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## **An Empirical Study of the Relationship Between Total Quality Management Activities and Business Operational Performance among Taiwan's High-Tech Manufacturers**

Yi-Chan Chung, Yau-Wen Hsu, Ching-Piao Chen and Chih-Hung Tsai  
Department of Industrial Engineering and Management, Ta-Hwa Institute of Technology,  
1 Ta-Hwa Road, Chung-Lin, Hsin-Chu, Taiwan, Republic of China

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**Abstract:** This research studies the impact of critical success factors of Total Quality Management (TQM) activities implementation and the impact of TQM activities implementation on business operational performance. The two intermediate variables, industry group and enterprise scale are considered. Through literature review, this research developed a theoretical model of the factors influencing the relations. The empirical analysis results on Taiwan's high-tech firms in the Hsinchu Science-Based Industrial Park show that the degree of executive involvement in TQM success factors revealed significant influence on the degree of TQM activities execution. Furthermore, the research hypothesis the degree of executive involvement in TQM activities revealed significant influence on business operational performance was statistically tested and proven in this research. The two intermediate variables, industry group and enterprise scale do not show noticeable impact on TQM activities implementation and business operational performance.

**Key words:** Business operational performance, critical success factor, total quality management

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### **INTRODUCTION**

Taiwan's high-tech industry has been the economic support of Taiwan. The standard of research on import and export product structure classification of Ministry of Finance in Taiwan allocated the industries with high additional value products, complicated techniques and high degrees of technical manpower and R and D funds, including chemical, mechanical, electronic and transportation manufacturing industries, into high-tech industry. With the advancement of technology and quality consciousness, the customers had more requirements for the quality of the products. When facing the environmental pressure with high degree of competitiveness, how to select proper critical success factors of Total Quality Management (TQM), constantly managing TQM activities and developing the products meeting the customers' demands have become the key points emphasized by the corporate operational strategies. Although some scholars proposed the critical success factors of TQM, there were very few scholars proving the influence of critical success factors of TQM on the executive degree of TQM activities and business operational performance. In order to find out if Taiwan high-tech firms' TQM activities would lead to the upgrading of business operational performance, surveys

using questionnaire is conducted in the study. The main purposes of the research were to explore the influence of high-tech firms' adoption of different key TQM success factors on the executive degree of TQM activities, explore the influence of high-tech firms' executive degree of TQM activities on business operational performance and to explore the executive degree of TQM activities executive degree of companies with different industry characteristics on business operational performance. The followings are mainly to explore domestic and foreign scholars' review of related literatures of this research and briefly reorganize the data as the theoretical base when this research observes Taiwan's high-tech industry.

**Theoretical base review:** Ismail and Ebrahimpour (2003) defined TQM as below: Total meant all of the staff in the firms cooperating with the firms for continuous improvement; Quality meant to satisfy the customers' needs; Management meant the executives could thoroughly make promises and executive them. Elshennawy *et al.* (1991) indicated that TQM was the process of constant improvement of production and service system. The continuous improvement process included all vertical and horizontal groups in the organization. Brown (1992) thought that TQM was a kind

of management philosophy looking for the quality efficacy of all business process, product and service in the organization and constant improvement. The goal of TQM was to use the participation of managerial level, employees, suppliers and customers to reach the continuous improvement in order to maintain high-quality products and manufacturing process and further accomplish the management philosophy satisfying or even surprising the customers (Hackman and Wageman, 1995; Powell, 1995). Based on the quality theory, Saraph *et al.* (1989) reorganized 120 factors to evaluate TQM activities and targeted on 162 managers in 20 companies for questionnaire data collection and analysis. Subsequently, the researchers allocated the executive items of TQM activities into 8 dimensions, including the roles played by high-rank managerial levels, roles played by quality management department, training, product and service design, suppliers' quality management, manufacturing process control, quality management data figures and employ relations.

