3.64	7.75	9.47	6.45	3.64	19.33
Average days of sales (days)	58.59	100.27	47.10	38.54	56.59	100.27	18.88
Fixed assets turnover (times)	1.34	1.56	4.99	24.64	17.43	0.58	242.85
Total assets turnover (times)	0.45	0.42	0.69	0.63	0.73	0.35	1.72
Return on assets (%)	7.96	13.35	13.72	8.15	10.53	5.8	4.98
Return on equity (%)	9.47	15.63	17.68	12.8	17.67	9.86	12.07
Operating income to paid-in-capital (%)	50.28	21.51	27.03	5.7	68.94	8.31	26.46
Profit before tax to paid-in-capital (%)	48.09	21.65	49.31	29.7	68.08	9.63	47.78
Net profit margin (%)	17	30.22	19.13	12.22	13.39	14.6	2.74
Earning per share (NTD)	4.09	2	4.53	2.92	6.19	0.96	4.24
Cash flow ratio (%)	127.96	104.26	33.33	3.39	8.41	42.96	-3.12
Cash flow adequacy (%)	115.38	167.3	114.41	69.73	160.92	58.6	4.52
Cash reinvestment ratio (%)	11.62	3	-5.54	-6.49	-7.27	8.4	-9.77

Source: Taiwan Stock Exchange Corporation

return on assets, return on equity, net profit margin, cash flow ratio, and cash flow reinvestment ratio. Of these ratios, debt ratio, total assets turnover, return on assets, and return on equity are the most frequently used; therefore, they are worthy of reference. The correlation function of the companies are calculated and tabulated in Table 6.

Selecting Transaction Timing

This research used the grey forecast model to predict stock prices over four subsequent days, and compared the forecasts with actual prices. When the actual closing price was higher than the forecast, this research predicted that the stock price would increase in the following four days, which was regarded as a buy signal. When the real closing price was lower than the forecast, this research predicted that the stock price would drop in the subsequent four days, and was regarded as a sell signal. Other situations should be observed further before taking any actions. This research used the NGBM grey forecast model to construct the data of the model; that is, the daily closing prices of the investment targets. Then, this research used the forecast data to predict future stock prices, and finally compared the forecasted and actual stock prices for determining buy and sell signals. To investigate the feasibility of the transaction strategy proposed by this research, we selected technical indicators according to the frequency of usage; therefore, the moving average, moving average convergence and divergence, stochastic, and relative strength indices were selected.

Verification of the Forecast Model

In order to verify the feasibility of proposed transaction mechanism, Taiwan semiconductor manufacturing company (TSMC) is selected to be the sample company. The research period is from July 1, 2009 to December 31, 2010. This research used the moving average (MA), moving average convergence and divergence (MACD), stochastic index (KD), and relative strength indices (RSI) and the grey forecast model for determining buy and sell signals. If a holding stock shows no buy and sell signal until December 31, 2010, we used that date as the final settlement day for calculating profits.

(1) Moving average index (MA)

This research used the intersection of quick and slow (short-and long- term) MA to judge transaction timing. When the quick (short-term) MA ascends past the slow (long-term) MA, this is the "golden cross," the time to buy. However, when the quick (short-term) MA descends past the slow (long-term) MA, this is the "death cross", or the time to sell. The transaction situation is shown in Table 7. During this period, profit was NTD -3.6.

(2) Moving average convergence and divergence index (MACD)

This research also used the intersection of difference (DIF) and difference exponential mean (DEM) to determine transaction signals. When DIF breaks DEM in ascension, it is a buy signal; conversely, when DIF breaks DEM in declination, it is a sell signal. The transaction situation is shown in Table 8. During this period, profit was NTD -2.8.

(3) Stochastic index (KD)

When the K line ascends past the D line and D is below 35, it is a buy signal. However, when the K line descends past the D line and D is above 65, it is a sell signal. The transaction situation is presented in Table 9. *D*uring this period, profit was NTD 9.6.

(4) Relative strength index (RSI)

Generally, the base period of the relative strength index can be 5, 10, or 20 days. This research used short- and long-term RSI to determine transaction timing. When the short-term (5 days) breaks the long-term (20 days) ascendingly, it shows a buy signal; when the short-term breaks the long-term descendingly, it indicates a sell signal . The transaction condition is

presented in Table 10. During this period, profit was NTD -15.2.

(5) Determining transaction timing using the grey forecast

We know that buying at a low price and selling at a high price is the best condition for making profits. However, individual investors observe stock markets over a long time period, and the low of stock prices is confirmed afterwards; hence, delayed buy and sell are common. When an actual price is lower than the forecast, we assume that the stock price may increase in the future, and we buy. Conversely, when an actual price is higher than the forecast, we assume that the stock price may decrease, and we sell the stock. The grey forecast transaction mechanism features objective mechanical operation, which can avoid errors caused by human emotions.

The transaction signal mechanism is shown in Fig. 3. At time point 1 (or day1), the actual stock price was higher than the forecasted price, and the predicted stock price tend increase over the following four days; hence, the stock was purchased. At time point 3(or day3), the actual stock

price was lower than the forecasted price, but the predicted stock price still increase in the subsequent four days; hence, the stock was held and prices were observed. At time point 7(or day7), the actual stock price was lower than the forecasted price, and the predicted stock price tend to drop in the following four days; thus, the stock was sold. At time point 11(or day11), the actual stock price was higher than the forecasted price, and the predicted stock price tend to decrease in the following four days; thus, a time to buy was anticipated. The transaction conditions are shown in Table 11. During the period, the profit was NTD 12.8.

