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The Influence of Innovation Management on New Product Development Performance in Taiwan's Hi-Tech Industries*

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Abstract: Due to the progress in manufacturing technology, rapid changing business environment and shorter product life cycle, hi-tech industries must place greater effort in increasing their innovation technologies to meet customer demands and achieve new product development performance. This research examines Taiwanese hi-tech companies by conducting a series of innovation management activities. The influences of these activities on new product achievement is determined and analyzed. Two intermediate variables for corporate status and innovation tendency are considered in discussing the relationship between innovation management and new product development. The former belongs to the influence factor for exterior strategy, while the latter is related to interior organization. Since Taiwan hi-tech industries has gradually entered the age in which core technologies and innovative competence are starting to determine a business's competitive advantages, this study will focus on innovation management for hi-tech industries, which is very meaningful both academically and practically. Some of the research findings are: (1) New product development performance is significant when innovation management ability is stronger (2) New product development performance is significant when innovation tendency is higher (3) Enterprise scale is not a key factor for new product development (4) New product development performance is significant when technology status is superior.

Key words: Taiwan hi-tech industries, ability of innovation management, new product development

INTRODUCTION

Innovation management plays a vital role in a corporation's growth and development. In the past literature research on the success factors of new product development, some researchers concentrated on researching the phases and flows of the product development process, while other studies used a single viewpoint to draw into other specific research topics such as the impacts of technology innovation on the organizational climate and structure and resource allocation etc. However, although related product development and annual sale figures are as important in the hi-tech industry, the ability of innovation management may be of more significance. Due to the lack of comprehensive research studies on the influences of integrated technology planning and innovation on new product development, this research will focus on innovation management. The study will examine and discuss the influences of innovation management on new product development performance in Taiwan's hi-tech industries. The specific nature of different organizational structures and the business environment will be used as the two intermediate variables when conducting the research. Based on the research

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motives stated above, this study has generalized three research questions shown below: (1) Will strong and weak innovation management cause significant impacts on new product development performance in Taiwan Hi-tech industries? (2) Will the difference in corporate innovation tendency cause different innovation management impacts on new product development performance? (3) Will the difference in industry and corporate status cause different impacts on innovation management new product development performance?

Gould and Keeble (1984) suggested that hi-tech industry players should consider three indicators: The ratio of research and development spending on organizational output, the speed of technology innovation and the relative significance of the research and development staff. Shanklin and Ryans (1984) contended that a hi-tech industry player must have these three characteristics: A solid scientific technological base, the ability to replace its current technology with new technology and the ability to develop and change market needs with the application of its new technology. Thus, with planned promotional assistance from the government and alignment with the market's movement, the industries in Taiwan are moving towards developing hi-tech products. Furthermore, there is a hope that Taiwan will become a country that is strategically led by hi-tech industries. This study will categorize the hi-tech industries in Taiwan into six major categories: (1) Semiconductor Manufacturers (2) Computer and Peripheral Manufacturers (3) Telecommunications (4) Optoelectronics (5) Precision Machinery Manufacturers (6) Bio-technology. These six categories are the research targets for this study.

Innovation Management

Academics' viewpoints on innovation management are described as below: (1) Product View: Blau and McKinley (1979), Burgess (1989) and Kelm *et al.* (1995) indicated that corporations emphasize the impacts and results derived from innovation activities and the performance of these innovations can be measured according to the product (2) Process view: Amabile (1988), Johannessen and Dolva (1994) and Scott and Bruce (1994) proposed that innovation activity is a process and the innovation evaluation should emphasize a series of stages and phases (3) Product and Process view: Dougherty and Bowman (1995) and Lumpkin and Dess (1996) suggested that corporations should consider the dual viewpoints of product and process simultaneously when defining innovation activities and integrate both the process and result (4) Diverse viewpoints: Damanpour (1991), Russell (1995) and Robbins (1996) expressed that innovation activities should focus on the technological implications and the management implications. This is because innovation activities consist of technological innovation in the product, process and equipment. Daft and Becker (1978) classified innovative activities into: (1) innovations on management structure (2) innovations in procedures (3) innovations in the organizational structure. The research conducted by Allan and Nik (1995) concluded that the degree of technology innovation should progress from small to large in a systematic manner and proceed in the order of progressive innovation, model innovation, organizational innovation and break-through innovation.

