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The effects of industry cluster knowledge management on innovation performance ☆

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ABSTRACT

Research on industrial clusters mostly focuses on the effects of the competitive advantage they generate. This study takes a different approach, conducting empirical research on three types of Taiwanese parks (export processing zones, industrial zones, and science parks), in which economic development is particularly prominent, and which have industry cluster characteristics. The study explores the effects of special resources and relationships among cluster firms on innovation performance, and focuses on knowledge management as the mediator for investigation. A survey, regression analysis, and correlation analysis probe into the effects of the special resources and relationships among industrial clusters on corporate knowledge management and innovation performance. Knowledge management emerges as the mediator of industry clusters in terms of corporate innovation performance, thus providing support for the research hypotheses. The findings of this study are valuable for further research and strategic thinking on the sustainability of corporate operations.

1. Introduction

Over the last few decades, scholars are dedicating an increasing amount of their research efforts to the relation between industrial cluster knowledge management and innovation (Arikan, 2009; Bell, 2005; Casanueva, Castro, & Galán, 2013; Connell & Voola, 2013; Gnyawali & Srivastava, 2013; Lissoni, 2001; Phelps, 2010; Tallman, Jenkins, Henry, & Pinch, 2004). The knowledge necessary for corporate innovation activities is, however, more complex, and even large-scale firms face shortages of knowledge. Given their scarce resources, firms attempt to cooperate with other firms to acquire knowledge and resources, and engage in cross-organizational learning to enhance innovation performance (Casanueva et al., 2013; Yli-Renko, Autio, & Sapienza, 2001). The industrial cluster is a new organizational form that aims to enhance regional development. By forming a cluster, firms can lower their investment costs and facilitate the acquisition of professional labor, knowledge, and techniques to access common suppliers, cultivate professional labor, create spillover effects of techniques and knowledge, and enhance competitiveness (Amin & Thrift, 1995; Bell, Tracey, Jan, & Heide, 2009; Casanueva et al., 2013; Connell & Voola, 2013; Gertler, 2003; Tallman et al., 2004).

Most extant studies on industrial clusters discuss the relationships and effects between innovation systems or activities, and clusters (Bell, 2005; Gnyawali & Srivastava, 2013; Phelps, 2010; Porter & Stern, 2001; White & Bruton, 2007; Yeh & Chang, 2003; Yli-Renko et al., 2001), the effects of industry clusters on corporate competitive advantages (Amin & Thrift, 1995; Bahrami & Evans, 1995; Bell et al., 2009; Gertler, 2003; Zhang & Li, 2010), and the knowledge management of cluster firms (Arikan, 2009; Casanueva et al., 2013; Lissoni, 2001; Tallman et al., 2004). Although, in terms of innovation performance, knowledge is one of the most important factors in an industrial cluster (Arikan, 2009; Belso-Martinez, Molina-Morales, & Mas-Verdu, 2011; Casanueva et al., 2013; Tallman et al., 2004), the effect of industry clusters on innovation performance and the role of knowledge management as a mediator are seldom the focus of discussion (Connell & Voola, 2013). With the increasing importance of knowledge management and innovation, what is the current level of awareness of knowledge management in relation to cluster firms? With the special resources and relationships that characterize cluster firms, are the effects on corporate knowledge management significant and do they influence performance? This study aims to explore the theory regarding the effects of industry cluster knowledge management on innovation performance and validation in an attempt to contribute to both theory and practical management.

In terms of its industry cluster development index for the years 2007–2009, Taiwan ranks first worldwide, according to the

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competitiveness ratings of the WEF (World Economic Forum, 2007–2009). This leading position demonstrates the competitive advantage of Taiwan's industry cluster development. Following the economic reforms in China, Taiwan's economic development is particularly prominent. China is taking its cue from the Taiwanese model when establishing its own Export Processing Zones. More than 200 economic zones following the EPZ model are now appearing around the world. Thus, the three main kinds of parks used to compile the Taiwanese industrial cluster index are the focus of this study.

2. Research hypotheses

In accordance with its research purpose and motivation, this study develops four hypotheses to explore the effects of the relationships between the knowledge management of industrial clusters and innovation performance. A description of these hypotheses appears below.

