2016 International Conference on Management Science & Engineering (23rd)
August 18-20, 2016 Olten, Switzerland

Relationships between Organizational Innovation and Technological Innovation in High-end Equipment Manufacturing Enterprises

JIN Wei[1]，SHI Chun-sheng[1]，LIANG Min[2]
1 School of Management, Harbin Institute of Technology, P.R.China, 150001
2 School of Management, Qiqihar University, P.R.China, 161006

Abstract: On the basis of the definition of the high-end equipment manufacturing enterprise, propose the theoretical model of in-period and cross-period relationships between organizational innovation and technological innovation in these enterprises, apply the survey data of sample enterprises in two periods of 2007-2010 and 2011-2014, and use the least square regression to analyze and validate the model. The results show: the two types of innovation in high-end equipment manufacturing enterprises often influence each other in the given period, and organizational innovation promotes the adoption of technological innovation in the next period, but not vice versa. The research results provide some references for enterprises to attach great importance to organizational innovation, to coordinate relationships between two types of innovation, and to reasonably adopt relevant innovative strategies in practice.

Keywords: Cross-period relationship, High-end equipment manufacturing enterprise, In-period relationship, Organizational innovation, Technological innovation

1 Introduction

The high-end equipment manufacturing industry is the national strategic emerging industry, the key link of the equipment manufacturing industry, and the engine to promote the intelligence, precision and green development of the manufacturing industry. Fostering and developing the high-end equipment manufacturing industry has the important strategic significance to promote the core competitiveness of the manufacturing industry and accelerate the transformation into the manufacturing powerhouse in China.

From the perspective of socio-technical system, the high-end equipment manufacturing enterprise is composed of the technical system and the social system[1-2]. Technological innovation that occurs in the technical system, is that the enterprise adopts a new product or service idea, or introduces new elements in the production process or service providing process[3]. And organizational innovation that occurs in the social system, is that the enterprise adopts a new management and working concept or behavior in the strategy, the structure, the system or the culture[4]. Although enterprises that carry out technological innovation activities are not always successful, those do not attach importance to technological innovation may harm their long-term developments[5].The importance of technological innovation and its positive effect on the performance have been widely recognized. But the innovation of the high-end equipment manufacturing enterprise involves multiple aspects and levels. Those only rely on technological innovation are difficult to fully enhance their abilities, because they need organizational innovation to support and coordinate with technological innovation. In order to maintain the balance between the social system and technical system and ensure the enterprise to operate effectively, it is important that innovations introduced to the two systems should be consistent, but the consistency of organizational innovation and technological innovation is not simply a one-to-one relationship[6].

Therefore, this study researches on in-period and cross-period relationships between organizational innovation and technological innovation in the evolution process of the high-end equipment manufacturing enterprise, and provides some references for managers to take into account the adoptions of two types of innovation, and to promote social and technical systems to achieve the joint optimization and the performance improvement.

2 Definition of high-end equipment manufacturing enterprise

The high-end equipment manufacturing industry refers the equipment manufacturing sector that provides the high technology and high added value equipment to the transformation and upgrade of the traditional industry and the development of the strategic emerging industry. The high-end of high-end equipment manufacturing

Supported by the National Natural Science Foundation of China (71272176)

enterprises is mainly manifested in the following five aspects.

2.1 Technology intensive

The technology dependence of high-end equipment manufacturing enterprises is far more than other equipment manufacturing enterprises. Their high-end equipment products contain the cutting-edge technologies, which are the integrated carrier of the industrial technology, the information technology and a variety of the emerging technologies in the foreland of science and technology at this stage. And the production process of high-end equipment manufacturing enterprises also includes the most advanced production equipments, the most precision production process and the complex operation process.

2.2 Knowledge intensive

The high-end equipment manufacturing enterprise has the more complete knowledge system, which includes the knowledge of the high-end equipment product itself and the knowledge of the product production, which integrate the multi-disciplinary and multi-field science and technology knowledge. The knowledge system also includes all kinds of knowledge about the technology introduction, application, improvement and promotion.

