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The Influences of R and D Management Capacity and Design/Manufacturing Integration Mechanisms on New Product Development Performance in Taiwans High-Tech Industries

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Abstract: With rapid changes in technology, product manufacturing techniques and extreme market changes, the life cycles of high-tech products have become increasingly shorter. The high-tech industry must continue research and development (R and D) and innovation to improve New Product Development (NPD) industry performance. This research analyzed the influences of R and D management activities and design/manufacturing integration mechanisms introduced by Taiwan's high-tech industry on NPD performance. This study on the relationship between R and D management capacity and NPD performance considers the intervening variables of industry and corporate position. Taiwan's high-tech industry has gradually entered the technical capacity-based and design/manufacturing integrated industry improvement era. This research reveals the significance of academic and empirical application to the high technology industry. The research result found that the stronger the R and D management capacity of Taiwans high-tech industry, the more significant its influence on NPD performance, the better the design/manufacturing integration mechanisms of Taiwan's high-tech industry, the more significant the influence on NPD performance, the stronger the R and D management capacity of Taiwans high-tech industry, the better the design/manufacturing integration mechanism and the more significant their influences on NPD performance, corporate scale was not necessarily the major factor for the NPD success and corporate scale did not result in significant differences in NPD performance and the higher the leading degree of corporate techniques, the more significant the NPD performance.

Key words: R and D management capacity, Design/manufacturing integration mechanism, new product development performance

INTRODUCTION

Research and development (R and D) techniques have increasingly become more complicated and unpredictable. How Taiwans high-tech industry properly manages the upgrade in R and D techniques, plan and acquires the resources related to new techniques to increase New Product Development (NPD) performance and international competitiveness is a critical research issue. With the life cycles of high-tech products shorter, NPD performance is critically important in corporate operations. The positions of R and D management and design/manufacturing integration in NPD have become increasingly important. There is a close connection between the effective operation of the original techniques and the acquisition of new techniques. R and D management capacity was the critical indicator of corporate growth. In past studies exploring the factors influencing the success of NPD, most focused on exploring the interfaces in the product development process. However, the high-tech industry is led by techniques, although product development and sales are important, R and D management capacity is even more critical. R and D management capacity and design/manufacturing integration mechanisms are the subjects of this research. The research purposes are described as: (1) exploring if R and D management capacity had critical influence on NPD performance of Taiwans high-tech industry; (2) exploring if different levels of design/manufacturing integration mechanisms lead to different R and D management NPD development effects; (3) exploring if different industries and corporate positions lead to different NPD performance effects. We describe the literatures related to high-tech industry R and D management capacity, design/manufacturing integration mechanisms and NPD performance.

High-tech industry: Bleicher and Paul (1983) indicated that the high-tech industry was high capital and technical precision industry which emphasized professional knowledge, research development and

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technology talent cultivation and the attributes of high technology intensity, large economic scale, high risk and high return. Gould and Keeble (1984) suggested that the high-tech industry should be measured by three indicators: proportion of research development expense in output, speed of technical innovation and the proportions of technical personnel and research development personnel. Shanklin and Ryans (1984), Liu *et al.* (2004, 2005) argued that the firms must have powerful base of scientific techniques. New techniques could rapidly eliminate the original techniques. With the application of new techniques, the market and demand could be constructed or changed. When the firms fulfilled these three conditions, they could be considered high-tech. Rogers and Larson (1984) suggested that high-tech industry should possess 4 conditions: (1) high proportions of the scientists and engineers among the technicians, (2) rapid growth of the industry, (3) high proportion of research development expenditure in business volume and (4) global market of the products. Riggs (1985) argued that high-tech companies were firms treating technology as their major competitive strategy and tool. They valued R and D functions, had short product life cycles, high risk and changed rapidly. Chiu (2002), Tien *et al.* (2007) suggested that the characteristics of Taiwans high-tech industry included: (1) talent-intensive, (2) capital-intensive, (3) high technical level and complicated manufacturing process, (4) high market concentration and (5) short life cycle of products. Based on above, the industry of Taiwan was marching toward high-tech development with the planned promotion of the government and the movement of the industry environment. It was expected that Taiwan could be a technological nation treating high-tech industry as the strategic mainstream and innovation orientation in the future. According to the literature review, this research allocated the characteristics of Taiwans high-tech industry into 6 categories: (1) integrated circuit industry, (2) computer and related industry (3) communication industry, (4) optoelectronics industry, (5) precision machinery industry and (6) biotechnology industry as the targets of the questionnaire survey in this research.

