From Manufacturing and Innovation Functional Area to Assess Corporation's Performance – Example of Taiwan Manufacturing Industry

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ABSTRACT
This research develops an exploratory model to evaluate the relationship between resources of corporate competencies and business performance, which targets manufacturing industry in Taiwan, analyzes 21 competence items in two competence dimensions: product design and development, and manufacturing. The results from 750 valid samples from managers of Taiwan's manufacturing enterprises reveal that in manufacturing competence were ranked high by Taiwan's manufacturing enterprises managers. At the very top of the prevailing management competitive priority list are: (1) prompt delivery of customer orders, (2) improving process quality control, (3) increasing reliability of transportation, (4) introduction of new concepts and continuous improvement, (5) increasing utilization of production capacity, and (6) increasing efficiency of production scheduling. The six items mentioned above, five belong to manufacturing competence, and one is in product design and development competence. The two competence dimensions are found highly correlated to business performance, which shows the strategy adjustments that Taiwan's manufacturing enterprises have made to respond to the more rigorous competitive market.

Keywords: Manufacturing Industry, Competencies, Business Performance

1.0 Introduction

The position of manufacturing enterprises in Taiwan's economic growth, and their contribution to industrial progress are broadly recognized. Nowadays, under the globalization and liberation trends, Taiwan's manufacturing enterprises have realized management hardships due to increases in operational cost and market scale limitations. The subjects of primary concern to manufacturing enterprises are improving enterprise quality and selecting appropriate management strategies. Porter [1990] confirmed that to position themselves in a leading role, enterprises must adopt strategies to take advantage of their own competencies including new product design, new production technology, training plan, quality control plan and improved supplier relationships. Corporate strategies and business performance have been the core topics of strategic management for the past three decades. A typical empirical example is the resource-based "core competence" concept (Prahalad and Hamel [1990]). Market competitiveness is based on enterprise internal competence and determines the future development of the enterprise. Internal competence is the cornerstone for enterprises to succeed in market competition (Corbett and Wassenhove [1993]). As one of four Asian dragons, Taiwan created a worldwide famous economic miracle, in which, the performance of manufacturing enterprises played a critical role. After Taiwan joined the WTO, the challenges facing Taiwan manufacturing industry have ever intensified. Improving manufacturing industry competencies has become a core topic that concerns both industry and government. Until now, there are few researches that have been attended to the analysis of product design and development, and manufacturing resolution chose by Taiwan's manufacturing industry. The purpose of this study intends to assess the relationship between the resources of corporate competencies and business performance of Taiwan's manufacturing industry.

2.0 Related research

Early studies were oriented towards a discussion of the impact that a single enterprise functional competence area has on overall enterprise performance (Ettlie [1997]; Hayes and Wheelwright [1984]; Tunalv [2001]). Brown and Eisenhardt [1995] asserted that functional integration is highly correlated to time, cost and quality. Recent studies showed that enterprises could increase their market competitiveness only by coordinating functional area competencies (Evans and Lindsay [1996]; Hill and Jones [1989]; Porter [1990]). Consequently, in this study, we have integrated two functional areas to evaluate the relationship between resources of corporate competencies and business performance.

We propose that capabilities in product design and development, and manufacturing are origins of

competencies of manufacturing industry. Academic researches proved the importance of manufacturing functions to factories and plants (Blackburn [1991]; Hayes and Wheelwright, [1984]; Skinner [1985]; Tunalv [1992]). Capon *et al.* [1990] advocated that corporate profitability is closely correlated to product innovation competence and market development competence. According to previous study, we argue that the strategy development process should include such dimensions as manufacturing, research and development etc. Functional strategy involves developing unique competences to provide companies or organizations competitive advantages (Hunger and Wheelen [2001]). Based on the literature and the characteristics of Taiwan's manufacturing industry, this study summarizes origins of corporate competencies are attributed primarily to competence execution in product innovation, and manufacturing dimensions, a comprehensive list of 21 competence items was developed. Only inter-functional enterprise competencies integration can support sustainable growth in intensified competition.

