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# Interaction between the Sustainable Innovation Capability on Patent Based On Entrepreneurial Culture: Empirical Research from China

Aimin QI<sup>1</sup>

## Abstract

Currently the rapid growth of global economy has the competition among high-tech industries develop from regional to global, and the competition becomes fierce. In face of such fierce competition in global high-tech industry, it is realized that tangible assets could no longer be the differentiation basis, but intangible assets are regarded as the differentiation capital. An enterprise with sustainable innovation would dominate the world market and enhance the international competitiveness of domestic economy. When internal entrepreneurial culture is prevalent, an enterprise would naturally promote the innovation capability. Such a point of view also explains more popular of the innovative products or services of some enterprises than those with larger scales. Aiming at employees in high-tech industry in Guanxi Province, total 500 copies of questionnaire are randomly distributed, and 337 valid copies are retrieved, with the retrieval rate 67%. The research results reveal significantly positive correlations between 1.entrepreneurial culture and sustainable innovation capability, 2.sustainable innovation capability and patent, and 3.entrepreneurial culture and patent. According to the results, suggestions are proposed, expecting to explain how a high-tech business outperforms in the changeable digital era and acquires the sustainable innovation capability and patent to grasp the opportunity.

*Keywords:* entrepreneurial culture, persistence, innovation capability, patent, high-tech industry, social change, development.

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## Introduction

In face of the environment with economic globalization and rapid knowledge development in the 21<sup>st</sup> century, the delivery of information is accelerated due to network technology, and the acquisition of message becomes easier. The past obstacles caused by space and geography have been eliminated. The competition among high-tech industries develops from regional to global, and the competition becomes fiercer. Especially, when information could be rapidly acquired, the technology and knowledge possessed by a high-tech business would no longer be the exclusive advantage. Under currently rapid growth of global economy, high-tech businesses in science and technology parks are increasing the demands for information electronics because of PC, mobile phones, digital cameras, and digital TV. Nonetheless, in face of the globally fierce competition in high-tech industry, the past differentiation bases of quality, cost, economic planning, customer services, and mass advertising, under the spread of best practice, are gradually imitated by other competitors. It is realized that tangible assets are no longer the differentiation basis, while intangible assets are considered as the differentiation capital for high-tech businesses.

Sustainable innovation is a critical key in the increasing profits of an enterprise. It might integrate some old markets to create new opportunities, destroy existing markets, assist enterprises in acquiring the leading status in the market, and overthrow the original market leaders. An enterprise with sustainable innovation could dominate the world market and enhance the international competitiveness of domestic economy. For this reason, sustainable innovation could enhance markets, the success of an enterprise, and the economic growth of a nation. Accordingly, business managers and governments in the world are aware of the importance of sustainable innovation. When internal entrepreneurial culture is prevalent in an enterprise, the innovation capability would be naturally enhanced. Such a point of view also explains why some enterprises are more popular with the innovative products or services than others with larger scales. Based on the viewpoint of entrepreneurial culture, the correlation between sustainable innovation capability and patent is studied, expecting to explain how a high-tech business outperforms in the changeable digital era and grasps opportunities by the acquisition of sustainable innovation capability and patent.

## Literature review

### *Entrepreneurial culture*

Qiu & Wan (2015) pointed out culture as the common recognition and common core attitudes and measures of members in a nation or an enterprise. Most researchers considered that culture was reflected on common cognition and standard operation programs. Foss & Saebi (2017) stated that culture was the unique product of human beings, was developed slowly and implicitly, and was not easily defined and transmitted to another nation or enterprise. Maisonobe et al. (2016) pointed out various dimensions of culture, some of which could enhance or inhibit the innovation capability of an enterprise. Culture which encouraged continuous innovation could assist an enterprise in maintaining the leading advantage in innovation. Kim & Park (2017) contained three attitudes and three measures in corporate culture and sustainable innovation. Schumpeter (2017) mentioned that benefits generated from existing products or services were the key factors in the sustainable innovation of an enterprise. The willingness of resource allocation referred to the consideration of sacrificing the assets which could currently generate profits, including current revenues and successfully innovated products, so that the enterprise could acquire the opportunities in the next-generation innovation to further acquire large success. Bonakdar et al. (2017) indicated that future market orientation allowed an enterprise comprehending the limit and restriction of current technologies and considered that the new-generation technology could be the mainstream in the future market. Current profits could guarantee the future development, while future profits presented uncertain risks, which could not be predicted and managed. It was extremely important for an enterprise cultivating and promoting the employees with risk tolerance attitudes and capabilities.