This study will arrange the discussion topics mentioned above and categorize innovation activities into management innovation, technical innovation, market innovation and cultural innovation. These will form the four main facets of the innovation management framework illustrated in this study. Each facet will be explained as below:

Facet of Management Innovation

Cooper (1979) conducted a comprehensive research study on the performance of new product development from a product technology and management perspectives. Rosenberg and Frischtak (1985) also indicated that the level of a corporation's technological competence is derived from an accumulation of planning, designing and manufacturing activities. Hence, the more complete the information collection and protection procedures, the higher a corporation's level of competence.

Facet of Technical Innovation

Christopher and Gina (2002) adopted market choice, resource management and personnel as their strategic viewpoints to illustrate the main purpose and challenges faced by innovations. Tatikonda and Stock (2003) integrated the manufacturing and marketing viewpoints and expressed the influential facets of innovation management on corporate performance which included internal facets such as product quality, unit cost, the timing of the new product's entry to the market and external facets such as product marketing, customer satisfaction and profitability level.

Facet of Market Innovation

The research study by Raudsepp (1987) suggested that innovation ability can only represent a corporation's ability to develop new product. That is, the corporation must consider the related facets that will affect the market itself when performing innovative activities. In many traditional large corporations, break-through innovation often does not receive as much support.

Facet of Cultural Innovation

Cooper and Kleinschmidt (1996) conducted a study with 161 corporations as research samples and suggested that when discussing the relationship between new product development and corporations, the important facets will be the strategy, procedures, culture and innovation climate. Upon combining the viewpoints from the past academic literatures mentioned above, one can see that the greater openness of the organizational structure, the higher the employee willingness to create an innovative atmosphere and result in strengthening corporate innovative ability.

Performance of New Product Development

Calanton *et al.* (1995) adopted these indicators when evaluating new product development performance: The ratio of investment and investment growth rate, ratio of sales, market share and market growth rate. Alternatively, Song and Parry (1997) applied these four indicators when evaluating the comparative level of new product success: (1) the quality of the new products in comparison to that of competitors (2) the sales level of the new product in comparison to that of competitors (3) the profitability of the new products in comparison to competitors products (4) the commercial success rate of the new product in comparison to the planned target rate. This research incorporates the empirical theories and researches discussed above and adopts the following five indicators when evaluating new product development performance: (1) market entry time (2) quality level (3) market share (4) commercialization success rate of the new product (5) the cost of promoting the new product in the market.

RESEARCH DESIGN

The components of this research design include: Questionnaire design and data collection, research framework and hypothesis and data analysis.

Questionnaire Design and Data Collection

The research objective for this study is analyzing and evaluating the influences of innovation management on new product development performance. Taiwan hi-tech industries were adopted as the population. The test sample consists of the top six hundred renowned enterprises in the hi-tech industries. Six hundred survey questionnaires were issued and two hundred and forty questionnaires were returned on June 2006. The response rate was 40%. Two hundred and ten questionnaire responses were valid and the effective response rate was 35%. The questionnaire consisted of four major components. The first, second and third components were measured using the Likert 5-point

scale. The first component is the innovation management capability. The second component is new product development performance. The third component is the corporation's innovative tendency. The fourth component is the company's primary data, including: (1) company's capital account (2) business turnover and (3) number of employees.

Research Framework

The conceptual framework for this research is show in Fig. 1. The evaluating facets for the innovation management ability in the figure include: Technical innovation, market innovation, management innovation and cultural innovation. Organizational innovation tendency consists of these variables: The level of supportability of organizational communication, the degree of organizational decision-making and authorization and the degree of emphasis placed on the organizational innovation tendency. Furthermore, the variables within the industry and corporate status facet include: Industry characteristics, the corporation's technical leadership and scale of the business operations. In addition, the new product development performance evaluation facets include: The timing of new product entry into the market, the quality of the new product, the percentage of market share of the new product, the success rate of the new product in the market and the cost of the new products' entry into the market.