2.1 Product design and development

In his landmark study on "The Competitive Advantage of Nations", Porter [1990] emphasized the importance of innovation strategies to Japanese industries, which is also the essential factor driving the success of Japanese companies. To gain competitive advantages in market competition, product lines should have the following dimensions: new product introduction, product development cycle time, product improvement/refinement, new product development and original product development (Calantone *et al.* [1995]; Ettlie[1997]; Porter[1990]). The critical factors to success in new product design and development include understanding the market needs, early mover strategies and integrated design practices (Ettlie[1997]). Product design and development are considered enterprise innovation competence. The success or failure of a new product is measured in multiple dimensions. The research of product innovation showed that innovation has an obvious effect on overall enterprise performance, for example, profitability and revenue growth (Calantone and di Benedetto[1990]; Hayes and Wheelwright[1984]). Calantone *et al.* [1995] proved in his study on the furniture industry that new product research and development activities have significant impacts on ROI, ROI growth, market share, and market share growth. In general, the research results showed that a focus on innovation competence would increase overall business performance.

2.2 Manufacturing

The close correlation between manufacturing and competitive strategies supports competitive priorities (Leong *et al.* [1990]; Zahra and Das [1993]). Moreover, the alignment of manufacturing strategy and business strategy has a positive effect on business performance improvement, which will in turn help accomplish business objectives. The indicators that measure performance improvement include profitability and market share and so on (Sun and Hong [2002]). In the past, most literature concerning manufacturing competence stressed the selection of key tasks for manufacturers including materials management, production planning and control and capacity management (Hayes and Wheelwright [1990]; Hill [1994]; Krajewski and Ritzman [1996]). Materials management involves suppliers, inventory, production level, and distribution and so on. Product planning and control focus on planning, scheduling, process quality control and reducing manufacturing costs. Appropriate production levels and capacity management enable manufacturers to meet current and future demand and secure opportunities for sales growth and profits.

2.3 Performance

Dess and Robinson [1984] recognized that the most common performance measurement was economic, using indicators like the rate of return on assets and sales growth rate. In comparing the correlation of strategy and performance in multinational enterprises and global industry, Carpano *et al.* [1994] adopted two performance indicators: the rate of return on investment and sales growth rate. Tsuneo [1981] summarized numerous researches performed by many scholars and concluded that enterprise objectives should include multiple objectives; sales growth, profitability, cash flow, market share and stability, etc.

Based on the previous studies, we argue the measures of performance in this study include in financial and marketing dimensions by such indicators as after-tax profit, return on investment, sales and market share.

3.0 Methodology

3.1 Sample

This study is part of a large-scale survey of manufacturing industry in Taiwan. During the period between July 2006 and August 2006,the six-page questionnaire was mailed to the managers of firms registered in the computerized database in Industrial Development Bureau Ministry of Economic Affairs (IDB). Seven hundred ninety-two responses were received from 2,500 questionnaires sent. Forty-two invalid questionnaires were excluded. The valid questionnaires totaled 750, accounting for a 30.0 per cent valid response rate. Table 1 shows the manufacturer data by industry, revenue, capital amount, and number of employees.

Table 1: Basic Data in Survey

Basic Data Item		Times	(%)	Basic Data Item		Times	(%)
Industry	Electronic	73	9.6	Number of Employees	Below 5	90	17.8
	Photoelectricity	33	4.3		6~20	173	34.2
	Instrument and Equipment	52	6.8		21~50	113	22.4
	Plastic Processing	49	6.4		51~200	130	25.6
	Machinery Processing	105	13.8				
	Textile	28	3.7				
	Materials	50	6.6				
	Pharmaceutical	20	2.6	R&D Expense % of Revenue	0~1%	228	30
	Electrical Machinery	42	5.5		1%~3%	202	26.6
	Auto Parts	45	5.9		3%~5%	164	21.6
	Food	67	8.8		5%~10%	98	12.9
	Service	86	11.3		Over 10%	68	8.9
	Other	110	14.5	Primary Sales Area	Domestic	475	62.5
Average Revenue for the Past 3 Years (NT$)	Below 50 million	331	43.6		China Mainland	61	8.0
	50 ~ 100 million	186	24.5		Other Areas in Asia	81	10.7
	100 ~ 300 million	103	13.6		Europe and North America	128	16.8
	300 ~ 500 million	34	4.5		Other Areas	15	2.0
	500 million ~ 1 billion	24	3.2	Average Education of Employees	Elementary	26	3.4
	Above 1 billion	82	10.8		Junior High	44	5.8
Capital (NT$)	Below 50 million	420	55.3		High School	245	32.2
	50 ~ 100 million	166	21.8		2-year College	419	55.1
	100 ~ 300 million	66	8.7		Graduate School	26	3.5
	300 ~ 500 million	18	2.4				
	500 million ~ 1 billion	23	3.0				
	Above 1 billion	67	8.8				