With respect to the effect of industrial clusters, the conditions for successful clusters mean that firms should form networks with knowledge sharing and information exchange (Breschi & Malerba, 2001; Porter, 1998). Therefore, cluster zones with advanced knowledge and techniques are attractive to new companies because they can reinforce local industry's capabilities and knowledge base (Maskell, 2001b). In a knowledge economy, information and knowledge exchange within a cluster can enhance firms' capabilities and lead to knowledge creation (Arikan, 2009; Casanueva et al., 2013; Lissoni, 2001; Lorenzen & Maskell, 2004; Maskell, 2001a, 2001b). Drawing on these findings, this study suggests that interaction and exchange within an industrial cluster can center on knowledge. The use of cluster resources and relationships by firms to acquire knowledge management, and obtain or create new knowledge influences the performance of innovation activities.

H1. Industry clusters significantly and positively influence knowledge management.

Knowledge management facilitates effective information exchange and cost benefits. Afuah (1998) and Porter (1990) suggest that the key to innovation activities is to apply new knowledge to commercialization, and to create corporate value. Corporate innovation activities mean that members contribute implicit techniques and knowledge to create and confirm the concepts of new products. Finally, knowledge that individuals acquire in the innovation process spreads to different departments, and even different organizations. Thus, knowledge management is one of the main forms of lowering uncertainties when reforming technical systems (Carrillo & Gaimon, 2004; Nonaka & Takeuchi, 1995). Arikan (2009), Belso-Martinez et al. (2011), Casanueva et al. (2013), Koskinen (2000), Koskinen, Pihlantob, and Vanharanta (2003), Nonaka and Takeuchi (1995), and Oliver, Dostaler, and Dewberry (2004) all indicate that the enhancement of knowledge management yields improvements in innovation performance. Drawing on the above literature, innovation activities create an environment for the exchange of knowledge. As for product development, innovation enhances both member exchange and interaction, which in turn triggers demand for knowledge, and develops diverse knowledge activities for knowledge integration. Therefore, knowledge management and innovation activities share a relationship.

H2. Knowledge management significantly and positively influences innovation performance.

Industrial clusters enhance the depth and breadth of cooperation and competition, and bring together various industries to form cluster relationship networks, which boosts corporate operational performance (Anderson, 1994; Kotler, 2000; Olson, 1998; Porter, 1990). Maskell (2001a) argues that the cooperation of both upstream and downstream firms effectively lowers mutual transaction costs and develops fixed contracts. Trust develops to enhance transactions. From the perspective of network theory, positive interaction is a key factor for firms to maintain their competitive advantage (Bell et al., 2009). According to Audretsch and Feldman (1996), Feldman and Florida (1994), Gnyawali and Srivastava (2013), Phelps (2010), White and Bruton (2007), and Zhang and Li (2010), industry clusters can strengthen firms' innovation performance. On the basis of the above literature, through industrial clusters, firms can more easily acquire resources, and thus cut costs. This approach reinforces cluster relationship effects, which in turn influences corporate innovation performance.

H3. Industry clusters significantly and positively influence innovation performance.

Numerous governments use industry clusters as an important policy tool for regional economic development on account of their capacity to attract talent, which results in a variety of information and knowledge exchange modes. Through the formation of clusters, firms can lower their investment costs, access common suppliers, cultivate a professional work force, and develop a spillover effect for techniques and knowledge (Tallman et al., 2004). Lissoni (2001), and McEvily and Zaheer (1999) point out that the structure of an organization's alliance network can strengthen through the sharing of knowledge. According to Leonard and Swap (2000), in highly competitive industry clusters, some important skills in business management, or techniques to do with knowledge, are necessary for the industry cluster to support the activities of the industry. Yli-Renko et al. (2001) find that networks provide critical access to information, and that knowledge acquisition shares a positive correlation with knowledge exploitation in innovation performance. Finally, the knowledge that individuals acquire in the innovation process spreads to different departments and even organizations. In a knowledge economy, information and knowledge exchanges that occur within the cluster reinforce the firms' capability, knowledge creation, and innovation performance (Arikan, 2009; Bathelt, Malmerg, & Maskell, 2004; Casanueva et al., 2013; Connell & Voola, 2013; Lorenzen & Maskell, 2004; Maskell, 2001b; Tallman et al., 2004). According to the above literature, the industry cluster is an important policy for numerous governments when developing regional economies. Industry clusters not only enhance relationships and reorganize resources, but also attract talent. Thus, firms can easily acquire a professional work force, knowledge, and techniques to enhance innovation performance. This study posits that a relationship exists among industrial clusters, knowledge management, and innovation performance.

H4. Knowledge management is the mediator of a significant and positive effect of industry clusters on innovation performance.

3. Methodology

3.1. Research framework

This study first establishes the research framework, then deduces the research hypotheses, and finally describes the analysis tools, statistical methods, sampling method, and sample structure. SPSS statistical software allows for the analysis of the questionnaire data, the description of the research findings, and a comparison of theories with empirical results, all with the aim of drawing conclusions from the study. As per the literature, this study divides industrial clusters into two variables (namely, cluster resources and cluster relationships) and divides knowledge management into knowledge creation and acquisition, and knowledge dissemination and storage. Innovation performance breaks down into market performance and product performance, which serve as variables for the study. Fig. 1 shows the research framework.

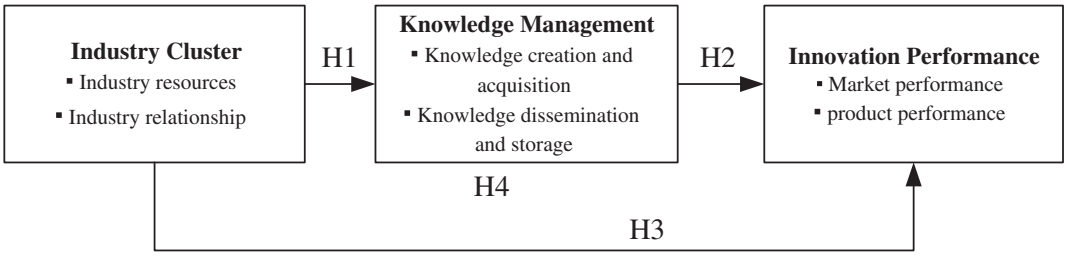

Fig. 1. Research framework.

3.2. Operational definitions and measurement of dimension variables

For all items, this study employs a 5-point Likert scale ranging from strongly agree to strongly disagree. The operational definitions of dimensions appear below.

3.2.1. Industry cluster

The industry cluster splits into two variables, with six items for cluster resources and five items for cluster relationships (11 items).

3.2.2. Knowledge management

Knowledge management breaks down into two variables, with eight items for knowledge creation and acquisition, and eight items for knowledge dissemination and storage (16 items).

3.2.3. Innovation performance

Innovation performance splits into two variables, with five items for market performance and five items for product performance (10 items).

3.3. Research subjects and sampling design

In the formation of industrial clusters, special economic zones make a prominent contribution to national economic development, and are thus important indices of industry cluster development. The subjects of this study are the three main kinds of parks that make up the industrial cluster index in Taiwan: science parks, export processing zones, and industrial zones. Table 1 displays a description of these three types of parks.

The data sources for this study are the science parks, export processing zones, and industrial zones in Taiwan, which serve as the subjects. Random sampling, stratified by firms with the same characteristics within the cluster industry, yields partial samples for investigation, and the results shed light on the overall situation. A total of 1500 respondents received questionnaires, returning 210 usable questionnaires; a valid retrieval rate of 14% (38 questionnaires from science parks, 50 questionnaires from export processing zones, and 122 questionnaires from industrial zones). The confidence level of the sample is 95% with a sampling error of ±6.72%. Of the questionnaires, 73% (154 questionnaires) come from the manufacturing industry (food, plastic, chemistry, machinery, LCD and IC, optics, and energy manufacturing) and the remaining 27% (56 questionnaires) come from other industries (trading, software, service companies). Of the firms that responded, 31 have more than 1000 employees, and 16 have an annual turnover of over 334 million USD.

Table 1
Statistics of parks in industry clusters.

Parks	Number of firms	Number of employees	Business volume (hundred million USD)
Export processing zone	538	69,892	126.5
Industrial zone	13,782	556,231	2,495.2
Science parks	856	237,841	717.8
Total	15,176	963,964	3,339.5

4. Empirical analysis

4.1. Reliability and factor analysis

This study has three dimensions. As Table 2 shows, all values of Cronbach's α are above 0.84, suggesting that the questionnaire of this study has very good reliability, and very clearly classifies each dimension, given that all the values of the factor loadings are high and with considerable concentration. These figures also suggest good discriminate and convergent validity.

