THE IMPACT OF THE DEGREE OF APPLICATION OF E-COMMERCE ON OPERATIONAL PERFORMANCE AMONG TAIWAN'S HIGH-TECH MANUFACTURERS

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ABSTRACT

This study probes the correlation of types of operational strategy, degrees of organisational learning, types of organisational culture, the degree of the application of e-commerce, and operational performance among high-tech firms in Taiwan. The data was collected by questionnaires distributed via mail to senior supervisors at high-tech firms in six industries at three Taiwanese science parks. The results showed that a higher degree of e-commerce application leads to a significant and positive effect on operational performance. This study suggests that, in order to upgrade operational performance, firms should enhance their organisational learning and e-commerce, along with their rational, hierarchical, consensual, and developmental cultures, and the execution of prospector and defender strategies.

OPSOMMING

Die studie ondersoek korrelasievorms van operasionele strategie, grade van organisasiekunde, tipes organisasiekultuur, die toepassingsgraad van e-handel en operasionele vertoning by hoë tegnologie ondernemings in Taiwan. Gegewens is versamel met behulp van vraelyste gerig aan seniortoesighouers by ses ondernemings in Taiwan. Die slotsom van die opname toon dat 'n hoë grad van e-handel daartoe lei dat 'n betekenisvolle positiewe resultaat by operasionele vertoning bereik word. Daar word aanbeveel dat bestaande ondernemings daarvan gebruik moet maak teen die agtergrond van die eienskappe van 'n e-handel milieu.

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1   INTRODUCTION

The high-tech industry is the economic backbone in Taiwan. According to the "Standard of study on structure categories of exports and imported products" by the Taiwanese Ministry of Finance, high-tech industries produce high-added-value products, possess complicated technologies, and have a high investment in technical staff and R&D. With the progress of technology, the life cycle of high-tech products becomes shorter and the product development and time-to-market are significantly reduced. In the high-pressure environment of strong competition, how a high-tech industry selects the proper operational strategy and organisational culture – including organisational learning in the application of e-commerce to provide better product service quality to customers and to enhance operational performance – is the key to its operational strategy.

According to related studies, applying a higher degree of applied e-commerce leads to significant and positive operational performance [1,14,17,38,42]. Different types of operational strategies significantly and differently influence the degree of e-commerce application [4,18,40], as does increased organisational learning [17,30,32]. Different types of organisational culture also have this effect [6,13,21,36]. Few of these studies included operational strategy, organisational learning, or organisational culture in the application of e-commerce to discover their effects on operational performance. Thus this study studies the high-tech industry, and probes the correlation of types of operational strategies, the degree of organisational learning, types of organisational culture, the degree of e-commerce application, and operational performance.

The purposes of this study are (1) to probe the effect of types of operational strategies on the degree of e-commerce application; (2) to explore the effect of organisational learning on the degree of e-commerce application; (3) to probe the effect of types of organisational cultures on the degree of e-commerce application; (4) to probe the effect of the degree of e-commerce application on operational performance; (5) to suggest how the high-tech industry could apply e-commerce and increase its business performance.

2   LITERATURE REVIEW

2.1   Types of operational strategy

Chandler [2] defined operational strategy as corporate decision-making that involves action plans and resource allocation to accomplish long-term objectives. According to Porter [27], enterprise competitive strategies include cost leadership strategy, differentiation strategy, and focus strategy. Durand and Coeurderoy [11] divided operational strategy into cost leadership strategy, marketing differentiation strategy, and innovation differentiation strategy. Miles and Snow [20] defined four types of operational strategy: prospector strategy (to value the development of new products and new markets, and to provide differentiated products); defender strategy (market segmentation based on a limited niche market, and reducing the cost and improving efficiency to obtain competitive advantage); analyser strategy (between prospectors and defenders, immediately responding to changes in the market by following the prospectors, and by maintaining the original products and services in a stable market as defenders); and reactor strategy (when encountering a change in the environment, it lacks a complete plan and ability to adapt, and it passively reacts to environmental pressure). Song et al. [33] suggested that a reactor strategy cannot respond to abrupt changes in the market thus inhibiting sustainable operations; it lacks competitive advantage. This study classifies three kinds of operational strategy in the high-tech industry: prospector strategy, analyser strategy, and defender strategy.

2.2   Organisational learning

Pace [23] suggested that organisational learning is the internal adjustment of an organisation in response to the environment. The process is the method of organisational learning to accomplish specific goals. Templeton et al. [35] indicated that organisational learning is the combination of a series of organization alactivities, including information

acquisition, information communication, information explanation, and organisational memory. Pace [23] divided organisational learning into information sharing, style of consultation, learning practice, and achievement mindset. Tippins and Sohi [37] categorised organisational learning into information acquisition, information communication, shared interpretation, and organisational memory. This study treats four dimensions of organisational learning – information acquisition, information communication, shared interpretation, and organisational memory – proposed by Tippins and Sohi [37].

2.3 Types of organisational culture

Cristiano and Wazlawick [8] suggested that organisational culture is the values, beliefs, and regulations shared by the members of an organisation. Jones and George [15] suggested that organisational culture is the shared values, regulations, behavioural standards, and expectations that influence the exchanges and cooperation among individuals and groups in the process of carrying out organisational objectives. As to types of organisational culture, Wallach [39] classified organisational culture into bureaucratic, innovative, and supportive types. The competing values framework proposed by Quinn [28] includes four types of culture: rational, hierarchical, consensual, and developmental. This study treats four kinds of culture suggested by Quinn [28] as the categories of organisational culture.

2.4 Degree of e-commerce application

Turban et al. [38] suggested that e-commerce is the process of exchange, purchase, sales, and transfer of products, services, and information through the Internet. Chaston et al. [3] defined e-commerce as a firm's use of network technology, including e-mails, business websites, the Internet, on-line shopping, etc. Kalakota and Whinston [16] described three dimensions of e-commerce applications: B-to-B e-commerce, B-to-C e-commerce, and internal e-commerce within the firms. Rayport and Jaworski [29] categorised e-commerce applications into firms-to-firms, firms-to-consumers, consumers-to-firms, and consumers-to-consumers.

Chuang [7] generalised the definitions and categories of e-commerce suggested by other scholars, experts, and organisations, and divided e-commerce into three types: (1) B-to-B e-commerce, including e-finance transactions, knowledge sharing and communication, group discussions, and work process integration; (2) B-to-C e-commerce, including announcing organisational information, online transactions, checking products or services, customer service, and advertising marketing; (3) internal e-commerce, including knowledge sharing and communication, group discussion, and work process integration. Adopting the categories of Kalakota and Whinston [16], this study probes the degrees of e-commerce application in terms of B-to-B e-commerce, B-to-C e-commerce, and internal e-commerce.

2.5 Operational performance

Croteau and Bergeron [9] measured corporate performance using profit capacity and growth of sales. Shrader [31] measured operational performance using profit rate and sales growth rate. Farrell [12] suggested that operational performance means customer retention rate, success rate of new products, sales growth rate, rate of return, and overall performance, in comparison with their competitors. Tippins and Sohi [37] measured organisational performance using profit rate, rate of return, customer retention rate, and sales growth rate. In the research of Su et al. [34], operational performance was measured using a firm's profits and customer satisfaction. Pelham [26] measured corporate performance using corporate efficiency, growth, share rate, and profit capacity.

Based on the literature review above, and on the business characteristics of the high-tech industry, this study uses the following indicators to measure corporate performance: profit rate, sales growth rate, product and service quality, customer retention rate, success rate of new product launch, operational cost, and overall operational efficiency.

2.6 Types of operational strategy and degree of e-commerce application

Chen [4] suggested that the operational strategy (cost leadership and differentiation) that firms choose will influence their degree of e-commerce application. Wang [40] indicated

that different operational strategies (cost leadership, differentiation, and focus) will influence a firm's degree of e-commerce application and competitive advantage. Lin [18] suggested that the degree of e-business application is closely related to the types of strategy adopted by business managers.

Based on the above literature review, this study proposes H_1: Different types of operational strategies significantly and positively influence the degree of e-commerce application.

2.7 Degree of organisational learning and degree of e-commerce application

Silverstein [32] suggested that, to introduce e-commerce successfully, firms must construct a structural learning system and reorganise how they share useful information with members. According to Li [17], firms with higher degrees of organisational learning have higher degrees of e-commerce application. Shih [30] indicated that an organisation's learning capability positively influences its e-commerce application capability.

Based on the above literature review, this study proposes H_2: A higher degree of organisational learning leads to a significant and positive effect on the degree of e-commerce application.

2.8 Types of organisational culture and degree of e-commerce application

Liu and Tang [19] suggested that organisational culture will influence the degree of e-commerce application. Cheng et al. [6] indicated that an organisational culture that cultivates its talent, offers full empowerment, and has a complete knowledge management system will enhance the firm's introduction of e-commerce. Gibbs et al. [13] and Teo and Ranganathan [36] indicated that, without innovation in their organisational culture, firms will encounter obstacles when introducing e-commerce. Nickels and Kwun [21] suggested that a firm's construction of an innovative culture that can face risk will enhance the degree of e-commerce application.

Based on the above literature review, this study proposes hypothesis H_3: Different types of organisational culture significantly and variously influence the degree of e-commerce application.

2.9 Degree of e-commerce application and operational performance

According to Turban et al. [38], the main benefits of dealing with inter-corporate transactions through a business network include a reduction in cost, a reduction in business cycle time, and improved customer service. Girishankar [14] suggested that the application of e-commerce will reduce costs, and provide rapid service through instant transactions with customers. Wu [42] suggested that with e-commerce, information access will be more convenient and provide new services and products for the customers, enhancing the corporate image and reputation. According to Berrill et al. [1], the application of e-commerce can enhance corporate competitiveness, communication capability, and the performance of products and services. Li [17] suggested that the application of e-commerce positively influences operational performance.

Based on the above literature review, this study proposes hypothesis H_4: A higher degree of e-commerce application leads to a significant and positive effect on operational performance.

3 RESEARCH METHODS

This study probed the correlation among types of operational strategies, organisational learning, organisational culture, degree of e-commerce application, and operational performance. The research framework is shown in Figure 1.

3.1 Research hypotheses

In the light of the literature review, the hypotheses are shown below:

H₁: Different types of operational strategies significantly and differently influence the degree of e-commerce application

H_1: Different types of operational strategies significantly and differently influence the degree of e-commerce application

H_2: A higher degree of organisational learning leads to a significant and positive effect on the degree of e-commerce application.

H_3: Different types of organisational culture significantly and differently influence the degree of e-commerce application.

H_4: A higher degree of e-commerce application leads to a more significant and positive effect on operational performance.
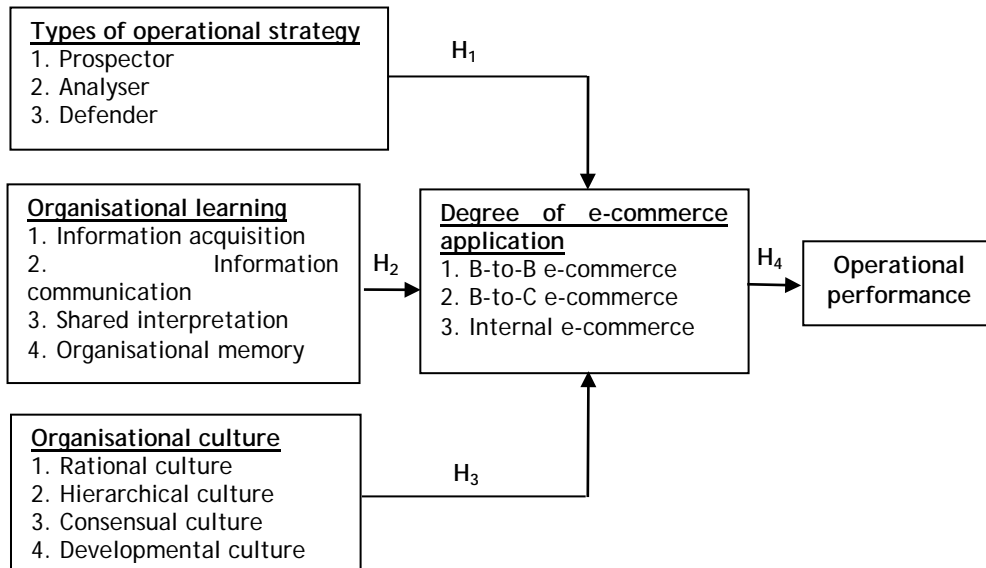

Figure 1: Research framework

3.2 Questionnaire collection and data analysis

This study treated the firms in the top three Taiwanese science parks as the subjects. The anonymous questionnaires were distributed to senior managers in 658 companies at the beginning of February 2012. A total of 63 effective samples were collected by April 2012. The questionnaire design was based on the literature review, and consisted of six parts.

- Part 1: industry type and corporate scale. Industry type includes integrated circuit, computer and peripheral device, communication, electro-optical, precision machinery, and bio-technology. The corporate scale was divided into large-, small- and medium-scale firms according to the number of employees.

Parts 2 to 6 are measured by the Likert 5-point scale.

- Part 2: type of operational strategy, including (1) prospector strategy; (2) analyser strategy; (3) defender strategy.
- Part 3: degree of organisational learning, including: (1) information acquisition; (2) information communication; (3) shared interpretation; (4) organisational memory.
- Part 4: types of organisational culture, including (1) rational culture; (2) hierarchical culture; (3) consensual culture; (4) developmental culture.
- Part 5: degree of e-commerce application, including: (1) B-to-B e-commerce; (2) B-to-C e-commerce; (3) internal e-commerce within the firm.
- Part 6: operational performance, including profit rate, sales growth rate, product and service quality, customer retention rate, success rate of new product launch, operational cost, and operational efficiency.

The data was analysed using SPSS; the main statistical analysis approach was variance analysis. The reliability of the variables in this study is shown in Table 1. Nunnally [22] suggested that in exploratory studies, a reliability of at least 0.7 is acceptable. The reliability of the variables in this study is above 0.7, suggesting a positive reliability.

Table 1: Reliability of variables in this study

Dimensions of questionnaire		Cronbach's á
Types of operational strategy	Prospector Strategy	0.892
	Analyser strategy	0.856
	Defender Strategy	0.813
Organisational learning degree	Information acquisition	0.861
	information communication	0.889
	shared interpretation	0.898
	organisational memory	0.907
Organisational culture	Rational culture	0.829
	Hierarchical culture	0.856
	Consensual culture	0.924
	Developmental culture	0.942
Application degree of e-commerce	B-to-B e-commerce	0.936
	B-to-C e-commerce	0.913
	Internal e-commerce	0.902
Operational performance		0.932

3.3 Measurement of variables

The variables include the type of operational strategy, the degree of organisational learning, the type of organisational culture, the degree of e-commerce application, operational performance, and corporate characteristics. The measurement of variables is shown below.

3.3.1 *Measurement of type of operational strategy*

This study treats prospector strategy, analyser strategy, and defender strategy as the operational strategy categories for the high-tech industry. According to the indices of Croteau and Bergeron [9] for these three strategies, and the business characteristics of the high-tech industry, the researcher allocates the types of operational strategy as follows:

- Prospector strategy: (a) the firms have leading innovative techniques or products in the industry; (b) the firms suggest that they can be leaders in the industry by using new techniques and product development; (c) the firms can rapidly respond to opportunities in the early stage of the business environment; (d) the actions adopted by the firms usually trigger a response from the competition; (e) the firms instantly adopt their prospective innovation operation plan.
- Analyser strategy: (a) the firms carefully study the innovative operation plan; (b) the firms monitor the competitors' actions.
- Defender strategy: (a) the firms search for a safe niche in the relatively stable operation scope; (b) the firms try to maintain safe niche in relatively stable operation scope; (c) the firms, in comparison with their main competitors, provide the operational items in smaller scope; (d) the firms focus on the operational market with a relatively smaller scope in order to produce the best performance; (e) the firms try to maintain regular operational items; (f) the firms try to maintain stable operational items.

The measurement is based on the Likert 5-point scale, where "Strongly agree" is 5 points, "Agree" is 4 points, "Fair" is 3 points, "Disagree" is 2 points, and "Strongly disagree" is 1 point.

3.3.2 *Measurement of degree of organisational learning*

This study treated the four dimensions of organisational learning proposed by Tippins and Sohi [37] as the indices to measure organisational learning. Consistent with the business characteristics of the high-tech industry, organisational learning activities are categorised as shown below:

- Information acquisition: (a) the firms are in regular contact with their customers to discover their needs and expectations; (b) the firms confirm their customers' needs through study; (c) the firms treat their customers as sources of market information; (d) the firms frequently ask their customers about their needs or expectations; (e) the firms frequently collect related information about the customers' goals.
- Information communication: (a) members of the firms' different departments share customer information; (b) the members who need customer information the most can easily acquire it; (c) representatives of the firms' departments regularly hold meetings to discuss the customers' needs; (d) after the departments have acquired important customer information, they share it with other departments; (e) departments can easily acquire customer information.
- Shared interpretation: (a) supervisors in the firms usually have consistent views about their customers' needs; (b) supervisors usually have consistent views about the most satisfying forms of customer service; (c) supervisors usually have consistent views about how new customer information will influence the firms.
- Organisational memory: (a) the firms have a procedure to deal with customer orders; (b) the firms learn to deal with difficult customers according to past experience; (c) the firms have a standard procedure to determine the customers' needs; (d) the firms have a standard procedure to deal effectively with customer complaints; (e) the firms recognise the customers' problems according to past experience; (f) the firms have information about overall operational goals related to their customers.

The measurement is based on the Likert 5-point scale, as above.

3.3.3 Measurement of types of organisational culture

The organisational culture scale in this study is based on the "organisational culture questionnaire" designed by Quinn [28], following the competing values framework and organisational culture measurement of Deshpande and Farley [10] and Parker and Bradley [24]. Organisational culture is classed into four types:

- Rational culture: (a) the firms value job performance and the achievement of tasks; (b) the firms' leaders act as instructors, encouraging the employees to achieve the corporate goals, (c) cohesion of the firms is based on job performance and the achievement of tasks; (d) the organisational climate is mutually competitive and values achievement; (e) the firms' rewards for the employees depend on the achievement of job objectives or performance.
- Hierarchical culture: (a) the firms are formal organisations with concrete ranks. Every member's duties are specifically regulated; (b) leaders of the firms expect the employees to carry out their jobs according to the rules, policy, or procedures; (c) laws, rules, and policy are the basis for corporate cohesion, and the main task is to maintain a successful organisational operation; (d) the firms emphasise stability and stable efficiency; (e) the firms' rewards for the employees depend on their rank in the organization.
- Consensual culture: (a) the firms are humanised organisations, like big families; (b) the leaders, as teachers and friends, help employees to develop their potential; (c) loyalty and mutual trust are the bases of corporate cohesion; (d) the firms value human resources, emphasise team work, and trigger the employees' spirits; (e) the firms treat the employees equally, and offer fair rewards.
- Developmental culture: (a) the firms are creative workplaces where employees are willing to take risks and face challenges; (b) leaders encourage employees to take risks and innovate; (c) the firms' cohesion is based on the pursuit of innovation, research and development, and being leaders in the market; (d) the firms value growth, and acquire new resources so that they are ready for new challenges; (e) rewards for the employees depend on the employees' creativity and readiness to propose new plans.

The measurement is based on the Likert 5-point scale, as before.

3.3.4   Measurement of application degree of e-commerce

In respect of the degree of e-commerce application, the researcher adopted the classification of Kalakota and Whinston [16] – B-to-B e-commerce, B-to-C e-commerce, and internal e-commerce – to probe the degree of e-commerce application. The measures of the degree e-commerce application are shown below:

- Evaluation of the B-to-B degree of e-commerce application is based on the related measures adopted by Wu [41] and Pan [25]. It includes the following: (a) firms offer e-consultation for upstream and downstream firms or partners; (b) firms offer an e-catalogue for upstream and downstream firms or partners; (c) firms allow e-orders from upstream and downstream firms or partners; (d) firms exchange e-information with upstream and downstream firms or partners; (e) firms integrate the job process with upstream and downstream firms or partners using e-business; (f) firms provide after-sale service using e-business; (g) firms conduct e-transactions with upstream and downstream firms or partners.
- Evaluation of the B-to-C degree of e-commerce application is also based on the related measures adopted by Pan [25] and Wu [41]. It includes the following: (a) firms introduce themselves and communicate corporate information to customers using an e-process; (b) firms have online products, and conduct transactions with customers using an e-process; (c) firms allow customers to check on related products and services using an e-process; (d) firms provide an e-service for customers, and respond to their questions; (e) firms implement e-advertising marketing to reach customers.
- Evaluation of the degree of internal e-commerce application within the firm is based on the related measures adopted by Chen [5], Wu [41], and Pan [25]. It includes the following: (a) firms send relevant information by e-mail; (b) firms announce information via BBS; (c) firms integrate internal business process by e-business; (d) firms manage e-documents; (e) firms share resources with employees using an e-process; (f) firms provide e-communication channels for employees; (g) firms use video or online conferences.

The measurement is based on the Likert 5-point scale, as before.

3.3.5   Measurement of operational performance

In the light of the literature review and the business characteristics of a high-tech industry, this study treats profit rate, sales growth rate, product and service quality, customer retention rate, success rate of new product launch, and rate of return as indicators to measure corporate performance.

The indicators are as follows: (1) a firm's profit rate, in comparison with that of its rivals, is higher; (2) its sales growth rate, compared with its rivals, is higher; (3) customer satisfaction with the product or service quality is higher that that of its rivals; (4) a high percentage of long–standing customers trade with the firm; (5) the success rate of new products to the market is higher than that of its rivals; (6) its operational cost is lower than that of its rivals; (7) overall operational efficiency is higher than that of its rivals.

3.3.6   Measurement of corporate characteristics

In this study, corporate characteristics are divided into two groups: industry type and corporate scale.

- Industry type: according to the categories in the address book of the firms in Taiwanese science parks in 2012, the top three science parks include various types of industry: integrated circuits, computer and peripheral devices, communications, electro-opticals, precision machinery, and bio-technology.
- Corporate scale: In Accordance with the standards set by the Ministry of Economic Affairs, this study divides high-tech firms into two categories, based on the number of employees. Large-scale firms have more than 200 employees; small- and medium-scale firms have fewer than 200 employees.

The measurement of industry type and corporate scale is based on a nominal scale.

4   RESEARCH RESULTS

4.1   Correlation between types of operational strategy and degree of e-commerce application

This study divides the types of operational strategy (prospector, analyser, and defender) into two groups: high and low executive degrees. In respect of the means of the degree of e-commerce application of three groups (B-to-B e-commerce, B-to-C e-commerce, and internal e-commerce within the firms), the researcher tries to find if there is any significant difference. Table 2 is a variance analysis of operational strategy on the degree of e-commerce application. The research finding supports H_1: different types of operational strategy significantly and differently influence e-commerce application. Executive degrees of defender strategy and prospector strategy significantly influence the degree of e-commerce application. Executive degrees of analyser strategy do not significantly influence the degree of e-commerce application.

Table 2: Variance analysis of operational strategy on degree of e-commerce application

Operational strategy / e-commerce application		Prospector strategy	Analyser strategy	Defender strategy
B-to-B e-commerce	Low[#]	3.33	3.4	3.4
	High[#]	3.87	3.75	3.82
	F-value	14.01	3.32	7.82
	P-value	<0.001*	0.073	0.007 *
B-to-C e-commerce	Low[#]	3.35	3.48	3.35
	High[#]	3.86	3.73	3.85
	F-value	11.91	1.68	11.12
	P-value	0.001 *	0.2	0.001*
Internal e-commerce within the firms	Low[#]	3.45	3.62	3.51
	High[#]	4	3.85	3.96
	F-value	16.08	1.61	9.28
	P-value	<0.001*	0.21	0.003*

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

4.2   Correlation between degree of organisational learning and degree of e-commerce application

This study divides the degree of organisational learning (information acquisition, information communication, shared interpretation, and organisational memory) into two groups: high and low degrees. According to the means of e-commerce application, three groups (B-to-B e-commerce, B-to-C e-commerce and internal e-commerce within the firms), the researcher tries to find if there is a significant difference. Table 3 is a variance analysis of the degree of organisational learning on e-commerce application. The research finding supports H_2: the degree of organisational learning significantly and positively influences the degree of e-commerce application.

4.3   Correlation between organisational culture and degree of e-commerce application

This study divides the types of organisational culture (rational, hierarchical, consensual, and developmental culture) into two groups: high and low degrees. According to the means of the degree of e-commerce application for three groups (B-to-B e-commerce, B-to-C e-commerce, and internal e-commerce within the firms), the researcher tries to find if there is any significant difference. Table 4 is a variance analysis of the effect of organisational culture on the degree of e-commerce application. The research finding rejects H_3: different types of organisational culture significantly and variously influence the degree of e-commerce application. Different types of organisational culture do not significantly influence the degree of e-commerce application. The higher executive degrees of rational culture, hierarchical culture, consensual culture, and developmental culture do enhance the degree of e-commerce application.

Table 3: Variance analysis of effect of organisational learning on degree of e-commerce application

Organisational learning / *e-commerce application*		Information acquisition	Information communication	Shared interpretation	Organisational memory
B-to-B e-commerce	Low[#]	3.1	3.23	3.33	2.83
	High[#]	3.72	3.88	3.87	3.79
	F-value	4.15	20.16	13.57	20.63
	P-value	0.046*	<0.001*	<0.001*	<0.001*
B-to-C e-commerce	Low[#]	3.2	3.28	3.37	3
	High[#]	3.66	3.86	3.85	3.64
	F-value	4.18	14.61	10.42	4.87
	P-value	0.045*	<0.001*	0.002 *	0.031 *
Internal e-commerce within the firms	Low[#]	3.1	3.43	3.5	2.96
	High[#]	3.86	3.97	3.98	3.92
	F-value	6.79	13.48	10.83	22.16
	P-value	0.012*	0.001*	0.002*	<0.001*

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

Table 4: Variance analysis of effect of types of organisational culture on degree of e-commerce application

Organisational learning / *e-commerce application*		Rational culture	Hierarchical culture	Consensual culture	Developmental culture
B-to-B e-commerce	Low[#]	3.21	3.41	3.24	3.29
	High[#]	3.8	3.79	3.86	3.82
	F-value	11.8	5.38	16.96	11.1
	P-value	0.001*	0.024*	<0.001*	0.001 *
B-to-C e-commerce	Low[#]	3.28	3.4	3.31	3.35
	High[#]	3.79	3.8	3.84	3.81
	F-value	8.37	6.08	11.26	7.82
	P-value	0.005*	0.017*	0.001*	0.007*
Internal e-commerce within the firms	Low[#]	3.26	3.53	3.39	3.45
	High[#]	3.95	3.92	3.98	3.94
	F-value	18.12	6	15.98	9.75
	P-value	<0.001*	0.017*	<0.001*	0.003*

Note: [#]Low: executive degree of organisational culture is lower than 3.50; High: executive degree of organisational culture is higher than 3.50; * $p < 0.05$.

4.4 Relationship between degree of e-commerce application and operational performance

This study divides the degree of e-commerce application (B-to-B e-commerce, B-to-C e-commerce, and internal e-commerce within the firms) into two groups: high and low executive degrees. According to the means of operational performance for the two groups, the researcher tries to find if there is any significant difference. Table 5 is a variance analysis of the effect of the degree of e-commerce application on operational performance. The research finding supports H_4: a higher degree of e-commerce application leads to a significant and positive effect on operational performance.

4.5 The influence of e-commerce application with different industry characteristics on operational performance

According to the research finding in Table 6, firms of different industry types and corporate scales do not reveal significant differences on their degree of e-commerce application. According to the research findings in Table 7, the operational performance of firms of different industry types and corporate scales is not significantly different. Based on the above, the effects of the degree of e-commerce application on operational performance in firms with different industrial characteristics are not significantly different.

Table 5: Variance analysis of effect of degree of e-commerce application on operational performance

e-commerce application	Operational performance			
	Low[#]	High[#]	F-value	P-value
B-to-B e-commerce	3.15	3.93	43.98	<0.001 *
B-to-C e-commerce	3.11	3.90	40.63	<0.001*
Internal e-commerce of the firms	3.04	3.87	42.72	<0.001*

Note: [#] Low: e-commerce application degree is lower than 3.50; High: e-commerce application degree is higher than 3.50; * $p < 0.05$.

Table 6: Variance analysis of industrial characteristics and degree of e-commerce application

e-commerce application	Industry type		Scale	
	F-value	P-value	F-value	P-value
B-to-B e-commerce	0.77	0.578	0.57	0.570
B-to-C e-commerce	0.80	0.558	0.29	0.749
Internal e-commerce of the firms	0.61	0.693	1.34	0.270

Table 7: Variance analysis of industrial characteristics and operational performance

	Industry type		Scale	
	F-value	P-value	F-value	P-value
Operational performance	0.49	0.786	2.23	0.141

The results show that hypotheses H_1, H_2 and H_4 are accepted, but that hypothesis H_3 is rejected (Table 8).

Table 8: Test results of research hypotheses

Item	Research hypotheses	Results
H_1	Different types of operational strategy significantly and postively influence degree of e-commerce application	Accepted
H_2	Higher degree of organisational learning leads to significant and positive effect on degree of e-commerce application.	Accepted
H_3	Different types of organisational culture significantly and variously influence degree of e-commerce application.	Rejected
H_4	Higher degree of e-commerce application leads to significant and positive effect on operational performance.	Accepted

5 DISCUSSION AND CONCLUSIONS

Few previous studies have included operational strategy, organisational learning, and organisational culture in e-commerce application in exploring their effects on operational performance. Using the high-tech industry in Taiwan as subjects, this study explored the correlation between types of operational strategy, degree of organisational learning, types of organisational culture, degree of e-commerce application, and operational performance. The results showed that a higher degree of e-commerce application leads to a significant and positive effect on operational performance. Different types of operational strategy significantly and variously influence the application of e-commerce. Executive degrees of defender strategy and prospector strategy significantly influence the degree of e-commerce application. Executive degrees of analyser strategy do not significantly influence the degree of e-commerce application.

As to the degree of organisational learning, it significantly and positively influences the executive degree of the application of e-commerce. In addition, different types of

organisational culture do not significantly influence the degree of e-commerce application. Higher executive degrees for rational culture, hierarchical culture, consensual culture, and developmental culture will enhance the degree of e-commerce application. Thus, if firms can combine and use the four culture characteristics, they can significantly enhance the degree of e-commerce application.

This study suggests that, in order to increase performance, firms must enhance their organisational learning and their degree of e-commerce application, strengthen their rational, hierarchical, consensual, and developmental cultures, and implement the prospector and defender strategies.

6   RESEARCH LIMITATIONS AND SUGGESTIONS

This research has only discussed the influences of operational strategies, organisational learning, and organisational culture on the degree of e-commerce application. Future studies should probe other factors that might affect it. This study mailed the survey questionnaires, and the retrieval rate was low, possibly because the questionnaire was long. Interviews should be conducted in future studies to increase the retrieval rate and thus render the research more robust. Moreover, this study only probed high-tech firms. Future studies should do an empirical study of other industries in order to explore the correlation between operational strategy, organisational learning, organisational culture, e-commerce application, and the operational performance of organisations in different industries to obtain more complete research findings.

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