Summary

In order to validate the feasibility of proposed model, the stock price of TSMC is adopted to simulate the whole transacting process. Based on the reason of comparison, this research used the moving average, moving average convergence and divergence, stochastic, and relative strength indices and the grey forecast model for determining transaction signals and comparing profits. The results are demonstrated in Table 12.
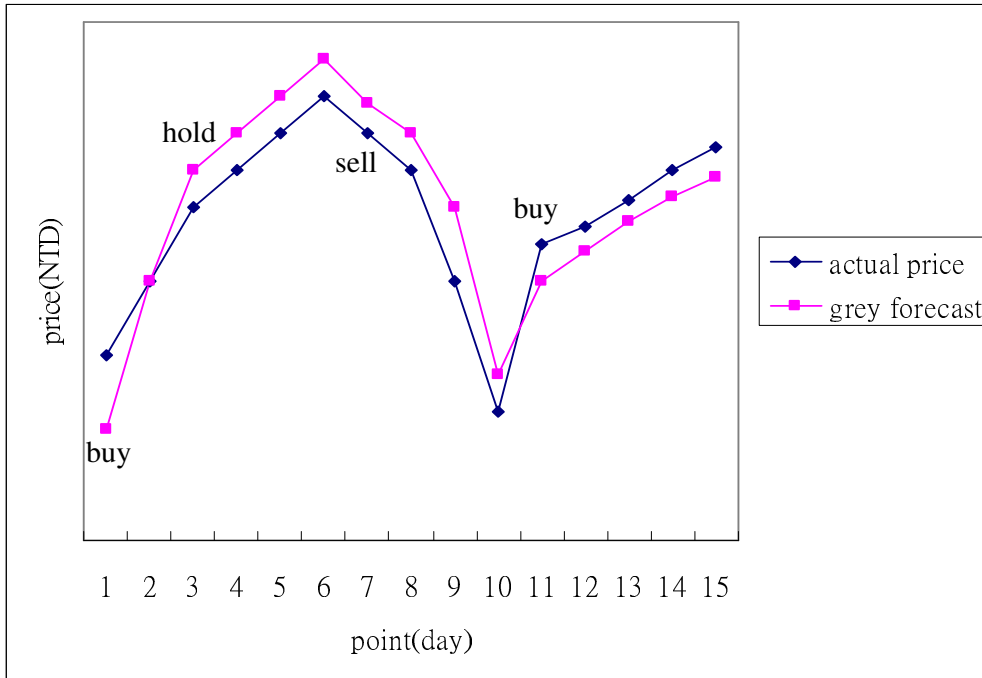
Figure 3. The grey forecast for transaction signals

Table 5. The joint fields of TSEC Taiwan Technology Index stocks

Financial analysis ratio indict-ors	The range of joint field	
	Lower limit	Upper limit
Debt ratio (%)	6.82	76.17
Long-term capital ratio (%)	89.39	39257.60
Current ratio (%)	17.70	1040.16
Quick ratio (%)	17.42	696.46
Time interest earned (%)	-58.14	740074.10
Receivable turnover (times)	2.76	161.12
Average collection period (days)	2.27	132.13
Inventory turnover (times)	2.18	14341.52
Average days of sales (days)	0.03	167.57
Fixed asset turnover (times)	0.30	298.23
Total asset turnover (times)	0.13	2.43
Return on assets (%)	-8.16	23.85
Return on equity (%)	-14.05	38.41
Operating income to paid-in-capital (%)	-10.07	324.72
Profit before tax (%)	-14.36	343.95
Net profit margin (%)	-22.03	95.29
Earning per share (NTD)	-1.45	30.58

Cash flow ratio (%)	-89.18	149.14
Cash flow adequacy (%)	-48.35	610.04
Cash reinvestment ratio (%)	-27.40	15.83

Table 6. The correlation coefficient of the financial analysis ratio indices of TSEC Taiwan Technology Index stocks

	Kinsus	Macronix	Advantech	Synnex	Novatek	Winbond	Acer
Excellent	0.01142	-0.20154	-0.39957	-0.47841	-0.46761	-0.40942	-0.5137
Good	-0.41738	0.02626	0.04556	-0.29352	-0.25264	-0.33238	-0.21976
Moderate	-0.21635	-0.21822	0.09144	0.32447	0.15136	0.00651	0.00936
Poor	-0.33785	-0.45216	-0.11978	0.0569	0.0902	-0.13174	-0.00034
Poorest	-0.43002	-0.41566	-0.43203	-0.32322	-0.35895	-0.22857	-0.30586

Figure 4. The selecting stock strategies by Extentics

The result of these verifications identified that the grey forecast model is feasible in determining transaction signals.

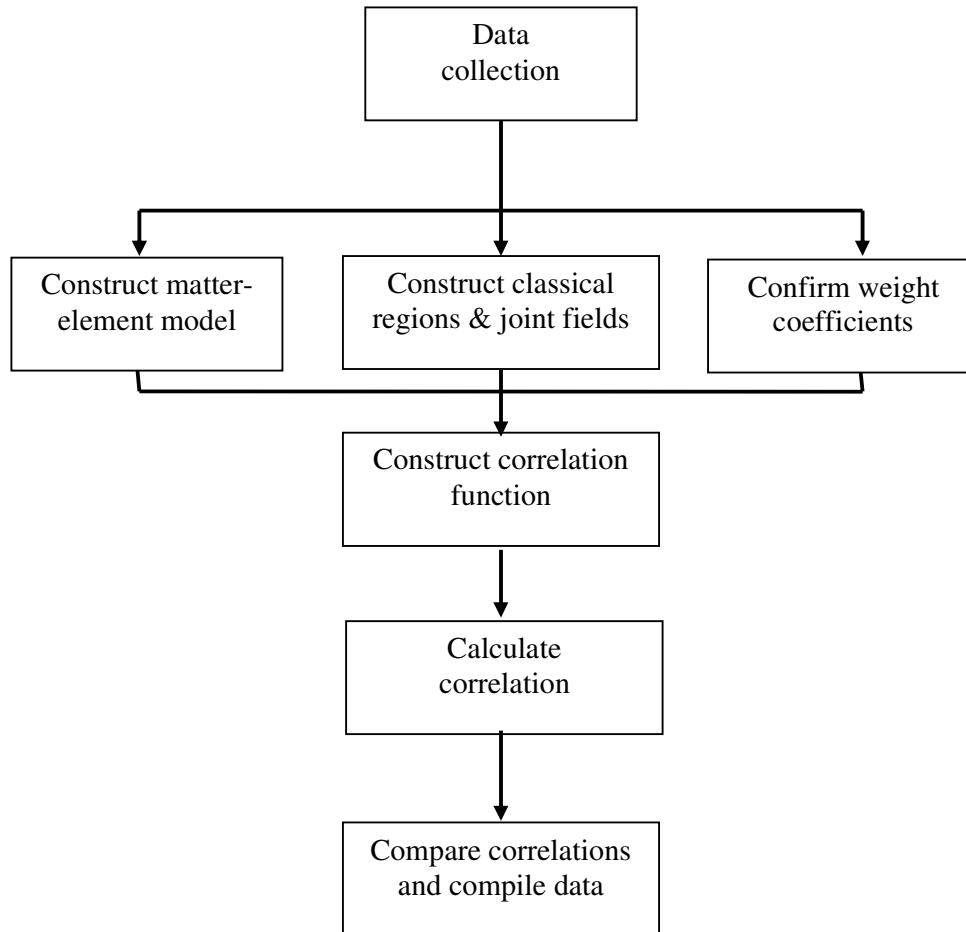Moreover, the profitability of the grey forecast model is superior to other analysis methods, with fewer samples and less time

to achieve forecast results.Practical Case - Stocks In Information Technology Sector

Constructing Selection Strategies

The model variables were composed of 20 financial analysis indicators of the five dimensions published by TSEC. This research adopted these variables to construct the selection model for Extentics, which is shown in Fig. 4.

