

Ershi Qi
Jiang Shen
Runliang Dou *Editors*

The 19th International Conference on Industrial Engineering and Engineering Management

Management System Innovation

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Ershi Qi · Jiang Shen · Runliang Dou
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Contents

1	Research on Self-Organization Evolution Mechanism of Knowledge Capital in High-Tech Virtual Industry Cluster . . .	1
	Chang-yuan Gao and Xiao-yan He	
2	A Fuzzy Multi-Attribute Decision-Making Method for Partner Selection of Cooperation Innovation Alliance	9
	Dan Li	
3	A Priority Analysis Algorithm for Technology Innovation Risks of Research Solutions for Complex Project	19
	Ning-sheng Guo and Xiansheng Qin	
4	A Study on Assessment of Human Nature Needs in Human Resource Management	25
	Qiong Zhang, Xiao-mei Wang and Wei-xun Hu	
5	An Analysis of the Factors Influencing the Enterprise’s Cooperation and Innovation Risks in Western Minority Regions of China: Based on a Sample of 100 Enterprises in Minority Autonomous Areas of Gansu Province	31
	Ji-yuan Liu and Ping Zhang	
6	An Empirical Analysis on the Influence of Household Consumption on Economic Growth in Hubei Province	41
	Xi-xiang Sun and Ling-li Deng	
7	Analysis of Competency Elements Based on Grey Cluster	53
	Hao-jie Liu, Yan Xu, Jia-hai Yuan and Min-peng Xiong	
8	Analysis on the Technological Innovation Mechanism of Regional Equipment Manufacturing Industry Cluster	61
	Liang-qun Qi, Cheng-dong Wang and Li-li Lu	

9	Analyzing International Scientific Collaboration in Materials Science Through Co-authorship	73
	Dan Xiang	
10	Assessment Study of Power Enterprise Soft Power Based on Fuzzy-ANP	85
	Dong-xiao Niu, Lin Zhu and Dai Mu	
11	Competency Evaluation Engineering of R&D Personnel based on Rough Set	91
	Xiao-feng Liu, Yan Xu, Jia-hai Yuan and Chang-hong Zhao	
12	Demonstration Analysis on Effectiveness of Coal Resource Integration in Shanxi Province	99
	Lei Tong, Xue Peng and Xu-lu Zhang	
13	Empirical Analysis About the Promotion Effect of Financial Intermediation on Science & Technological Innovation	107
	Wei Wei	
14	Gas Expansion and Development of Compressed and Cryogenic Technology Support	115
	Rui-yuan Xu, Hong-fa Shi, Zi-lin Sun and Jun Xie	
15	Industry Technology Road-Mapping Research Based on XRWS System Approach	123
	Rui Tong and Congdong Li	
16	Institutional Development and Controlling Shareholder's Expropriation: Evidence from China	131
	Wen-gui Li	
17	Inward FDI's Impact on the Environment and the Countermeasures in Jiangsu	141
	Hong-bing You	
18	IT-Enabled Enterprise Agility Based on Process Flexibility and Knowledge Sharing	151
	Zhu-qing Yang, Hong Ling and Cheng Zhang	
19	Modeling and Simulation of the Inter-Organizational Knowledge Transfer Impact Factors in Industrial Clusters	161
	Ji Xiong, Zhao Duan and Yang Wang	

20	Optimal Subsidy for Abatement R&D in Different Organizations with Emissions Tax	173
	Wei-jun Meng and Bin-yu He	
21	Performance of the Product Innovation Team and Organizational Structure Characteristics from the Perspective of Cross-Level Research	181
	Xu-gao Qi, Er-shi Qi and Liang Liu	
22	Research on Enterprises' Innovation Performance in University-Industry-Government Networks Based on Absorptive Capacity	191
	Yang Wang, Zhao Duan and Ji Xiong	
23	Research on Problem and Strategy for Chinese Engineering Practice Education	205
	Shi-ying Liu, Jun-li Liu, Wei Zhang and Chao-yi Chen	
24	Research on Restraining Obstacles of Technical Knowledge Diffusing and Sharing in High-Tech Enterprises: Based on Analyzing Level Variables and Rate Variables Fundamental In-Tree Modeling of System Dynamics	213
	Hua Chen, Lei Zhou, Deng-ke Yu and Qin Zhu	
25	Research on the Effect of Knowledge Search on Product Innovation	225
	Peng-hu Lu	
26	Research on the Performance Evaluation of Enterprise Knowledge Management Within Clusters Based on BSC	235
	Guang-ling Li and Yu Liu	
27	Research on the Relationship Between the Energy Resource Endowment and Industrial Structure Based on PVAR Model	245
	Hai-bing Wu, Yan-qiong Zhou and Xin-xin Wang	
28	Strategic Choices of Development of China International Education in the Early Twenty-First Century	259
	Jia-fu Cheng, Shu-fang Hou and Song-lin Chen	
29	Supervisory Game Between Sci-Tech Bank and VC Firm	271
	Xing-guo Gong and Yu-hong Chen	