Factor analysis methodology extracts mutually independent common factors from multiple relevant variables in cases with unknown factorial model structures. To confirm whether the data are suitable for factorial analysis prior to formal analysis, this study first calculates the KMO values, originally planning to apply 37 questions relating to three dimensions. All KMO values are above 0.87. Therefore, the data are suitable for factor analysis. By using the principal components approach to factor analysis, this study extracts six factors and 30 questions, with accumulative explanatory variation exceeding 67.3%.

4.2. Correlation analysis

Pearson correlation analysis validates the correlation between variables. According to Table 3, although the effects of industry cluster resources on market performance and the effects of industry cluster relationships on product performance are insignificant, they do share a small relationship. Nonetheless, the p values of the other variables are below 0.05, and thus the correlation among the variables is both significant and positive.

The correlation between knowledge creation and acquisition and knowledge storage and dissemination in the knowledge management of the industry cluster is both significant and positive. Thus, the original resources and the relationship of the industrial cluster can enhance the degree of knowledge management. With the enhancement of knowledge management, innovation performance is more significant in relation to market performance and product performance. Thus, the data supports H1, H2, and H3: industry clusters and knowledge management have direct, significant, positive relationships with corporate innovation performance.

4.3. Regression analysis

Table 4 displays the results of the regression analysis, showing that an industry cluster and its resources and relationships can influence knowledge management and innovation performance. The coefficients of Model 1 are significant overall, meaning that the industry cluster significantly and positively influences knowledge management, thus supporting H1. The coefficients of Models 2 and 3 are also all significant, meaning that the resources and relationships of the industry cluster

Table 2
Factor analysis.

Dimensions/factors and variables	Factor loading	Eigenvalue	Accumulated explained variance (%)	Cronbach's α
Industrial cluster				
Industrial cluster resources		4.70	36.82	0.86
Q1. The company can easily obtain individuals with talent and with high educational levels.	0.86			
Q2. The company can obtain experienced and required core technique talents.	0.84			
Q3. The company can retain professional technical talents.	0.80			
Q4. The company can obtain technical interaction and innovation from the employees' flow.	0.70			
Industry cluster relationship		1.45	68.34	0.87
Q7. The company can have vertical cooperation with upstream and downstream firms to lower costs.	0.78			
Q8. The company can connect with firms in the supply chain and be devoted to innovative techniques and production.	0.77			
Q9. The company can enhance information exchange and sharing.	0.78			
Q10. The company can more easily enhance corporate interpersonal exchange and relationship.	0.79			
Q11. The company can easily develop strategic alliances.	0.78			
Knowledge management				
Knowledge creation and acquisition		5.63	35.23	0.86
Q3. The company establishes special project feedback to improve the performance of future projects.	0.75			
Q4. The company values the creation of new knowledge and methods through internal cooperation.	0.84			
Q5. The company has good mechanisms to encourage the employees to propose creative or effective improvements.	0.84			
Q6. The company develops many creative ideas through various creative methods.	0.82			
Q7. The company systemizes the information collected and constructs a knowledge system.	0.82			
Q8. The company records and reorganizes work knowledge as the employees' database.	0.76			
Knowledge dissemination and storage		2.67	69.13	0.87
Q11. Employees have the ability to disperse and transfer personal experience and knowledge in the organizations.	0.74			
Q12. The company can completely preserve professional techniques and knowledge of work.	0.87			
Q13. Employees of the company can obtain data required for work from databases or other members.	0.80			
Q14. Employees of the company usually communicate with other members to solve work problems.	0.80			
Q15. The company has complete management mechanisms for professional techniques and knowledge.	0.88			
Q16. The company manages professional techniques, knowledge, and content by a computer system.	0.86			
Innovation performance				
Market performance		4.80	36.55	0.84
Q2. Customers of the company have high demand for products and techniques.	0.76			
Q3. Customers of the company are highly satisfied with products and techniques.	0.78			
Q4. Market share of the company increases continuously.	0.86			
Q5. Profit rate of the company is increasing year by year.	0.74			
Product performance		1.25	67.29	0.87
Q6. Senior supervisors are highly satisfied with innovative products and techniques.	0.74			
Q7. Because of the development of product innovation, frequency of design and revision is lower.	0.80			
Q8. Because of product innovation development, manufacturing costs of similar products are lower.	0.77			
Q9. Because of product innovation development, time of similar products to the matrix is shortened.	0.78			
Q10. The company's product innovation programs are usually successful.	0.78			