2.3 Capital intensive

The high-end equipment needs the considerable capital investments in the pre research, the development, the proto sample, the sample and the production stages, especially the scale of investment in the civil space, the large aircraft and so on are frequently in million units. The talent capital of the high-end equipment manufacturing enterprise is also intensive. The technical and management personnel with the high knowledge level and work abilities account for a larger proportion, and even the operating personnel also have very high knowledge level and work skills.

2.4 High relevance

High-end equipments, especially large-scale high-end equipments, are composed of many parts. A large number of components form singles, subsystems, subsystems, and ultimately constitute the overall equipment. Therefore, based on certain high-end equipment, the closely related and interdependent cooperation network will form between high-end equipment manufacturing enterprises. In order to realize the development target of the overall equipment, the relationship between high-end equipment manufacturing enterprises is not simply the undertaking relationship, but the formation of locking effect and the strong relevance relationship.

2.5 High driving power

High-end equipment manufacturing enterprises are in the core link of the industrial chain, and their technologies radiate and overflow the upstream and downstream enterprises. They can promote the development of related and supporting industries, and their development level determines the overall competitiveness of the industry chain. And due to the strong intrinsic relevance of the equipment manufacturing technologies, the manufacturing technology of high-end equipment can also be widely extended to other equipment manufacturing enterprises. The development of manufacturing technology of high-end equipment is important for the breakthrough of key technologies in the whole industry, and may promote the leap forward technology development in the equipment manufacturing industry.

3 Theoretical model

Based on the organizational characteristics discussed above, the high-end equipment manufacturing enterprise tends to devote more resources to the technical system. Technological innovation can enable the enterprise to maintain the vigor and vitality, promote the continuous improvement of the organizational performance, and ultimately help enterprises gain the unparalleled competitive advantage[7-8]. The more valuable and more rare technological innovation is, the higher organizational performance will be[9]. But only innovating in the technical system is not enough, the social system should also be changed accordingly[10]. The enterprise that can successfully carry out technological innovation should both have the high technology ability and the high management ability[11].

After the introduction of technological innovation, the high-end equipment manufacturing enterprise usually carries out complementary organizational innovation activities, such as the adjustment or redesign of the organizational system, structure, process and other aspects, to ensure the smooth implementation of technological innovation and promote the performance improvement. For example, in order to meet the increasing demand for high-end products and the decreasing demand of low-end products, Qiqihar Heavy CNC equipment Limited by Share Ltd has promoted the technological level of the high-end products through the technology introduction, the independent innovation and the cooperative innovation since 2010. To ensure the smooth implementation of technological innovation, the company implemented the target cost control systems to decrease the design and manufacturing costs, and continued to implement the excellent projects to achieve the leap of the product quality.

The innovation in the social system may also cause the corresponding innovation in the technical system[12-13]. In order to introduce technological innovation successfully, the high-end equipment manufacturing enterprise may adopt innovations in the organizational strategy, structure, system and procedure to form the internal social environment and the organizational foundation, which promote the generation

of technological innovation. For example, during the '12th Five-Year' period, aerospace equipment manufacturing enterprises have set up research institutes in different technology fields to break through the key technical bottlenecks. The organizational structure, the development procedure and the personnel management of these institutes have the obvious differences with the original institutions. These organizational innovations give the personnel the greater development autonomy, promote their work enthusiasm, and are conducive to the generation of new key technologies.

However organizational innovation of the high-end equipment manufacturing enterprise does not only depend on technological innovation, the group, political and social factors in the sub-environment of the social system will also lead to the change of management abilities. These organizational innovations are likely to cause the changes inside the technical system, promote the correction of the technical system, and affect the adoption of new products (new service) or new process technology[14-15]. For example, after the merger with China General Technology (Group) Holding Company limited, Qiqihar Number Two Machine Tool (Group) Company limited adjusted and restructured the organizational structure, management systems, business processes and other aspects, and formed nine production departments and subsidiary, the function management department and technology research and development center. These organizational innovations had laid the foundation for technological innovations in the high-end heavy computerized numerical control machine tool products.