30	Technical Innovations and Demand–Supply Models of the Taiwanese Tea Industry After Joining WTO	281
	Tain-fung Wu and Chih-lan Kao	
31	Technological Leapfrogging Ability Study and Policy Suggestion for Strategic New Industries.	293
	Jie Liu and Li-ping Fu	
32	Technology Imports, R&D Investment and Technical Efficiency of Chinese High-Tech Industry	303
	Feng Peng and Ling Li	
33	The Contribution of VTE to Labor Force Transfer in Rural Area of China.	309
	Jing Song and Tong Zhou	
34	The Design of Master of Engineering’s Dynamic Training Mode and Management Informatization System	317
	Wei-tao Liu, Yun-juan Liu and Jian-jun Shen	
35	The Incentive Model of People-Oriented Innovative Organization: Based on Dill’s Comprehensive Incentive Theory.	327
	Yi Liu and Heng-ying Li	
36	The Option-Pricing Model of Wind Power Investment Projects Included Value-Leaking Losses	335
	Hao Lu and Peng Cheng	
37	The Research of Key Factors in Higher Agricultural Education Resource Management	343
	Li Zhang, Jia-song Ren, Hong-yan Xie and Ze-guo Qiu	
38	The Research on Expansibility of IE Tradition to Social Sciences	353
	Ya-qiang Zhang	
39	The Research on Knowledge Spillover of Industry-University-Research Institute Collaboration Innovation Network	361
	Li-ping Fu, Xiao-ming Zhou and Yue-feng Luo	
40	Review of Culture Industry Agglomeration on the Influencing Factors, Characteristics and Empirical Researches	373
	Li-ping Fu, Yong-jun He and Jun-hui Li	

41	The Recognition and Optimization of the Critical Chain	385
	Huan-pei Wang, Bing-nan Liu and Xiao-feng Dong	
42	Using the Network Link Data to Analyze the Status of Cloud Computing	393
	Lu-Cheng Huang and Bo Jiang	
43	XBRL and Corporate Governance	403
	Kao-hua Yao, Si-pei Xiao and Jing-jing Li	
44	Independent Innovation and Equity Finance: Empirical Analysis on Small and Medium-Sized Enterprises	413
	Wei Wei	
45	A Explanatory Model of Public Acceptance for Nuclear Power Technology: From Low-Carbon Perspective	423
	Yuan-hua Yang, Li Li and Guo-hua Niu	
46	Study on the Innovative Characteristics of Systematic Evolution of Creative Industrial District	433
	Yan-fei Xiao, Jia-hua Zhao and Shuang-hong Liao	
47	Coordinated Development of Independent Innovation and Transformation of Economic Mode.	441
	Hui He	
48	Exploration and Practice on Innovative Education of Sino-Australian Cooperation	449
	Jian-zhong Lou and Jian-ping Li	
49	Path Choice of Constructing a Scientific and Technological Innovation System in Universities	457
	Jin-ping Wang and Lian-sheng Yang	
50	Large-Scale Collaboration Network Structure and Firm Innovation: An Empirical Research.	467
	Yan Zhao and Xiang-jie Zheng	
51	The Operation Mechanism of Open Innovation Community Network: A System Dynamics Model.	475
	En-jun Xia, Ming Zhang and Huai-jia Zhu	