3.2 Instrument

Competencies and performance were measured using a Likert 5 Points Scale. The question items in the questionnaire were confirmed during the interviews with several managers on site, covering 21 items in two functional areas, as shown in Table 2. Managers first filled out the current situation of competence items where "1" indicates very poor and "5" indicates very well. Business performance was measured using the following items: Sales revenue (Y1), After-tax profit (Y2), Market share (Y3), and Return on investment (Y4). In the scores for performance items, "1" indicates no good at all, and "5" indicates very well.

Table 2: Ranking of Indicators for All Competence Dimensions

Product Design and Development (PDD)	
Introducing New Concept and Continuous Improvement	4.0408
Existing Products and Services Enhancement	4.0013
Research and Development of New Products and Services	3.8605
Reducing Lead Time of New Product Research and Development	3.7303

Infusion of Research and Development Fund	3.7197
Manufacturing Competence (MFG)	
Materials Management	
Reducing Inventory Level	3.9250
Improving the Quality of Suppliers	3.8829
Increasing Number of Standard Components in Manufacturing Process	3.7645
Increasing Number of Outsourced Parts	3.4776
Reducing Number of Suppliers	3.3592
Product Planning and Control	
Prompt Delivery of Customer Orders	4.1039
Improving Process Quality Control	4.0763
Increasing the Reliability of Transportation	4.0618
Reducing Replication	3.9803
Reducing Waste Material Ratio	3.9803
Reducing Production, Material, and Recurring Expenses	3.9526
Production Capacity Management	
Increasing Utilization of Capacity	4.0145
Increasing Efficiency of Production Scheduling	4.0118
Arranging Preparation Effectively	3.9487
Reducing Preparation Time for Machinery	3.8697
Expanding Capacity	3.8658

3.3 Analysis

Based on the research methodology literature, descriptive statistics and regression analysis are appropriate for examining the subjects covered in this study. The conceptual and theoretical structure of the relationship between corporate competencies and business performance derived from this study is illustrated in Figure 1.

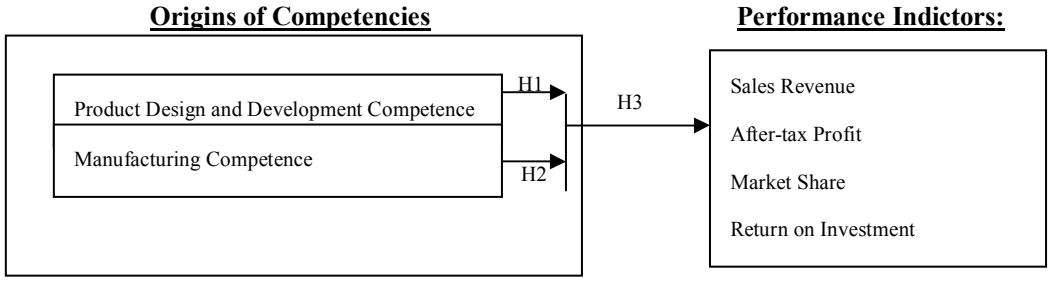

Figure 1: Origins of Competencies and Performance

The sections related to competencies and business performance indicators in the questionnaire were all based on the theories in the relevant literature. The scales or measurement items were derived from academic researches reflecting expert opinions. Therefore, this study has high reliability. Cronbach α coefficient was calculated for all question items in every dimension according to the answer scores. Nunnally [1978] proposed acceptable reliability of 0.8 for fundamental research and 0.7 for exploratory research. As shown in Table 3, the product design and development competence, and manufacturing competence reliability were all above 0.8, indicating that this research meets the reliability requirement.

Table 3: Reliability of Variables in Study

	Origins of Competencies	
Questionnaire Dimension	Product Design and Development Competence	Manufacturing Competence
Cronbach α	0.8464	0.8757

The data analysis is comprised of two phases. In Phase 1, descriptive statistics is used to illustrate the current situation of competencies. In Phase 2, relational analysis and regression analysis are applied to investigate the relationship between the origins of competencies and performance (Droge et al. [1994]). A

simple regression coefficient (βi) for every performance element is estimated using least-squares, as explained by the following formulas:

Performance1 =α1 +β1X1(PDD) + μ1 (1)

Performance2 =α2 +β2X2(MFG) + μ2 (2)

To analyze the impact of the two competence dimensions on performance, the following multiple regression formulas were established in this study. The multiple regression coefficient (βi) is estimated using least-squares, as illustrated by the formula below:

Performance3 = α3 + β1X1(PDD) + β2X2(MFG) +μ3 (3)

Where μi is a random disturbance term and regression coefficient (βi) represents the expected change in performance index caused by a unit of change in the ith independent variable (origins of competencies).

3.4 Assumption

The study is focus on the two main origins of corporate competencies. Product design and development (X1), and manufacturing (X2), are independent variables. Sales revenue, after-tax profit, market share, and return on investment are dependent variables. The assumptions were developed according to the model presented in Figure 1. The following assumptions were used in this study:

H1: The competence of product design and development is positively related to business performance.

H2: The competence of manufacturing is positively related to business performance.

H3: The improvement of corporate competencies jointly leads to positive business performance.

4.0 Results

4.1 The Correlation between Competencies and Performance

Table 4 shows the significant correlations between the four performance measures when $p < 0.01$. As shown in Table 5, the two competences (PDD, MFG) are significantly correlated to the four performance measures when $p < 0.01$. The results proved that an increase in product design and development competence, and manufacturing competence all make positive contributions to business performance.

Table 4: The Correlation between Descriptive Statistics and Performance

Performance	Mean	Standard Deviation	Correlation with			
			Y_1	Y_2	Y_3	Y_4
Y_1 (Sales Revenue)	3.9207	0.5291	1			
Y_2 (After-Tax Profit)	3.8079	0.5915	0.8171***	1		
Y_3 (Market Share)	3.8632	0.5955	0.7841***	0.7984***	1	
Y_4 (Return on Investment)	3.8786	0.5857	0.7632***	0.8260***	0.8129***	1

Note: *P < 0.1; **P < 0.05; ***P < 0.01

Table 5: The Correlation between Competencies and Performance

Performance	**Correlation with**	
	X_1(Product Design and Development)	X_2(Manufacturing)
Y_1 (Sales Revenue)	0.5247***	0.5101***
Y_2 (After-Tax Profit)	0.5072***	0.5140***
Y_3 (Market Share)	0.4976***	0.5000***
Y_4 (Return on Investment)	0.5254***	0.4964***

Note: *P < 0.1; **P < 0.05; ***P < 0.01

4.2 Results from Regression Analysis

In this study, two types of regression analyses were employed. In the simple regression model, two competence areas were considered independent variables and four performance measures were defined as dependent variables. The model ran 8 times. In the multiple regression model, PDD and MFG were the

independent variables and every performance index was a dependent variable. The multiple regression model ran 2 times. The simple regression analysis results with two competence areas (PDD, MFG) as the independent variables are shown in Tables 6, and 7.

Table 6: Simple Regression Analysis Results with PDD (X_1) being Independent Variable

Dependent Variable	Model R^2	Intercept	β Value of X_1		Error
			Non-Standard	Standard	
Y_1(Sales Revenue)	0.274***	2.331***	0.410	0.525	1.692
Y_2(After-Tax Profit)	0.256***	2.067***	0.450	0.507	1.752
Y_3(Market Share)	0.247***	2.144***	0.444	0.498	1.853
Y_4(Return on Investment)	0.275***	2.093***	0.461	0.525	1.689

Note: *P < 0.1; **P < 0.05; ***P < 0.01

Table 7: Simple Regression Analysis Results with MFG (X_2) being Independent Variable

Dependent Variable	Model R^2	Intercept	β Value of X_2		Error
			Non-Standard	Standard	
Y_1(Sales Revenue)	0.259***	1.956***	0.505	0.510	1.633
Y_2(After-Tax Profit)	0.263***	1.565***	0.576	0.514	1.723
Y_3(Market Share)	0.249***	1.667***	0.564	0.500	1.761
Y_4(Return on Investment)	0.245***	1.734***	0.551	0.496	1.688