The degree of the sub-environment uncertainty of the technical system of the high-end equipment manufacturing enterprise is higher than that in the sub-environment of the social system, so in response to changes in the environment, the enterprise carries out more and more technological innovations in order to provide more advanced equipments to the market. Therefore the adoption rate of technological innovation is usually higher than the adoption rate of organizational innovation[16]. The implementation of technological innovation has the stronger trial and error and the higher visual degree of the results[17]. Organizational innovation usually needs to reconfigure tasks, rights and so on[18], so it has the wider influence scope inside the enterprise than technological innovation, and its diffusion is slower and more random[19-20]. So the implementation rate of the new technology is faster than that of the new management idea in the high-end equipment manufacturing enterprise. Because of the differences in the adoption frequency and the adoption speed, technological innovation has the immediate effect on organizational innovation, and organizational innovation is more easier to initiate technological innovation in the subsequent period[21].

Based on the previous analysis, the theoretical model of relationships between technological innovation and organizational innovation of the high-end equipment manufacturing enterprise is shown in Fig. 1.

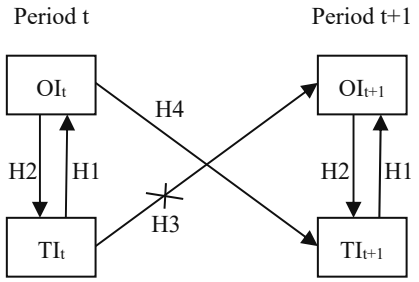

Fig.1 Theoretical model of relationships between technological innovation and organizational innovation

On the one hand, the in-period relationships between technological innovation and organizational innovation are that in order to maintain the balance between the social system and the technical system and improve the performance, innovations in one system usually affect those in the other system. On the other hand, the cross-period relationships between technological innovation and organizational innovation are that innovations in the social system promote the innovation introduction in the technical system in the next period, and the effect of technological innovation on the innovation introduction of the social system in the next period is not significant. Therefore, we propose the following hypotheses.

H1: TI_t will positively influence OI_t.

H2: OI_t will positively influence TI_t.

H3: TI_t will not significantly influence OI_{t+1}.

H4: OI_t will positively influence TI_{t+1}.

4 Research design

4.1 Variable measure

According to the previous definitions of organizational innovation(OI) and technological innovation(TI), this study adopts four elements of the culture innovation(CI), the strategy innovation(STI), the structure innovation(SI) and the system innovation(SYI) to measure organizational innovation of the high-end equipment manufacturing enterprise, and two elements of the product innovation(PTI) and the process innovation(PSI) to measure technological innovation. On the basis of analyzing and screening the frequently used and mature items[22-25], we interview 16 top managers who work in high-end equipment manufacturing enterprises, to deliberate, revise and determine the questionnaire items. The questionnaire contains 19 items to measure organizational innovation, and 9 items to measure technological innovation, as shown in Tab. 1.

