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Original Article

Research on the Correlation between TQM Activities and New Product Development Performance in Taiwan's High-Tech Industry

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Abstract *- Taking high-tech manufacturers as the research object, this study explored the impacts of leadership style, organizational learning, and information technology investment on the implementation degree of total quality management activities and the correlation between the implementation degree of total quality management activities and new product development performance. The results show that the higher the implementation degree of total quality management activities, the more significant the positive impacts on new product development performance. Goal-oriented, steady and conservative, compassionate and supportive, and innovative and adaptable leadership styles are conducive to implementing total quality management activities. The higher the level of information technology investment and organizational learning, the more significant the positive impacts on the implementation of total quality management activities. High-tech manufacturers can enhance new product development performance by implementing total quality management activities, adopting a goal-oriented, steady and conservative, compassionate and supportive, or innovative and adaptable leadership style, and strengthening the level of information technology investment and organizational learning.*

Keywords *- Total quality management, Organizational learning, Information technology, New product development performance.*

1. Introduction

In Taiwan, the high-tech industry is the backbone of the economy. According to the "Identification Criteria for the Research on the Structure and Complex Classification of Import and Export Commodities" developed by the Ministry of Finance (Taiwan), industries with a high added value of products, complex technology, and high investment ratio of technical manpower and R&D funds belong to high-tech industries. With the progress of science and technology, the life cycle of high-tech products is becoming shorter and shorter, and the shortening of the product development process is particularly important. Under the pressure of a highly competitive environment, how to choose the appropriate leadership style, integrate the concepts of organizational learning and information technology investment into total quality management activities, and then provide customers with better product quality and improve new product development performance has become the focus of many high-tech manufacturers. The empirical studies on the implementation of total quality management activities focused on factors affecting total quality management activities [21,16,39,6], the application of total quality management in the industry [12,8,32,39], and the implementation degree of total quality management activities by manufacturers with different enterprise characteristics and the impact on business performance [1,35,22,13,48] and other related topics. Few empirical studies have incorporated the concepts of leadership style, organizational learning, and information technology investment into total quality management activities to explore their impacts on new product development performance. Therefore, this study took the high-tech industry as the research object to explore the correlation between leadership style, organizational learning, information technology investment, total quality management activities, and new product development performance. The purposes of this study are: (1) to explore the impact of leadership style on the implementation degree of total quality management activities; (2) to explore the impact of organizational learning on the implementation degree of total quality management activities; (3) to explore the impact of information technology investment on the

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implementation degree of total quality management activities; (4) to explore the impact of the implementation degree of total quality management activities on new product development performance; and (5) based on the results of this study, to provide suggestions for high-tech manufacturers to implement total quality management activities and improve new product development performance.

2. Literature Review

2.1. Leadership Style and TQM Activities

Robbins [37] suggested that leadership is the ability to influence a group to achieve its goals. Quinn [36] pointed out that leadership styles can be divided into four categories: rational goal model (goal-oriented style), internal process model (steady and conservative style), open system model (innovative and adaptable style), and crowd relationship model (compassionate and supportive style). Bass and Avolio [5] divided leadership styles into transactional leadership and transformational leadership. Hersey and Blanchard [14] divided leadership styles into informative, promotional, participatory, and authorized styles. Since the leadership structure proposed by Quinn [36] is based on the new leadership theory, this study used the four categories proposed by Quinn [36] as the classification of leadership styles.

Achour and Sarra [2] mentioned that leadership style affects the implementation of total quality management activities. Ng et al. [29] pointed out that different leadership styles have different degrees of impact on the implementation of total quality management activities. Kumar and Sharma [18] suggested that an appropriate leadership style is conducive to the implementation of total quality management activities. Soliman [45] mentioned that different leadership styles have different degrees of impact on the implementation degree of total quality management. Through the literature review, this study proposed H1: Different leadership styles have significantly different impacts on the implementation of total quality management activities.

2.2. Organizational Learning and TQM Activities

Pace [31] pointed out that organizational learning is a method or procedure of common learning within an organization to achieve specific goals by adjusting internal mechanisms in response to the environment. Tippins and Sohi [49] divided the content of organizational learning into four procedures: information acquisition, information dissemination, shared interpretation, and organizational memory. Templeton et al. [47] pointed out that organizational learning includes information capture, information transmission, information interpretation, and organizational memory. Pace [31] divided organizational learning into four aspects: information sharing, consulting atmosphere, learning practice, and achievement tendency. This study took the four dimensions of organizational learning proposed by Tippins and Sohi [49] as the dimensions of organizational learning activities. Mahmood et al. [23] pointed out that total quality management activities are positively correlated with the level of organizational learning. Kocoglu et al. [17] mentioned that organizational learning has a positive impact on the implementation of total quality management; when a company implements total quality management activities, organizational learning plays an important role [25]. Yusr et al. [51] suggested that there is a positive correlation between total quality management and organizational learning. Through the literature review, this study proposed H2: The higher the level of organizational learning, the more significant the positive impact on the implementation of total quality management activities.

2.3. Information Technology and TQM Activities

According to the literature review, Lee [20] defined information technology investment as the resources and effort invested by an organization to complete the management function of information technology. Sakaguchi and Dibrell [38] mentioned that the level of information technology investment can be measured by the investment and training of information technology. Miller and Doyle [27] pointed out that it must pay attention to the following three aspects of information technology investment: (1) understanding the importance of information technology in a company; (2) a certain degree of investment in software, hardware, and personnel can bring benefits; (3) personnel training should be conducted based on the needs of developers and users. Based on the literature [27,44,10,26,38, 20] review, this study divided the level of information technology investment into three aspects, namely personnel cognition, investment in software and hardware, and personnel training.

Marefat and Faridfathi [24] mentioned that information technology investment contributes to the implementation of total quality management activities. Siam et al. [41] and Ang et al. [3] suggested that information technology investment positively impacts the implementation of total quality management activities. Tiwari and Chaudhari [50] pointed out that information technology investment contributes to the implementation of total quality management activities. Through the literature review, this study proposed H3: The higher the level of information technology investment, the more significant the positive impact on the implementation of total quality management activities.

2.4. Total Quality Management Activities

Ismail and Ebrahimpour [15] pointed out that the key success factors of total quality management include leadership, strategic planning, customer and market orientation, information analysis, human resource management, and process management. Seetharaman et al. [40] summarized six key factors affecting the success of the implementation of total quality management activities, including support from senior managers, active involvement

of employees in implementation, the establishment of performance measurement methods, the establishment of a culture of continuous improvement, attention to customer needs, and education and training of employees. Motwani [28] mentioned that the main aspects of the implementation of total quality management activities include support from senior managers, quality measurement and benchmarking learning, process management, product design, employee training and empowerment, supplier quality management, customer participation, and customer satisfaction. Through the review of relevant literature, Antony et al. [4] proposed 11 key factors for the successful implementation of total quality management activities, including education and training, quality information and data analysis, manager commitment, customer satisfaction orientation, the role of quality management department, communication to improve quality, continuous improvement, product and service design, supplier quality management, process management, and employee relations. Through the literature review [4,40,28,15], this study divided the implementation of total quality management activities into five dimensions (leadership, information analysis, human resource management, process management, and customer and market orientation) and 28 activities.

2.5. TQM Activities and New Product Development Performance

In the study of Song and Parry [42], four indicators were used to measure the relative success level of new product development of manufacturers: (1) comparing the quality of new products with competitors; (2) comparing the sales volume of new products with competitors; (3) comparing the profit margin of new products with competitors; (4) comparing the ratio of the successful launch of new products with the expected profit target. Calantone et al. [7] used return on investment and its growth rate, sales growth rate and its growth rate, and market share and its growth rate as the measurement indicators of new product development performance. Dwyer and Mellor [11] used four indicators to measure the success of new product development: (1) overall success/failure ratio; (2) profit level; (3) sales target; (4) opportunities to be brought by new products for the company in the future. Based on the review of relevant literature, this study took five indicators as the dimensions of new product development performance, namely: (1) the launch date compared with the same industry; (2) the quality level of new products compared with the same industry; (3) the market share of new products compared with the same industry; (4) the ratio of a successful launch of new products compared with the same industry; and (5) the cost of new product development to market compared with the same industry.

Song and Su [43] pointed out that a company can improve new product development performance by implementing quality management activities. Sun and Zhao [46] suggested that the implementation degree of total quality management is positively correlated with new product development performance. Prajogo and Hong [34] mentioned that the implementation of total quality management contributes to the improvement of new product innovation performance. Lee et al. [19] pointed out that the implementation of total quality management contributes to the improvement of new product development performance. Through the literature review, this study proposed H4: The higher the implementation degree of total quality management activities, the more significant the positive impact on new product development performance.

2.6. Company Size and New Product Development Performance

In terms of company size, Quek and Yusof [35] mentioned that large companies have more resources to implement total quality management activities, and their implementation of total quality management activities is better than that of small and medium-sized companies. The higher the implementation degree of total quality management activities, the better the product innovation performance (Prajogo and Sohal, [33]). Terziovski and Samson [48] suggested that large companies implement total quality management activities better, and companies with better implementation of total quality management have better new product development performance (Sun and Zhao, [46]). However, the research results of Hendricks and Singhal [13]) are, on the contrary, showing that small companies can more effectively implement total quality management activities and improve their business performance than large companies. Through the literature review, this study proposed H5: The implementation degree of total quality management activities varies with company size, resulting in significantly different impacts on new product development performance.

3. Research Methods

This study explored the correlation between leadership style, organizational learning, information technology investment, the implementation degree of total quality management activities, and new product development performance. Through the review of relevant literature, this study established the following hypotheses:

H1: Different leadership styles have significantly different impacts on the implementation of total quality management activities.

H2: The higher the level of organizational learning, the more significant the positive impact on the implementation of total quality management activities.

H3: The higher the level of information technology investment, the more significant the positive impact on the implementation of total quality management activities.

H4: The higher the implementation degree of total quality management activities, the more significant the positive impact on new product development performance.

H5: The implementation degree of total quality management activities varies with company size, resulting in significantly different impacts on new product development performance.

3.1. Questionnaire Collection and Data Analysis

The questionnaire of this study was divided into six parts. Part 1 is leadership style, mainly including (1) goal-oriented style, (2) steady and conservative style, (3) compassionate and supportive style, and (4) innovative and adaptable style.

Part 2 is the level of organizational learning, mainly including four dimensions: (1) information acquisition, (2) information dissemination, (3) shared interpretation, and (4) organizational memory.

Part 3 is information technology investment, mainly including the dimensions of (1) personnel training, (2) investment in software and hardware, and (3) personnel cognition. Part 4 is the implementation degree of total quality management activities, mainly including five dimensions of (1) leadership, (2) information analysis, (3) human resource management, (4) process management, and (5) customer and market orientation. Part 5 is new product development performance, including five measurement indicators of (1) the launch date of new products, (2) the quality level of new products, (3) the market share of new products, (4) the ratio of a successful launch of new products, and (5) the cost of new product development to market.

Part 6 is manufacturer size, dividing manufacturers into large-scale manufacturers and small and medium-sized manufacturers according to the number of employees. In this study, 880 high-tech manufacturers from three science parks in Taiwan (including 531 from Hsinchu Science Park, 147 from Central Science Park, and 202 from Southern Science Park) were selected as the empirical research objects. The respondents were supervisors in charge of new product development activities. In this study, the relevant data were collected by mailing the questionnaires distributed from November to December 2021, and 89 valid samples were recovered.

The reliability values of each variable in this study are shown in Table 1. Nunnally [30] mentioned that in exploratory studies, reliability above 0.7 is acceptable. The reliability of all variables in this study is above 0.7, so it is reliable. The main statistical analysis method adopted in this study is ANOVA.

3.2. Measurement of Variables

The variables measured include leadership style, organizational learning, information technology investment, the implementation degree of total quality management activities, new product development performance, and manufacturer size, as follows.

3.3. Measurement of Leadership Style

The scale of leadership style used in this study is the one developed by Chou [9] and modified according to the performance characteristics of manufacturers. The leadership styles were divided into:

1. Goal-oriented style: the contents include: (a) company executives shall clearly tell colleagues the company's pursuit of goals; (b) executives shall clearly define each person's area of responsibility; (c) executives shall guide colleagues with standard operating procedures and correct them in due course; (d) executives shall determine the priority of things and the direction of efforts; (e) executives are performance-oriented.

Table 1. The Cronbach's coefficients for all variables in this study

Questionnaire Dimension		Cronbach's α
Leadership style	Goal-oriented style	0.883
	Steady and conservative style	0.877
	Compassionate and supportive style	0.909
	Innovative and adaptable style	0.869
Organizational learning	Information acquisition	0.861
	Information dissemination	0.870
	Shared interpretation	0.910
	Organizational memory	0.919
Information technology investment	Personnel training	0.896
	Investment in software and hardware	0.849
	Personnel cognition	0.850
Total quality management	Leadership	0.868
	Information analysis	0.852
	Human resource management	0.886
	Process management	0.891
	Customer and market orientation	0.878
New product development performance		0.879

2. Steady and conservative style: the contents include: (a) executives shall attach importance to the details of various written documents; (b) executives shall regularly review the progress of plans; (c) executives shall regularly analyze the company's situation to keep staff informed of the direction of improvement; (d) executives shall establish measures to check performance; (e) executives shall maintain the normal and stable operation of the company.
3. Compassionate and supportive style: the contents include: (a) executives shall put themselves in the employees' shoes; (b) executives shall assist employees in planning their future careers; (c) executives shall communicate the problems raised by employees in a supportive manner; (d) executives shall allow employees to express their personal views and promote consensus fully; and (e) executives shall encourage employees to participate in decision-making.
4. Innovative and adaptable style: the contents include: (a) executives shall solve problems creatively; (b) executives shall clearly state the company's vision and continuously reiterate and reinforce it; (c) executives shall try new things with new ideas and procedures; (d) executives shall encourage colleagues to continuously improve their methods of doing things; and (e) executives shall strive to maintain a good relationship with their superiors.

The 5-point Likert scale was used for scoring: 5 points for strongly agree, 4 points for agree, 3 points for neutral, 2 points for disagree, and 1 point for strongly disagree.

3.4. Measurement of Organizational Learning

In this study, the four dimensions of organizational learning proposed by Tippins and Sohi [49] were used as indicators to measure the level of organizational learning. Considering the operation types of the high-tech industry, the organizational learning activities were divided into:

1. Dimension of Information Acquisition: the contents include: (a) the company shall contact customers regularly to find out their needs and expectations; (b) studies shall be conducted to identify customer needs; (c) customers shall be regarded as a source of market information; (d) the company shall often ask customers about their needs or expectations; (e) information shall be often collected for customer needs.
2. Dimension of Information Dissemination: the contents include: (a) all department members of the company would like to share customer information; (b) members who need customer information can easily obtain relevant information; (c) regular meetings shall be held between representatives of different departments to discuss customer needs; (d) each department shall timely disseminate the collected important information to other departments; (e) all departments shall have easy access to relevant customer information.
3. Dimension of Shared Interpretation: the contents include: (a) company executives shall often have consistent views on what their customers want; (b) executives shall often have consistent views on how to provide customers with the most satisfactory service; (c) executives shall often have consistent views on how the important information received will affect the company.
4. Dimension of Organizational Memory: the contents include (a) a set of operating procedures for processing customer orders; (b) learning from previous experience how to deal with difficult customers; (c) a standard procedure to be followed to determine customer needs; (d) a standard procedure for dealing effectively with customer complaints; (e) understanding the problems faced by customers based on previous experience; and (f) a perfect management system for customer information.

The 5-point Likert scale was used for scoring: 5 points for strongly agree, 4 points for agree, 3 points for neutral, 2 points for disagree, and 1 point for strongly disagree.

3.5. Measurement of Information Technology Investment

From the research perspective of information technology, this study, based on the literature [27,44,38,20] review, divided the level of information technology investment into three dimensions, namely personnel cognition, investment in software and hardware, and personnel training, as follows:

1. Personnel Training: including sufficient information technology education and training received by employees, skilled use of information technology by employees, sufficient information technology professionals, and complete information system teaching materials and manuals;
2. Investment in Software and Hardware: including sufficient funds for information technology, sufficient software for investment in information technology, and sufficient hardware for investment in information technology;
3. Personnel Cognition: including the attitude of supporting the involvement in information technology, the common cognition of the importance of information technology, and employees' high acceptance degree of information technology.

The 5-point Likert scale was used for scoring: 5 points for strongly agree, 4 points for agree, 3 points for neutral, 2 points for disagree, and 1 point for strongly disagree.

3.6. Measurement of Implementation Degree of Total Quality Management Activities

The total quality management activities proposed in this study are mainly based on the review of relevant literature and modified according to the characteristics of the industry. The implementation of total quality management activities by high-tech manufacturers was divided into:

1. Leadership Dimension: the activities include: (a) managers shall regularly guide and review operation and

service quality; (b) showing the determination to implement total quality management to all employees; (c) giving top priority to quality when making decisions; (d) allocating resources to efforts to improve quality; (e) developing quality objectives for operations and services in detail; and (f) encouraging all staff to participate in quality management activities.

2. Dimension of Information Analysis: the activities include (a) collecting, sorting, and analyzing quality-related data; (b) taking the merits of major competitors as benchmarks and models to follow; (c) focusing on identifying and analyzing key quality indicators; (d) establishing effective quality data and performance measurement methods; and (e) ensuring the integrity of information storage and transmission processes.
3. Dimension of Human Resource Management: the activities include (a) conducting staff education and training and regular evaluation of effectiveness; (b) encouraging staff innovation and continuous improvement operation; (c) rewarding employees committed to achieving quality objectives; (d) allocating necessary resources to employees to assist in solving problems identified by them; (e) encouraging staff to propose quality improvement suggestions and review and implement them; and (f) specifying an incentive system suitable for employees' needs.
4. Dimension of Process Management: the activities include (a) monitoring operation and service processes with statistical methods; (b) continuously improving operation and service processes to improve quality; (c) using quality management techniques to improve operations and processes; (d) considering quality factors to design operation and service processes; (e) regularly reviewing and timely revising process indicators; and (f) continuously reviewing and measuring the performance of each process.
5. Dimension of the Customer and Market Orientation: the activities include (a) actively exploring the reasons for customer complaints; (b) using systematic surveys to ascertain customer satisfaction with products or services; (c) collecting information on customer responses to understand customer needs; (d) processing customer comments as soon as possible; and (e) actively looking for ways to improve customer satisfaction.

The 5-point Likert scale was used for scoring: 5 points for strongly agree, 4 points for agree, 3 points for neutral, 2 points for disagree, and 1 point for strongly disagree.

3.7. Measurement of New Product Development Performance

Based on the review of relevant literature, this study adopted five indicators as the measurement indicators of new product development performance, namely (1) the launch date compared with the same industry; (2) the quality level of new products compared with the same industry; (3) the market share of new products compared with the same industry; (4) the ratio of a successful launch of new products compared with the same industry; and (5) the cost of new product development to market compared with the same industry. The 5-point Likert scale was used for scoring.

3.8. Measurement of Manufacturer Size

In this study, according to the identification standard of domestic industry scale of the Ministry of Economics, the scale of high-tech manufacturers was divided into two categories according to the number of employees, namely large-scale manufacturers with more than 200 employees, and small and medium-sized manufacturers with less than 200 employees. Manufacturer size was measured by nominal scale in this study.

4. Research Results

4.1. Correlation between Leadership Style and the Implementation Degree of TQM Activities

This study divided leadership styles (goal-oriented, steady and conservative, compassionate and supportive, and innovative and adaptable styles) into two groups (high and low levels).

It examined whether there were significant differences between the two groups according to the average score of the implementation degree of total quality management activities (leadership dimension, information analysis, human resource management, process management, and customer and market orientation) of each group.

Table 2 shows the ANOVA test of the impact of the leadership style on the implementation degree of total quality management activities, and the research results reject H1. Goal-oriented, steady and conservative, compassionate and supportive, and innovative and adaptable leadership styles all have significant impacts on the implementation of total quality management activities.

4.2. Correlation between Organizational Learning and the Implementation Degree of TQM Activities

This study divided organizational learning (information acquisition, information dissemination, shared interpretation, and organizational memory) into two groups (high and low levels).

It examined whether there were significant differences between the two groups according to the average score of the implementation degree of total quality management activities of each group.

Table 3 shows the ANOVA test of the impact of organizational learning on the implementation degree of total quality management activities, and the research results support H2.

Table 2. ANOVA of leadership style on TQM activities

		Leadership	Information analysis	Human resource management	Process management	Customer and market orientation
Goal-oriented style	Low#	3.739	3.708	3.781	3.801	3.775
	High#	4.104	4.151	4.061	4.109	4.209
	F-value	11.121	17.061	6.839	6.785	15.672
	P-value	0.001	<0.001	0.011	0.011	<0.001
Steady and conservative style	Low#	3.679	3.735	3.779	3.792	3.783
	High#	4.125	4.090	4.038	4.091	4.166
	F-value	17.570	10.158	5.710	6.283	11.735
	P-value	<0.001	0.002	0.019	0.014	0.001
Compassionate and supportive style	Low#	3.558	3.609	3.734	3.673	3.702
	High#	4.103	4.088	4.014	4.096	4.136
	F-value	25.221	17.931	6.038	11.962	13.770
	P-value	<0.001	<0.001	0.016	0.001	<0.001
Innovative and adaptable style	Low#	3.604	3.646	3.671	3.687	3.681
	High#	4.096	4.084	4.058	4.103	4.163
	F-value	20.285	15.056	12.728	11.976	18.246
	P-value	<0.001	<0.001	0.001	0.001	<0.001

Note: #Low: executive degree of operational strategy is lower than 3.50; High: executive degree of operational strategy is higher than 3.50; * $p < 0.05$

Table 3. ANOVA of organizational learning on TQM activities

		Leadership	Information analysis	Human resource management	Process management	Customer and market orientation
Information acquisition	Low#	3.633	3.652	3.726	3.583	3.735
	High#	4.065	4.066	4.017	4.142	4.119
	F-value	14.338	12.751	6.562	23.350	10.458
	P-value	<0.001*	0.001*	0.012*	<0.001*	0.002*
Information communication	Low#	3.711	3.731	3.704	3.726	3.782
	High#	4.082	4.079	4.087	4.131	4.152
	F-value	11.354	9.634	13.445	12.116	10.695
	P-value	0.001*	0.003*	<0.001*	0.001*	0.002*
Sharing interpretation	Low#	3.757	3.742	3.783	3.759	3.761
	High#	4.071	4.010	4.407	4.135	4.204
	F-value	7.932	10.306	5.997	10.420	16.494
	P-value	0.006*	0.002*	0.016*	0.002*	<0.001*
Organizational memory	Low#	3.738	3.753	3.794	3.788	3.857
	High#	4.199	4.195	4.113	4.208	4.193
	F-value	18.224	16.050	8.595	12.777	8.311
	P-value	<0.001*	<0.001*	0.004*	0.001*	0.005*

Note: #Low: executive degree of operational strategy is lower than 3.50; High: executive degree of operational strategy is higher than 3.50; * $p < 0.05$

4.3. Correlation between Information technology investment and the Implementation Degree of Total Quality Management Activities

This section explores the impact of information technology investment on the implementation degree of total quality management activities. This study divided information technology investment (personnel training, investment in software and hardware, and personnel cognition) into two groups (high and low levels). It examined whether there were significant differences between the two groups according to the average score of the implementation degree of total quality management activities of each group. Table 4 shows the ANOVA test of the impact of information technology investment on the implementation degree of total quality management activities, and the research results support H3.

Table 4. ANOVA of information technology involvement on TQM activities

		Leadership	Information analysis	Human resource management	Process management	Customer and market orientation
Personnel training	Low#	3.696	3.739	3.724	3.805	3.795
	High#	4.159	4.127	4.134	4.111	4.197
	F-value	19.302	12.484	15.389	6.608	13.215
	P-value	<0.001	0.001	<0.001	0.012	<0.001
Investment in software and hardware	Low#	3.735	3.762	3.754	3.818	3.849
	High#	4.178	4.158	4.159	4.143	4.186
	F-value	16.843	12.685	14.528	7.355	8.518
	P-value	<0.001	0.001	<0.001	0.008	0.004
Personnel cognition	Low#	3.704	3.689	3.701	3.742	3.793
	High#	4.095	4.120	4.097	4.125	4.149
	F-value	12.788	15.768	14.688	10.736	9.924
	P-value	0.001	<0.001	<0.001	0.002	0.002

Note: #Low: organizational learning degree is lower than 3.50; High: organizational learning degree is higher than 3.50

Table 5. ANOVA of TQM activities on new product development performance

		New product development performance
Leadership	Low#	3.185
	High#	3.683
	F-value	11.408
	P-value	0.001*
Information analysis	Low#	3.207
	High#	3.682
	F-value	10.572
	P-value	0.002*
Human resource management	Low#	3.214
	High#	3.672
	F-value	9.467
	P-value	0.003*
Process management	Low#	3.166
	High#	3.674
	F-value	11.208
	P-value	0.001*
Customer and market orientation	Low#	3.098
	High#	3.696
	F-value	16.406
	P-value	<0.001*

Note: #Low: organizational learning degree is lower than 3.50; High: organizational learning degree is higher than 3.50;* $p < 0.05$.

4.4. Correlation between the Implementation Degree of TQM Activities and New Product Development Performance

This study divided the implementation degree of total quality management activities (the dimensions of leadership, information analysis, human resource management, process management, and customer and market orientation) into two groups (high and low levels). It examined whether there were significant differences between the two groups according to the average score of new product development performance of each group.

Table 5 shows the ANOVA test of the impact of the implementation degree of total quality management activities on new product development performance, and the research results support H4.

4.5. The influence of the executive degree of TQM activities of the high-tech manufacturers with different scales on new product development performance

This section explores the influence of the executive degree of TQM activities of the high-tech manufacturers with different scales on new product development performance. The results in Table 6 show that scale does not have a significant influence on the executive degree of TQM activities. Table 7 reveals that the high-tech manufacturers from different scales do not reveal a significant influence on their new product development performance. As seen above, for the high-tech industry with different scales, the executive degree of TQM activities does not reveal a significant impact on new product development performance. The research results reject H5: the implementation degree of total quality management activities varies with company size, resulting in significantly different impacts on new product development performance. This study showed that there was no significant difference in the implementation degree of total quality management activities and the impact on new product development performance among companies of different sizes.

Table 6. ANOVA of scale on TQM activities

	Scale	
	F-value	**P-value**
Leadership	0.267	0.607
Information analysis	0.005	0.946
Human resource management	0.008	0.930
Process management	1.327	0.253
Customer and market orientation	0.192	0.663

Table 7. ANOVA of scale on new product development performance

	Scale	
	F-value	**P-value**
New product development performance	1.617	0.207

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