Note: *P < 0.1; **P < 0.05; ***P < 0.01

Tables 6, and 7 also show that the Model R2, two-tail P-value, estimated intercept, and estimated non-standard and standard slope. R2 for all models are significant at the $P < 0.01$. All estimated intercept values are significant at the $P < 0.01$. The results proved the inference in this study that execution degree in all competence areas positively contributes to business performance when $P < 0.01$. From the individual perspective, the two competence areas are all important determinants in measuring overall business performance. This conclusion supports the accuracy of the operational definition of competence given in this study, and also agrees with the conclusions from the literature mentioned above. Prior to the multiple regression analysis, this study performed multilinearity test.

In this step, the independent variables were examined for multilinearity. The variance inflation factor (VIF) was used in this study for estimation. The results are shown in Table 8. All independent variables show VIF < 10 and the average VIF equals 1.882 (Berk [1977]; Chang [1997]; Marquardt [1970]). The result proves that no multilinearity exists in the multiple regression model in this study. This in turn supports the correct implementation of multiple regression analysis.

Table 8: VIF from Multiple Regression Model

Independent Variables	**Variance Inflation Factor (VIF)**
Product Design and Development Competence (PDD)	2.017
Manufacturing Competence (MFG)	1.748
Average VIF	1.882

In the multiple regression model: product design and development, and manufacturing competence were the independent variables while the four performance measures were the dependent variables. The analysis results are shown in Table 9, including model R2, model P-value, β value of independent variables and intercept. The dependent sales revenue, after-tax profit, market share, and return on investment variables in the multiple regression model were all significant at the $P < 0.01$ level. This conclusion supports hypothesis 3 proposed in this study. Based on the multiple regression results, the focus on manufacturing competence and product design and development competence certainly have positive impacts on the financial and marketing performance of manufacturing industry. So far, the three hypotheses proposed in this study were all supported by the statistical analysis results. Eight simple regression analysis model iterations and 2 multiple regression analysis model iterations show that product design and development, and manufacturing competence have significant impacts on the four performance measures; sales revenue, after-tax profit, market share, and return on investment.

Table 9: Multiple Regression Analysis Results

Dependent Variables	Model R^2	Intercept	β Value		Error
			X_1	X_2	
Y_1(Sales Revenue)	0.418***	1.226***	0.148***	0.193***	1.764
Y_2(After-Tax Profit)	0.420***	0.724***	0.129***	0.237***	1.828
Y_3(Market Share)	0.400***	0.828***	0.126***	0.225***	1.899
Y_4(Return on Investment)	0.408***	0.934***	0.192***	0.198***	1.757

Note: *P < 0.1; **P < 0.05; ***P < 0.01

5.0 Discussion

5.1 Critical Competencies Factors

In this study 21 competence items were ranked by current execution degree. In the manufacturing area, prompt delivery of customer orders, improving process quality control and increasing transportation reliability were the common focus among Taiwan's manufacturing industry managers. The significance of quality control agrees with the findings from academic researches (Evans and Lindsay [1996]). Superior quality is the basis of other competitiveness sources, for example, transportation and cost efficiency (Nobel [1995]). Excellent process quality control can reduce the replication rate and quantity of waste materials and make a positive contribution to prompt delivery of customer orders. Therefore, superior process quality control is an important index in the manufacturing competence area. In the product design and development competence area, managers emphasize the introduction of new concepts and improvement of existing products and services. Because of limited resources and the unique business features of manufacturing industry, gradual innovation is more appropriate for better and longer-term growth (Afuan [1998]).

5.2 Critical Factors of Business Performance

The simple regression analysis results show that the focus on product design and development, and manufacturing competence has a positive impact on various performance measures. From the multiple regression analysis results, the two competence dimensions showed a positive impact on business performance. Wathen [1995] proved that the concentration on manufacturing competence cannot directly impact business performance because production strategy is only part of the overall business strategy. To the managers of manufacturing industry, employee loyalty and assistance must be obtained for production process control, design and improvement. The change of concept should acknowledge by all managers.

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