Tamimi (1995) used Deming's 14 principles as the theoretical base and successfully interviewed the TQM activities execution of department managers of 173 companies and divided the executive activities of TQM into 8 dimensions, including the managers' commitment, supervisors' leadership, education, communication with horizontal department on quality improvement, management on the suppliers, training, product/service innovation and commitment to the employees. Powell (1995) treated the literature review as the theoretical base and the study found out 12 executive dimensions of TQM activities, including high-rank executives' commitment, quality management, customer satisfaction, management on the suppliers, model system, educational training, open organizational culture, employee empowerment, perfection spirit, flexible manufacturing management, process management and quality monitoring. Anderson *et al.* (1995) used Deming's management method as the theoretical base and found out 7 executive dimension of TQM activities, including vision leadership, internal and external negotiation and cooperation, learning, manufacturing process management, continuous improvement, employee practice and customer satisfaction. Ahire *et al.* (1996) employed literature review and the opinions of business circle as the base and found out 10 executive dimensions of TQM activities, including commitment of management, suppliers' quality management, focus on customers, statistical process control, benchmarking, use of internal quality information, employee empowerment, employee participation, employee training and management of design quality. Black and Porter (1996) used the evaluation items of Malcolm Baldrige National Quality Award as theoretical base and found out 10 executive

items of TQM activities, including quality culture of the companies, strategic quality management, evaluation system of quality improvement, employee and customer management, quality planning of business, partnership with the suppliers, structure of team cooperation, external interface management, customer satisfaction orientation and communication of information improvement.

According to the research finding of Sharma and Gadenne (2001), the executive items of TQM activities which were mostly adopted were reducing inferior goods, quality policy commitment and communication, open trust culture, good interaction with the customers and suppliers. They also suggested the following three strategies to upgrade the total organizational performance: quality management commitment strategy of high-rank managerial level, establishing complete organizational communication mechanism and quality management principle to establish better customer relations. Quazi *et al.* (1998) generalized the executive items of TQM activities promotion into 6 categories: leadership and management, information and analysis, strategies and planning, human resource application, business and service process and customer satisfaction. Chin *et al.* (2002) treated the electronics and toy industries in Hong Kong as the research targets and explored 7 core executive factors of quality management promotion of Hong Kong manufacturing industry, including customer focus, leading force, strategic quality planning, design quality, speed and prevention, employees' participation and cooperation, management upon facts and continuous improvement. The study of Motwani (2001) proposed 7 major dimensions of TQM activities execution: high-rank managers' support, quality evaluation and benchmarking, manufacturing process management, product design, employee training and empowerment, supplier quality management, customer participation and satisfaction. This research combined the related literature reviews and divided the phases of TQM activities into 6 phases, including leadership and management, strategies and planning, human resource operation, information and analysis, business and service process management and customer satisfaction.

Flynn *et al.* (1995) indicated that the critical success factors of TQM included the design process of products, statistical control and feedback, customer relation and supplier relation. According to 14 principles of Deming's quality management, three steps of Juran quality management, 14 steps of Crosby quality improvement and the evaluation principles of Baldrige Award, Cheng and Guo (2001) proposed that the critical success factors of TQM included high-rank executives' commitment, TQM vision, focus on the customers' needs, management on the suppliers, establishment of benchmarking system, educational training, open business culture, perfection

spirit, employ empowerment, clear business standard and dealing process, continuous improvement and quality evaluation. Tamimi (1998) indicated that the critical success factors of TQM included high-rank managers' commitment, executives' leadership, educational training, cross department communication, management on the suppliers, innovation and commitment to the employees. The study of Shiba *et al.* (1993) proposed that the critical success factors of TQM included establishing customer-oriented culture, emphasis on team work, figures and facts management and continuous improvement. Barkley and Saylor (1993) pointed out that the critical success factors of TQM execution included the managers' participation and leadership, educational training, team work, use of statistical method, quality cost analysis, suppliers' participation and focus on customer service. Lu (1995) indicated that the critical success factors affecting TQM execution included quality consciousness, employees' participation, hand-rank executives' support, quality principle, system operation and basic characteristics. This research combined the related literature reviews and generalized the critical success factors of TQM into five dimensions: (1) high-rank executives' commitment and devotion, (2) employee empowerment, participation, training and effective stimulation, (3) team work and communication; (4) focus on customers' needs and continuous improvement and (5) establishing effective quality information analysis system and further proposed the hypotheses.