Tab.1 Items of questionnaire

Variable	Element	Item
OI	STI	According to changes in the environment, the enterprise adjusts the core business, product or service (X_{11})
		The enterprise improves the importance of the innovation in the development of the strategy (X_{12})
		The enterprise enhances the extent of the attention to changes in the competition and the market demand (X_{13})
		The enterprise has a more clear understanding of the internal resources and capabilities (X_{14})
		The enterprise enhances the ability to develop and revise the term medium and the long term strategies (X_{15})
	SI	The enterprise reduces the management levels between senior managers and workers (X_{21})
		The enterprise streamlines or adds the department (X_{22})
		The enterprise improves the communication speed and efficiency among different departments (X_{23})
		The personnel's autonomy and decision-making scope in various departments have been expanded (X_{24})
		The enterprise improves the communication speed and efficiency between the management levels (X_{25})
	CI	The enterprise has a clear vision of CI and the corresponding objectives (X_{31})
		The enterprise strengthens the cultivation of the employee's innovation spirit (X_{32})
		The enterprise improves the tolerance of the innovation risk and failure (X_{33})
		The enterprise increases the intensity to create a strong learning atmosphere (X_{34})
		The enterprise strengthens the cultivation of the team cooperation spirit (X_{35})
	SYI	The enterprise develops or improves the quality system (X_{41})
		The enterprise develops or improves the management system that motivate the personnel to innovate (X_{42})
		The enterprise develops or improves the system related to the intellectual property management(X_{43})
		According to the need of innovation activities, the enterprise revises or adds management systems (X_{44})
TI	PSI	The enterprise introduces advanced production equipments (Y_{11})
		The enterprise improves the existing product process or operation process (Y_{12})
		The enterprise improves the work standards or production methods (Y_{13})
		The enterprise develops a new technology for the product process or operation process (Y_{14})
	PTI	The enterprise develops a new product (service) accepted by the market (Y_{21})
		The enterprise improves the technology of existing products (services) (Y_{22})
		The product (service) research and development cycle of the enterprise has been shortened (Y_{23})
		The enterprise increases the proportion that research and development expenditures account for sales (Y_{24})
		The number of proprietary technologies and patents of the enterprise have increased (Y_{25})

4.2 Sample data acquisition

The questionnaire survey method is used to collect data, and we issue questionnaires by e-mail and paper mail. The sample data come from the high-end equipment manufacturing industry, including the aviation equipment manufacturing industry, the aerospace equipment manufacturing industry, the advanced rail transportation equipment manufacturing industry, the marine engineering equipment manufacturing industry and the intelligent manufacturing equipment industry. The survey areas of the questionnaire are limited to Beijing, Tianjin, Shanghai, Heilongjiang Province, Jilin Province, Liaoning Province, Shandong Province, and Zhejiang Province. The questionnaire includes two parts: the first part is the basic information of the enterprise, and the second part is the measure scale of organizational innovation and technological innovation. In order to research on relationships between organizational innovation and technological innovation over time, it is very important to determine the periods of innovation adoption, so we select two time periods, which are 2007-2010 and 2011-2014, to investigate organizational innovation and technological innovation in high-end equipment manufacturing enterprises. The two periods are long enough that enterprises have implemented most innovations listed in the questionnaire. Organizational innovation needs the relatively long time to create internal organizational conditions to induce technological innovation[26-27], and this feature of organizational innovation could be reflected in the two selective periods. Every item in the questionnaire is measured by the Likert five-point scale method(1-5 point). The survey objects are senior managers or middle managers who have been worked in the research and development department, the production department, the marketing department or other departments since 2007. A total of 572 questionnaires are issued in this study. Finally, a total of 449 questionnaires are recovered, of which 356 are valid, and the effective recovery rate is 62.2%. The samples of sub-industries are shown in Tab. 2.

Tab.2 Samples of sub-industries

Sub-industry	Recovered questionnaire	Effective questionnaire
Aviation equipment	90	72
Aerospace equipment	93	78
Advanced rail transportation equipment	86	65
Marine engineering equipment	79	61
Intelligent manufacturing equipment	101	80
total	449	356

4.3 Reliability and validity of questionnaire

We use SPSS 22.0 to check the reliability and the validity of the questionnaire. The Cronbach's α coefficients of element levels are all above 0.7, and the Cronbach's α coefficient of the whole questionnaire is 0.866. So the questionnaire has the good reliability. Items of the questionnaire are all from mature items of previous studies, and individual items are revised

through interviewing the senior managers and the middle managers of high-end equipment manufacturing enterprises, so the questionnaire has the good content validity. We test the construct validity of the questionnaire using the factor analysis method. The KMO value of the questionnaire is 0.795, and the initial eigenvalues of six factors are greater than 1. These factors are named as STI, SI, CI, SYI, PSI and PTI, and the factor loading value of every item is more than 0.6 (as shown in Tab. 3). Therefore, the questionnaire has the good construct validity.