52	The Different Impact of Innovative Human Capital and R&D Subsidy on the Technological Progress: An Empirical Study Based on Zhejiang	487
	Yi-bing Tang, Li-jun Meng and Cheng-xia Hu	
53	An Incentive Mechanism for Knowledge Sharing in Research Team	495
	Huo-di Zhu, Yan Liu and Bu-yu Xu	
54	Knowledge Structure Research on Achievement Transformation in Scientific and Technical Research Talented Person	507
	Qi Suo	
55	An Analysis of Employee Turnover Based on Behavioral Economics	515
	Ke-da Gao	
56	Empirical Research on the Influence Factors of Knowledge Absorptive Capacity of High-Tech SME	523
	Mei-ying Yang, Yu-ning Zheng and Li-wen Peng	
57	Enterprises' Social Capital and the Economic Performance of Local Government Funded Science and Technology Projects: An Empirical Research	533
	Tian-qi Li, Guo-qing Huo and Xiao-dong Zhang	
58	Status and Prospect on Converging Technology: Technology Management Perspective.	545
	Hong Miao, Li-fang Qin and Lu-cheng Huang	
59	A Model of Product Development Team Knowledge Creation from a Behavioral Perspective.	553
	Xian-guo Zhang	
60	Influencing Factor Analysis of College Students' Learning Interest in Specialized Courses by Rough Set Theory.	561
	Wen-zhun Huang, Ying Wang and Zheng-guang Zhou	
61	Reflections on the Team-Building of High-Level Talent in Shandong Characteristic Industry Town	569
	De-liang Zhang	

62 Study on the Model of Coal Industry Cycle Economic Development and Evaluation System 583
 Bo Wang, Wei Jiang, Ji-hui Zhang and Cheng-xia Wu

63 Analysis of Technological Innovation Capability of Equipment Manufacturing Industry in the Early Days of the Development Drive of Western China 591
 Yang Yang, De-gang Yi and Chang-hui Xu

64 Analysis on the System Dynamics for Formation Mechanism of Independent Innovation Capability in Large-Scale Projects 601
 Min Li, Jin Zhou and Jun Gao

65 The Preliminary Research of Stock Option Incentive and Good Power Price to Senior Executives of the Listed Companies in China 611
 Hao Zhou

66 A Review on User Innovation Virtual Community and Suggestions for Future Research. 623
 Da-liang Zhang and Yuan-yi Zhang

67 Research on the Popularization and Application of the TRIZ Theory in Shanxi Province 631
 Jing-wen An and Xiao-chuan Wang

68 Study on the Performance Indicator Weights of Higher Agricultural Education Resources Anagement Based on the Triangular Fuzzy Function. 641
 Li Zhang, Yan-li Zhao and Liu-cheng Zhang

69 Research on Sustainable Develop of Chinese Family Enterprise Based on Independent Innovation Ability 651
 Yu-chun Sun, Xiu-ming Sun and Wen-zhuo Wang

70 Organizational Advantage, Social Capital and Organizational Learning 659
 Yi Dong

71 Inbound and Outbound Open Innovation in Clusters. 667
 Yin-jie Xu and Jian-zhuang Zheng

72	Knowledge Supply Chain and Enterprise Innovation Capacity . . . Ying-chun Song	677
73	Absorptive Capacity and Enterprise Modular Reconstruction—Perspectives Based on Open Innovation Ying-chun Song	687
74	Research on the Reverse Knowledge Transfer Mechanism Through the Overseas M&A of China’s Companies: Based on the BSC Ideology Yuan Wang and Xiao Zhao	695
75	The Application of MBTI Theory in Hiring Sales Staffs Chang Luo	703
76	The Effect of Innovation Environment on the Equipment Manufacturing Industry in China Xu-sheng Chen, Hong-qi Wang and Yu Gu	711
77	A Study on Cluster Brand Growth Based on Five Forces Su-ping Zhou	721
78	Reflections on the Team-Building of Science and Technology Innovative Talent in Shandong Characteristic Industry Town . . . De-liang Zhang	733
79	Review on Affective Commitment of Manager Feng-lian Li	743
80	Innovations of Human Resource Management in New Knowledge Economy Times Jing-yi Sun	753
81	Who is the Best Connected Researcher? An Analysis of Co-Authorship Networks of Knowledge Management from 2000 to 2010 Mei-yun Zuo, Xiao-qing Hua and Xiao-wei Wen	761
82	Study on the Standardization of Knowledge Management Facing the Open Innovation Yang Ping	771