H<sub>1</sub>: Executive degree of critical success factors of TQM revealed significant influence on the executive degree of TQM activities.

The study of Samson and Terziovski (1999) pointed out that the practice of TQM revealed significant influence on the operational performance of the firms. The research of Kunst and Lemmink (2000) found out that TQM practice in the hospitals revealed significant influence on the operational performance (efficiency, cost and service quality). Douglas and Judge (2001) thought that TQM was one of the potential sources of competitive

advantages. The firms executing TQM were more likely to obtain competitive advantages, comparing with the firms without TQM. The study of Agus and Abdullah (2000) found out that the duration of TQM execution significantly influenced the operational performance of the firms. The study of Barker and Cagwin (2000) pointed out that TQM implementation had significant and positive relation with the operational performance of the firms. The research of Hendricks and Singhal (2001) found out that the higher the degree of the operational level's participation and support on TQM activities was, the higher the degree of operational performance improvement of the firms was. The scholars such as Lee *et al.* (2008), Elg (2007), Ahire *et al.* (1996), George and Weimerskirch (1998), Yusuf *et al.* (2007) and Flynn *et al.* (1995) thought that the execution of TQM activities had positive influence on corporate operational performance. The practice of TQM could reduce the defective rate of the products in the firms, reduce the producing time, increase product quality and lead to competitive advantage. Anderson *et al.* (1995) thought that TQM activities could increase the quality and productivity of the firms and reveal significant and positive relation on the operational performance of the firms. Through the empirical result, Forza and Filippini (1998) found out that TQM activities execution directly influenced the degree of quality qualification and customer satisfaction and it had significant and positive influence on the operational performance of the firms. This research combined the related literature reviews and proposed the hypotheses.

H<sub>2</sub>: The executive degree of TQM activities revealed significant influence on business operational performance.

## MATERIALS AND METHODS

This research mainly focused on the correlation among high-tech firms' executive degrees of critical success factors of TQM, executive degrees of TQM activities and business operational performance. The research framework was shown in Fig. 1.

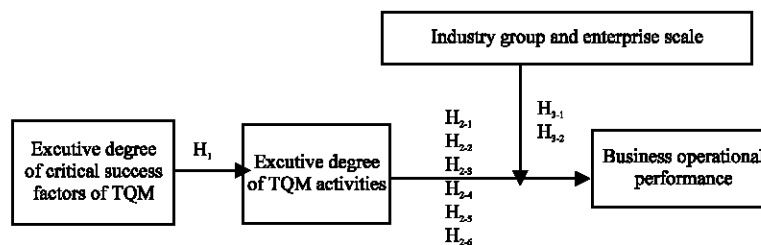


Fig. 1: Research framework

**Research hypotheses:** According to literature review, the hypotheses developed by this research were below:

- Hypothesis H<sub>1</sub>: The executive degree of critical success factors of TQM had significant influence on the executive degree of TQM activities.
- Hypothesis H<sub>2</sub>: The executive degree of TQM activities had significant influence on business operational performance.
- H<sub>2.1</sub>: The executive degree of leadership and management phase activities had significant influence on business operational performance.
- H<sub>2.2</sub>: The executive degree of information and analysis phase activities had significant influence on business operational performance.
- H<sub>2.3</sub>: The executive degree of strategies and planning phase activities had significant influence on business operational performance.
- H<sub>2.4</sub>: The executive degree of human resource operation phase activities had significant influence on business operational performance.
- H<sub>2.5</sub>: The executive degree of business and service process management phase activities had significant influence on business operational performance.
- H<sub>2.6</sub>: The executive degree of customer satisfaction phase activities had significant influence on business operational performance.
- Hypothesis H<sub>3</sub>: For the firms with different industry characteristics, the executive degree of TQM activities revealed significant influence on business operational performance.
- H<sub>3.1</sub>: For the firms with different industry groups, the executive degree of TQM activities revealed significant influence on business operational performance.
- H<sub>3.2</sub>: For the firms with different enterprise scales, the executive degree of TQM activities revealed significant influence on business operational performance.