Selecting Stocks

This research used the 43 companies (in table 3) which belong to information technology sector selected by the TSEC Taiwan Technology Index in December 2010. The information technology sector is the core competitiveness and niche industry of Taiwan, which is an indicator of the Taiwanese stock market. The TSEC Taiwan Technology Index is a basket of blue-chip and indicative electronic stocks as investment targets. In addition to the indicative characteristic, the index is a reference for investors. Therefore, this research employed the TSEC Taiwan Technology Index as the research subject for collecting financial analysis indicators and stock selection analysis.

The evaluation of the company level depends on the positive and maximum correlation function. Therefore, regarding stock selection strategy, we adopted the maximum correlation function. In evaluating firms using the extension selection strategy, Kinsus was an excellent company; Macronix and Advantech were good companies; and Pegatron, Asus, Winbond, Acer, Realtek, Gigabyte, MSI, Synnex, Faraday, Novatek, Transcend, and Liteonit were moderately good companies. According to the sequence of the correlation functions, Synnex and Novatek of the former sequence and Winbond and Acer of the latter sequence were selected. Therefore, Kinsus, Macronix, Advantech, Synnex,

Novatek, Winbond, and Acer were selected for determining transaction signals.

Determining Transaction Signals

This research used the grey forecast model to determine the transaction signals of the investment targets selected by the Extentics, and further compared to the methods for technical analysis of stocks. We employed the NGBM model to construct the daily closing price of the investment targets and forecasted the stock prices over the following four days. After comparison with actual prices, we determined the buy and sell signals. In addition, this research referenced the result of the literature review and selected four technical stock analysis methods, which were the moving average, moving average convergence and divergence, stochastic, and relative strength indices. Finally, this research compared the profitability of the stock analysis methods.

The investment targets of this research selected by the stock selection strategy were Kinsus, Macronix, Advantech, Synnex, Novatek, Winbond, and Acer. The research data were published between October 1, 2010 and March 31, 2011. We used the five methods explained above to determine buy and sell signals. If a given stock had no sell signal until March 31, 2010, the date was the settlement day, and the profit was calculated. The comparison of profits is shown in Table 13. Regarding the excellent firm Kinsus, the profit was NTD 6.3 in grey forecast model, which was the most profitable method. For the good and moderately good companies, the application of the grey theory method was not significant; however, the grey theory effectively controlled profits and losses to within a relatively small range. For example, this research employed the grey forecast model to forecast the portfolio in Table 13, and the interval of losses and profits was between NTD -2.9 and 6.3. If the profit of Kinsus

(NTD 6.3) is deducted, the interval was between NTD -2.9 and 2.4. Therefore, in addition to being applicable to investment in companies with excellent profits, this method can be effective in investment risk control when investing the companies with modest profits.

Conclusions and Suggestions

For investors, it is crucial to investigate and analyze the basic and technical information of investment targets when making investment decisions. Because of the high fluctuation in stock prices, the careful selection of investment targets and comprehensive investment strategies can assist investors in gaining higher profits. Therefore, this research developed an objective and precise investment reference model using Extentics and the grey forecast model. According to the empirical results of this research, we conclude the following.

(1) In model verification, this research uses TSMC as the research subject to verify the feasibility of the grey forecast model. An overall comparison of the technical indices indicates that the proposed grey transaction mechanism obtained the best profitability.

Table 7. The profits of TSMC using MA

Buy				Sell				
Date	Short-term	Long-term	Stock price	Date	Short-term	Long-term	Stock price	Profit (NTD per share)
2009/7/3	55.08	52.56	55	2010/2/6	61.62	61.69	58	3
2010/4/9	61.58	61.46	62.7	2010/5/14	61.42	61.43	61.2	-1.5
2010/6/25	60.86	60.68	61.4	2010/7/6	60.94	60.95	59.9	-1.5
2010/7/30	61.16	61.15	62.4	2010/8/27	60.42	60.78	58.8	-3.6
total								-3.6

Table 8. The profits of TSMC using MACD

Buy				Sell				
Date	DIF	DEM	Stock price	Date	DIF	DEM	Stock price	Profit (NTD per share)
2009/7/24	1.81	1.80	57.2	2009/10/30	2.36	2.46	60	2.8
2010/4/9	0.65	0.63	62.7	2010/5/7	0.45	0.59	59.4	-3.3
2010/7/30	0.21	0.13	62.4	2010/8/13	0.13	0.14	60.1	-2.3
total								-2.8

Table 9. The profits of TSMC using KD.

Buy				Sell				
Date	K	D	Stock price	Date	K	D	Stock price	Profit (NTD per share)
2010/9/17	36.98	34.8	61.2	2010/12/24	80.97	83.64	70.8	9.6
total								9.6

Table 10. The profits of TSMC using RSI

Buy				Sell				
Date	Short-term	Long-term	Stock Price	Date	Short-term	Long-term	Stock price	Profit(NTD per share)
2009/7/10	57.11	54.56	56.1	2009/7/17	44.61	51.96	54	-2.1
2009/7/24	60.91	55.37	57.2	2009/8/6	53.73	54.38	56.8	-0.4
2009/8/14	63.04	56.54	58.9	2009/8/21	50.37	53.85	56.8	-2.1
2009/8/28	62.49	56.64	59.5	2009/10/9	54.2	56.8	61.1	1.6
2009/10/16	59.23	57.69	61.9	2009/10/23	55.43	57.07	61.5	-0.4
2009/11/13	59.97	57.07	61.8	2009/11/27	40.86	54.01	60	-1.8
2009/12/11	64.01	57.56	62.6	2009/12/18	55.71	56.29	61.9	-0.7
2009/12/25	67.13	58.36	63.4	2010/1/22	35.66	53.21	61.1	-2.3
2010/3/12	53.61	52.69	60.8	2010/3/19	45.09	51.15	60	-0.8
2010/3/26	63.31	54.65	62	2010/4/23	49.93	53.43	61.7	-0.3
2010/6/4	54.66	51.82	61	2010/6/11	50.19	50.81	60.5	-0.5
2010/6/18	65.65	54.88	62.7	2010/7/2	44.6	50.01	60.3	-2.4
2010/7/23	66.19	54.84	62.8	2010/8/6	46.63	50.78	60.9	-1.9
2010/9/17	60.29	51.89	61.2	2010/9/24	48.16	49.17	60.1	-1.1
total								-15.2

Table 11. The profits of TSMC using the grey forecast

Buy		Sell		
Date	Stock price	Date	Stock price	Profit(NTD per share)
2009/7/7	55.4	2009/7/8	54.4	-1
2009/7/14	55.8	2009/7/24	57.2	1.4
2009/7/28	57.9	2009/7/31	58.9	1
2009/8/5	56.9	2009/8/6	56.8	-0.1
2009/8/10	57.8	2009/8/12	57.5	-0.3

2009/8/19	57.4	2009/8/31	59.2	1.8
2009/9/1	61	2009/9/9	62	1
2009/9/11	62.4	2009/9/21	62.3	-0.1
2009/9/24	60.8	2009/9/30	64.5	3.7
2009/10/7	62.1	2009/10/13	61.8	-0.3
2009/11/2	59.8	2009/11/10	60.5	0.7
2009/11/12	62.2	2009/11/17	62.6	0.4
2009/11/19	62.9	2009/11/23	62	-0.9
2009/11/26	62	2009/11/27	60	-2
2009/11/30	61.1	2009/12/11	62.6	1.5
2009/12/17	62.2	2010/1/5	64.5	2.3
2010/1/6	64.9	2010/1/8	64	-0.9
2010/1/12	63.6	2010/1/13	62.8	-0.8
2010/1/26	60.1	2010/1/28	60	-0.1
2010/2/6	58	2010/2/22	59	1
2010/2/23	59.8	2010/3/1	59.6	-0.2
2010/3/3	60	2010/3/9	61.3	1.3
2010/3/12	60.8	2010/3/16	59.7	-1.1
2010/3/19	60	2010/3/26	62	2
2010/4/1	62.1	2010/4/2	62.4	0.3
2010/4/7	63.5	2010/4/13	62.9	-0.6
2010/4/21	62.4	2010/4/23	61.7	-0.7
2010/5/5	59.8	2010/5/12	60.1	0.3
2010/5/19	59.3	2010/5/20	58.9	-0.4
2010/5/24	59	2010/5/25	58.4	-0.6
2010/5/26	58.9	2010/5/28	58.7	-0.2
2010/5/31	60.2	2010/6/2	59.8	-0.4
2010/6/7	59.2	2010/6/18	62.7	3.5
2010/6/30	60.6	2010/7/2	60.3	-0.3
2010/7/5	61.4	2010/7/7	59.5	-1.9
2010/7/9	60.4	2010/7/13	59.6	-0.8
2010/7/15	60.3	2010/7/22	62	1.7
2010/7/23	62.8	2010/7/27	62.5	-0.3
2010/8/6	60.9	2010/8/9	60.7	-0.2
2010/8/11	61	2010/8/13	60.1	-0.9
2010/8/16	60.3	2010/8/20	59.9	-0.4
2010/8/24	59.6	2010/8/27	58.8	-0.8
2010/8/31	58.9	2010/9/3	59.8	0.9
2010/9/9	59.5	2010/9/17	61.2	1.7
2010/9/21	61.8	2010/9/29	61.5	-0.3
2010/10/11	61.5	2010/10/13	61	-0.5
2010/10/15	61.9	2010/11/8	63.3	1.4
2010/11/11	63.7	2010/11/15	63.9	0.2
2010/11/17	63.8	2010/11/18	63.3	-0.5
2010/11/22	63.8	2010/11/24	63.2	-0.6
2010/11/29	64.3	2010/12/2	66.2	1.9
2010/12/6	68.5	2010/12/8	68	-0.5
2010/12/13	69.4	2010/12/16	71.2	1.8

2010/12/23	71	2010/12/27	70.7	-0.3
			total	12.8

Table 12. The profit comparison of TSMC

Technical indicators	The profit comparison of TSMC
Moving Average（MA）	-3.6
Moving Average Convergence and Divergence (MACD)	-2.8
Stochastic Index (KD)	9.6
Relative Strength Index (RSI)	-15.2
Grey Forecasting Model	12.8

Table 13. Comparison of profits from various methods

Investment targets	Moving average index	Moving average convergence and divergence index	Stochastic index	Relative strength index	Grey fore-cast model
Kinsus	*	*	*	-4.6	6.3
Macronix	*	-1	*	1.55	0.9
Advantech	*	-2.9	*	-6.4	-0.7
Synnex	-1.1	2.9	*	*	2.4
Novatek	3.3	2.5	*	-8.1	-1.9
Acer	-9.6	1.8	*	11.5	-2.9
Winbond	*	-0.48	2.08	1.34	1.1
Total prof-its	-7.4	2.82	2.08	-4.71	5.2

* indicates the absence of buy and sell signals during the research period

(2) This research used the Extentics to select the constituent stocks of the TSEC Taiwan Technology Index and the selected companies were used to study the transaction timing. The result indicated grey forecast model is not optimal in determining the profitability of individual stocks; however, its total profitability is superior to those of the other four technical indicator analyses. This proves that the grey forecast method has high feasibility.

(3) This research applied the Extentics to select and investigate the profitability performance of Kinsus (excellent), Macronix (good), and Advantech (good). The result of the grey forecast found that the profitability of Kinsus was the best, and that Advantech could hedge its risk. In addition, though the other technical analysis could better determine profitability than the grey forecast, none of them could hedge against investment of high risk. The grey forecast can ensure profitability and hedge against risk, thereby reducing investor exposure to risk.

Acknowledgements

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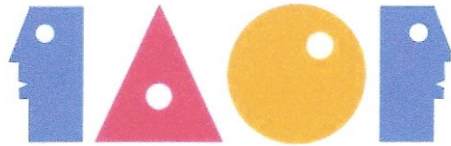
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120

USING STRUCTURAL EQUATION MODELING TO EVALUATE A CONSUMER BEHAVIOR MODEL: THE CASE OF RETAIL CHAIN STORES IN TAIWAN

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Abstract

Service quality, brand equity, marketing mix strategy, and customer loyalty are critical factors to improve the business effectiveness, and those factors have been recognized a consumer behavior model in existing marketing research. The purposes of this quantitative study are to identify the relationship between service quality, brand equity, marketing mix strategy and customer loyalty, and to test this consumer model by SEM approach. The population in this research was selected as customers from four retail chain stores in Taiwan, resulting in 200 individual surveys for analysis. The results indicated brand equity and service quality have significant and positive relationship with customer loyalty, while marketing mix strategy has no significant relationship with customer loyalty. Finally, this research generated the recommendations for retail chain stores business and suggested future scholar studies.

Key Words: Brand Equity, Marketing Mix Strategy, Service Quality, Customer Loyalty, Retail Chain Stores, SEM

Introduction and Theoretical Foundation

Hu (2011) indicated service quality, brand equity, and marketing mix strategy have significant relationship to customer loyalty. Current enterprises agree those factors are critical to maintain the growth for business activities. Customer loyalty has been regards as the key indicator for customer retention. Oliver (1997) claimed the customer loyalty will drive customers to buy the same brand products even competitors' have better offers. Deming (1981) and Garvin (1987) identified the service quality is the critical factor for satisfying customer demand. Lo (2012) claimed brand equity may strengthen intangible assets and create overall success for companies. Ponnam (2011) indicated the most common brand equity model encompasses five dimensions,

such as brand awareness, perceived quality, brand royalty, brand association, and other proprietary asset. This model has been empirically applied in previous researches (Atilgan, Aksoy, and Akinci, 2005; Kim and Kim, 2004). The most well known marketing mix strategy tools—4Ps model (McCarthy and Perreault ,1994) suggested marketing mix strategy encompasses four factors, such as Product, Price, Promotion, and Place. Hsieh and Lee (2007) indicated the relationship between publication relationship and customer loyalty is moderated by brand image.

Although many studies have tried to test the relationship among those factors, very few studies have examined the four factors (service quality, brand equity, marketing mix strategy, and customer loyalty) in overall path analysis with structure equation modeling. Therefore, this study extended previous research and modified the model by Hu (2011), and suggested the consumer behavior model: the dependent variable is customer loyalty and the independent variables are service quality, brand equity, and marketing mix strategy. This study applied SEM approach to examine the model fit and conduct path analysis for this consumer behavior model.

Research Purposes and Hypotheses

Based on the theory concept, the purposes and the significance for this study are: (a) to examine the model fit with path analysis for a consumer behavior model composing of service quality, brand equity, marketing mix strategy and customer loyalty, (b) to generate the recommendations for managerial application of retail chain stores business, and (c) to identify areas for future scholarly inquiry. Based the research purposes for this study, the researcher proposed three hypotheses as follows.

Hypothesis 1: There is positive and significant relationship between the service quality and customer loyalty.

Hypothesis 2: There is positive and significant relationship between the brand equity and customer loyalty.

Hypothesis 3: There is positive and significant relationship between the marketing mix strategy and customer loyalty.

Methodology

Instrumentation and Data Collection

The *Brand Equity Questionnaires.*

(7 items) were from Aaker (1991)'s 5 factor model and adopted four dimensions, such as Brand Awareness (1 item), Brand Association (2 items), Perceived Quality (2 item) and Brand Loyalty (2 items). The *Marketing Mix Satisfaction Questionnaires* (14 items) were based on McCarthy and Perreault (1994)'s 4 Pc model which encompasses four dimensions, such as Product (5 items), Price (3 items), Promotion (2 items), and Place (3 items). The *Service Quality Questionnaires* (19 items) were modified from the SERVQUAL questionnaire (Parasuraman, Zeithaml, and Berry, 1988) which encompasses five dimensions, such as Tangible (5 items), Responsiveness (5 items), Assurance (2 items), Empathy (3 items), and Reliability (4 items). The *Customer Loyalty Questionnaires* (3 items) were modified from the Behavioral Intentions Battery developed by Parasuraman, Zeithaml, Berry (1996) and encompasses three dimensions, such as Positive Manner

(1 item), Recommendations (1 item) and Repeated Purchase (1 item). This study also included the *Personal Demographic Factors* (7 factors): Gender (2 items), Marital Status (2 items), Ages (8 items), Job (6 items), Education (5 items), Income (5 items) and Order Frequency (4 items).

The customers from four retail chain stores in the Kaohsiung city of south Taiwan attended this research. The pretest was conducted with Item Analysis in 50 samples. The results for all Levene test values (t> │1.96│, p<.05) indicated this search should keep all scales. The researcher applied the method of random sampling. Each store randomly invited volunteer customers who shopping in stores to participate the questionnaire survey. The total number of valid responses was 200 (not including 15 invalid response), providing an adjusted response rate of 93%. To assess the non-response bias issues for samples, this research applied Chi-square test and results indicated the reply time for samples (130 early respondents and 70 late respondents) with 6 personal factors have no significant relationship(>.05), except for only the factor of Income (>.05). Thus, non-response bias is likely not an inhibitor in this research.

Validity and Reliability

The researcher applied SEM approach for CFA tests to examine validity and reliability issues. The study applied composite reliability (CR) and average variance extracted (AVE) values to measure the internal consistency as an estimate of reliability for questionnaires as summarized in Table 1. Fornell and Lacker (1981) indicated CR and AVE value should greater than .7 and .5 separately. Hair, Anderson, Tatham and Black (2009) also stated key components for convergent validity as: 1. Factoring loadings (>.7), 2. Composite Reliability (>.7), 3.

Square multiple Correlations, SMCs (>.5), 4. Average Variance Extracted , AVE (>.5). In overall, the reliability and convergent validity are fine.

Construct Validity is the foundation to ensure the quality of CFA test and includes two factors as Discriminant Validity and Convergent Validity. The convergent validity has been examined to ensure the quality of construct validity in Table 1. This study applied Bootstrap Confidence Intervals approach to examine the discriminant validity as Table 2. Torkzadeh, Kouferos, and Pflughoeft (2003) claimed the values within intervals should not include value 1.00 if the testing model has well discriminant validity. The results meet this standard and demonstrate the discriminant validity is fine.

Analysis of Results

The Structure Equating Modeling (SEM) by Analysis of Moment Structure (AMOS) software has applied to test the model structure and hypotheses in this study. The path model is shown in Figure one, while the regression weight values between brand equity, marketing strategy, service quality , and customer loyalty are highlighted in Table 3. For model fit issues: The Chi-Square value is 137.03. The Normedo value is 1.631. Ullman (2001) claimed the Normedo value should below 2.00. The Goodness of Fit Index (GFI) value is .916, and scholars recognized the GFI value should greater than .900. The Adjusted Goodness of Fit Index (AGFI) value is .880. Macallum and Hong (1997) suggested GFI value should greater .800. The Comparative Fit Index (CFI) value is .967, while the CFI value has been discussed its value should close to 1.00. The Root Mean Square Error of Approximation (RMESA) value is .056, while Hu and Bentler (1999) suggest

Table 1. The Results of CFA Analysis for Reliability, Convergent Validity and Model Fit

| Factors | Parameters of Factors | | | | Convergent Validity | | | | Model Fit Index | | | | | |
	UNStd FL	S.E.	C.R.	P	Std. FA	SMC	C.R.	AVE	χ2	DF	χ2/DF	GFI	AGFI	RMSEA
SE1	.61	.081	7.543	***	.542	.294								
SE2	.914	.083	10.951	***	.75	.563	.857	.55	13.41	5	2.681	.974	.923	.092
SE3	1.055	.088	11.93	***	.811	.657								
SE4	1.028	.092	11.175	***	.764	.583								
SE5	1				.807	.651								
BE1	1.164	.133	8.724	***	.769	.592								
BE2	1.031	.116	8.891	***	.796	.634								
BE3	.988	.116	8.496	***	.739	.547	.759	.442	17.51	2	8.754	.956	.782	.197
BE4	1				.663	.439								
MK1	.981	.081	12.05	***	.897	.805								
MK2	1.052	.096	10.958	***	.789	.622								
MK3	1.065	.107	9.908	***	.717	.514	.799	.5	.230	2	.115	.999	.997	.000
MK4	1				.749	.561								
CU1	.827	.07	11.733	***	.803	.645								
CU2	.973	.08	12.161	***	.865	.749	.675	.409	0	0	0	1	-	-
CU3	1				.808	.652								

Note: SE1:tangible, SE2:responsiveness, SE3:assurance, SE4: empathy, SE5: reliability., BE1: brand Awareness, BE2: brand association, BE3:perceived quality, BE4: brand loyalty; MK1: product, MK2: price, MK3: promotion, MK4: place; CU1: positive attitudeCU2: recommendations, CU3: repeated Purchase

Table 2. Testing Results of Bootstrap Confidence Intervals for Discriminant Validity

| Parameter | | Estimate | Bias-Corrected | | Percentile | |
			Lower	Upper	Lower	Upper
Service Quality	<--> Brand Equity	.562	.262	.758	.289	.769
Brand Equity	<--> Marketing Strategy	.716	.447	.852	.472	.867
Marketing Mix Strategy	<--> Customer Loyalty	.629	.459	.764	.450	.755
Brand Equity	<--> Customer Loyalty	.727	.608	.813	.612	.817
Service Quality	<--> Customer Loyalty	.590	.346	.763	.349	.767
Service Quality	<--> Marketing Mix Strategy	.735	.580	.845	.596	.855

Figure 1. Path Analysis Diagram for Consumer Behavior Model

Table 3. Regression Weight Values between Brand Equity, Marketing Mix Strategy, Service Quality, and Customer Loyalty

Dependent Variable	Independent Variable	Estimate	S.E.	C.R.	P	Label
Customer Loyalty	Brand Equity	.604	.124	4.972	.000	***
Customer Loyalty	Service Quality	.333	.146	2.279	.023	**
Customer Loyalty	Marketing Strategy	.086	.172	.502	.616	

Dependent variable：Customer Loyalty, *** $p<.001$(2-tailed) ** $p<.01$(2-tailed), * $p<.05$ level (2-tailed).

RMESA value should close to .06. Therefore, the overall model fit is reasonable.

Regression analysis was applied to examine hypotheses. The results are summarized in Figure 1 and Table 3. The results supported H1 and H2. Service quality (β=.604, p<.001) and brand equity (β=.333, p<.05) have positive and significant relationship with customer loyalty. However, the results did not support H3. Marketing mix strategy (β=.086, p>.05) has positive relationship, but has no significant relationship with customer loyalty.

Discussion and Recommendations

The results in H1 and H2 indicated service quality and brand equity have significant and positive relationship with customer loyalty, while service quality has stronger relationship with customer loyalty than brand equity. The findings in H3 also indicated that marketing mix strategy has no significant relationship with customer loyalty. The findings suggest that customers may need innovative services or unique brand image rather than traditional promotion activities in retail chain store business. Retail chain stores may apply this concept for developing more friendly services for customers, as well as the brand image activities to positively impact customer loyalty. In addition, the retail chain stores may need to develop innovative marketing strategy to profoundly arouse customers' needs instead of focusing on traditional discount promotion. All the findings meet the current business practice which administrations need to develop the Blue Ocean Strategy which focusing on growing pioneering service products rather than the Red Sea Strategy which only engaging the price wars. This research suggested future research recommendations: 1).Due to time constraints and limited finances, this research utilized convenience sampling and focused on limited number store. Future study may extend the research to more stores or customers through larger random selection, 2).Moreover, the population may extend to other countries for comparisons to understand the differences in

cultures, and 3) Future study may identify more effective factors to influence the customer loyalty, also generate future scholar studies.

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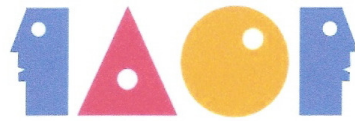
IMPROVING INDONESIA'S COMPETITIVENESS: INNOVATION, VALUE CHAINS AND CLUSTER-BASES FOR REALISING THE HUGE POTENTIAL OF MARINE AND FISHERIES

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Abstract

This paper is intended to continue and complete a presentation by Porter (2009), focusing on innovation in the Indonesian fisheries. On 28 September 2009, Michael E. Porter gave advice to the president of Indonesia on the subject "How to improve Indonesia's competitiveness in the international world". According to Porter, the problems faced by Indonesia still include weakness in innovation and the low level of cluster-based development. One area of huge potential for Indonesia is marine and fisheries, which is managed by the Ministry of Marine Affairs and Fisheries (MMAF), who are the principal agency responsible for the planning, policy and administration that will determine future achievements. Porter's original concept requires additional in-depth study so that the fishery policymakers can choose and enhance a cluster-based strategy with value chains supports. The cluster-bases (Minapolitan) concept is actually an implementation of Porter's cluster concept for improving the competitiveness of the marine and fisheries sector and needs to be enhanced by ongoing study.

Key Words: Indonesia, Marine and Fisheries, Cluster-based, Innovation, Value Chains

Introduction

The theme "Indonesia Can" was introduced by the government in order to unite and works to increase self-reliance and competitiveness, with a distinguished and proud nation as the prerequisites for becoming a developed nation, which is likely to be full of challenges as well as opportunities (CMEA, 2011). Given that two-

thirds of Indonesia's territory consists of marine and inland waters with an abundance of natural resources, the development of capture fisheries and aquaculture still has the potential to make the fisheries industry a leading engine of growth for Indonesia.

The fisheries sector has a role and potential as a prime mover of the national economy, however, until recently this has continued to be neglected and not optimized. Excellence in natural resources has not been fully maximized. In other words, innovation must be different for each potential resource. It should be possible to transform comparative advantages into competitive advantages. A clear vision will ensure the performance of the fisheries-based economy in facing the various problems that emerge and require rapid and precise handling.

Indonesia's Potential and Challenges

Indonesia is one of the worlds' largest maritime countries. With approximately 5.8 million square kilometres of marine territory and 92,000 kilometres of beach and coast, Indonesia is second only to Canada. According to MMAF (2010a), Indonesian fishery production in 2010 reached 10.86 million tons. The national fisheries production growth rate between 2005 and 2010 reached an average of 10.02 % per year, and in 2010 the growth of aquaculture production is nearly proportional to that of the capture fisheries. World production of fisheries and aquaculture has supplied with about 148 million tons in 2010, providing approximately 16 % of the population's animal protein intake. As a country with huge marine resources, the livelihoods of the majority of the Indonesian people are related to the fishery sector. Indonesia has a population of over 220 million and fish consumption per capita per year reached 33.89 kg in 2012.

The risks to the programmes which aim to promote the export of Indonesian fishery include constraints of capacity and institutional, primarily industrial level issues of the exchange rate and the macroeconomic policy level (Lord, Rina and Ruehe, 2010). With the opening of the market in other countries there will be challenges for national fisheries development. In regional trade, Indonesia faced the free market in the ASEAN region and was internationally bound by the WTO agreements. The other problem is the free and open nature of marine and fisheries (e.g. lack of enforceable rights) need the role of decision-making processes in Regional Fisheries Management Organizations (RFMOs) properly (Garcia, 2005). If these problems are not addressed, then it will not be possible to control the increase of competition in the fisheries sector in the future. A cluster approach, innovation and the value chain will be the key factors in maximizing the potential for growth for each fisheries area according to Porter's concept.

In the last five years Indonesia became the fourth major fisheries producer in the world. However Indonesia's fishery exports shows it is still low in the competitiveness compared to other country's fish producers, Indonesia is ranked 12th, far below other Southeast Asian countries such as Thailand and Vietnam, respectively ranked at 3rd and 5th. This is because the fishery industry in Indonesia has not been able to produce value-added products and is still dependent on exports of non-processed fish, which has a low impact on the value of exports and employment.

The low quality and level of innovation of the Indonesian fishery is characterized by weak competition of their products in the export market. The export value of world fisheries has been increasing since 2003 and in 2010 reached more than US $

103 billion. At the top is China with a value of US $ 13.5 billion with a 13.5% market share, then Norway (US $ 8.66 billion), Thailand (US $ 7.01 billion), The United State (US $ 4.54 billion), Vietnam (US $ 4.26 billion) and Canada (US $ 3.80 billion), while Indonesia ranks 12th with a value of approximately US $ 2.6 billion and a market share of 2.5% (MMAF, 2012).

The vision of the Ministry of Maritime Affairs and Fisheries to make Indonesia the largest producer of fishery products in the world and create a marine and fisheries sector that has entered the stage of industrialization, demands a paradigm shift in the mindset of fishery society in Indonesia. Old paradigm was just as the producer of the raw material or fresh fish, it is need to be transformed into the new paradigm to producing product innovation in fisheries.

In order for this vision to be realized value needs to be added to fishery re-

sources both fish farmed on land and sea fishing. That's why innovation in the marine fisheries sector must be addressed and improved, with the focus on processing through industrialization. Building a competitive advantage for the fisheries requires government intervention aimed at improving the quality and competitiveness of fishery products so that they are highly competitive in the international market. As the main focus of policy of the Ministry of Maritime Affairs and Fisheries is the industrialization and modernization of the fisheries, this will be gradually implemented through excellent programmes.

There needs to be a continuous effort in innovation transfer in the field of fisheries, because the majority of Indonesia's fishery is traditional and small and medium enterprises (SMEs). However, innovation is the key to success for improving business competitiveness (Shapiro, 2002).

Figure 1 Developing an Indonesian Economic Strategy (Porter, 2009)

Porter's presentation; "Improving Indonesia's Competitiveness" is based on multiple theories for developing the economy of Indonesia. Relation to marine and fisheries sector, Porter's concept is needs

to be explored more deeply by policy makers, stakeholders, managers and fisheries entrepreneurs to do the right interpretation.

The key to the implementation of regional development based on clustering is to know what the force can be established and prioritized, see "The Five Forces That Shape Industry Competition" (Porter, 2008). Weaknesses e.g. in infrastructure, government services, and licensing facilities, to invest need to be addressed. The main attraction for using the cluster concept was development and growth of fisheries business can be focused and concentrated. In other words, the core an area already mapped and has studied completely, including specialized business potential will be prioritized. Thus eventually the fisheries-based clusters will have a characteristic and superior product.

Building Indonesia's Competitiveness (A Cluster-Based Concept)

The success of cluster-bases on area fisheries can be characterized by integration and functioning of all the supporting elements optimally. In addition, a fisheries cluster environment creates involvement the various activities to mutual support between one actor to another actor (Daranto, 2009). Therefore, in order to achieve levels of success, several key factors those need to be considered in a cluster of fisheries.

(1) Human resources: these must be reliable and able to maintain the sustainability of natural resources. Quality human resources need to be prepared through variety of programmes and training in order to create a productive and creative source of manpower. The success of a cluster is in integrating human resources who can manage natural resources to their maximum extent, and so that they remain sustainable. With human resources who are reliable and have strong discipline, the development of fisheries will be run properly. Capital support, effective institutions and clear rules and directions will promote the country into the ranks of countries that

have the highest achievement and progress.

(2) Innovation, R&D and value chains: Innovation is when an idea or object is perceived as new by individuals or adoption groups [Rogers, (2003), p.12]. It would involve an effort to improve the fisheries product, accompanied by new discoveries in the effectiveness (energy and cost per unit) of the production process. R&D for the fisheries and marine sector is related to assessment and research which could generate breakthroughs of better quality and more cheaply. These efforts also consider the value chain where each stage has been important in increasing value.

(3) Market orientation, partnership, and networking: Market orientation must be in line with the vision of the country in order to compete and excel in world competition. Creating partnerships and networks that are characterized by inter-institutional cooperation (government and entrepreneurs) is fundamental to the realisation of harmonisation and the workings of the entire system. A productive and competitive culture also plays a role in the fisheries sector, based on what the clusters in each region have done thorough research towards the potential planning development stages and long-term goals. The development of a region is assessed according to its potential. The decision to develop a cluster fishery must be based on the combination of various factors affecting the availability of resources (raw materials), transportation facilities, supporting infrastructure, labour availability, environmental structures, information access and marketing centres.

Indonesian Fisheries Trade Networks: Constraint and Opportunity

In the context of global fisheries and situation among international trade was

needed determination and commitment to making marine and fisheries sector has more competitive advantage. This only can be realised through the strengthening and development of the processing industries and biotechnology, in order to create added value and make the economic multiplier effect greater and more sustainable. A fishery product processing industry (e.g. handling, processing, and packaging) can provide added value, job creation and economic multiplier effects which are very large. Dahuri (2010) stated that the focus

of government should be to help and address problems that must be faced, including: (1) paying attention to home industry, small-scale industry and medium industry to increase awareness of quality and capital assistance; (2) ensuring innovation and the application of technology and biotechnology processing of fishery products (machinery, equipment, and methods) (3) ensuring infrastructure development, and connectivity (from production centres to the consumer) between subsystems in the Supply Chain Management (SCM).
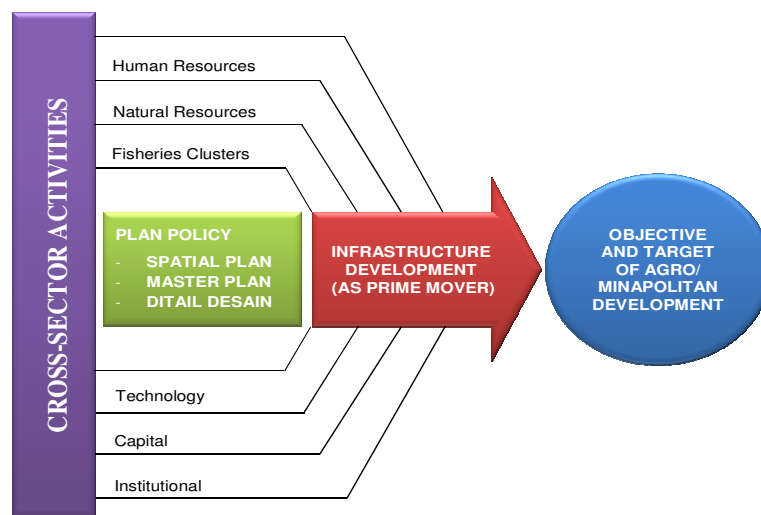

Figure 2. Development of the strategic sectors in area based fisheries (MMAF, 2010b)

Davidsson (2009) argues that there are many opportunities in the seafood trade but there are competitive factors as well: "what is the stability of the seafood industry?", "what is the competition?", "what are the trade barriers?", "what are the political risks?", "why are we seeing the industry getting less complicated and more concentrated. The answer to these questions lies in the fact that growing markets and growing trade will come to those who can consistently deliver a high-quality product at stable or declining costs (Anderson & Valderrama, 2009). The op-

portunities for the fisheries sector lie in further product diversification and value addition, as well as better scientific awareness of the benefits and risks of fish consumption (Valdimarsson, 2009).

MOPI, MOIQ and MOVA in Fishery Value Chains

Concepts of the Market Oriented Product Innovation (MOPI), the Market Oriented Quality Innovation (MOIQ) and the Market Oriented Value Added (MOVA) are important which may match to developed in Indonesian fisheries value

chain in order to gain competitiveness. Market value can further be improved by marketing activities and building customer relationships which strengthen the transaction between seller and buyers (Trondsen, 2001).

Innovation and adding value in the value chain can be empowered through the latest science. Innovation also needs to be kept up to date and must be encouraged simultaneously. Competitive advantage, according to Porter (1990), is the value chain and strategy to find ways to add value for customers. If broadly interpreted, the state as a coordinator of development is able to add value to all areas of responsibility (fishing, aquaculture, processing and marketing). Activities involved can be classified into two general categories: (a) primary activities that include logistics entry, operations, outbound logistics; marketing and sales, and services, (b) support activities that include procurement, technology development, human resource management, and company infrastructure. In order to gain a competitive advantage it is necessary to find a new way of coordinating all activities, empowering new procedures and new technologies, and different inputs.

Ardjosoediro and Goetz (2007) state that the value chain approach can focus on four key factors that affect competitiveness; (1) inter-firm (inter fisheries area) cooperation and coordination; efficient inputs, product and information flows (2) relationships among firms (fisheries industries): facilitating mutually beneficial, or "win-win," relationships in a value chain creates incentives (3) the distribution of benefits creates incentives or disincentives for performance, and (4) learning and innovation are essential for creating and sustaining competitiveness.

Conclusions

Improving competitiveness and sustaining growth momentum will influences Indonesia's economic future (WEF, 2011; World Bank, 2006; Arifin, 2012). Porter (1990) defines competitiveness as a country's ability to create sustainable added value through company activities, and to maintain quality of life for its citizens. The most fundamental thing for improving the performance of Indonesian fisheries is to implement a work programme on target. A conducive business climate must be created through a balance of business cooperation and a fully supportive government.

Internally

The Ministry of Marine Affairs and Fisheries (MMAF) of Indonesia, as the leader in the field of fisheries, must be proactive in facilitating entrepreneurs and able to quickly overcome barriers to development in this sector. The engine of technological breakthroughs throughout the economy is innovation, spearheaded by new entrepreneurs and businessmen eager to apply their new ideas (Acemoglu and Robinson, 2012). There are four main pillars necessary to sustain and support firms, and to make Indonesian fisheries competitive: (1) innovation in products and support systems (2) a value chain from upstream to downstream (3) cluster-bases characterised with the development of targeted through good planning (4) a marketing strategy (promotion) to make both the local market and international markets stronger. Opportunities and challenges were equally open. Indonesia will be able to rise up and become a successful fishery power with institutional support, adequate capital and good infrastructure.

Externally

International fishery trade and globalization must be faced with an optimistic

attitude by all business actors and stakeholders. The demands currently faced include (1) superior quality (2) product performance that meets market trends (3) the ability to follow the rules and regulations of the global market. By focussing on both internal and external factors, Indonesia can become a country that is able to manage its resources and has a solid advantage.

Future Development

It is essential that the fisheries' decision-making process involves stakeholders and the fishing community because it will be the subject and object development. Cooperation and harmonization are the keys to improving fishery management, however, the process for mutual control in giving criticisms will playing an important role in various policy and implementation. There is a shared responsibility between the government, industry, NGOs and communities to step forward to build the competitiveness of Indonesia with a cluster-based strategy, coupled with the strengthening of innovation. Indonesia must remain focused on developing sustainable and responsible fisheries.

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Appendix

Export Value of Fisheries of the World (2006-2010)

No	Countries	Value (million US $)					Share (%)
		2006	2007	2008	2009	2010	2010
1	China	9,162.11	9,508.86	10,364.12	10,500.16	13,539.77	13.06
2	Norway	5,379.80	6,089.74	6,722.43	6,923.22	8,660.35	8.35
3	Thailand	5,196.57	5,614.68	6,487.52	6,208.88	7,012.62	6.76
4	USA	4,337.28	4,387.76	4,364.02	4,075.66	4,544.43	4.38
5	Viet Nam	3,359.70	3,764.00	4,510.57	4,253.37	4,368.40	4.21
6	Canada	3,629.53	3,657.84	3,672.86	3,211.09	3,804.87	3.67
7	Netherlands	2,381.88	2,713.90	2,865.08	2,627.14	3,439.00	3.32
8	Spain	2,834.89	3,285.14	3,490.64	3,131.11	3,293.28	3.18
9	Chile	3,080.35	3,166.16	3,409.71	3,010.62	2,846.10	2.74
10	Denmark	2,885.71	3,057.14	3,226.54	2,677.19	2,730.81	2.63
11	Sweden	1,539.78	1,623.84	1,869.81	2,012.25	2,611.58	2.52
12	Indonesia	1,985.90	2,127.76	2,503.84	2,285.89	2,611.58	2.52
13	Russia	586.80	589.00	558.68	1,768.89	2,226.02	2.15
14	Japan	1,693.79	1,963.34	1,940.29	1,784.08	2,164.02	2.09
15	Germany	1,741.18	1,896.58	2,115.62	2,108.41	2,160.47	2.08
	Others	31,216.59	34,175.08	37,679.35	34,546.97	37,288.07	35.96
	Total	81,397.35	87,994.67	96,171.67	91,436.68	103,696.01	100.00

Source: MMAF (2012)