Tab.3 Factor analysis of questionnaire

Item	STI	SI	CI	SYI	PSI	PTI
X_{14}	0.795	0.129	0.017	0.157	-0.050	0.083
X_{11}	0.745	0.121	0.031	0.053	0.156	0.255
X_{13}	0.724	0.026	0.047	0.160	0.178	0.146
X_{15}	0.695	0.082	0.069	0.105	0.196	0.236
X_{12}	0.678	0.045	0.165	0.052	0.047	0.259
X_{21}	0.018	0.805	0.023	0.070	0.071	0.015
X_{24}	0.019	0.737	0.125	0.021	0.101	0.151
X_{22}	0.102	0.711	0.031	0.239	0.027	0.056
X_{25}	0.004	0.682	0.117	-0.049	0.190	0.055
X_{23}	0.132	0.656	0.026	0.052	0.118	0.158
X_{35}	0.083	0.152	0.770	0.016	0.050	0.080
X_{34}	0.016	0.094	0.709	0.023	0.105	0.252
X_{33}	0.058	0.068	0.699	0.152	0.121	0.148
X_{31}	0.056	0.070	0.676	0.116	0.003	0.064
X_{32}	0.032	0.007	0.643	-0.025	0.110	0.145
X_{44}	0.068	0.027	0.073	0.769	0.129	0.225
X_{41}	0.010	0.117	0.083	0.737	0.297	0.019
X_{43}	0.065	-0.001	0.062	0.692	0.017	0.178
X_{42}	0.040	0.069	0.019	0.660	0.045	0.159
Y_{14}	0.151	0.077	0.024	0.121	0.770	0.186
Y_{13}	0.032	0.067	0.071	0.058	0.722	0.120
Y_{12}	0.070	0.033	0.084	0.196	0.687	0.227
Y_{11}	0.085	0.192	0.057	0.110	0.641	0.180
Y_{21}	0.116	0.020	0.072	0.091	0.274	0.819
Y_{22}	0.019	0.080	0.042	0.120	0.161	0.735
Y_{24}	0.104	0.058	0.012	0.027	0.138	0.714
Y_{25}	0.089	0.003	0.015	0.064	0.113	0.683
Y_{23}	0.049	0.020	0.052	0.097	0.117	0.631

5 Results

According to the variation coefficient method, we normalize the factor loading value of each item, and get the weights of the subordinate indicators to their superior elements. Let α_{mi} be the weight that is the normalization of the standardized factor loading value η_{mi} of item X_{mi} of organizational innovation, and let β_{nj} be the weight that is the normalization of the standardized factor loading value θ_{nj} of item Y_{nj} of technological innovation, as shown in (1) and (2).

$$\alpha_{mi} = \frac{\eta_{mi}}{\sum_{i=1}^{k} \eta_{mi}} \tag{1}$$

$$\beta_{nj} = \frac{\theta_{nj}}{\sum_{j=1}^{r} \theta_{nj}} \tag{2}$$

Among them, n and m are respectively the numbers of the elements of organizational innovation and technological innovation, and i and j are respectively the numbers of the indicators of different elements of organizational innovation and technological innovation.