Referring to Zhang & Tang (2017) entrepreneurial culture is divided into three dimensions in this study: (1) *Resource allocation*: In consideration of sacrificing assets which could currently generate profits, including current revenues and successfully innovated products, so that the enterprise could acquire the opportunity in the next-generation innovation; (2) *Market orientation*: Comprehending the limit and restriction of current technologies and considering that the new-generation technology could be the mainstream in the future market; (3) *Risk tolerance*: An enterprise cultivating and promoting the employees with risk tolerance attitudes and capabilities.

### *Sustainable innovation capability*

Kim & Lee (2015) pointed out the source of innovation from the development and extension of existing knowledge and proposed several definitions that it could promote and improve existing products and services for either new products or services. Innovation therefore could appear on products, programs,

or organizational activities. Dimitratos et al. (2016) indicated that employees were the source of an enterprise's innovation capability, which was transferrable knowledge to generate new knowledge and further develop new products and services or improve existing products and services (Piening et al., 2016). Klamer (2016) proposed that sustainable innovation capability was a primary key allowing an enterprise or a nation possessing high competitiveness internationally. Any enterprises would encounter important strategy selection that the improvement or reinforcement of existing capabilities could acquire short-term success, while the investment in sustainable innovation capability could benefit the long-term development of an enterprise (Gloet & Samson, 2016).

Referring to Lee & Lee (2017), sustainable innovation capability contains two dimensions in this study: (1) *Technological innovation*: The improvement of existing products, services, and programs, which could result in better performance than past production and service processes, or promote brand-new products and services to satisfy customer needs; (2) *Product innovation*: An enterprise reinforcing the research & development and design abilities, promoting the product quality, developing new products or services conforming to the market demand, and evaluating the goal achievement of the sales amount and customer satisfaction of new products or services.

### *Patent*

Sheng & Chien (2015) explained that, in order to protect the deserved rights of an invention or a creation, it was applied for patent in local intellectual property protection agencies. After being examined the conformity to the patent act, it would be approved the patent and the owner was authorized the right to exclude others manufacturing, selling, offering for sales, using, or importing the article without the agreement. McCahery et al. (2016) described utility patent as the owner had the exclusive right to exclude others applying the utility, selling, offering for sales, or importing the utility without the agreement. Duane & Fisher (2016) explained patent as the government sector authorized the inventor exclusive rights for producing, selling, or using the invention in certain periods. Patent contained invention, utility model, and appearance design. Kocak et al. (2017) indicated that a patent owner enjoyed the exclusive rights for producing, using, selling, and importing the invention and creation. He & Wintoki (2016) also mentioned that any units or individuals could not produce, manufacture for business, use, sell, and import patent products without the agreement of the patent owner; it would infringe the patent to use the patent of utility or produce, manufacture for business, use, sell, and import products directly acquired with the utility without the permission of the patent owner.

Referring to Li et al. (2017), patent covers three invention, utility, and design in this study: (1) *Invention patent*: referring to an invention regulated in the patent act must present the technology and at least satisfy the utilization of natural rules

and techniques to perform on the object or usage; (2) *Utility patent*: It could define that utility is the technical ideas generated with natural rules to perform on the shape, structure, or device of objects for innovation, and to generate certain new function or enhance effectiveness; (3) *Design patent*: It could define design as to promote the quality, friendliness, and high value with the shape, pattern, color, or the combines of objects to enhance the product competitiveness and the visual comfort on the use.