Research Hypothesis

As the topic discussion and theoretical analysis, this study formed the following research hypotheses:

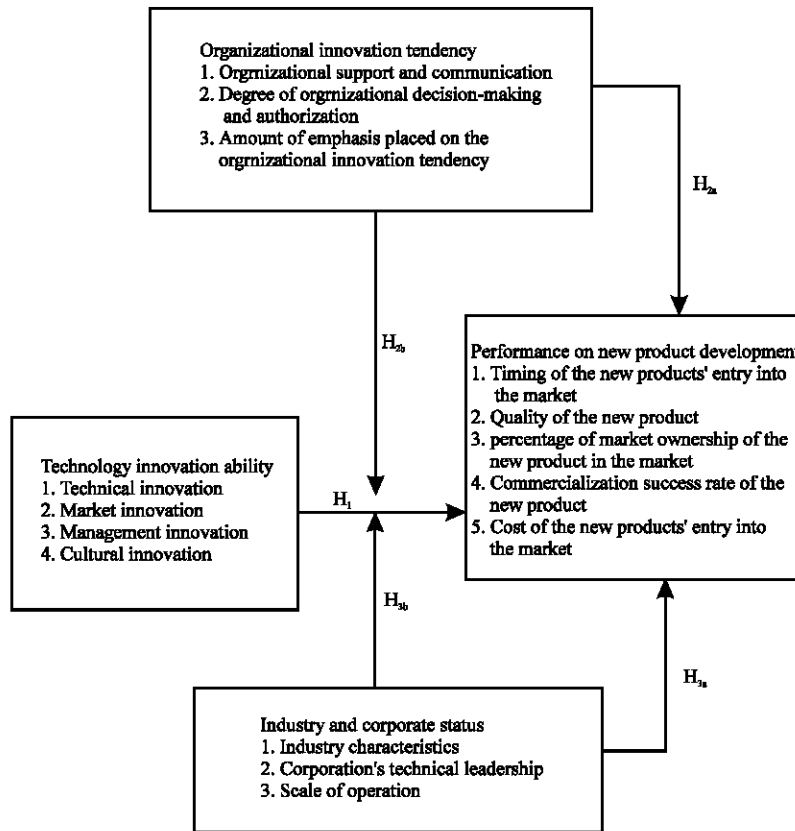


Fig. 1: Research framework

H₁

New product development performance is more significant as the innovation management ability to execute strengthens.

H₂

The organizational innovation tendency will influence the innovation management effects and the new product development performance.

The sub-hypotheses derived from the intermediate variables are as below:

H_{2-1a}

The difference in organizational communication will lead to a variance in the new product development performance.

H_{2-1b}

The increase in the innovation management ability and the level of organizational communication will result in a significant improvement in new product development performance.

H_{2-2a}

The degree of organizational decision-making and authorization has a significant influence on new product development performance.

H_{2-2b}

An increase in the innovation management ability and the degree of organizational decision-making and authorization will result in a significant improvement in new product development performance.

H_{2-3a}

The degree of emphasis placed on organizational innovation has a significant influence on new product development performance.

H_{2-3b}

The increase in innovation management ability and the degree of emphasis placed on organizational innovation will result in a significant improvement in new product development performance.

H₃

Industry and corporate status will influence new product development performance.

The sub-hypotheses derived from the intermediate variables are shown below:

H_{3-1a}

The industry characteristics have a significant influence on new product development performance.

H_{3-1b}

Under different industry characteristics, an increase in the innovation management ability will lead to a variance in new product development performance.

H_{3-2a}

The corporation's technical leadership has a significant influence on new product development performance.

H_{3-2b}

Higher corporation technical skills will lead to an increase in innovation management ability, resulting in a significant influence on new product development.

H_{3-3a}

The scale of business operation has a significant influence on new product development performance.

H_{3-3b}:

Under different business scales, an increase in innovation management ability will lead to a variance in new product development performance.

Data Analysis

The research subjects in this study were hi-tech industry players in Taiwan. The test sample consists of famous business enterprises with experiences in new product development. The questionnaire participants must have extensive knowledge on the new product development process. To increase the questionnaire validity, the focus was placed on the following job titles; New Product Development Project Manager, Senior Product Planning Personnel, Senior R and D Manager and Innovation Management Supervisors. The Cronbach's α index was used when measuring the reliability of all questions in each facet. A larger Cronbach's α coefficient indicates a higher level of consistency and reliability for the items in each facet. Nunnally (1978) indicated that in primary research, a reliability level of 0.7 is acceptable. Since the reliability coefficient for ability innovation management, organic innovation tendency and new product development performance were 0.86, 0.88, 0.91 for this study, one can conclude that the reliability level of this research was above 0.7 and hence is acceptable. This research study adopted the SPSS 12.0 for Windows analytical tools to assist in data analysis and evaluation. The statistical analysis used in this research included the t-test, One-Way ANOVA and Two-Way ANOVA analysis.

RESULTS AND DISCUSSION

T-Test of the Relationship between the Ability of Innovation Management and Performance on New Product Development

According to the mean value for innovation management ability in the four facets of innovation management mentioned above, this study separated the hi-tech industries in Taiwan into two independent groups; strong ability in innovation management (mean value above 0.5) and weak ability in innovation management (mean value below 0.5). The t-test was used to determine the influences of technology innovation on new product development. As illustrated in Table 1 ($p = 0.000$), there was a high significance level in innovation management ability in Taiwan's hi-tech industries and new product development performance. The research findings confirm that strong innovation management ability in hi-tech industries in Taiwan had positive influences on new product development performance. This supports research hypothesis H₁.

Table 1: T-test of the influences on the ability of innovation management in new product development

Data	Weak ability in innovation management	Strong ability in innovation management	t-value	p-value
Average performance of new product development	0.0817	0.6815	-5.77	0.000***

***p<0.001

Table 2: T-test of the Influences of support for organizational communication, the degree of emphasis placed on the organizational Innovation and organizational decision-making and authorization and their influences on new product development performance

Performance of new product development	Mean value of weak support ability of organizational communication	Mean value of strong support ability of organizational communication	t-value	p-value
Overall mean performance	0.1723	0.5467	-3.59	0.000***
Performance on new product development	Low level of organizational decision-making and authorization	High level of organizational decision-making and authorization	t-value	p-value
Overall mean performance	0.0851	0.5388	-4.68	0.000***
Performance on new product development	Low level of emphasis on organizational innovation	High level of emphasis on organizational innovation	t-value	p-value
Overall mean performance	0.0893	0.5358	-4.52	0.000***

***p<0.001

Table 3: Two-way ANOVA analysis of organizational communication support and innovation management ability on new product development performance

Source of difference	f-value	p-value
Main effects from technology innovation	18.69	0.000***
Main effects from support and communication	7.65	0.000***
Combined effects	0.49	0.56
Overall effects	11.25	0.000***

***p<0.001

T-Test of the Influences of Organizational Innovation Tendency on New Product Development Performance

As illustrated in Table 2 (p = 0.000), new product development performance is influenced by the level of organizational communication, the degree of organizational decision-making and the degree of emphasis placed on new product development. High organizational innovation tendency has a significant influence on new product development performance. The findings support research hypotheses H_{2-1a} , H_{2-2a} and H_{2-3a} . The research results provide empirical evidence to the research theory by Thomas (1993) and Damanpour (1991) on organizational innovation.

Two-Way ANOVA Analysis on the Influence of Organizational Support and Communication and Innovation Management on New Product Development

As the organization's innovative tendency is an intermediate variable in this research study and the innovation management ability separated into strong and weak groups, Two-Way ANOVA analysis was conducted on new product development performance based on the level of support and communication within the organization. The result (p = 0.56) in Table 3 indicated that differences in organizational communication support will not affect the innovation management ability on new product development. There is a high positive significance level in the main and overall effects. This is the same as the finding results mentioned above.

One-Way ANOVA Analysis on the Influence of Organizational Communication Support and Innovation Management Ability on New Product Development

With the aim of gaining further understanding on the differences in new product development performance, this study categorized the strength in a firms' innovation management ability and

Table 4: One-way ANOVA analysis on the combination of the strength of innovation management and organizational communication support and their influences on new product development performance

Organizational communication	Weak ability in technology innovation	Strong ability in technology innovation	f-value	Scheffe's multiple-comparison
Weak support ability of organizational communication	A 0.072 (Worst)	C 0.455 (Medium)	11.27	A-C A-D
Strong support ability of organizational communication	B 0.135 (Medium)	D 0.664 (Best)		B-D