According to (1) and (2), the weights of different elements of organizational innovation and technological innovation can be calculated respectively, and the measure formulas of different elements of the two types of innovation are shown as follows.

$$STI = \sum_{i=1}^{5} \alpha_{1i} \cdot X_{1i} = 0.205X_{11} + 0.186X_{12} + 0.199X_{13} + 0.219X_{14} + 0.191X_{15} \tag{3}$$

$$SI = \sum_{i=1}^{5} \alpha_{2i} \cdot X_{2i} = 0.224X_{21} + 0.198X_{22} + 0.183X_{23} + 0.205X_{24} + 0.190X_{25} \tag{4}$$

$$CI = \sum_{i=1}^{5} \alpha_{3i} \cdot X_{3i} = 0.193X_{31} + 0.184X_{32} + 0.200X_{33} + 0.203X_{34} + 0.220X_{35} \tag{5}$$

$$SYI = \sum_{i=1}^{5} \alpha_{4i} \cdot X_{4i} = 0.258X_{41} + 0.231X_{42} + 0.242X_{43} + 0.269X_{44} \tag{6}$$

$$PSI = \sum_{j=1}^{4} \beta_{1j} \cdot X_{1j} = 0.227Y_{11} + 0.244Y_{12} + 0.256Y_{13} + 0.273Y_{14} \tag{7}$$

$$PTI = \sum_{j=1}^{5} \beta_{2j} \cdot X_{2j} = 0.229Y_{21} + 0.205Y_{22} + 0.176Y_{23} + 0.199Y_{24} + 0.191Y_{25} \tag{8}$$

We apply the calculation results of (3), (4), (5), (6), (7) and (8), and use Amos 21.0 to carry out the confirmatory factor analysis to verify the relationships between the variables and their elements. All the standardized factor loading values of the elements to their variables are greater than 0.6, as shown in Tab. 4. All the standardized factor loadings are significant at the 0.05 level.

According to the variation coefficient method, the weights of the elements to their variables are calculated, and the state measure formulas of the two types of innovation are obtained as follows.

$$OI = \alpha_1 \cdot STI + \alpha_2 \cdot SI + \alpha_3 \cdot CI + \alpha_4 \cdot SYI = 0.283STI + 0.258SI + 0.240CI + 0.219SY \tag{9}$$

$$TI = \beta_1 \cdot PSI + \beta_2 \cdot PTI = 0.461PSI + 0.539PTI \tag{10}$$

Tab.4 Confirmatory factor analysis of each dimension

Path	Standardized factor loading
STI←OI	0.905
SI←OI	0.883
CI←OI	0.845
SYI←OI	0.894
PSI←TI	0.891
PTI←TI	0.907

We apply (9) and (10) to respectively calculate the state values of organizational innovation and technological innovation of per sample in two time periods of 2007-2010 and 2011-2014, and use SPSS 22.0 to carry out the variable descriptive statistical analysis, as shown in Tab. 5.

Tab.5 Descriptive statistical analysis

Sample	N	Variable	Max	Min	Mean
2007-2010	356	OI_1	4.49	1.86	3.69
		TI_1	5	2.71	4.02
2011-2014	356	OI_2	4.68	1.88	3.88
		TI_2	5	3.05	4.37

The results in Tab. 5 show that in the two time periods of 2007-2010 and 2011-2014, the means of organizational innovation are less than those of technological innovation, which indicates that the high-end equipment manufacturing enterprise in China pays more attention to technological innovation activities, and the level of technological innovation is higher than that of organizational innovation. This is related to the organizational characteristics, such as technology intensive. The comparisons between means of organizational innovation and technological innovation in different time periods find that the tendencies of the two types of innovation in the high-end equipment manufacturing enterprise are both progressively increasing, which is closely related to vigorous supports of the government to the high-end equipment manufacturing enterprise and the changes in the market environment.

