

Effects of Innovative Education on Innovation Capability and Organizational Performance in High-Tech Industry

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ABSTRACT

Looking at the development of domestic industries, the industrial structure has turned from agriculture in the past to the focus on manufacturing and service industries. With constant investment in R&D and the promotion of technology, manufacturing even turns to technology-intensive high-tech industry. Excellent talents and R&D innovation capability have been the critical but difficult problems for high-tech industry. For this reason, the quality of work force and the product innovative R&D capability in high-tech industry could merely be enhanced by reinforcing innovative education. Semiconductor manufacturers with the revenue ranked top three in 2016 in Taiwan are selected as the research subjects. Total 600 copies of questionnaire are distributed to the supervisors and employees, and 469 valid copies are retrieved, with the retrieval rate 78%. The research results show significantly positive effects of 1.innovative education on innovation capability, 2.innovation capability on organizational performance and 3.innovative education on organizational performance. According to the results, suggestions are proposed in this study, expecting to assist high-tech businesses in promoting human capital and innovation capability.

Keywords: high-tech industry, innovative education, innovation capability, organizational performance

INTRODUCTION

The rapid development of domestic economy has the industrial structure face the transformation, promoting from past labor-intensive industries to the focus on technology-intensive structure. The effort made for the development of high-tech industry is significant to increase the demand for senior technology talents. In order to thoroughly supply distinct science and technology talents required for industrial development, the cultivation of science and technology talents has become the prior point. The rich science and technology talents and established famous technology industries or products are the niche to develop high-tech industry domestically. However, the demand for innovation talents in future high-tech industry appears serious gap, and talents excessively concentrate on certain popular industries to cause talent exclusion that it is adverse to the long-term balance development of high-tech industry.

The urgent demand for professional technology talents and the accelerating change in personnel in high-tech industry has changed the management conditions from business competition to the competition of the quality of work force. Education of high-tech employees is therefore emphasized domestically and becomes the focus to compete with businesses in the same industry. Furthermore, the fast change in technology, particular in high-tech industry, has shorten the update cycle of products and technology that even experts perceive the risk of not being able to catch up. Simply speaking, an enterprise has to constantly and frequently educate the employees for innovative R&D in order to have high-tech industry catch up the advance of technology in the world. Apparently, excellent talents and R&D innovation capability are the primary but difficult problems for high-tech industry. The quality of work force and the product innovative R&D capability of high-tech businesses could merely be enhanced by reinforcing the innovative education. Nonetheless, how is employees' innovation capability after the innovative education? This study therefore intends to discuss the effect of innovative education on innovation capability and organizational performance in high-tech industry.

Contribution of this paper to the literature

- Seniors present rich social networks, social experiences, and innovation experiences that the experiences and opinions could be the reference for developing innovation in high-tech businesses.
- The construction of cultural climate with innovative education is initiated by the organizational structure; especially, the encouragement from a leader presents the demonstration of leadership.
- To have employees consciously reflect and maintain the systems and innovation culture of the enterprise, employees' realization is necessary.

LITERATURE REVIEW

Innovative Education

Innovation of itself is vitality and energy, which could help a target become more exquisite and excellent after making changes (Hyung, 2016). Bakker et al. (2016) regarded "innovation" as successfully introducing and applying new tactics or purposes to a situation. Schmitt et al. (2016) pointed out "innovation" as the process transforming creative ideas into useful products, services, or working methods to enhance the improvement and promotion of the quality of an organization. It aimed to have an organization sustainably maintain the competitive advantages and generate new value through new procedures and directions (DeCenzo et al., 2013). Tims et al. (2016) regarded innovative education as the strategy of an organization having the employees pursue breakthrough, change current conditions, and develop characteristics on products, processes, or services through education so as to enhance organizational performance. Alessandri et al. (2015) explained innovative education as a leader presenting creative ideas and actively establishing various educational trainings useful for innovation, e.g. members commonly participating in decision-making, shaping communication and dialogue situations without slaughter, inducing opportunities for members' innovation, and further creating innovative and excellent organizational culture to enhance the overall competitive advantages and maintain the sustainable status of the organization. Noe (2013) indicated that the promotion of innovative education aimed to establish the mechanism for organizational employees participating in knowledge sharing and the ability of innovation and group creation, intending to integrate dispersed knowledge to create larger added value and benefits. Innovative education is the knowledge and skills used for changing behaviors and action to help an organization cope with changes in external conditions and enhance the efficiency of organizational innovation. Innovative education is developed through vision, innovative knowledge, mental model, and the sharing of past innovation experiences. It is considered as the major process to generate management innovation and stresses on organization innovation as an autonomous output through the past knowledge of the organization and the process of innovation experience (Xie et al., 2016). Referring to Fang and Zhang (2014), innovative education is measured with learning commitment, vision sharing, and open mind in this study.