83	Study of Knowledge Diffusion FSAI Model for High-Tech SMES Clusters	783
	Su-ping Zhou	
84	Research on the Difficulties and Development Strategy for the Construction of Innovative Enterprises.	795
	Xin Zhu and Ying Li	
85	Construction of Organization Coordination Network of Major Scientific and Technological Projects.	807
	Xin-wen He, Ye Wang and Guang-ming Hou	
86	Research on Factors Composition Model of Independent Innovation Capability for High-Tech Enterprises Based on Factor Analysis	817
	Xiang-dong Li, Shu-qiang Wang, Ling Ma, Shu-cheng Luo and Shuo Wang	
87	Research on Data Filtering Technology Based on the RFID Middleware in the Internet of Things	829
	Kun Huang, Bing-wu Liu and Jun-tao Li	
88	The Application of Panel Data Mining Based on Gene Schema in Predicting Finance Distress	837
	Feng-ning Ma, Ji-ting Yang, Shi-qiang Jiang and Qin-yu Ren	
89	Capacity Planning with Cooperative Resources	845
	Shuai Li, Zhi-cong Zhang, Shao-yong Zhao and Kai-shun Hu	
90	A Study of the Application Scope of Valuation Principles of Project Variation	855
	Ying Li, Ling-jie Han and Xiao-dong Zhang	
91	Study on Process Reengineering of Coal Mine Ventilation Area	863
	Jing-wen An, Zhi-qiang Zhang and Xiao-chuan Wang	
92	Study on the Estimation of Coal Washing and Processing Charges	873
	Qing-he Yuan, Zong-qing Cui and Chao Liu	
93	College Moral Education Decision System Designing Based on Web Mining	885
	Ying Xi	

94 KPI-Based Private Enterprise Staff Performance Index Design. 893
Ya-dong Wang and Yu-ling Hao

95 Measuring the Sharing Effect of Tacit Knowledge Based on Structural Holes Theory: Case Study on a Military Enterprise 903
Li-ping Shi, Shu-lin Tang, Qiang Liu and Jing-ting Yuan

96 Research on Countermeasures of Henan Province Agricultural Products Quality Standard System in the Past Five Years 913
Ying Shi

97 Research on the Effect of Leader Evaluation on the Employee Knowledge Sharing: The Moderating Effect of Process Oriented. 923
Li-ling Cai and Gong-min Bao

98 Analysis on Pricing of Vegetables in Supermarkets Based on Consumer Surplus 933
Yuan-yuan Yu and Li-wei Bao

99 CAVE Based Visual System Design and Implementation in Marine Engine Room Simulation. 939
Hong Zeng, Jun-dong Zhang, Wen-long Yao and Xiao-jun Zhang

100 Countermeasure Research on Strengthening the Tax Administration of Network Trade 949
Wen-yi Dong and Yang-fan Zhang

101 Developing a New Foot Shape and Size System for Taiwanese Females 959
Yu-Chi Lee, Wen-Yu Chao and Mao-Jiun Wang

102 Exploring User Experience Measurement of Location-Based Service Applications 969
Jun Zhuo, Danyang Huang and Ying Chen

103 In Virtual Community: Fostering the Members Participation. . . 979
Juan Luo

104 Model Research of Multi-Objective and Resource-Constrained Project Scheduling Problem 991
 Rong Zhou, Chun-ming Ye and Hui-min Ma

105 On Pareto Optimal Criterion for Long-Term Economic Growth. 1003
 Jin-she He

106 Political Connection of State-Owned Enterprises: An Analysis Based on the Listed Companies of Shanghai and Shenzhen Stock Markets 1009
 Jing Liu

107 Power Balance of Equity and Corporate Performance 1019
 Jian Su and Xiaoming Ji

108 Research on Current Situation Analysis and Solving Strategies of Large Inflows and Large Outflows of Telecom Customers. . . 1025
 Yang Gao and Qun Yuan

109 Research on Risk Assessment of the Equipment Maintenance Contractor Support 1035
 Hua Yang, Chao-jun Ji and Qiao-yun Wu

110 Research on the Informatization Mode of Solid Waste Outsourcing in the Eco-Industrial Park. 1047
 Jian Li, