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To cite this article: Sewon Park, Han-Kyoul Kim, Haeng-Jun Lee, Mankyu Choi, Munjae Lee & Mihajlo Jakovljevic (2023) Strategic management and organizational culture of medical device companies in relation to corporate performance, Journal of Medical Economics, 26:1, 781-792, DOI: [10.1080/13696998.2023.2224168](https://doi.org/10.1080/13696998.2023.2224168)

To link to this article: <https://doi.org/10.1080/13696998.2023.2224168>



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Published online: 19 Jun 2023.



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ORIGINAL RESEARCH



Strategic management and organizational culture of medical device companies in relation to corporate performance

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ABSTRACT

Aims: Strategies focus on securing the competitiveness of medical device corporations by strengthening their organizational capabilities, which, in turn, ensure their continuous development. This study aims to investigate both management strategies and organizational culture, which may affect the performance of these companies, and analyzes the influence of education and training investment.

Materials and methods: We used data from the 3rd to 6th Human Capital Corporate Panel surveys by the Korea Research Institute for Vocational Education and Training as well as data from the Korea Information Service and 6,112 workers and 260 companies were analyzed. For the analysis, management strategy and organizational culture were set as independent variables, and corporation performance was set as the dependent variable. Additionally, investment in education and training was set as a control variable between the independent and dependent variables. Corporate performance was analyzed by dividing into organizational satisfaction and organizational commitment.

Results: Differentiation strategy and innovative culture had a positive (+) effect on organizational satisfaction, while cost leadership strategy and hierarchical culture had a negative (–) effect. On the other hand, in the case of interaction with education and training investment, cost leadership strategy and hierarchical culture had a positive (+) effect, while differentiation strategy and innovation culture had a negative (–) effect. In organizational commitment, innovation culture had a positive (+) effect, and hierarchical culture had a negative (–) effect. In the case of interaction with investment in education and training, only the hierarchical culture had a positive (+) effect.

Conclusions: The innovation culture positively influenced the performance of medical device companies. Furthermore, cost leadership strategy, hierarchical culture, education and training investment improved the corporate performance of these companies. To enhance corporate performance, these companies should create an innovation culture and invest in education and training in accordance with the organizational culture.

PLAIN LANGUAGE SUMMARY

COVID-19 has proven the excellence of Korea's medical devices, and the medical device industry is expected to continue to grow due to the increase in chronic disease and non-face-to-face treatment. However, the current medical device industry is monopolized by global companies with capital and technological prowess. To overcome this, Korean medical device companies are developing innovative medical devices centered on start-ups, but now is the time to strategically respond to them in order to compete with global companies. In general, companies establish management strategies for survival and growth by analyzing threats and opportunities based on the market environment to maintain the optimal organization according to market competition, government policies, and changes in consumer needs. Strategies are often established based on the culture of the organizations that make up the company. When it comes to strategy establishment, the medical device industry has special characteristics compared to other industries. The medical device industry is based on advanced technology and puts patient safety first, requiring continuous product upgrades. Therefore, it is an essential industry for employees to invest in education and training. The analysis shows the effectiveness of investment in education and training according to the management strategy and organizational culture of medical device companies. It was confirmed that when medical device companies create an Innovation

ARTICLE HISTORY

Received 28 April 2023
Revised 7 June 2023
Accepted 8 June 2023

KEYWORDS

Medical device company;
strategic management;
organizational culture;
corporate performance;
innovation strategy;
investment in education
and training

JEL CLASSIFICATION CODES

I11; I1; I; J24; J2; J; L10; L1;
L; M10; M1; M

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culture, their performance improves. It also shows that when medical device companies adopt a cost leadership strategy, they need to increase their investment in education and training to improve corporate performance.

Introduction

In the medical device industry, global corporations that have capital and technology tend to become monopolies and oligopolies. The size of the global medical device market in 2020 was about \$409.5 billion, and the domestic medical device market was about \$6.7 billion, ranking 10th in the world. Of the 3,283 domestic medical device corporations in Korea, nearly 81% have sales of less than US\$1 million. Companies with less than 20 employees account for 82.4% of the total, revealing the centrality of small and medium-sized enterprises (SMEs) to this market. The domestic medical device market is showing a high growth rate of 6% per year on average, but its import share accounts for 62.8% [1,2]. The higher degree of dependence on imports also suggests a highly vulnerable corporate competition structure compared with global companies.

However, the excellence of Korea's medical devices was proved during the COVID-19 pandemic, and the medical device industry based on the 4th industrial revolution is growing because of the increase in chronic diseases and the virtual treatment [3]. Accordingly, the government is implementing policies such as manpower training and deregulation to foster the medical device industry. Therefore, it is necessary to seek a strategic direction for the growth of the domestic medical device industry [4–6].

Contemporary corporations find themselves in a *management* environment that has been undergoing rapid changes because of uncertainties in market competition, the diverse needs of consumers, shortened product lifecycles, and automation. In response, companies are attempting to secure competitive advantage through effective strategic management and improving corporate performance through the strategic management of the organization [7,8]. Organizational culture may become a major cause of failure in implementing such strategies; thus, to establish and execute successful strategic management, it is necessary to align organizational members with the strategic goals of the company. This can be done by attuning the values of these members with the strategies that the company pursues [9,10].

To adapt to the paradigm shift in an economy moving toward greater *creativity*, a corporation strives to cope with environmental changes brought about by new ideas from organization members. Companies have been increasing investment in education and training to improve their competitiveness based on human resources and promoting attempts to encourage the participation of workers thereof [11,12]. This development of human resources may affect the competitiveness of corporations, which is also closely related to the successful implementation of strategic management [13]. It is thus necessary for medical device corporations to

increase its investments in education and training to reinforce the capability of organization members, and simultaneously improve corporate performance [14,15].

As the extant research on the corporate performance of medical device companies mainly focuses on the characteristics of companies, research and development (R&D) activities, or technology commercialization, there is no comprehensive study that examines strategic management and organizational culture in relation to corporate performance as of yet. To elaborate, there is a dearth of literature that studies the interactions among corporate performance/organizational culture and investment in education and training with corporate performance [16–18].

Domestic companies have secured a competitive advantage through the mass production of low-priced products. However, due to the recent low wages-induced underpricing offensive by China, Southeast Asia, and other developing countries, securing a competitive advantage has become more difficult [19]. In addition, while the development of innovative medical devices has been actively focused on by startups, it is insufficient to compete with global companies due to the lack of capital. In such a complicated and competitive environment, effective strategic management is crucial for the survival of domestic medical device corporations [20–22].

The purpose of this study is to empirically analyze the impact of strategic management, organizational culture, and education and training investment on corporate performance, focusing on domestic medical device companies. We investigate both strategic management and organizational culture, which may affect the corporate performance of medical device companies and analyze the influence of education and training investment [23].

Theoretical background and hypotheses

Competitive strategy and performance

Corporations are striving to create profits by maintaining the organizational structure, strategic management, and personnel system, or by changing them according to circumstances. Similarly, domestic and foreign companies seek to sustain *optimal organization* based on changes in the competitive environment of the market, government policy, and consumer needs.

Currently, the *environmental factor* has emerged as a differentiating factor necessary for the future strategic management of the company. Existing domestic companies have secured a competitive advantage through the mass production of low-priced products. However, due to the recent low wages-induced *underpricing offensive* by China, Southeast Asia, and other developing countries, securing a competitive

advantage has become more difficult. Therefore, corporations must now establish a strategy to achieve this goal—which is essential for survival and growth—by analyzing the threats and opportunities associated with these market conditions [14,24,25].

Studies to classify the types of strategic management are Miles and Snow and Porter. Miles and Snow classified corporate strategies into *prospector*, *defender*, *analyzer*, and *reactor* types. They suggested that an organization is an integrated system that dynamically interacts with the environment and focused on the organization's response to the changing environment [26]. In contrast, Porter classified corporate strategies into *focus*, *cost leadership*, and *differentiation* strategies [27]. Between the two, only Porter distinguishes strategies based on *costs*, *degree of discrimination*, and the presence of *corporate core efforts*, suggesting the best strategies based on adjustable variables of corporations in a competitive environment.

We intend to make use of Porter's strategy patterns as valid strategic patterns that companies can adopt in the same industry [28,29]. The *focus strategy* refers to the strategy of pursuing a cost leadership or differentiation strategy based on the nature of the market [30]. Therefore, according to this strategy, a limited market is an intensive target. A *focus strategy* is a concept that covers cost leadership strategy and differentiation strategy and has limitations in classifying it as an independent strategy type. Thus, we divide strategic management into cost leadership and differentiation strategy.

The cost leadership strategy is to achieve a competitive advantage by providing goods and services at lower costs compared to rival companies. It seeks to gain cost advantage through increased productivity, efficiency, and strict cost control. The goal is to acquire technology that can increase the efficiency of the process and realize all possible economies of scale through highly skilled employees. In the differentiation strategy, products or services that the company sells are differentiated. That is, competitive advantage is achieved by producing unique products or services that are distinct from those of other companies. To meet customer needs, the product line must be more vast than that of the firms pursuing cost leadership strategies; this increases uncertainty in the management environment [31–33].

According to previous studies that analyzed the impact of differentiation strategies and cost leadership strategies on corporate performance, differentiation strategies have a positive effect on organizational performance. In contrast, the cost leadership strategy does not affect organizational performance [33,34]. However, according to previous studies that analyzed the impact of the differentiation strategy, cost leadership strategy, and focus strategy on corporate performance, differentiation strategy and cost leadership strategy have a positive effect on corporate performance [35]. In consideration of these, it is necessary to study how differentiation strategy and cost leadership strategy affect corporate performance.

The differentiation and cost leadership strategies are mutually contradictory; the choice of strategy is then closely related

to the environment surrounding the company. As the average amount of production per unit for medical devices is 270–340 million, they are a typical industry for small-quantity batch production, that is, for SMEs. A greater number of start-ups are involved in medical device production, involving the use of *big data* and *artificial intelligence*. Most domestic medical device companies are SMEs, such that Korea's medical device industry could be considered a small-scale industry.

There are many cases in which a medical device business falls into an uncertain environment; this encourages the adoption of differentiation strategies. On the contrary, among medical device start-ups, there are cases in which a cost leadership strategy is sought to gain a competitive advantage for lower costs compared with rivals. Thus, most medical device companies in Korea can be said to opt for differentiation strategies, and based on circumstances, pursue a cost leadership strategy. Because of this, it is necessary to analyze both the differentiation strategy and the cost leadership strategy's impact on corporate performance. We thus develop the following hypotheses:

Hypothesis 1: *Strategic management will affect corporate performance.*

Hypothesis 1-1: *Differentiation strategies will have a positive (+) impact on corporate performance.*

Hypothesis 1-2: *A cost leadership strategy will have a positive (+) impact on corporate performance.*

Competitive strategy, training investment, and performance

Corporations invest in human resource development for their organization members through training and education. Thus, human resource development is considered a major determinant of corporate competitiveness. The investment in human capital supposes that corporations intend to improve workers' *knowledge*, *skills*, and *abilities* through such investments to improve corporate performance.

Corporate performance is the process of measuring the *effectiveness* and *efficiency* of management activities. It is largely divided into *financial* and *non-financial* corporate performance. The former mainly uses quantified financial metrics that employ factors such as sales and net profit, whereas the latter reflects the intangible values of the company, measured based on, for example, satisfaction, commitment, and labor productivity.

Financial performance is related to short-term performance, while non-financial corporate performance is measured by diverse, long-term criteria. Thus, the latter can overcome the limitations of the former. Since medical device products include a long process from development to achieving substantial results post-sales, they are determined by external factors (e.g. government policies) *other than* product competitiveness, where corporate performance is measured through non-financial long-term performance. The non-financial corporate performance itself has been divided into organizational *satisfaction* and *commitment* [36,37].

The investment in education and training differs from the business strategy pursued by companies. Companies seeking differentiation strategies cope with the environment through different training methods because of environmental uncertainty. They intend to invest in education and training to acquire a variety of information needed to cope with environmental changes and to manufacture products that fulfill market changes. These corporations generally hire talented workers with specialized skills; here as well, investment in education and training seeks to develop these workers [38,39].

However, companies pursuing a cost leadership strategy strive to bring about changes in existing products and services through minimal R&D. They seek minimum costs in terms of raw materials, production operations, marketing, and human resources. Thus, all prime costs are expended for corporate operation. Such corporations tend to operate human resources at a minimum and consider the cost of education and training as best reduced. The education and training of corporations pursuing a cost leadership strategy focus on the efficient performance of the scheduled work done by the workers, sometimes assessing workers based on quantitative objectives [40].

As the medical device industry requires both *medical technologies* and *clinical expertise*, along with high professionalism, the importance of investment in workers' education and training is emphasized for strengthening organizational capability. When such investments for corporate members increase, job satisfaction and commitment may also increase, possibly affecting corporate performance.

According to previous studies that analyzed the interaction of strategic management and investment in education and training, the interaction between the differentiation strategy and education training investment has a negative effect on corporate performance. On the other hand, when a corporate with sufficient management capacity pursues a cost leadership strategy, the interaction between investment in education and training has a positive effect on the corporate's performance [28].

Therefore, corporates should consider their strategic management and capacity when drawing up plans for education and training investment. Furthermore, unlike previous studies, the present study seems to indicate that additional analysis is needed on the interaction between the strategic management and investment in education and training of medical device corporates that do not have sufficient production and management capacity due to a lack of manpower. Thus, we develop the following hypotheses to analyze the effect of education and training investment according to strategic management after dividing corporate performance into organizational satisfaction and commitment:

Hypothesis 2: *Strategic management and investment in education and training will affect corporate performance through interaction effects.*

Hypothesis 2-1: *Differentiation strategies and investment in education and training will have a positive (+) interaction effect on corporate performance.*

Hypothesis 2-2: *Cost leadership strategies and investment in education and training will have a positive (+) interaction effect on corporate performance.*

Organizational culture, training investment, and performance

Organizational culture refers to complex values, beliefs, and ways of thinking that are shared by the organizational members. It affects the performance of the organization because it can influence the behavior of members of the organization as informal guidelines in various situations [41]. The effect of education and training predicted that interacted with organizational culture. This is because education and training in the organization lead to various types of interaction among employees, and the contents of education are reflected in the organizational culture [42]. Therefore, organizational culture can be a factor controlling the effectiveness of education and training. Furthermore, for efficient investment in education and training, corporates must change the form of education and training according to the organizational culture.

The literature divides organizational culture into *innovation*, *relational*, *hierarchical*, and *task* cultures, among many other types. The organization is thus flexible and dynamic, emphasizing creativity because an innovation culture is characterized by *change*. Relational culture stresses on family-like relationships, considering trust among members and participation as important values. Hierarchical culture is a traditional bureaucratic culture, which prioritizes rules and order, and pursues efficiency within the organization [43]. Task culture focuses on competition among members within the organization, making it more result oriented.

Thus, investment in education and training, as well as corporate performance, may also depend on the type of organizational culture. Since innovation and relational cultures have higher investments, their corporate performance is also high, indicating a positive relationship between the two. Corporate innovation has been found to have a significant impact on corporate performance, and innovative culture and relational culture has a positive effect on corporate innovation and corporate performance [44,45]. In contrast, hierarchical culture has a negative effect not only on corporate innovation but also on corporate performance [46,47]. In hierarchical culture, there appears to be no significant relationship between investment in education and training and corporate performance [48,49].

Medical devices are products associated with the lives of people, where safety and reliability are important values. Strict management and control are required in their manufacture. Moreover, these devices need the accumulation and convergence of highly advanced diverse technologies, in which product development must reflect the speed of technological innovation [50]. Thus, it is more likely that medical device companies might simultaneously exhibit both innovation and hierarchical cultures. To analyze the effects of organizational culture on corporate performance based on

its categorization into innovation and hierarchical culture, we develop the following hypotheses:

Hypothesis 3: *Organizational culture will affect corporate performance.*

Hypothesis 3-1: *Innovation culture will have a positive (+) impact on corporate performance.*

Hypothesis 3-2: *Hierarchical culture will have a negative (-) impact on corporate performance.*

Organizational culture affects the characteristics of investment in education and training; such investments sometimes influence company performance by *changing* the organizational culture. A company seeking an innovation culture attempts to create an organizational culture that can innovate and develop creative ideas through these investments. In other words, it intends to invest in education and training, while focusing on altering the internal make-up of the organization into one that is flexible and innovative, thereby enhancing its corporate performance.

On the contrary, companies pursuing a hierarchical culture create an organizational culture that emphasizes norms, values, and rules through investment in education and training. That is, while focusing on developing a top-down culture in product development procedures, hierarchical organizations intend to use such investments to improve their corporate performance [51–53]. We thus hypothesize:

Hypothesis 4: *Organizational culture and investment in education and training will have a positive (+) interaction effect on corporate performance.*

Hypothesis 4-1: *Innovation culture and investment in education and training will have a positive (+) interaction effect on corporate performance.*

Hypothesis 4-2: *Hierarchical culture and investment in education and training will have a positive (+) interaction effect on corporate performance.*

Materials and methods

Research model and Hypothesis

Based on the theoretical background presented in Section 2, we now grasp the moderating effect of investment in education and training on strategic management and organizational culture in relation to corporate performance. To this end, management strategy and organizational culture are set as the independent variables, with differentiation and cost leadership strategies as sub-concepts of the management strategy, and innovation culture, and hierarchical culture as sub-concepts of organizational culture. Corporate performance is the dependent variable, with organizational satisfaction and organizational commitment as its sub-concepts. Investment in education and training is the moderating variable between the independent and dependent variables. The research model is illustrated in Figure 1, and the hypotheses are presented in Table 1.

Data sources

We used data from the 3rd to 6th surveys of the Human Capital Corporate Panel(HCCP) data by the Korea Research Institute for Vocational Education and Training as well as data from the Korea Information Service. HCCP is a panel dataset that has been collected biennially since 2005 to assess the quantitative and qualitative levels of human resources in Korean companies. The sample includes over 10,000 employees employed in more than 450 companies nationwide, ensuring representativeness across industries and company sizes. The HCCP data allows for analysis by matching data on companies and workers, providing a wide range of information on general business conditions, employment status, and human resource management related to company operations. Additionally, financial data for individual companies provided by NICE Investors Service Co. can be utilized, making it a suitable dataset for conducting this study.

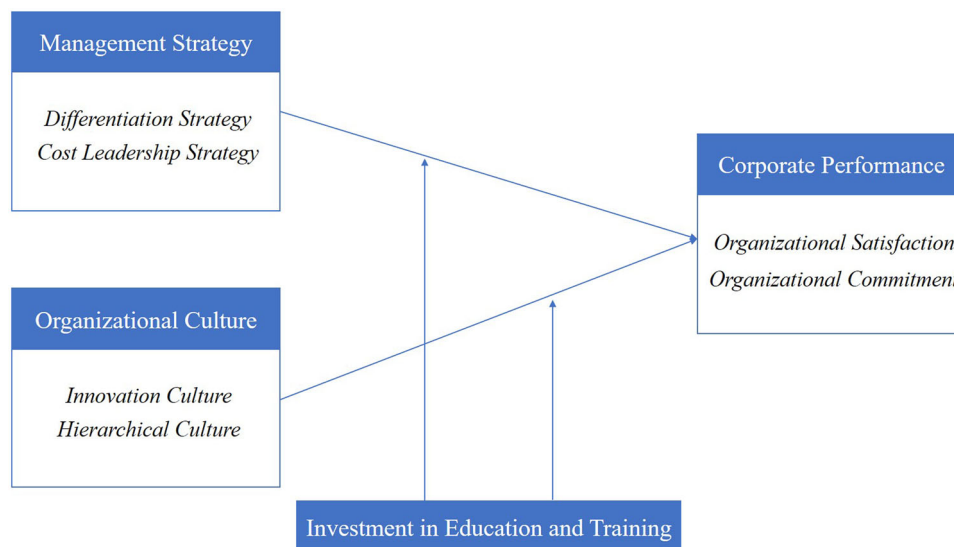


Figure 1. Research model.

Table 1. The hypothesis of the research model.

Hypothesis 1	Strategic management will affect corporate performance.
Hypothesis 1-1	Differentiation strategies will have a positive (+) impact on corporate performance.
Hypothesis 1-2	A cost leadership strategy will have a positive (+) impact on corporate performance.
Hypothesis 2	Strategic management and investment in education and training will affect corporate performance through interaction effects.
Hypothesis 2-1	Differentiation strategies and investment in education and training will have a positive (+) interaction effect on corporate performance.
Hypothesis 2-2	Cost leadership strategies and investment in education and training will have a positive (+) interaction effect on corporate performance.
Hypothesis 3	Organizational culture will affect corporate performance.
Hypothesis 3-1	Innovation culture will have a positive (+) impact on corporate performance.
Hypothesis 3-2	Hierarchical culture will have a negative (–) impact on corporate performance.
Hypothesis 4	Organizational culture and investment in education and training will have a positive (+) interaction effect on corporate performance.
Hypothesis 4-1	Innovation culture and investment in education and training will have a positive (+) interaction effect on corporate performance.
Hypothesis 4-2	Hierarchical culture and investment in education and training will have a positive (+) interaction effect on corporate performance.

Table 2. Classification of medical device corporations.

KSIC	Items
	Manufacturing
26	Manufacturing businesses of electronic components, computers, videos, and sound and communication equipment
27	Manufacturing businesses of medical treatment, precision instruments, optical instruments, and watches
	Publishing, Videos, Broadcasting and telecommunication services, Information service
61	Communication business
62	Businesses of computer programming, and system integration and management
63	Information service business

Table 3. Measurement of variables.

Name of variable	Name of item	Unit
Differentiation strategy	Ability to develop new products	Likert five-point scale
	Quickly respond to customer needs	
	Product diversity	
Cost leadership strategy	Management of brand image	Likert five-point scale
	Efficiency of business processes	
	Securing competitive advantage through cost reduction	
Innovation culture	Product quality	Likert five-point scale
	Reduction of defect rate and improvement of production yield	
	Encouraging change and new attempts	
Hierarchical culture	Compensation for innovation	Likert five-point scale
	Special treatment of creative people	
	Emphasis on formal procedures, rules, and policies	
Satisfaction	Top-down communication or information flow	Likert five-point scale
	An organizational atmosphere that emphasizes awareness of rank	
	Job satisfaction	
Commitment	Wage satisfaction	Likert five-point scale
	Satisfaction in relationship with coworkers	
	Possibility of changing jobs (inverse coding)	
	Consentience with the company	
	Losing a lot after retirement	
	Loyalty to the company	

Data sampling was conducted by targeting the business types related to medical devices extracted from the industrial classification system of the panel data. Based on this criterion, several businesses were extracted: 26 (manufacturing businesses of electronic components, computers, videos, and sound and communication equipment), 27 (manufacturing businesses of medical treatment, precision instruments, optical instruments, and watches), 61 (communication business), 62 (businesses of computer programming, and system integration and management), and 63 (information service business). Considering the development of AI-based medical devices, we also included medical device companies under AI-related video and information service industries, without limiting our dataset to manufacturing businesses. Finally, except for cases with no data value or which have partly unresponsive data, we performed an analysis targeting 6,112 workers from 260 companies. Table 2 reports the

classification systems of the companies related to the medical device industry.

Description of variables

The measurement questions for variables are reported in Table 3. Investment in education and training, our moderating variable, incorporates the total amount of investment costs in education and training. The total amount of investment costs that the company expended on education and training to develop the vocational ability of workers was first converted into a log value. Organizational culture and organizational commitment were used as indicators of corporate performance. For organizational satisfaction, the questionnaire items related to the satisfaction of workers currently engaged in work were used. For organizational commitment,

the questionnaire items measuring the degree to which workers are currently aware of the organization were used.

Statistical analysis

The statistical analysis was performed using SPSS 25.0. First, a correlation analysis examined the relationship among the variables. Second, to verify the validity of the variables, a factor analysis was conducted, followed by a calculation of Cronbach's α through a reliability analysis. Third, a regression analysis identified the causal relationship between management strategy or organizational culture and corporate performance. We also used it to analyze the moderating effect of investment in education and training.

Results

Feasibility and reliability analysis

To examine the relationship among the variables, a correlation analysis was conducted on the extracted factors, and the results are reported in Table 4.

Next, exploratory factor analysis and reliability testing verified the validity and reliability of the questionnaire items for each variable. In the factor extraction method, a principal component analysis was conducted, and we found that only the factors with a *communality value* of 0.5 or higher and with an *eigenvalue* of 1 or higher were selected. The *factor loading value* was judged based on a significance of 0.6. In the rotation of the factor matrix, the Varimax method was used among the right-angle rotation methods. The results of the analysis are reported in Table 5.

Based on the principal component analysis, we found that four factors had an eigenvalue of 1 or more, that is, 7.16, 4.08, 3.32, and 1.66. In addition, the *explanatory power* of each factor was as follows: 53.02% for differentiation; 26.82% for cost leadership; 4.54% for innovation culture; and 3.21% for hierarchical culture. This suggests that they account for 87.57% of the total. The analysis also reveals a *Kaiser–Meyer–Olkin value* of 0.935, indicating that the variable selection for factor analysis was relatively good. The *Barlett construction test value* reveals a significant probability of 0.000, indicating the appropriateness of factor analysis. Thus, the overall factor analysis suggests that the selection of variables in this study was appropriate and valid.

To analyze the reliability of the composing factors, the reliability coefficient value was investigated. We thus used the Cronbach's α coefficient. The reliability coefficient of the questionnaire items for each variable was 0.6 or more,

exceeding the standard value for reliability. Thus, there were no reliability issues.

Hypothesis test results

Table 6 reports the results of the regression analysis for the main variables and organizational satisfaction (dependent variable).

First, Model 1 represents the relationship between organizational satisfaction (dependent variable) and strategic management; Model 2 represents the relationship between strategic management and organizational culture/organizational satisfaction; Model 3 represents the relationship between strategic management and organizational culture as well as investment in education and training and organizational satisfaction; Model 4 includes the interaction between strategic management and investment in education and training; and finally, Model 5 comprehensively includes the key independent variables and their interactions.

In Model 5, differentiation strategies had a positive (+) effect on organizational satisfaction, whereas cost leadership strategies had a negative (–) effect on organizational satisfaction, but these effects were insignificant. Thereby, *Hypothesis 1* was rejected.

Innovation culture had a significantly positive (+) impact on organizational satisfaction and hierarchical culture had a significantly negative (–) impact on organizational satisfaction, which suggests that *Hypothesis 3* was supported.

Hypothesis 2-1 was rejected because the interaction between differentiation strategies and investment in education and training had a significantly negative (–) effect on organizational satisfaction.

Hypothesis 2-2 was supported after confirmation that the interaction between cost leadership strategies and investment in education and training had a significantly positive (+) impact on organizational satisfaction.

Finally, innovation culture had a significantly negative (–) effect on organizational satisfaction through the interaction with investment in education and training. Thus, *Hypothesis 4-1* was not supported.

Hypothesis 4-2 was supported because the hierarchical culture had a positive (+) effect on organizational satisfaction through the interaction with investment in education and training.

Next, Table 7 reports the results of the regression analysis on organizational commitment (the dependent variable). In Model 5, *Hypothesis 1* was rejected; although differentiation strategies and cost leadership strategies had a positive (+) effect on organizational commitment, this effect was not significant.

Table 4. Correlation between variables.

Variable	Average	Standard deviation	Correlation			
			(1)	(2)	(3)	(4)
(1) Differentiation strategy	4.15	2.43	1			
(2) Cost leadership strategy	4.21	1.78	0.78**	1		
(3) Innovation culture	11.68	3.20	0.11**	0.15**	1	
(4) Hierarchical culture	11.55	2.92	0.07*	0.15**	0.88**	1

* $p < .01$; ** $p < .05$.

Table 5. Verification of validity and reliability.

Item		Commonality	Component			
			1	2	3	4
Management strategy	Differentiation 1	0.866	0.960			
	Differentiation 2	0.924	0.950			
	Differentiation 3	0.903	0.939			
	Differentiation 4	0.882	0.930			
	Cost leadership 1	0.876		0.968		
	Cost leadership 2	0.915		0.956		
	Cost leadership 3	0.937		0.935		
	Cost leadership 4	0.673		0.808		
Organizational culture	Innovation 1	0.884			0.935	
	Innovation 2	0.869			0.919	
	Innovation 3	0.839			0.884	
	Hierarchical 1	0.949				0.924
	Hierarchical 2	0.871				0.923
	Hierarchical 3	0.871				0.905
Cronbach's α			0.968	0.947	0.933	0.887
Eigenvalue			7.16	4.08	3.32	1.66
Explain dispersion (%)			53.02	26.82	4.54	3.20
Cumulative dispersion (%)			53.02	79.83	84.37	87.57
KMO = 0.935, Bartlett's $\chi^2=12,580.271^{***}$						

*** $p < .001$.

Table 6. Results of regression analysis (dependent variable: Organization satisfaction).

Variable	Dependent variable: Organizational satisfaction				
	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	13.67 (75.355)	7.76 (9.413)	7.96 (9.574)	7.90 (9.458)	8.05 (9.686)
Differentiation strategy	0.14** (2.636)	0.08* (1.657)	0.08* (1.673)	0.28 (1.386)	0.35 (1.648)
Cost leadership strategy	-0.05 (-0.753)	-0.01 (-0.193)	-0.01 (-0.237)	-0.20 (-0.836)	-0.20 (-0.761)
Innovation culture		0.38*** (7.800)	0.38*** (7.923)	0.38*** (7.717)	0.80*** (4.353)
Hierarchical culture		0.08 (1.440)	0.07 (1.366)	0.08 (1.484)	-0.39** (-2.037)
Investment in education and training			-0.04 (-1.597)	-0.04 (-1.186)	-0.04 (-1.176)
Differentiation strategy * Investment in education and training				-0.05 (-1.021)	-0.07** (-1.386)
Cost leadership strategy * Investment in education and training				0.05 (0.804)	0.05** (0.814)
Innovation culture * Investment in education and training					-0.11** (-2.387)
Hierarchical culture * Investment in education and training					0.12** (2.549)
R^2	0.041	0.247	0.255	0.258	0.277
F-value	5.560**	21.444***	17.767***	12.844***	10.886***

** $p < .05$, *** $p < .001$.

Organizational culture appeared to be similar to organizational satisfaction. Innovation culture had a significantly positive (+) impact on organizational commitment and hierarchical culture had a significantly negative (-) effect on organizational commitment, which supported *Hypothesis 3*.

The interaction with investment in education and training had a significant effect only on hierarchical culture, unlike organization satisfaction. Differentiation strategy and cost leadership strategy had a negative (-) effect on organizational commitment *via* interaction with investment in education and training, but this effect was insignificant. Thus, *Hypothesis 2* was rejected.

Innovation culture had a negative (-) effect on organizational commitment through interaction with investment in education and training, but this effect was insignificant. Thus, *Hypothesis 4-1* was rejected.

Further, since the hierarchical culture had a significantly positive (+) influence on organizational commitment through interaction with investment in education and training. Thus, *Hypothesis 4-2* was supported.

The results of the hypothesis testing are reported in **Table 8**. *Hypothesis 3* and *4-2* were supported for all dependent variables (organizational satisfaction and organizational commitment), whereas *Hypothesis 2-2* was supported only for organizational satisfaction.

Discussion

In this study, we intended to examine the moderating effect of investment in education and training on the relationship between strategic management/organizational culture and the corporate performance of medical device companies

Table 7. Results of the regression analysis (dependent variable: Organizational commitment).

Variable	Dependent variable: Organizational commitment				
	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	12.78 (62.395)	6.70 (7.034)	6.92 (7.198)	6.93 (7.163)	7.01 (7.323)
Differentiation strategy	0.15** (2.596)	0.10* (1.694)	0.09* (1.709)	-0.05 (-0.206)	0.17 (0.710)
Cost leadership strategy	-0.03 (-0.468)	0.01 (0.045)	0.01 (0.004)	0.17 (0.597)	0.38 (1.268)
Innovation culture		0.38*** (6.737)	0.38*** (6.850)	0.39*** (6.852)	0.71** (3.379)
Hierarchical culture		0.09 (1.427)	0.08 (1.356)	0.08 (1.240)	-0.43* (-1.943)
Investment in education and training			-0.05 (-1.509)	-0.05 (-1.397)	-0.06 (-1.609)
Differentiation strategy* Investment in education and training				0.03 (0.618)	-0.02 (-0.399)
Cost leadership strategy* Investment in education and training				-0.04 (-0.612)	-0.09 (-1.204)
Innovation culture* Investment in education and training					-0.08 (-1.604)
Hierarchical culture* Investment in education and training					0.13** (2.368)
R ²	0.047	0.211	0.218	0.219	0.245
F-value	6.473**	17.490***	14.516***	10.360***	9.247***

* $p < .01$; ** $p < .05$; *** $p < .001$.

Table 8. Results of Hypothesis testing.

Hypothesis		Support hypothesis	
		Organizational satisfaction	Organizational commitment
Hypothesis 1	Hypothesis 1-1	X	X
	Hypothesis 1-2	X	X
Hypothesis 2	Hypothesis 2-1	X	X
	Hypothesis 2-2	O	X
Hypothesis 3	Hypothesis 3-1	O	O
	Hypothesis 3-2	O	O
Hypothesis 4	Hypothesis 4-1	X	X
	Hypothesis 4-2	O	O

Abbreviations. O, Acceptance of the hypothesis; X, Rejection of the hypothesis.

[54]. We found that innovation culture had a positive effect on corporate performance. This is consistent with the research indicating that job satisfaction and organizational commitment may be higher in company members who work within innovative cultures than in those working within hierarchical cultures [52, 55]. Further, medical device companies pursuing a cost leadership strategy and hierarchical culture could improve corporate performance through investment in education and training. This finding is contrary to prior research, wherein a company pursuing differentiation strategies may exhibit high corporate performance when investing heavily in education and training [56]. This finding is similar to the research in which hierarchical organizational culture and investment in education and training have a significant effect on corporate performance by improving the performance safety of the members [57–59].

We thus outline the implications of these results. First, medical device companies should improve their corporate performance by fostering a culture of innovation. This type of culture is *outward-oriented*; it emphasizes flexibility and change, which, in turn, *should be* characterized by *creativity*. Further, an innovation culture works as a crucial factor for developing new products and achieving a competitive

advantage in the industry. This dynamic is necessary as a strategy that benefits members to adopt innovative values and producing new products [60]. The medical device industry must react sensitively to a combination of many disciplines and continuously changing technologies. Thus, corporations should have the capability to flexibly cope with rapidly changing environments, while focusing on the interaction with and adaptation to the environment. Further, the rise in start-ups based on advanced medical technologies has made it necessary for corporations to advance into markets using values based on creativity and competition.

Second, medical device companies pursuing cost leadership strategies need to strengthen investment in education and training. In general, as differentiation strategies stress the importance of expertise, they maintain extensive infrastructure for investment in education and training. On the contrary, since the cost leadership strategy emphasizes cost reduction, corporations that take this line invest less in education and training. In our study, we found that medical device companies pursuing the cost leadership strategy could improve their corporate performance *via* investment in education and training. Because the procedures required for product development in the medical device industry are more complex, a higher degree of professionalism is required. Cost reduction is difficult when the clinical trials and licensing procedures of products are prolonged [61]. Thus, the manufacturing structure requires manpower development and upskilling of members through continuous education and training. This seems to be a special property of medical device companies.

Third, medical device companies must invest in appropriate education and training according to organizational culture. In our study, innovation culture positively influenced the performance of medical device companies, but the effect of investment in education and training by medical device companies with an innovative culture was negative. On the

contrary, hierarchical culture had a negative effect on performance, whereas investment in education and training by medical device companies with a hierarchical culture was positive. Thus, medical device companies with innovative cultures should improve their corporate performance through individual investment in education and training that fit the jobs of members. Further, medical device companies with hierarchical cultures should improve their corporate performance *via* active investment in education and training. Although such investments can improve competitiveness and enhance corporate performance, domestic medical device companies tend to engage in passive investments due to cost bearing and lack of education and training programs. Accordingly, the government has been promoting specialized university support projects to nurture specialists in the medical device industry. However, because the investment in education and training should be based on the organizational culture of the medical device company, the government must provide diverse and accurate information on education and training. Moreover, it is necessary to seek directions that can be improved by the positive intervention of the government and the active participation of companies. This is possible by studying whether the training system of specialists for medical devices is implemented efficiently.

There are several limitations to this study. First, it is necessary to expand the sample of medical device companies. The medical device-related industrial classification in this study included imaging and information service industries in manufacturing. However, medical devices are often produced in industries that are included in existing pharmaceuticals. With the development of convergence medical devices, the definition of medical device companies is expanding as companies with security and imaging technologies develop medical devices. Therefore, future research should expand the medical device industry field to include the bio-health industry when defining a sample.

Second, financial performance was not included when considering corporate performance. Medical devices have a strong conservative tendency to continue to use existing popular products and have a high barrier to entry in the market. When a new medical device is introduced to the market, it is difficult to improve the company's financial performance immediately. Most medical device companies in Korea are small and medium-sized enterprises or startups, which limit the measurement of financial performance. In future research, measuring the corporate and financial performance of medical device companies should derive a strategy that can overcome the narrow scope of medical device companies.

Third, it is necessary to derive management performance by separating domestic medical device companies from global medical device companies. The domestic medical device market is composed of domestic medical device companies and global medical device companies. Domestic medical device companies are developing innovative products to create new markets, and global medical device companies are selling medical devices by importing new products into existing markets [62]. In the medical device market with a strong conservative tendency, products from global medical device

companies have a competitive advantage. Given this, it is necessary to derive a strategy to improve the corporate performance of domestic medical device companies by comparing and analyzing strategic management, organizational culture, and education and training investments between domestic medical device companies and global medical device companies.

Conclusion

Despite these limitations, this study aims to suggest ways to improve the corporate performance of domestic medical device companies through education and training investment. The results of the study indicate that education and training investment in medical device companies pursuing a cost leadership strategy is effective. In addition, medical device companies need to secure human capital with expertise. It suggests that it is possible to secure human capital through education and training according to the organizational culture and improve corporate performance. Particularly, companies in an uncertain business environment formulate and implement various strategies to create and sustain competitive advantage. From a managerial perspective, the results of this study demonstrate that expanding investment in education and training, which promotes the expansion of the company and the development of individual members' capabilities, can enhance a company's profitability.

The medical device industry is an industry where the values of various stakeholders, such as government regulations, ethical values, and cost-effectiveness, collide [63]. It is also one of the industries where products with high awareness and reliability have an advantage in market penetration and are difficult to enter the existing market [64–66]. However, with technological advancements and the emergence of new medical devices such as digital healthcare and AI medical devices, there is active development in the industry. This can also be advantageous for companies seeking to enter the medical device industry. The findings of this study not only indicate the importance of investment in education and training for global companies entering the evolving medical device industry, including Korea but also can be utilized to establish the utilization of education and training based on management strategy and organizational culture. In conclusion, medical device corporates can secure competent human capital by raising the potential capabilities of inherent human capital by investing in education and training costs. For this, it is required to appropriately use the cost leadership strategy, one of the strategic management techniques. Furthermore, the education and training method and cost leadership strategy should be applied differentially in consideration of the culture according to each organization.

Transparency

Declaration of funding

This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2019S1A5A2A03040304).

Declaration of financial/other relationships

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interests.

Author contributions

SP and ML have significantly contributed to the article's conceptualization, design, data collection, research analysis, and writing. H-K.K and H-J.L have significantly contributed to the article's software, validation, and visualization. S.P, M.L and M.J contributed to the draft article revisions for important intellectual content and approved the final manuscript. All authors contributed to the article and approved the final manuscript.

Acknowledgements

We are grateful for the support from the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2019S1A5A2A03040304).

Data availability statement

The data used in this study is available to individual researchers or institutions upon approval by the Korea Research Institute for Vocational Education and Training (KRIVET, <https://www.krivet.re.kr/ku/ha/kuCCADs.jsp>).

Reviewer disclosures

Peer reviewers on this manuscript have no relevant financial or other relationships to disclose.

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