influence knowledge management. The coefficients of Model 4 are significant, indicating that the industry cluster significantly and positively influences innovation performance. In other words, when firms are in an industry cluster, the degree of their innovation performance is higher, thus lending support to H3. The coefficients of Models 5 and 6 are significant. Thus, the resources and relationships of the industry cluster influence innovation performance. Similarly, knowledge management, knowledge creation and acquisition, and knowledge storage and dissemination influence innovation performance. The coefficients of Model 7 are significant, implying that knowledge management both significantly and positively influences innovation performance. In other words, when corporate knowledge management is satisfactory, innovation performance is better, thus providing support for H2. The coefficients of Models 8 and 9 are also significant, demonstrating that firms' knowledge creation and acquisition, and knowledge storage and dissemination influence innovation performance.

Table 3
Correlation analysis.

Variables	Mean	s.d.	1	2	3	4	5
1. Industry cluster resources	3.33	0.71					
2. Industry cluster relationship	3.48	0.67	0.58**				
3. Knowledge creation	3.59	0.71	0.17*	0.26**			
4. Knowledge storage	3.54	0.68	0.48**	0.46**	0.36**		
5. Market performance	3.58	0.63	0.12	0.17*	0.41**	0.22**	
6. Product performance	3.38	0.62	0.14*	0.13	0.58**	0.21**	0.63**

Number of observations: 210.
* $p < 0.05$.
** $p < 0.01$.

4.4. Analysis of knowledge management as a mediating effect

This section attempts to determine whether industrial clusters influence innovation performance through knowledge management. Taking the four conditions of mediators as a basis (Baron and Kenny, 1986), Fig. 2 shows the results of the mediator path analysis.

According to Fig. 2, the regression analysis includes correlation coefficients in a path diagram (βa, βb, βc, $'\beta c$). The effects of industry clusters on knowledge management ($\beta a = 0.42$, $t = 6.66$, $p < 0.05$), of knowledge management on innovation performance ($\beta b = 0.53$, $t = 8.95$, $p < 0.05$), and of industry clusters on innovation performance ($\beta c = 0.16$, $t = 2.40$, $p < 0.05$) are significant. Moreover, the indirect effect of industry clusters on innovation performance is insignificant ($'\beta c = -0.07$, $t = -1.06$, $p > 0.05$). Therefore, the originally significant, direct effect path becomes insignificant after including the mediator–which matches conditions 1 to 4 from Baron and Kenny (1986)–, indicating the possible existence of mediating effects. Thus, in industry clustering, knowledge management can improve corporate innovation performance. Therefore, results offer support for H4.

Table 4
Regression analysis.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
	Knowledge management			Innovation performance			Innovation performance		
Constant	2.35	2.72	2.47	2.96	3.10	3.00	1.50	1.94	2.79
Industry cluster	0.42**			0.16*					
Industry cluster resources		0.36**			0.14*				
Industry cluster relationship			0.41**			0.16*			
Knowledge management							0.53**		
Knowledge creation and acquisition								0.55**	
Knowledge storage and dissemination									0.24**
p value	0.00	0.00	0.00	0.02	0.04	0.02	0.00	0.00	0.00
F value	44.29	30.51	41.77	5.76	4.36	5.74	80.04	88.70	12.23
R^2	0.18	0.13	0.46	0.03	0.02	0.03	0.28	0.30	0.06
Adj. R^2	0.17	0.12	0.44	0.02	0.02	0.02	0.27	0.30	0.05
D-W	1.72	1.67	1.75	1.89	1.89	1.90	1.76	1.90	1.81

Number of observations: 210.
* $p < 0.05$.
** $p < 0.01$.

5. Conclusions and managerial implications

5.1. Conclusions

Under the pressure of global competition, participation in industrial clustering is important for sustainable corporate development. Through industrial clusters, firms can use resources more effectively, lower costs, and enhance competitiveness. In addition, geographical proximity positively influences firms' innovation performance.

By focusing on the three major types of parks that figure in the calculations of the Taiwanese industry cluster index, this study probes into industrial clustering resources and relationships, knowledge management, and innovation performance. The theoretical discussion gives rise to several hypotheses concerning relationships between the above variables. Statistical testing then validates these hypotheses and relationships.

Key findings are as follows. When the resources of an industrial cluster are complete, firms vertically integrate in central locations to lower costs and share resources. Such actions enhance knowledge creation and acquisition, and knowledge storage and dissemination, supporting H1.

With industrial clustering, corporate knowledge creation and acquisition, and knowledge storage and dissemination can influence innovation performance and reinforce the internal knowledge management of firms, thus supporting H2.

Upon the formation of an industrial cluster, firms directly influence innovation performance, with positive and significant effects. In practice, acquiring resources and information through industrial clusters is easy, and provides firms with more frequent interaction among different levels of government, schools, corporations, and upstream and downstream firms, resulting in better innovation performance. This study shows that, upon the formation of an industrial cluster, firms can easily acquire resources and lower costs, thereby reinforcing the effects of cluster relationships, which influence corporate innovation performance. In addition, the analysis uncovers significant, positive effects of industry cluster resources on innovation performance, and of the industry cluster relationship on innovation performance. H3 thus garners support from the data.

The firms in industry clusters achieve better innovation performance due to knowledge management. In practice, industrial clustering not only unites similar industries, but also attracts industry talent, which leads to information and knowledge exchange, with a spillover effect of sharing techniques. Regarding knowledge management, through the effects of industrial clustering, firms enhance their operational performance. Thus, industry clusters indirectly influence innovation performance. H4 posits this relationship, so the data offers support for H4.

5.2. Managerial implications

This study has the following key managerial implications.

(1) Industry clustering can positively enhance corporate innovation performance. This finding suggests that the enhancement of corporate sustainable development and competitiveness should rely on industrial clustering resources and relationships to increase competitive advantage.
(2) Industry clustering in science parks, industrial zones, and export processing zones can reinforce corporate knowledge creation and acquisition. Industrial clusters can help introduce innovative techniques of knowledge management to enhance core competitiveness.
(3) Knowledge management can boost the innovation as well as output performance of firms in industry clusters. Firms should cooperate with supply chain agents, and foster industry–academia cooperation, in an attempt to upgrade knowledge and technical management capabilities.

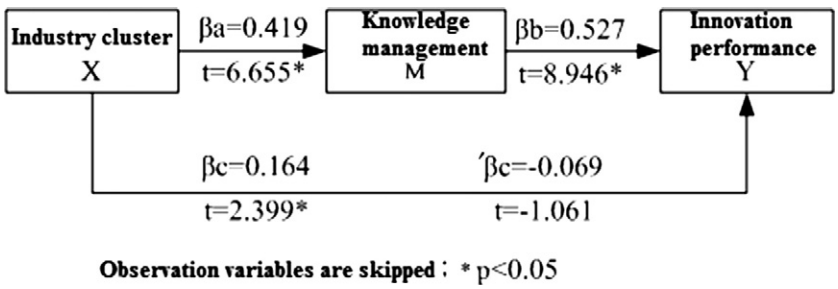

Fig. 2. Path analysis of mediating effect of knowledge management.

(4) Cluster relationships may differ depending on the kind (parks) of industry clusters. For instance, as the government devises and establishes different industrial types and orientations of science parks, industrial zones, and export processing zones, cluster relationships also differ. Thus, results imply that for better cluster relationships, such as vertical supplier integration, information sharing, and strategic alliances, firms can make the development of export processing zones a priority, followed by industrial zones. Therefore, in the selection of industrial zones, firms should rely on industrial characteristics and their own requirements, to achieve better results.

(5) The government and private companies should establish strategic cooperation platforms. Knowledge management is one of the factors that enhance competitiveness. Strategic alliances, competition and cooperation should work on the basis of the sharing and integration of resources. This facilitates joint efforts in innovation and R&D and improves the international competitiveness of companies. Clusters should develop high value-added products or services and brace themselves for new challenges in the marketplace.

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