***p<0.001

Table 5: T-test on the scale of business operation and technical leadership and their influences on the new product development performance

Performance of new product development	Mean score of small business operation	Mean score of large business operation	t-value	p-value
Overall performance mean score	0.2168	0.5535	-1.33	0.157
New product development performance	Low level of technical leadership	High level of technical leadership	t-value	p-value
Overall performance mean score	0.08145	0.5488	-4.84	0.000***

***p<0.001

organizational communication support into four sample groups for One-Way ANOVA analysis. A comparison to Scheffe's Multiple-Comparison was also made. As illustrated in Table 4, the result reveals that there is a significant difference among A-C, A-D and B-D. This suggested that strong innovation management ability and a high level of organizational communication support leads to a significant influence on new product development performance. Due to the significant differences between B, D and A, C and the lack of difference between C and D, new product C performance was less. There is also a significant difference among A and D, C which indicated that the innovation management ability and the level of organizational communication support have value-adding effects. This result provides empirical evidence for research hypotheses H_{2-2b} and H_{2-3b} .

The Influence of the Business Operation Scale and Technical Leadership on New Product Development Performance

Although the influences of the business operation scale on new product development performance is a controversial topic, the findings from this research study indicate that the scale of the business operation is not necessary a key success factor for new product development performance. The research result in Table 5 ($p = 0.157$) implies that there is no significant difference in new product development performance by large and small scale business operations. This research also discovered that the corporation's technical skill has a positive influence on new product development performance ($p = 0.000$). The hi-tech industry is one of the most popular industries in Taiwan. With high market growth and attention on Research and Development, there is an active push for product innovation. This research justified that the characteristics of this industry has a significant influence on innovation management. The empirical evidence supports H_{3-1a} and H_{3-2a} .

The Two-Way ANOVA Analysis of Industry and Corporate Status and Innovation Management Ability on New Product Development Performance

As industry and corporate status is an intermediate variable in this research, innovation management ability is separated into strong and weak groups. Two-way ANOVA analysis was conducted on new product development performance under different business operation scales. The research results in Table 6 ($p = 0.361$ and $p = 0.603$) suggests that there is no significant difference between the two variables. This indicates that there is no significant difference between innovation management ability in different business operation scales and new product development performance.

Table 6: The two-way ANOVA analysis on the scale of business operation and innovation management ability and their influences on new product development performance

Source of differences	f-value	p-value
Main effects from ability of Innovation management	24.08	0.000***
Main effects from scale of business operation	0.85	0.361
Effects from interaction	0.28	0.603
Overall effects	10.65	0.000***

***p<0.001

Hence, there is no empirical evidence to support H_{3-3b} . However, under the same methodology, there is a significant difference between the main effects of innovation management ability and the overall effects. This finding provided empirical support for H_{3-1b} and H_{3-2b} .

CONCLUSIONS

Innovation management ability consists of four main functions: Technical innovation, market innovation, management innovation and cultural innovation. This study explored the influences of innovation management ability on new product development performance considering two intermediate variables, the industry and corporate status and the organizational innovation tendency. Through extensive research on empirical theories and topic discussion, a relational theoretical framework was developed to provide empirical evidence and analysis on hi-tech industries in Taiwan. The research findings suggest that innovation management ability has significant influences on new product development performance. Statistical evidence justified the hypothesis that new product development performance is more significant as the innovation management ability is stronger. The empirical evidence also indicated that these five variables interact with new product development and have a combination effect on new product development performance: The level of organizational communication support, the degree of organizational decision-making and authorization, the degree of emphasis placed on innovation, industry characteristics and the corporate technical leadership.

The scale of business operations impact on innovation management ability has been a controversial discussion topic. This research justified that the scale of business operations is not a key success factor for new product development performance. Both large and small business enterprises have strength and there is no significant difference in their new product development performance. Further research is still required on this topic. This study allocated similar measurement scales to the four facets for innovation management ability. However, during the survey questionnaire research process, it was discovered that business enterprises place different emphasis on each facet. In reality, business enterprises with different industry backgrounds and corporate status will apply different technology innovation strategies. Hence, their focuses on each of the facets for innovation management ability will naturally vary. The benefit of innovation management influences new product development performance and also has a close relationship with the core technologies in hi-tech industry development in Taiwan.

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