R and D management capacity: Brown and Svenson (1988) argued that the entire R and D activity was treated as a system, including earnings, manufacturing process and output. The assessment system was divided into 5 stages: involvement, process, output, receiving system, results and the returns of output and results to explore R and D productivity. Karagozoglu and Brown (1993) indicated that with regard to the customers participation in the first stage of new product development, the application of the related marketing measures would lead to the success of NPD and shorten R and D time. In the study upon Battelle and the firms focusing on research development, Millett (1990) suggested that in order to respond to the customers needs, regularly manage upward and downward communication and techniques, the products and techniques did not necessarily influence R and D capability. Ellis and Curtis (1995) argued that R and D activities would influence customer satisfaction. Clausing (1994) suggested that the content of research development included the products which fully responded to the customers' needs, the feasibility of the design, powerful functions, successful integration, reused characteristic and strategic influence. McDonough (1993) suggested that introducing the techniques from external environment saved more time than internal R and D. Karagozoglu (1993) indicated that firms would save R and D time if they used external techniques. Chakrabarti (1991) argued that for high-tech, capital-intensive and labor-intensive industries, there was significant and positive correlation between R and D involvement growth rate and business growth rate. DeMott (1990) suggested that to acquire advantages over rivals, the firms could establish strategic alliances, share facilities and share information with other firms. Rosenau (1998) suggested that high-rank managers participation could help resource offering and support. Mabert *et al.* (1992) suggested that when R and D group recognized the competitive threat from the rivals, their R and D time would be shortened. Kamath and Liker (1994) indicated that in the process of NPD, if the firms can allow the suppliers to participate in, the lead time will be efficiently reduced, manufacturing costs will be reduced and the design process accelerated.

After literature review, this research listed 5 constructs to measure R and D management of high-tech industry below:

- **The degree of customer participation in new product R and D at the early stage:** Karagozoglu and Brown (1993) indicated that customer participation and NPD could allow R and D department to effectively solve the customers demands. Kamath and Liker (1994) suggested that if the firms can allow the suppliers participation during the process of NPD, the lead time could be effectively reduced.
- **The cooperative degree of R and D project with external techniques:** Karagozoglu (1993) indicated that if the firms can use the external techniques, R and D time and costs will be reduced.
- **Cooperative degree of R and D project with external funds:** Chakrabarti (1991) suggested that high-tech was capital-intensive and labor-intensive industry and there was significant and positive correlation between R and D involvement growth rate and business growth rate.

- **Cross-department degree of R and D project:** Youssef (1994) indicated that through the early participation in the design of the manufacturing, the adjustment between the design and the manufacturing and re-evaluation could be considerably reduced. Cusumano and Nobeoka (1992) suggested that in NPD, the multi-functional team could lead to better performance in terms of manufacturing productivity, design productivity, overall quality and easy-to-make design.
- **The degree of high-ranking managers involvement in R and D project:** Rosenau (1998) suggested that high-ranking managers participation could increase resource offering and support and stimulate the personnel when managing new product R and D. Karagozoglu and Brown (1993) indicated that high-ranking managers' participation in new product R and D could accelerate R and D speed and cooperation and allow the multi-functional team to be more efficient.

Design/manufacturing integration mechanism: Vandevelde and Van Dierdonck (2003) argued that cross departmental obstacles could be overcome if industries can understand D-M integrated mechanism. Susman and Ray (1999) suggested defining cross-functional integrated mechanism as the policy and practice which could avoid the possible negative influences of functional difference. Integrated mechanisms could be accomplished through the factors influencing the organizational and individual value, targets, knowledge and skills. Adler and Helleloid (1997) suggested that NPD efficacy was influenced by the quality of project management, techniques used and the organizational characteristics. Trygg (1991) argued that the corporate integrated factors were: (1) organizational factor and (2) technical factor. Twigg (2002) indicated to divide integrated mechanism into organizational and technical mechanism patterns. Liker *et al.* (1999) suggested allocating the organizational design into organic and mechanical according to the characteristics. Swink (2000) used 136 NPD project managers from the American manufacturing industry as the targets and explored the influences of new product design integration and high-ranking managerial support on project performance.