We adopt the least square regression method and use SPSS 22.0 to calculate the influence coefficients between OI_1 and TI_1 in 2007-2010, between OI_2 and TI_2 in 2011-2014, between OI_1 and TI_2, and between TI_1 and OI_2, as shown in Fig. 2. Within the two time periods, the influence coefficients between organizational innovation and technological innovation are positive and significant at the 0.05 level, and the influence coefficients of technological innovation on organizational innovation are both greater than those of organizational innovation on technological innovation. Those indicate that within a certain period of time, the two types of innovation of the high-end equipment manufacturing enterprise are interrelated, but technological innovation is easier to cause organizational innovation in line with its development. Therefore, H1 and H2 have been verified. Across the two time periods, the influence coefficient of TI_1 on OI_2 is not significant at the 0.05 level. That indicates technological innovation in one period is not obvious to cause the related adoption of organizational innovation in the next period. Therefore, H3 has been verified. And the influence coefficient of OI_1 on TI_2 is positive and significant at the 0.05 level, which indicates organizational innovation in one period promotes the related adoption of technological innovation in the following period, and organizational innovation can lay the foundation for future technological innovation activities. Therefore, H4 has been verified.

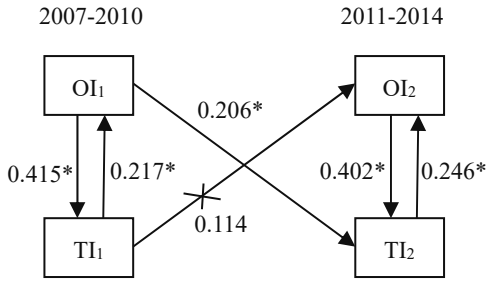

Fig.2 Influence coefficients between organizational innovation and technological innovation

6 Conclusion

H1 and H2 in this study are the in-period hypotheses, which verify the positive effects between two types of innovation of the high-end equipment manufacturing enterprise in a specific period. H3 and H4 are the cross-period hypotheses. They compare two types of innovation between two periods of 2007-2010 and 2011-2014, and verify the cross-period relationships between organizational innovation and technological innovation. In the period t, the more adoptions of organizational innovation in the high-end equipment manufacturing enterprise may increase the introductions of technological innovation in the subsequent period t+1, and in the period t, the improvement of the level of technological innovation may not possibly increase the adoption of organizational innovation in the subsequent period t+1. Therefore, the high-end equipment manufacturing enterprise should pay attention to the adoption of organizational innovation in the enterprise's development journey. In order to ensure the internal consistency of two types of innovation and promote the optimization and upgrading of the socio-technical system, the high-end equipment manufacturing enterprise needs to keep the adoptions of technological innovation and organizational innovation in balance within one period of time, and should introduce the reasonable organizational innovation activities and implement them effectively to promote the better sustainable development of technological innovation. But the cross-period relationships between technological innovation and organizational innovation in this study are associated with the specific organization characteristics and the differences in adoption rates of technological innovation and organizational innovation of the high-end equipment manufacturing enterprise, so in other types of organizations, H3 and H4 may be opposite. The future studies can further research on the complex relationships between organizational innovation and technological innovation in other types of organizations.

References

[1]E. Trist. The evolution of socio-technical systems: a conceptual framework and an action research program[M]. Toronto: Ontario Quality of Working Life

Centre, 1981.
[2]A. Smith, A. Stirling, F. Berkhout. The governance of sustainable socio-technical transitions[J]. Research Policy, 2005, 34: 1491-1510.
[3]W. W. Liu, R. Sun. Research on coupling degree measurement between knowledge innovation and technological innovation of high-end equipment manufacturing enterprises[J]. Science of Science and Management of S. & T., 2014, 35(7): 16-22. (in Chinese)
[4]F. Damanpour. Organizational innovation: a meta-analysis of effects of determinants and moderators[J]. Academy of Management Journal, 1991, 34(3): 555-590.
[5]C. Camisón, A. V. López. Organizational innovation as an enabler of technological innovation capabilities and firm performance[J]. Journal of Business Research, 2014, 67(1): 2891-2902.
[6]F. Damanpour, D. Aravind. Managerial innovation: conceptions, processes, and antecedents[J]. Management and Organization Review, 2012, 8(2): 423-454.
[7]R. C. M. Yam, W. Lo, E. P. Y. Tang, A. K. W. Lau. Analysis of sources of innovation, technological innovation capabilities, and performance: An empirical study of Hong Kong manufacturing industries[J]. Research Policy, 2011, 40(3): 391-402.
[8]P. D. Collins, J. Hage, F. M. Hull. Organizational and technological predictors of change in automaticity[J]. The Academy of Management Journal, 1988, 31(3): 512-543.
[9]A. A. Marcus. Policy uncertainty and technological innovation[J]. Academy of Management Review, 1981, 6(3): 443-448.
[10]J. Markard, B. Truffer. Technological innovation systems and the multi-level perspective: towards an integrated framework[J]. Research Policy, 2008, 37: 596-615.
[11]F. Damanpour. Footnotes to research on management innovation[J]. Organization Studies, 2014, 35(9): 1265-1285.
[12]A. K. Neyer, A. C. Bullinger, K. M. Moeslein. Integrating inside and outside innovators: a socio-technical systems perspective[J]. R&D Management, 2009, 39(4): 410-419.
[13]J. Nill, R. Kemp. Phases of the adoption of innovation in organizations: effects of environment, organization and top managers[J]. British Journal of Management, 2006, 17: 215-236.
[14]A. H. Van Der Zwaan. The socio-technical systems approach: a critical evaluation[J]. International Journal of Production Research, 2007, 13(2): 149-163.
[15]S. K. Piderit. Rethinking resistance and recognizing ambivalence: a multidimensional view of attitudes toward an organizational change[J]. Academy of Management Review, 2000, 25(4): 783-794.
[16]F. Damanpour. Technical versus administrative rates of organizational innovation: a study of ‘organizational lag’[D]. University of Pennsylvania, Pennsylvania, USA, 1983.
[17]Y. J. Yuan, C. J. Lv. A study of the evolutionary path of technological innovation modes in the equipment manufacturing industry of China[J]. Journal of Technology Management in China, 2011, 6(3): 257-266.
[18]F. Damanpour, R. M. Walker, C. N. Avellaneda. Combinative effects of innovation types and organizational performance: a longitudinal study of service organizations[J]. Journal of Management Studies, 2009, 46(4): 650-675.
[19]R. Evangelist, A. Vezzani. The economic impact of technological and organizational innovations: a firm-level analysis[J]. Research Policy, 2010, 39: 1253-1263.
[20]S. M. Lee, D. L. Olson, S. Trimi. The impact of convergence on organizational innovation[J]. Organizational Dynamics, 2010, 39(3): 218-225.
[21]F. Damanpour, K. A. Szabat, W. M. Evan. The relationship between types of innovation and organizational performance[J]. Journal of Management Studies, 1989, 26(6): 587-601.
[22]K. Jaskyte. Predictors of administrative and technological innovations in nonprofit organizations[J]. Public Administration Review, 2011, 71(1): 77-86.
[23]A. Ganter, A. Hecker. Configurational paths to organizational innovation: qualitative comparative analyses of antecedents and contingencies [J]. Journal of Business Research，2014，67(6): 1285-1292.
[24]M. M. Crossan, M. Apaydin. A multi-dimensional framework of organizational innovation: a systematic review of the literature[J]. Journal of Management Studies, 2010, 47(6): 1154-1191.
[25]M. L. Zhang, C. S. Shi, Y. Q. Jia. An empirical research on the matching relationships between OI and TI of enterprises indifferent life cycle stages[J]. R&D Management, 2015, 27(2): 77-88. (in Chinese)
[26]J. Birkinshaw, G. Hamel, M. J. Mol. Management innovation[J]. Academy of Management Review, 2008, 33(4): 825-845.
[27]P. R. Monge, M. D. Cozzens, N. S. Contractor. Communication and motivational predictors of the dynamics of organizational innovation[J]. Organization Science, 1992, 3(2): 250-274.