**Questionnaire collection and data analysis:** The subjects of this research were Taiwan's high-tech firms in the Hsinchu Science-Based Industrial Park. Questionnaire respondents were required to have a thorough

understanding of the company's entire quality management activity process. Quality management supervisors in the firms were the target respondents. The questionnaires were anonymous and distributed to 380 companies at the beginning of July 2007. We received 86 replies from Supervisors at 86 high-tech companies by September 2007, of which 79 were valid. Questions in the questionnaire were designed based on scholar and expert opinions and literature reviews. Nunnally (1978) suggested that in exploratory research, a reliability value of 0.7 or above is acceptable. In this study, the reliability values are all above 0.7 and therefore are reliable. Reliability values for all variables in this study are shown in Table 1. This research used SPSS statistical software to deal with data analysis. Methods of data analysis include analysis of variance (ANOVA) and correlation analysis.

**Evaluation of variables:** The variables evaluated included critical success factors of TQM, executive degrees of TQM activities, business operational performance, industry group and enterprise scale. The evaluations of variables were below:

**Critical success factors of TQM:** Through related literature review (Cheng and Guo, 2001; Fryer *et al.*, 2007; Flynn *et al.*, 1995; Tamimi, 1998; Shiba *et al.*, 1993; Barkley and Saylor, 1993; Lu, 1995; Hung *et al.*, 2007), this research allocated the critical success factors of TQM promotion into five dimensions: (1) high-rank executives' commitment and devotion dimension: the content of activities included distributing resources to improve the quality, regularly examining the effects of quality management system, setting up clear quality goals and encouraging the staff to participate in quality management activities; (2) employee empowerment, participation, training and effective stimulation dimension: the content of activities included to distribute the resources to the employees and assist them with problem solving, encouraging the employees to propose the suggestions, regularly holding educational training and evaluating results and encouraging the employees reaching quality goals; (3) team work and communication dimension: the content of activities included developing the long-term cooperation with the suppliers, having cross-department communication, encouraging the employees to proceed with team work and communication; (4) focus on customers' needs and continuous improvement dimension: the content of activities included establishing customer relation management system, immediate dealing with the customers' complaint, actively looking for the methods to improve customer satisfaction and business process of continuous improvement; (5) establishing

Table 1: Reliability values for all variables in this study

	Dimensions of questionnaire	Cronbach $\alpha$
Critical success factors of TQM	High-rank executives' promise and devotion	0.9351
	Employee empowerment, participation, training and effective stimulation	0.9255
	Team work and communication	0.9212
	Focus on customers' needs and continuous improvement	0.9213
	Establishing effective quality information analysis system	0.9095
Executive degree of TQM activities	Leadership and management	0.8189
	Information and analysis	0.8247
	Strategies and planning	0.8051
	Human resource operation	0.8888
	Business and service process management	0.9076
	Customer satisfaction	0.9093
	Business operational performance	0.8923

effective quality information analysis system dimension: the content of activities included the effective collection and classification on various business information, ensuring the completeness of data saving and delivery process and immediate delivering the related information of quality to the related units. The questionnaires were checked by the executives in charge of TQM activities in the target firms. The scoring was based on Likert 5-point scale and according to the answers checked by the respondents. Always execution referred to 5 points, frequent execution referred to 4 points, sometimes was 3 points, rare execution was 2 points and never was one point.

**Executive degree of TQM activities:** Through the related literature reviews (Quazi *et al.*, 1998; Motwani, 2001; Chin *et al.*, 2002; Sharma and Gadenne, 2001; Ahire *et al.*, 1996; Anderson *et al.*, 1995; Powell, 1995; Tamimi, 1995; Saraph *et al.*, 1989; Hsu *et al.*, 2007), this research allocated TQM activities into 6 phases and 21 activities, including (1) leadership and management phase activities: including regular instruction, examination and service quality, remaining close connection with the customers or down-stream units, revealing the determination of TQM promotion to all employees and regarding quality as the priority when making decisions; (2) information and analysis phase activities: including detail collection and reorganization of the various aspect data of business or service, detail analysis of every step of the business or service and devotion to find out the crucial operational indicators and have analysis; (3) strategies and planning phase activities: including detail setting of the quality goals in terms of business and service and involving the spirit of continuous improvement in the targets and planning established; (4) human resource operation phase activities: including the employee educational training, encouragement of innovation and continuous improvement, rewarding the employees for business or service quality improvement and cultivating the

employees' spirit of team work; (5) business and service process management phase activities: including using statistical method to monitor business and service process, continuing the business and service process improvement, using quality control method for business and process improvement, considering quality factors to design business and service process; (6) customer satisfaction phase activities: including actively reviewing the reasons of the customers' complaints, using systematic investigation to access to the customers' satisfaction with the business or service of the unit, using systematic investigation to access to the customers' expectation with the business or service of the unit and collecting the related customers' reactions to control and customers' needs. The scoring was based on Likert 5-point scale and according to the answers checked by the respondents. Always execution referred to 5 points, frequent execution was 4 points, occasional execution was 3 points, rare execution was two points and never referred to one point.

**Measurement of business operational performance:** In the study of Brah *et al.* (2002), the researchers evaluate the operational performance of TQM practice through the suppliers' performance, employees' service quality, product quality, employee satisfaction, customer satisfaction and manufacturing/service quality. In the study of Saraph *et al.* (1989), the evaluation of operational performance in TQM practice was based on the customers' satisfaction with the quality for the past three years and quality performance. Flynn *et al.* (1995) used the yield rate of the products and quality projects to measure the operational performance of TQM practice upon the benefits toward the professional capacity of the firm. Samson and Terziovski (1999) employed productivity to evaluate and operational performance of TQM implementation. Powell (1995) used the profits of the firms to evaluate the operational performance of TQM practice. In the study of Quazi *et al.* (1998), the researchers

evaluate the operational performance of TQM practice by the increase rate of the customers and profits in the firms. In the research of Su *et al.* (2003), the researcher measured the operational performance of TQM practice by the profits in the firms and customer satisfaction. Ahire *et al.* (1996) used the quality of products to measure the operational performance of TQM practice. Huarng and Chen (2002) evaluated the benefits of TQM implementation through the aspects of cost and operational performance. Through the related literature review, this research evaluated the business operational performance of TQM promotion by (1) the increase of profits in the firms; (2) increase of market share; (3) reduction of defective rate; (4) increase of productivity; (5) increase of customer satisfaction; (6) increase of product quality; (7) increase of manufacturing/service business quality; (8) reduction of costs. The scoring was based on Likert 5-point scale and according to the answers checked by the respondents. Total agreement referred to 5 points, agreement was 4 points, no comment was 3 points, disagreement was 2 points and total disagreement was one point.

**Evaluation of industry group and enterprise scale:** In terms of industry characteristics, industry group and enterprise scale were the major areas of discussion covered in this study: (1) industry group: according to the classification of companies in the 2007 Science Park address book; the firms in Hsinchu Science Park were divided into integrated circuit industry, computer and peripherals industry, telecommunication industry, electro-optical industry, automation industry and Biotechnology industry; (2) enterprise scale; according to identifying standards for domestic industries as adopted by the Ministry of Economic Affairs, manufacturers in the Hsinchu Science-Based Industrial Park were divided into three classes of scale, based on their capital and number of employees. They are large-scale firms: with a capital above NT\$80 million and number of employees exceeding 200; medium-scale firms: with a capital below NT\$80 million and number of employees from 20 to 199; small-scale firms: with a capital below NT\$80 million and number of employees under 20. The measurement of industry group and enterprise scale was based on nominal scale.

## RESULTS AND DISCUSSION

**The Relationship between critical success factors of TQM and the executive degree of TQM activities:** This section explores the possibility of the executive influence

in the various critical success factors of TQM showing a significant influence on the six TQM phase activities. We divided each success factor into two levels (high and low) according to the average values for each factor, to test the significance of the executive influence. Table 2 showed the ANOVA results of critical success factors of TQM and the degree of executive influence for each TQM phase activities. The research results in Table 2 confirmed the following hypotheses: H<sub>1</sub>: The executive degree of the critical success factors of TQM had significant influence on the executive degree of the TQM activities.

**The relationship between executive involvement in TQM activities and business operational performance:** The aim of this research was to discover, if the degree of executive involvement in each phase of the TQM activities significantly influence on business operational performance. We divided the executive involvement into two levels (high and low) according to the average values for each factor, to test the significance of the executive influence. Table 3 shows the ANOVA results for the correlation between the executive involvement in each TQM activity phase and business operational performance. The research results in Table 3 show that the following hypotheses were supported: H<sub>2,1</sub>: The executive degree of leadership and management phase activities had significant influence on business operational performance. H<sub>2,2</sub>: The executive degree of information and analysis phase activities had significant influence on business operational performance. H<sub>2,3</sub>: The executive degree of strategies and planning phase activities had significant influence on business operational performance. H<sub>2,4</sub>: The executive degree of human resource operation phase activities had significant influence on business operational performance. H<sub>2,5</sub>: The executive degree of business and service process management phase activities had significant influence on business operational performance. H<sub>2,6</sub>: The executive degree of customer satisfaction phase activities had significant influence on business operational performance.

**The influence of TQM activities executive degrees of the firms with different industry characteristics on business operational performance:** This research examined the influence of the executive degree of TQM activities in the firms with different business characteristics (industry group and enterprise scale) on business operational performance. The research results of Table 4 showed that business characteristics did not have a significant influence on the executive degrees of the six phases of

Table 2: ANOVA of critical success factors of TQM and the TQM activities implementation level

	High-rank executives' promise and devotion		Employee empowerment, participation, training and effective stimulation		Team work and communication		Focus on customers' needs and continuous improvement		Establishing effective quality information analysis system	
	F-value	p-value	F-value	p-value	F-value	p-value	F-value	p-value	F-value	p-value
Leadership and management	19.576	0.000***	30.946	0.000***	22.311	0.000***	5.664	0.021*	14.116	0.000***
Information and analysis	12.827	0.001**	22.608	0.000***	17.980	0.000***	5.263	0.026*	16.864	0.000***
Strategies and planning	13.313	0.001**	9.131	0.004**	11.699	0.001**	4.222	0.045*	9.758	0.003**
Human resource operation	15.855	0.000***	22.081	0.000***	13.124	0.001**	6.396	0.014*	13.607	0.001**
Business and service process management	17.498	0.000***	12.379	0.001**	10.752	0.002**	8.240	0.006**	5.692	0.021*
Customer satisfaction	25.991	0.000***	15.954	0.000***	17.631	0.000***	17.377	0.000***	7.517	0.008**

Note: \*p<0.05, \*\*p<0.01, \*\*\*p<0.001

Table 3: ANOVA of executive involvement in TQM activities and business operational performance

	Leadership and management		Information and analysis		Strategies and planning		Human resource operation		Business and service process management		Customer satisfaction	
	F-value	p-value	F-value	p-value	F-value	p-value	F-value	p-value	F-value	p-value	F-value	p-value
Business operational performance	4.765	0.002**	3.414	0.024*	9.341	0.000***	4.934	0.011*	8.932	0.000***	2.826	0.034*

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

Table 4: ANOVA of industry characteristics and executive involvement in each stage of TQM activities

	Industry group		Enterprise scale	
	F-value	p-value	F-value	p-value
Leadership and management	0.864	0.512	0.151	0.929
Information and analysis	0.594	0.705	0.784	0.508
Strategies and planning	0.979	0.440	1.676	0.183
Human resource operation	0.508	0.769	0.182	0.908
Business and service process management	1.384	0.246	0.654	0.523
Customer satisfaction	0.569	0.723	2.303	0.088

Table 5: ANOVA of industry characteristics and business operational performance

	Industry group		Enterprise scale	
	F-value	p-value	F-value	p-value
Business operational performance	1.862	0.115	0.265	0.850

TQM activities. The research results in Table 5 revealed that the firms with different industry group and enterprise scales did not reveal a significant influence on their business operational performance. In accordance with the analytical results in Table 4 and 5, we formulated hypothesis H<sub>3,1</sub>: For the firms with different industry groups, the executive degree of TQM activities revealed significant influence on business operational performance. H<sub>3,2</sub>: For the firms with different enterprise scales, the executive degree of TQM activities revealed significant influence on business operational performance. The reason might be, in that the firms with different industry groups or enterprise scales had already recognized the importance of executing TQM activities and therefore, they had a certain degree of TQM activities execution that was not different because of industry groups or enterprise scales.

**Correlation analysis of the critical success factors of TQM, executive involvement in TQM activities and business operational performance:** This research focuses on the correlation between executive involvement in TQM activities at various phases and business operational performance. Person's correlation analysis was applied to measure the correlation between all items. The items in this correlation analysis are explained as follows: (1) The correlation analysis of the degree of TQM activities implementation at various phases found that all phases were highly correlated; (2) The correlation between the degree of TQM activities implemented and business operational performance proved significant at the various TQM phases; (3) The correlation between the degree of implementation of key TQM success factor dimensions and the degree of TQM activities implemented at various phases proved significant. The correlation analysis results are shown in Table 6.



**Table 6: The correlation between the TQM activities implementation level and business operational performance**

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)	Pearson correlation	1.000	0.750	0.675	0.731	0.673	0.746	0.648	0.627	0.523	0.475	0.561	0.390	0.040	-0.065
	Significant		0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.003 <sup>#</sup>	0.769	0.633
(2)	Pearson correlation	0.750	1.000	0.654	0.709	0.750	0.737	0.527	0.555	0.484	0.380	0.536	0.321	-0.098	-0.168
	Significant	0.000*		0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.004 <sup>#</sup>	0.000*	0.015 <sup>^</sup>	0.470	0.211
(3)	Pearson correlation	0.675	0.654	1.000	0.620	0.602	0.716	0.482	0.398	0.403	0.421	0.449	0.760	-0.044	-0.062
	Significant	0.000*	0.000*		0.000*	0.000*	0.000*	0.000*	0.002 <sup>#</sup>	0.002 <sup>#</sup>	0.001 <sup>#</sup>	0.000*	0.000*	0.745	0.599
(4)	Pearson correlation	0.731	0.709	0.620	1.000	0.648	0.569	0.561	0.688	0.473	0.372	0.571	0.377	-0.085	-0.024
	Significant	0.000*	0.000*	0.000*		0.000*	0.000*	0.000*	0.000*	0.000*	0.004 <sup>#</sup>	0.000*	0.004 <sup>#</sup>	0.527	0.857
(5)	Pearson correlation	0.673	0.750	0.602	0.648	1.000	0.710	0.565	0.479	0.393	0.354	0.445	0.717	-0.012	0.096
	Significant	0.000*	0.000*	0.000*	0.000*		0.000*	0.000*	0.000*	0.002 <sup>#</sup>	0.007 <sup>#</sup>	0.001 <sup>#</sup>	0.000*	0.930	0.415
(6)	Pearson correlation	0.746	0.737	0.716	0.569	0.710	1.000	0.598	0.496	0.454	0.630	0.451	0.296	-0.004	0.128
	Significant	0.000*	0.000*	0.000*	0.000*	0.000*		0.000*	0.000*	0.000*	0.000*	0.000*	0.025 <sup>^</sup>	0.976	0.278
(7)	Pearson correlation	0.648	0.527	0.482	0.561	0.565	0.598	1.000	0.814	0.783	0.706	0.736	0.404	-0.066	-0.111
	Significant	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*		0.000*	0.000*	0.000*	0.000*	0.002 <sup>#</sup>	0.624	0.411
(8)	Pearson correlation	0.627	0.555	0.398	0.688	0.479	0.496	0.814	1.000	0.768	0.613	0.797	0.544	-0.083	-0.058
	Significant	0.000*	0.000*	0.002 <sup>#</sup>	0.000*	0.000*	0.000*	0.000*		0.000*	0.000*	0.000*	0.000*	0.541	0.667
(9)	Pearson correlation	0.523	0.484	0.403	0.473	0.393	0.454	0.783	0.768	1.000	0.682	0.783	0.384	-0.060	-0.060
	Significant	0.000*	0.000*	0.002 <sup>#</sup>	0.000*	0.002 <sup>#</sup>	0.000*	0.000*	0.000*		0.000*	0.000*	0.003 <sup>#</sup>	0.659	0.659
(10)	Pearson correlation	0.475	0.380	0.421	0.372	0.354	0.630	0.706	0.613	0.682	1.000	0.639	0.365	-0.180	-0.039
	Significant	0.000*	0.004 <sup>#</sup>	0.001 <sup>#</sup>	0.004 <sup>#</sup>	0.007 <sup>#</sup>	0.000*	0.000*	0.000*	0.000*		0.000*	0.005 <sup>#</sup>	0.181	0.773
(11)	Pearson correlation	0.561	0.536	0.449	0.571	0.445	0.451	0.736	0.797	0.783	0.639	1.000	0.482	-0.134	-0.020
	Significant	0.000*	0.000*	0.000*	0.000*	0.001 <sup>#</sup>	0.000*	0.000*	0.000*	0.000*	0.000*		0.000*	0.322	0.880
(12)	Pearson correlation	0.390	0.321	0.760	0.377	0.717	0.296	0.404	0.544	0.384	0.365	0.482	1.000	0.128	0.047
	Significant	0.003 <sup>#</sup>	0.015 <sup>^</sup>	0.000*	0.004 <sup>#</sup>	0.000*	0.025 <sup>^</sup>	0.002 <sup>#</sup>	0.000*	0.003 <sup>#</sup>	0.005 <sup>#</sup>	0.000*		0.278	0.731
(13)	Pearson correlation	0.040	-0.098	-0.044	-0.085	-0.012	-0.004	-0.066	-0.083	-0.060	-0.180	-0.134	0.128	1.000	-0.063
	Significant	0.769	0.470	0.745	0.527	0.930	0.976	0.624	0.541	0.659	0.181	0.322	0.278		0.641
(14)	Pearson correlation	-0.065	-0.168	-0.062	-0.024	0.096	0.128	-0.111	-0.058	-0.060	-0.039	-0.020	0.047	-0.063	1.000
	Significant	0.633	0.211	0.599	0.857	0.415	0.278	0.411	0.667	0.659	0.773	0.880	0.731	0.641	

<sup>^</sup>Correlation is significant at the 0.05 level (2-tailed); <sup>#</sup>Correlation is significant at the 0.01 level (2-tailed); \*Correlation is significant at the 0.001 level (2-tailed). Note: (1) Leadership and management phase; (2) Information and analysis phase; (3) Strategies and planning phase; (4) Human resource operation phase; (5) Business and service process management phase; (6) Customer satisfaction phase; (7) High-rank executives' promise and devotion dimension; (8) Employee empowerment, participation, training and effective stimulation dimension; (9) Team work and communication dimension; (10) Focus on customers' needs and continuous improvement dimension; (11) Establishing effective quality information analysis system dimension; (12) Business operational performance; (13) Industry group; (14) Enterprise scale

**CONCLUSION**

The TQM activities included six phases: leadership and management, information and analysis, strategies and planning, human resource operation, business and service process management, customer satisfaction. This research explored the influence of executive degrees of critical success factors of TQM on TQM activities executive degree as well as the influence of TQM activities executive degree on business operational performance. The researcher also considered the intermediate variables of industry group and enterprise scale; through theory and literature review, the theoretical model affecting the relations was developed. Besides, the researcher managed the empirical study on Taiwan high-tech firms. The research results found out that the execution of critical success factors of TQM revealed significant influence on TQM activities execution. In addition, TQM activities execution degree revealed significant influence on business operational performance. The hypothesis of the higher the executive degree of TQM activities is, the better the business operational performance is was significantly validated in terms of statistics. In addition, as to the intermediate variables industry group and enterprise scale, this research proved that they did not

reveal significant influence on the executive degree of TQM activities and business operational performance. When increasing the business operational performance, the firms should first enhance the execution of TQM activities. In order to upgrade the executive degree of TQM activities, the firms can increase the result of total TQM activities execution through high-rank executives' commitment and devotion, employee empowerment, participation, training and effective stimulation, team work and communication, focus on customers' needs and continuous improvement and establishing effective quality information analysis system. This research only explored the high-tech firms; in the future, the empirical analysis of other industries (such as traditional industries) can be managed in order to explore the influence of TQM activities executive degrees of different industries on business operational performance for acquiring more complete research results.

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