### *Research hypothesis*

Wani & Ali (2015) regarded corporate knowledge existing in human capitals and defined it as individual knowledge, skills, and experiences of employees; business managers displayed the value in the enterprise by setting objectives to form the corporate culture and the strategic direction to influence employees' application of the human capital. Höflinger et al. (2018) pointed out the success factors in entrepreneurial culture as exploring new knowledge and applying existing knowledge. A manager being willing to undertake the risk of using existing products and technologies for developing new markets or customers might generate limited new knowledge, but could deepen employees' existing knowledge and skills and have the employees understand the gap of existing knowledge and skills to pursue new knowledge and skills. McKelvey & Ljungberg (2017) indicated that, when an enterprise turned to new and different technologies, businesses, and products/services and the manager were willing to allocate resources to establish a lab or a research team and encourage the engagement of employees, the employees would acquire new knowledge and enhance opportunities to identify the abilities and apply the knowledge and skills to the enterprise to further enhance the human capital of the enterprise. For this reason, the following hypothesis is proposed in this study.

*H1: Entrepreneurial culture presents significantly positive correlations with sustainable innovation capability.*

Zhao et al. [23] proved that sustainable innovation capability would result in patent for a company, and patent would bring in excess market remuneration. Jeong et al. (2016) considered that sustainable innovation capability, in which many enterprises invested, could enhance the number of patents as the representative of the technological power of a company. The empirical results showed the remarkably positive correlations between sustainable innovation capability and number of patents. Paruchuri & Awate (2017) indicated that some companies invested large amount of money in sustainable innovation activities, i.e. high sustainable innovation capability, to have the companies acquire profitable new products or patents. In this case, sustainable innovation capability increased with the number of patents. The following hypothesis is therefore proposed in this study.

*H2: Sustainable innovation capability shows remarkably positive correlations with patent.*

Sumo et al. (2016) mentioned that, in the environment with entrepreneurial culture, the willingness of resource allocation allowed a company easily being a project organization, without the structure being easily rigid, and easily enhancing the internal competition and encouragement. New knowledge acquired through exploration, such as contact with heterogeneous markets/customers or technologies, could improve or reset the experience accumulated and opportunity identified in the routine knowledge to promote the patent of the enterprise. Kim (2016) considered that entrepreneurial culture with higher risk tolerance could better learn from mistakes in the exploration of new knowledge and structure experiences in databases, manuals, or processes to revise existing structured knowledge; besides, it was regarded as the accumulation of patents and the symbol of advance. Pauli (2016) indicated that entrepreneurial culture preferred resource allocation to have the organization present flexibility and cross-department integration ability to rapidly respond to external environmental changes for integrating or eliminating existing knowledge in the organization, creating new knowledge conforming to contemporary environment, and effectively enhancing the patent. Consequently, the following hypothesis is proposed in this study.

*H3: Entrepreneurial culture reveals notably positive correlations with patent.*

## Methodology

### *Method and model*

The goodness-of-fit test in LISREL model is generally measured from overall model fit (i.e. external quality of model) and internal quality of model. In regard to overall model fit test, the common goodness-of-fit evaluation indices contain (1) “ $\chi^2$  ratio” (Chi-Square ratio), standing for the difference between actual theoretical model and expected value, which is better below 3, (2) goodness of fit index (GFI) and adjusted goodness of fit index (AGFI), which show better goodness-of-fit when close to 1, (3) root mean square residual (RMR), reflecting the square root of “fit residual variance/covariance mean”, which is better below 0.05, and (4) incremental fit index (IFI), revealing excellent goodness-of-fit of the model when above 0.9.