Innovation Capability

Zumrah et al. (2013) pointed out "innovation" as the adoption of a new idea and behavior. From resource-based theory, innovation is defined as changing the output of resources that innovation capability is a new idea for internal facilities, systems, policies, procedures, products, and services of an enterprise (Guta, 2013). Barba Aragón et al. (2014) proposed the innovation capability required for modern enterprise organizations. First, it required constant development or improvement of current workflow to improve products or services which could continuously be competitive in the market within 2-3 years. Second, an organization could either utilize internal learning or absorb new knowledge externally to research and develop new products, based on current products or technologies, for next generation. Finally, an organization should present innovative process systems with the process of constant innovation, digestion, and re-innovation and not stick to the operation of basic knowledge, which would have new knowledge soon become out of date to lose the meaning to utilize new knowledge for innovation (Karatepe and Aga, 2016). Aksoy et al. (2014) defined innovation capability as the abilities 1. to develop new products to satisfy market requirements, 2. to apply proper processes and technologies to produce new products, 3. to develop and adopt new products, processes, and technologies to satisfy future requirements, and 4. to respond to unexpected technological actions taken by competitors and to create sudden opportunities.

Referring to Li (2014), technology innovation capability and management innovation capability in the organizational innovation capability scale are used for measuring innovation capability. Technology innovation capability refers to a company using new technologies and equipment for production and manufacturing so as to conform to the rapid market change. Management innovation capability refers to a company applying innovative

management measures (pay systems for encouraging innovation, novel performance measurement, use of leadership) to the entire business management system.

Organizational Performance

Organizational performance could be the output-input ratio in the entire business of an enterprise, the degree of target achievement, and the satisfaction of participants in the business process (Henseler et al., 2015). By organizing the points of view from various studies, Aküzüm (2014) proposed that (1) organizational performance was the core of organization theory, (2) there was not a single performance indicator presenting distribution, (3) it was difficult to show consensus for performance indicators, (4) there were different performance indicators corresponding to various situations, and (5) theory orientation was replaced with problem-solving orientation (Koffel et al., 2016). Organizational performance presents complexity that the interpretation should contain multiple dimensions so that there are different definitions, measurement methods, and indicators of organizational performance for current applications and requirements (Breevaart et al., 2016). Peng et al. (2014) suggested "job satisfaction", "organizational objective", and "job performance" as the measuring indicators of "organizational performance". According to researchers' suggestions, above three indicators are included in this study for evaluating "organizational performance". The definitions are explained as follows.

Job satisfaction

Degago (2014) was the first scholar proposing job satisfaction and regarded it as employees' subjective satisfaction with working environment and work itself psychologically and physiologically. Job satisfaction was considered as the degree of employees preferring the job that job satisfaction would appear when the job characteristics were suitable for the workers' expectation.

Organizational objective

An objective refers to the achieved standard in a job or a plan as well as a correct, specific, and logical post, which is pushed by intrinsic drive.

Job performance

Olçer and Florescu (2015) pointed out job performance as the "quality and quantity" performed by individuals or teams to achieve the tasks at work. Andrews et al. (2016) regarded job performance as the behavior of an individual, as an organizational member, completing what the organization expected, regulated, or required for a formal role.

Research on innovative education and innovation capability

Innovative education, as a part in the changing process of an organization, could induce the knowledge, belief, and behavior changes of an organization and eventually enhance organization growth and innovation (DeCenzo et al., 2013). Demerouti et al. (2015) argued that an enterprise could respond to the environment by proceeding product innovation as well as actively change the employees' attitudes, value, and behavior model toward innovation by proceeding innovative education. It could deliver the sustained innovation vision to the employees to have them integrate such a thought in daily life and enterprise business and enhance employees' innovation capability so that the enterprise could sustainably develop and maintain the competitive advantages. Bakker et al. (2016) indicated that an enterprise absorbing and assimilating external conditions through innovative education could assist in the promotion of internal innovation. In the research on the effects of innovative education on innovation management system in organizations, Milkovich et al. (2017) indirectly proved the possibility of direct effects of innovative education on innovation capability. Alessandri et al. (2015) mentioned that an enterprise simply changing the manufacturing process and product design was not the real innovation; an enterprise could merely sustainably develop to promote the employees' innovation capability and maintain the competitive advantages by applying innovative education to introduce innovation culture to the company culture and practice in employees' daily life and enterprise business. The following hypothesis is then proposed in this study.