Gonzalez and Palacios (2002) used 54 professional managers in Spain as the targets and explored the influence of NPD skills on the success of new products. Vandevelde and Van Dierdonck (2003) used 25 innovative firms in Belgium as the samples, interviewed 103 targets and scored 61 different product development projects. The regression analytical result showed that normalization was beneficial for stable production. Droge *et al.* (2004) suggested treating 57 corporate SBU from the direct suppliers of 3 leading automobile companies in North America as the targets and explored the influences of external integrated mechanisms on the speed of NPD and financial performance. Song *et al.* (1997) suggested treating high-tech firms in Mexico as the targets and explored the leading factors and results from cross-functional cooperation by three departments, R and D, manufacturing and marketing. Sicotte and Langley (2002) indicated that in the study of integrated mechanism and R and D project performance, they found that horizontal communication played partial intervening role between integrated mechanism and R and D project performance. Olson *et al.* (2001) suggested treating project managers from 9 firms as the research targets and explored the cooperative patterns of marketing, business and R and D during NPD process. Through explorative study, Pagell (2004) proposed the general model of the drives influencing the internal integration and indicated that job rotation, cross-functional teams, formal and informal communication, high-rank management support, information techniques and the rewards as the leading factors in internal integration. Internal integration could influence NPD performance. In the study of the influence of organizational integration and familiarity of NPD on market success, Millson and Wilemon (2002) found that there was significant correlation between overall organizational integration and the success of new product market. Based on the above literature review, this research adopted 2 indexes as the constructs of design/manufacturing integration mechanism: (1) organizational R and D design integration, (2) manufacturing technique capacity integration.

New product development (NPD) performance: Hopkins (1981) suggested that the assessment of new product development performance should be based on the following 5 indexes: (1) financial assessment, (2) target assessment, (3) proportion of new products in total sales, (4) success ratio of new products to market and (5) overall satisfaction with NPD. Calanton *et al.* (1995) treated the Ratio of Investment, Investment Growth Rate, Ratio of Sales, market share and Market Share Growth Rate as the measurement indexes for NPD performance. Song and Parry (1997) assessed the relative success level of a firms NPD using 4 indexes: (1) comparing the quality of the new products with the rivals, (2) comparing the sales of the new products with the rivals, (3) comparing the profits of the new products with the rivals and (4) comparing the success rate of new product to the market with the expected profits. Based on the above literature review, this research adopted 5 indexes as the constructs of NPD performance as below: (1) time of new product to the market, (2) quality level of new products, (3) market share

of new products, (4) success rate of new product to the market and (5) overall satisfaction with NPD.

RESEARCH DESIGN

This research design included questionnaire collection, research framework, research hypotheses and data analysis as:

- **Questionnaire collection:** This research treated the influence of R and D management capacity on NPD performance as the subject and selected Taiwan's high-tech industry as the population. It also selected 800 more well known and representative firms as the research samples and distributed 800 questionnaires in Feb., 2007. There were 360 returns, the return rate was 45%, there were 316 valid returns and the valid return rate was 39.5%. The questionnaire of this research was divided into 4 sections. The measurement of the first to the third section was based on Likert 5-point scale. The first section wasR and D management capacity; the second section was NPD performance; the third section was design/manufacturing integration mechanism; the fourth section was the basic information of the firms, including: (1) Corporate capital, (2) corporate business volume and (3) number of employees, etc.
- **Research framework:** The conceptual framework proposed by this research was shown as Fig. 1. The measurement constructs of R and D management capacity included: the degree of customer participation in new product R and D at the early stage, the cooperative degree of R and D project with external techniques, cooperative degree of R and D project with external funds, cross-department degree of R and D project and high-rank managers involvement degree in R and D project. The variables of design/manufacturing integration mechanism included: organizational R and D design integration and manufacturing technique capacity integration. The variables of industry and corporate position included the characteristics of industry, leading degree of corporate techniques, corporate scale, etc. The measurement constructs of NPD performance included time of new product to the market, quality level of new products, market share of new products, success rate of new product to the market and overall satisfaction with NPD.

Research hypotheses: Through literature review and theoretical analysis, this research proposed the research hypotheses for confirmation as follow:

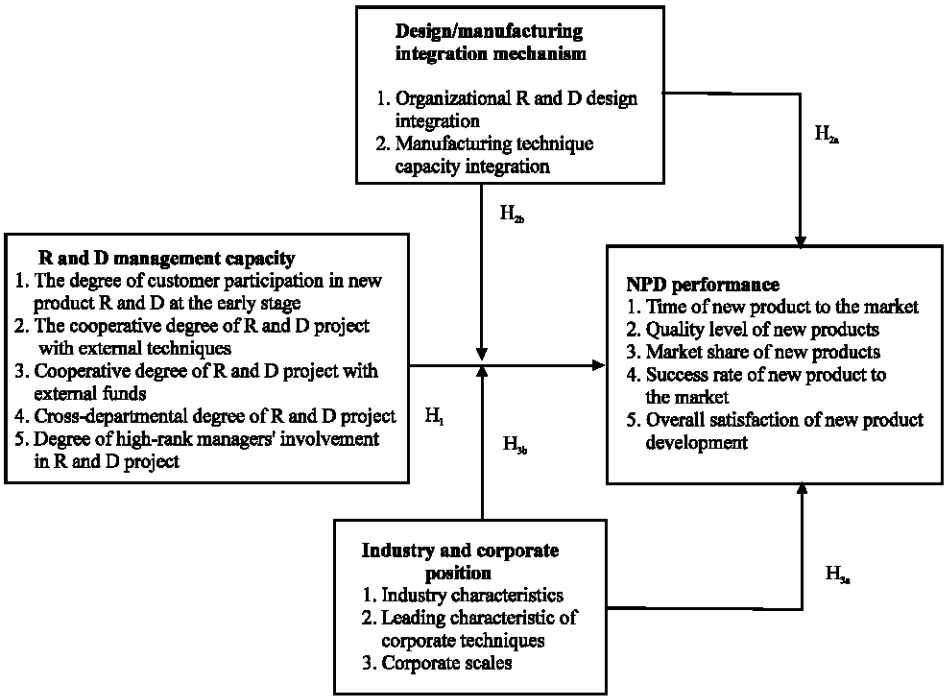

Fig. 1: The research framework

Table 1: Reliability, validity and confirmatory factor analysis of the constructs

	Variables and constructs	A-value	GFI	AGFI	RMR	CR	t-value
R and D management capacity	The degree of customer participation in new product R and D at the early stage	0.88	0.95	0.83	0.03	0.67	13.83~18.88
	The cooperative degree of R and D project with external techniques	0.86				0.66	13.13~18.15
	Cooperative degree of R and D project with external funds	0.87				0.68	15.14~18.44
	Cross-department degree of R and D project	0.91				0.69	13.22~19.06
	The degree of high-rank managers' involvement in R and D project	0.85				0.65	14.21~18.32
Knowledge share mechanism	Organizational R and D design integration	0.88	0.94	0.91	0.05	0.73	15.17~18.56
	Manufacturing technique capacity integration	0.87				0.88	12.36~18.88
NPD performance	Time of new product to the market	0.86	0.92	0.86	0.06	0.85	16.99~19.88
	Quality level of new products	0.85				0.85	16.76~19.84
	Market share of new products	0.88				0.84	16.36~19.76
	Success rate of new product to the market	0.91				0.88	16.34~19.46
	Overall satisfaction of NPD	0.88				0.83	16.51~19.78

H_1 : The stronger the executive degree of corporate R and D management capacity, the more significant the NPD performance.

H_2 : Organizational design/manufacturing integration mechanism would influence the fulfillment effect of R and D management capacity and NPD performance.

The sub-hypotheses developed upon the intervening variables were as follows:

$H_{2\text{-}1a}$: The differences in organizational R and D design integration lead to significantly different NPD performance.

$H_{2\text{-}1b}$: The stronger the R and D management capacity and the more organized the R and D design integration mechanism, the more significant their influences on NPD performance.

$H_{2\text{-}2a}$: The higher the degree of organizational manufacturing technique capacity integration, the more significant its influence on NPD performance.

$H_{2\text{-}2b}$: The stronger the R and D management capacity and the higher the degree of organizational manufacturing technique capacity integration, the more significant the NPD performance was.

H_3 : Industry and corporate position would influence NPD performance.

The sub-hypotheses developed upon the intervening variables were below:

$H_{3\text{-}1a}$: Industry characteristics had significant influence on NPD performance.

$H_{3\text{-}1b}$: With different industry characteristics, R and D management capacity revealed significantly different influences NPD performance.

$H_{3\text{-}2a}$: Leading characteristic of corporate techniques revealed significant influence on NPD performance.

$H_{3\text{-}2b}$: The higher the leading corporate technique characteristics and the stronger the R and D management capacity, the more significant the NPD performance.

$H_{3\text{-}3a}$: Corporate scale revealed significant influence on NPD performance.

$H_{3\text{-}3b}$: With different corporate scales, R and D management capacity revealed significantly different influences on NPD performance.

Data analysis: When distributing the questionnaires, it selected more well-known firms with NPD experience as the samples. The respondents must have thorough understanding with the NPD process. The research treated the project managers of NPD, experienced product planning personnel, experience R and D managers and R and D management executives as the respondents to increase the validity of the questionnaires. This researcher also calculated the Cronbachs α of the questions from each construct to test the questionnaire reliability. When α value was larger, it meant the internal consistency and reliability among the questions of the construct was higher. This research managed reliability, validity and confirmatory factor analysis on R and D management capacity, design/manufacturing integration mechanism and NPD performance to understand the fit situation of the scale in the measurement model. As to reliability, α value of each construct was more than 0.7; Composite Reliability (CR) was more than 0.6 which complied with the view of the scholars Baggozzi and Yi (1988) who emphasized that CR should at least be more than 0.6. With regard to fit index, GFI was between 0.93 and 0.96, AGFI was between 0.83 and 0.90, RMR was less than 0.05 which showed the relative consistency of the scale. As to validity, t-values of all questions of the constructs were significantly more than 2 which showed significant convergent validity. Nunnally (1978) argued that in basic study, when reliability was at least 0.7, it was acceptable. Reliability of this research was more than 0.7. Therefore, the reliability was reliable. This research analyzed and dealt with the data by SPSS 12.0 for windows statistical software. The researcher managed the confirmatory analysis using statistical methods such as t-test, Two way Analysis of Variance, factor analysis, correlation analysis and Multiple-regression-analysis. Reliability of each variable in this research and confirmatory factor analysis, as shown in Table 1.

RESULTS

t-test of the influence of R and D management capacity on NPD performance: Based on 5 R and D management constructs and according to the average overall R and D management capacity, this research allocated the firms from Taiwans high-tech industry into two groups: strong R and D management capacity (with average over 0.5) and weak R and D management capacity (with average less than 0.5) and managed t-test upon their influences on NPD performance as Table 2. In other words, when the R and D management capacity of the firms of Taiwans high-tech industry was stronger, the NPD performance would be more significant. The confirmation demonstrated that stronger R and D management capacity of Taiwans high-tech industry was substantially beneficial for their NPD performance. The research result supported research hypotheses H_1.

t-test of the influence of organizational design/manufacturing integration mechanism on NPD performance: According to Table 3, it revealed that organizational design/manufacturing integration mechanism revealed certain degree of influence on NPD performance. When the organizational design/manufacturing integration mechanism was stronger its influence on NPD performance was more significant. The result supported research hypotheses $H_{2\text{-}1a}$, $H_{2\text{-}2a}$.

Corporate scale and leading degree of corporate techniques influence on NPD performance: Although the influence of corporate scale on NPD has been a controversial topic, this research found that corporate scale was not necessarily the key factor in NPD success. The research result in Table 4 ($p = 0.157$) shows that large-scale firms and small-scale firms did not show significant differences in terms of overall NPD performance. This research also found that in the relationship between the leading degree of corporate techniques and overall NPD performance, when the leading degree of corporate techniques was higher, it had a significant and positive influence on NPD performance. This research treated Taiwan's high-tech industry as the targets. The high-tech industry is the most popular industry in Taiwan. It is vigorous in terms of market share, R and D involvement and product innovation. The research demonstrated that industry characteristics indeed showed significant influence on R and D management. The test result confirmed $H_{3\text{-}2a}$, $H_{3\text{-}2b}$, $H_{3\text{-}3a}$ and $H_{3\text{-}3b}$.

Two way analysis of variance of industry and corporate position and R and D management capacity on NPD performance: Since industry and corporate position are intervening variables in this research, the researcher managed Two way Analysis of Variance on the influences of two groups (strong and weak R and D management capacities) on NPD performance with different corporate scales as Table 5 which ($p = 0.369$ and $p = 0.608$) showed that the interaction between the two did not reach the significance. In other words, with different industry scales, the influences of R and D management capacity on NPD performance did not show significant difference. However, through the same analytical method, we found that the principal and overall effects of R and D management capacity both reached the significance. The research hypotheses $H_{3\text{-}1a}$ and $H_{3\text{-}1b}$ were confirmed.

Table 2: t-test of the influence of R and D management capacity on NPD performance

	Weak R and D management capacity	Strong R and D management capacity	t value	p-value
Overall performance average of NPD	0.0825	0.6828	-5.56	0.000***

***: Means $p<0.001$

Table 3: t-test of the organizational design/manufacturing integration mechanism influence on NPD performance

NPD performance	Average of weak design/ manufacturing integration mechanism	Average of strong design/ manufacturing integration mechanism	t-value	p-value
Overall performance average	0.1726	0.5469	-3.39	0.000***
NPD performance	High level of organizational R and D design integration	High level of organizational R and D design integration		
Overall performance average	0.0853	0.5386	-4.67	0.000***
NPD performance	Low level of manufacturing technique capacity integration	High level of manufacturing technique capacity integration		
Overall performance average	0.0896	0.5347	-4.53	0.000***

***: Means $p<0.001$

Table 4: t-test of the influence of corporate scale and leading degree of corporate techniques on NPD performance

NPD performance	Average of small-scale firms	Average of large-scale firms	t-value	p-value
Overall performance average	0.2169	0.5536	-1.34	0.157
NPD performance	Low leading degree of corporate techniques	High leading degree of corporate techniques		
Overall performance average	0.0816	0.5489	-4.85	0.000***

***: Means $p<0.001$

Table 5: Two way Analysis of Variance of corporate scale and R and D management capacity on NPD performance

Sources of variance	F-value	p-value
Principal effect of R and D management capacity	24.15	0.000***
Principal effect of industry scale	0.88	0.369
Cross effect	0.27	0.608
Overall effect	10.65	0.000***

***: Means p<0.001

Table 6: Multiple-regression-analysis of R and D management capacity on NPD performance

	Model 1			
Variables	B	Std. E	β	t-value
The degree of customer participation in new product R and D at the early stage	0.329	0.108	0.183	1.308
The cooperative degree of R and D project with external techniques	0.239	0.127	0.238	1.933
cooperative degree of R and D project with external funds	0.157	0.107	0.147	1.032
Cross-department degree of R and D project	0.286	0.104	0.329	2.835
The degree of the high-rank managers' involvement in R and D project	0.288	0.104	0.322	2.286
Adjusted R		0.795		

Table 7: Multiple-regression-analysis of design/manufacturing integration mechanism on NPD performance

	Model 2			
Variables	B	Std. E	β	t-value
Organizational R and D design integration	0.129	0.079	0.185	1.583
Manufacturing technique capacity integration	0.608	0.084	0.623	2.384
Adjusted R		0.782		

Table 8: Fit indexes of assumption and competition models

Model	GFI	NFI	CFI	RMR	RMSEA
Partial intervening model	0.94	0.95	0.94	0.07	0.03
Complete intervening model	0.97	0.99	0.97	0.07	0.00

Multiple-regression-analysis of R and D management capacity and design/manufacturing integration mechanism on NPD performance: Multiple-regression-analysis was a kind of extended application of simple correlation which aimed to understand the straight line relationship between a set of predicator variables and a criterion variable. Multiple-regression-analysis of this research is shown in Table 6 and 7. According to the figures in Table 6 and 7, the B-value, β value and t-value assumptions all reached a positive and significant level. β-values of Model 1 (Table 6) were, respectively 0.183, 0.238, 0.147, 0.329 and 0.322 and the model was $y_1 = 0.329x_1 + 0.239x_2 + 0.157x_3 + 0.286x_4 + 0.288x_5 + e_1$, ($x_1$ was the degree of customer participation in new product R and D at the early stage, x_2 was the cooperative degree of R and D project with external techniques, x_3 was cooperative degree of R and D project with external funds, x_4 was cross-department degree of R and D project and x_5 was the degree of high-rank managers involvement in R and D project) which revealed positive and significant relationship. Adjusted R was 0.795 and the explanatory power of all variables was extremely high. β-values of Model 2 (Table 7) were, respectively 0.185 and 0.623 and the model was $y_2 = 0.129x_6 + 0.608x_7 + e_2$, ($x_6$ was organizational R and D design integration and x_7 was manufacturing technique capacity integration) which all revealed positive and significant relationship. Adjusted R was 0.782. The explanatory power of all variables was extremely high. Thus correlation among R and D management capacity, design/manufacturing integration mechanism and NPD performance in this research could be confirmed.

LISREL model analysis: With regard to the fit of the research models, many scholars have proposed the indexes and criteria. The scholars Baggozzi and Yi (1988) suggested that GFI > 0.9, NFI > 0.9, CFI > 0.9, RMR > 0.05, RMSEA < 0.05 of the model were the indexes of the fit of the model. This research aimed to explore the relationships among different constructs. Research framework was constructed by one- hierarchy model and the research framework (partial intervening model) was shown as Table 8. The fit of the indexes all reached the standard argued by the above scholars. In face, a set of research data could include many fit models. A fit model was not necessarily the optimized model. This research adopted competition model and proposed two competition models (complete intervening and direct effect) to compare them with the assumption model. The research found that GFI = 0.97, NFI = 0.99, CFI = 0.97, RMR = 0.07 and RMSEA = 0.00 of the complete intervening model was the optimized path. The optimized path relationships of the constructs in this research are shown in Fig. 2.

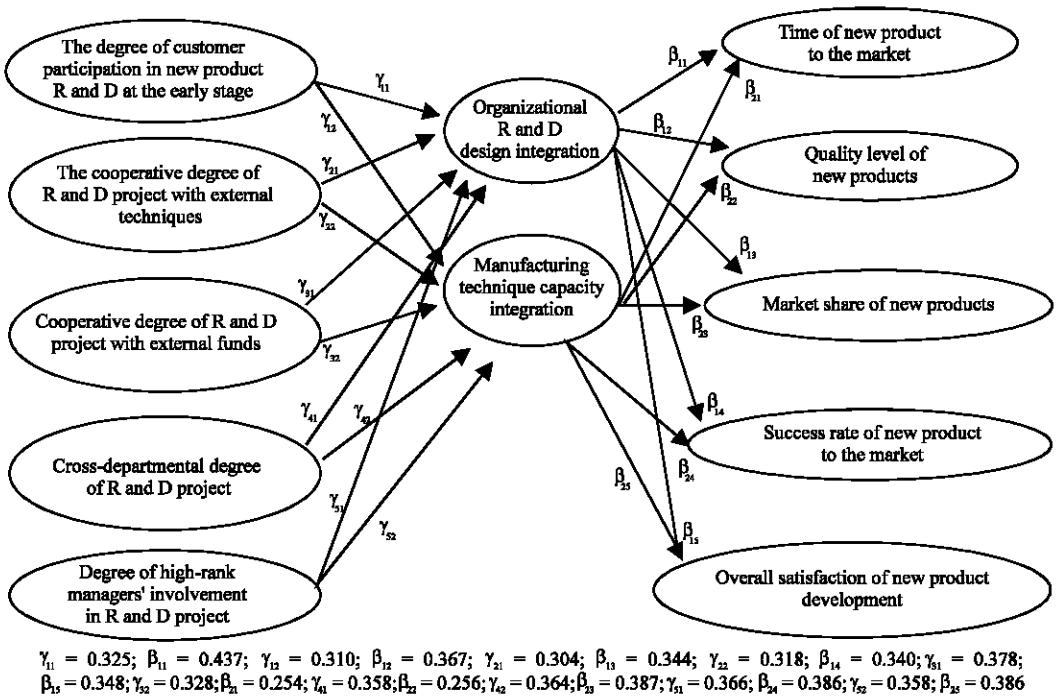

Fig. 2: The optimized model path (complete intervening model)

Result confirmation:

- Relationship between R and D management capacity and design/manufacturing integration mechanism: According to the figures of LISREL model analysis, we found that R and D management capacity had significant influence on organizational R and D design and manufacturing technique capacity as Fig. 2. In other words, when R and D management capacity was stronger, organizational R and D design integration and manufacturing technique capacity integration capacities were more likely to be increased. Thus, research hypotheses H_2 was supported.
- The influence of design/manufacturing integration mechanism on NPD performance: According to the figures of LISREL model analysis, organizational R and D design integrated mechanism and manufacturing technique capacity integration mechanism had significant influence on NPD performance as Fig. 2. In other words, the better the organizational R and D design integrated mechanism, the better the corporate NPD performance. The employee manufacturing technique capacity integration mechanism had a significant influence on NPD performance. In other words, the better the employee manufacturing technique capacity integration mechanisms, the better the corporate NPD performance. Thus, $H_{2\text{-}1a}$, $H_{2\text{-}1b}$, $H_{2\text{-}2a}$, $H_{2\text{-}2b}$ were supported.

CONCLUSIONS

This research treated R and D management capacity, design/manufacturing integration mechanism and NPD performance as the constructs for a correlation among R and D management capacity, design/manufacturing integration mechanism and NPD performance using statistical analysis. After theoretical and literature review, it found the theoretical model influencing the relationships and managed the empirical analysis of questionnaire survey on Taiwans high-tech industry. The research result revealed that R and D management capacity and design/manufacturing integration mechanism had a significantly positive influence on NPD performance. In other words, the hypothesis the stronger the R and D management capacity and the better design/manufacturing integration mechanism, the better the NPD performance effect was confirmed by the statistical analysis. Therefore, to survive and have sustainable operations, firms should value internal R and D management capacity and design/manufacturing integration mechanism to increase NPD performance:

- **R and D management capacity and NPD performance:** The research result revealed that when the employees were willing to effectively share their R and D skills and knowledge to others in need, the corporate NPD performance could be increased; thus,

good design/manufacturing integration mechanism among the employees would directly benefit corporate operational management and NPD performance.

- **Design/manufacturing integration mechanism and NPD performance:** The research result revealed that in the developing process, the employees design/manufacturing integration mechanism played critical role for NPD performance and had a positive and significant influence on NPD performance.
- **R and D management capacity and design/manufacturing integration mechanism:** The research result showed that corporate R and D management capacity was significantly beneficial for the development of corporate design/manufacturing integration mechanism. When the employees transformed R and D knowledge into beneficial development for the firms, they could create continuous competitive advantages.

Practical implications: According to the research result, the overall effect of the corporate introduction of R and D management on the upgrading of NPD performance was more significantly confirmed. Based on the research result, this research reorganized the empirical meanings of management as the follows:

- **R and D management capacity:** The research result showed that corporate R and D management capacity could help upgrade corporate design/manufacturing integration mechanism; thus, the firms should encourage employees to manage R and D management and design/manufacturing integration mechanisms to increase the corporate competitiveness.
- **Design/manufacturing integration mechanism:** According to the research result, design/manufacturing integration mechanism could influence the NPD performance; the firms should encourage the employees to contribute their R and D skills and knowledge to the organization to create more prominent corporate value.
- **Relationship among R and D management capacity, design/manufacturing integration mechanism and NPD performance:** With regard to corporate R and D management capacity and design/manufacturing integration mechanism, the employees' active R and D knowledge and skills share to the organization could make the employees to devote to the production and increase the corporate continuous NPD performance and operational performance.
- **R and D management capacity and corporate scale:** the influence of corporate scale on R and D management capacity has been a controversial topic. This research demonstrated that corporate scale was not necessarily the key factor influencing the NPD performance. Large-scale firms and small-scale firms had their own advantages. Thus, their NPD performances were not significantly different. Generally speaking, the average level of large-scale firms on NPD performance was slightly higher than that of small-scale firms which was an issue worthy of further in-depth study. In fact, with different industry backgrounds and corporate positions, the firms would adopt different technical innovation strategies; thus, their weight setting of R and D management capacity construct would certainly be different. R and D management capacity not only influenced NPD performance, but is also closely connected with the core techniques of Taiwan's high-tech industry development.

The employees of Taiwan's high-tech industry would lead to the vigorous development of the industry through organizational R and D design integration and manufacturing technique capacity integration mechanism. The managers of Taiwans high-tech industry should encourage the employees to actively participate in research development by guidance or the establishment of reward system to increase the employees R and D knowledge and creative spirit which will effectively upgrade the NPD performance of Taiwan's high-tech industry.

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