The evaluation indicators for the internal quality of model in LISREL include (1) SMC (square multiple correlation) of individual manifest variables, i.e. R<sup>2</sup> of manifest variables and latent variables, which should be above 0.5, (2) component reliability ( $\rho$ ) of latent variable, as the Cronbach’s  $\alpha$  of the observation indicator of the latent variable, which should be above 0.6, and (3) average variance extracted

of latent variable, which is calculated by dividing the R2 sum of manifest variables in a latent variable with the number of manifest variables to reveal the percentage of the latent variable being measured with the manifest variables; the value is better above 0.5.

#### *Research sample and subject*

Employees in high-tech industry in Guanxi Province are randomly distributed 500 copies of questionnaire in this study. Total 337 valid copies are retrieved, with the retrieval rate 67%. The retrieved questionnaire data are analyzed with the statistics software.

#### *Reliability and validity test*

Validity refers to a measurement scale being able to actually measure what a researcher intends to measure. The common validity contains “content validity”, tending to qualitative test, “criterion validity”, using known external criteria and the correlation coefficient of the test for the evaluation, and “construct validity” used for evaluating the theoretical consistency of the measurement to other observable variables. The questionnaire content in this study is based on past theories and referred to the actual conditions of the research objects to design the measuring tool, which could truly express the essence of the affair and the complete representativeness, to ensure the content validity of the questionnaire. The final commonality estimate of factor analysis is applied to test the construct validity of the measurement items, and the validity appears in 0.8~0.9, showing good validity test result of the questionnaire.

## **Results**

#### *Model goodness-of-fit test*

“Maximum likelihood method” is applied in this study for the estimation. The analysis results achieve the convergence. Overall speaking, the overall model fit indices in this study pass the test, Table 1, fully reflecting favorable external quality of the model.



Table 1: Model analysis result

Overall goodness-of-fit	Evaluation indicator	Judgment standard	Result
	p -value	p -value above 0.05	0.000
	$\chi^2/d.f.$	< 3	1.833
	GFI	> 0.9	0.991
	AGFI	> 0.9	0.912
	CFI	> 0.9	0.975
	RMR	below 0.05, below 0.025 excellent	0.016
	RMSEA	0.05~0.08 good below 0.05 excellent	0.027
	NFI	> 0.9	0.946
	IFI	> 0.9	0.938

*Path relationship test*

In terms of the test of internal quality of model, the square multiple correlation (SMC) of manifest variables is above 0.5 (Table 2 & Table 3), revealing good indices of the latent variables. Furthermore, latent variables of entrepreneurial culture, sustainable innovation capability, and patent show the component reliability above 0.6, and the average variance extracted of the dimensions is also above 0.5 (Table 4), apparently conforming to the requirements for internal quality of model.

Table 2: SMC of variable to dimension

entrepreneurial culture		
resource allocation	market orientation	risk tolerance
0.73	0.78	0.82

Table 3: SMC of variable to dimension

sustainable innovation capability		patent		
technological innovation	product innovation	invention patent	utility patent	design patent
0.75	0.77	0.74	0.81	0.85

Table 4: Component reliability and average variance extracted of variable

item	entrepreneurial culture	sustainable innovation capability	patent
component reliability	0.833	0.851	0.876
average variance extracted	0.82	0.84	0.88

Theoretical model

The research results are shown in the following *Figure 1*. The path coefficients reaching the significance are shown with solid lines, while the ones not reaching the significance are shown with dotted lines in this study. It is obvious that all of the path coefficients achieve the convergent validity, conforming to the basic requirements for the model analysis. According to the goodness-of-fit indices, GFI=0.991, AGFI=0.912, RMSEA=0.027, and CFI=0.975, the model fit is verified, revealing the research model conforming to the theory and being valid.

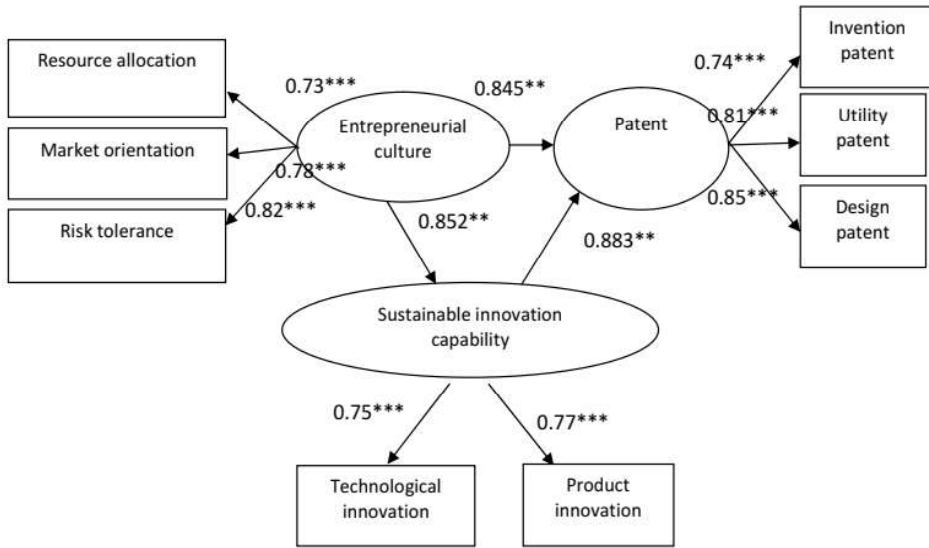


Figure 1: Relationship path diagram

From the model analysis result in *Table 5*, entrepreneurial culture and sustainable innovation capability (0.852) present positive and significant correlations, sustainable innovation capability and patent (0.883) show positive and remarkable correlations, and entrepreneurial culture and patent (0.845) appear positive and notable correlations that H1, H2, and H3 are supported. The research hypothesis test results of this study are shown in *Table 6*.

Table 5: Linear structural model analysis result

evaluation item	parameter/evaluation standards	result	t
internal goodness-of-fit	entrepreneurial culture→sustainable innovation capability	0.852	29.37**
	sustainable innovation capability→patent	0.883	35.49**
	entrepreneurial culture→patent	0.845	26.15**

Table 6: Hypothesis test

research hypothesis	correlation	empirical result	P	result
H1	+	0.852	0.00	supported
H2	+	0.883	0.00	supported
H3	+	0.845	0.00	supported

## Conclusion

The research results show that a high-tech business with entrepreneurial culture is willing to allocate resources, orient on future market, presents attitudes and measures with risk tolerance to affect the employees' value and consensus. Culture is the exclusive product of human beings and is slowly and implicitly developed, which is not easily defined and transmitted to another nation or enterprise. A high-tech business is mainly composed of and led by people; the construction of intelligent capital is the same. Corporate culture is implicit in all employees so that they are affected by specific value and consensus, when accumulating and applying knowledge. The acquisition of new knowledge would be distinct to create the sustainable innovation capability of the high-tech business. Apparently, the attitudes and measures covered in entrepreneurial culture would largely affect the organizational capital of a high-tech business to change the knowledge accumulation and application methods and processes, create the sustainable innovation capability, and further influence the patent.

## Suggestions

By summarizing the research results and findings, the following practical suggestions are proposed in this study.

1. A high-tech business should consider the real meanings behind sustainable innovation and precede strategic regulation. The future sustainable innovation could aim at multinational technology licensing and the establishment of technology transaction platforms. Besides, the cooperation with the governmental policies could activate the research and development outcomes and intelligent properties. The sustainable innovation and patent could be developed with network organization.
2. A high-tech business should reinforce the absorption ability of external knowledge and technology as well as cultivate the ability to identify and utilize external knowledge valuable for the organization, e.g. enhancing employees' abilities through internal education and training, selecting professional talents with rich experiences, knowledge, and techniques

when recruiting new members, and enhancing investment in research and development to enhance the effective acquisition of knowledge.

3. A high-tech business should develop the internal knowledge integration ability. Knowledge is power, particularly in the knowledge-based economic era. It relies on the establishment and promotion of entrepreneurial culture to enhance the knowledge saving and reinforce the competitive advantage of a high-tech business.

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