H1: Innovative education shows significantly positive effects on innovation capability.

Research on innovation capability and organizational performance

With actual tests, Hoon and Parent (2013) indicated that high-performance organizations, compared to low-performance ones, showed high correlations between management innovation and technology innovation, i.e. highly positive effects of innovation capability on organizational performance. Zumrah et al. (2013) pointed out the

positive effect of organization innovation on performance, and even the directly positive effects of technology innovation and management innovation on organizational performance. Seppälä et al. (2015) considered that the effect of management innovation on organizational performance was larger than the effect of technology innovation on organizational performance. Barba Aragón et al. (2014) particularly pointed out the factors in the contribution of innovation capability to organizational performance, including that 1. technology innovation could reinforce current value to the major customers of an organization to enhance the organizational performance and 2. innovation capability could acquire new customers by establishing new markets (Karatepe and Aga, 2016). In this case, the following hypothesis is proposed in this study.

H2: Innovation capability reveals notably organizational positive effects on performance

Research on innovative education and organizational performance

Aküzüm (2014) pointed out the positive effect of innovative education on organizational performance. Olçer and Florescu (2015) indicated that innovative education could indirectly affect organizational performance by improving the quality of market-oriented behavior, and the product, procedure, and system innovation, through creative learning, could directly affect organizational performance. Lin (2014) also stated that innovative education and organization knowledge could enhance competitive advantages and organizational performance. Degago (2014) mentioned that innovative education could enhance performance, productivity, and profits. Tsai et al. (2013) indicated that most small and medium enterprises did not practice innovative education; when traditional restrictions were eliminated to enhance innovative education, the innovation capability, flexible and rapid response capability, and information and communication capability could be promoted to further promote organizational performance. Breevaart et al. (2016) argued the importance of innovative education that the application of innovative education could enhance efficiency and promote innovation capability and performance. The following hypothesis is therefore proposed in this study.

H3: Innovative education presents remarkably positive effects on organizational performance.

DESIGN OF RESEARCH METHOD

Operational Definition and Measurement of Variable

Innovative education

Innovative education is divided into learning commitment, vision sharing, and open mind, which is referred to Fang and Zhang (2014). The overall reliability coefficients show 0.86, 0.82, and 0.87 for learning commitment, vision sharing, and open mind, respectively.

Innovation capability

Referring to Li (2014), innovation capability is divided into technology innovation capability and management innovation capability. The overall reliability coefficients appear 0.88 and 0.90 for technology innovation capability and management innovation capability, respectively.

Organizational performance

Referring to Peng et al. (2014), organizational performance contains three dimensions of job satisfaction, organizational objective, and job performance. The overall reliability coefficients reveal 0.83, 0.81, and 0.84 for job satisfaction, organizational objective, and job performance, respectively.

Research Object

Aiming at high-tech industry in Taiwan, semiconductor manufacturers with the revenue ranked top three in 2016 are studied. Total 600 copies of questionnaire are distributed to the supervisors and employees, and 469 valid copies are retrieved, with the retrieval rate 78%. According to the consolidated revenues in January-December, 2016, the three semiconductor manufacturers are Taiwan Semiconductor Manufacturing Company Limited, MediaTek Inc., and Advanced Semiconductor Engineering, Inc.

Table 1. Confirmatory Factor Analysis

Research dimension	Overall fit	Analysis result
innovative education	$\chi^2=0(P<0.001)$; DF=0; GFI=1.00; CFI=1.00	Good overall model fit
innovation capability	$\chi^2=0(P<0.001)$; DF=0; GFI=1.00; CFI=1.00	Good overall model fit
organizational performance	$\chi^2=0(P<0.001)$; DF=0; GFI=1.00; CFI=1.00	Good overall model fit

Table 2. Correlation analysis

Research dimension	α	innovative education	innovation capability	organizational performance
innovative education	0.85			
innovation capability	0.89	0.33**		
organizational performance	0.83	0.31**	0.37**	

Table 3. Analysis of overall linear structural model

overall fit	χ^2/Df	1.946
	GFI	0.969
	AGFI	0.921
	RMR	0.007

Note: * stands for $p<0.05$, ** for $p<0.01$, and *** for $p<0.001$

Test of Reliability and Validity Analysis

The reliability of the dimensions in this study achieves above 0.7, revealing the high reliability. The construct validity of the research scales is analyzed with Confirmatory Factor Analysis. From [Table 1](#), the scales present favorable convergent validity and construct validity.

ANALYSIS RESULT

Correlation Analysis

[Table 2](#) reveals the remarkable correlation among innovative education, innovation capability, and organizational performance. Such results show the possibility of multicollinearity among dimensions. Nested model analysis could be used for solving such a problem. The significant correlations among dimensions also reveal the correspondence with the hypotheses.

Discussion of Overall Model

In regard to overall model fit, [Table 3](#), the overall model fit standards χ^2/Df 1.946, smaller than the standard 3, and RMR 0.007 present the appropriate results. Furthermore, chi-square value is sensitive to sample size that it is not suitable for directly judging the fit. However, the overall model fit standards GFI 0.969 and AGFI 0.921 are higher than 0.9 (the closer GFI and AGFI to 1, the better model fit) that this model shows good fit index.

Discussion of Research Hypothesis

With nested model, chi-square difference test is used for the research hypotheses as each nested model appears a degree of freedom. When the difference between the chi-square value of nested model and the chi-square of theoretical model achieves the significance, the path coefficient set 0 is remarkable. The research results reveal the significance of the model; the analysis of nested model is shown in [Table 4](#), and the hypothesis test is shown in [Table 5](#).

Table 4. Nested model analysis

Model	χ^2	$\Delta\chi^2$	GFI	CFI	RMSEA
Theoretical model	251.84		0.969	0.977	0.08
Model 1: Testing hypothesis	257.97	6.13*	0.969	0.977	0.08
Model 2: Testing hypothesis	263.81	5.84*	0.969	0.977	0.08
Model 3: Testing hypothesis	270.25	6.44*	0.969	0.977	0.08

Table 5. Test of hypothesis

Research hypothesis	Correlation	Empirical result	P	Result
H1	+	0.423	0.00	supported
H2	+	0.512	0.00	supported
H3	+	0.388	0.00	supported

CONCLUSION

The research findings show the direct effect of innovative education on innovation capability and organizational performance that high-tech businesses could improve the innovation capability through internal innovative education to directly and obviously enhance the organizational performance. High-tech businesses could promote the organizational members' innovation capability through the reinforcement of innovative education and to have them present knowledge with low replaceability and high added value. In this case, the completion of innovative education to help high-tech businesses enhance talent training could simultaneously cultivate employees' uniqueness and professional capability and further accumulate organizational human capital. A high-tech business could have the employees continuously learn, share experiences and knowledge, and create organizational value through innovative education. Employees with strong intention to maintain the relationship with the organization would agree with the innovation objective and value of the organization and be willing to make more effort to innovation. In this case, new innovation capability could be brought in the organization and organizational performance could be promoted.

SUGGESTION

The results and findings are organized in this study, and practical suggestions are proposed as follows.

- I. Seniors present rich social networks, social experiences, and innovation experiences that the experiences and opinions could be the reference for developing innovation in high-tech businesses. Besides, assisting new staff in the socialization with seniors' influence and experiences could have new staff soon realize the innovation culture in the organization and develop the role function to enhance the innovation capability.
- II. In the tide of multi-intelligence, most employees in high-tech industry follow the rule of better keeping still than move and would not easily step out the original frame. The construction of cultural climate with innovative education is initiated by the organizational structure; especially, the encouragement from a leader presents the demonstration of leadership. In the era with multiple challenges, the rapid development and circulation of information technology have changed the current pattern of high-tech industry. Employees in high-tech industry have to keep up with the trend, self-reflection, self-fulfillment, accumulating new energy, and stressing on organizational learning and knowledge sharing to present endless innovation and appear creative behaviors.
- III. The innovative education courses in high-tech industry could be vivid. Corporate culture is not learned, but acquired through "realization". To have employees consciously reflect and maintain the systems and innovation culture of the enterprise, employees' realization is necessary. Various innovative education approaches, including lecturing, case study, team participation, and games, could be applied and arranged according to the contents and subjects. For instance, lecturing might be suitable for the inheritance from high-level supervisors to employees; games could be used for the contact with new staff or the re-training of employees in order to induce the passion and agreement; and, cast study is suitable for employees proceeding in-depth exploration of innovation so as to cohere consensus.

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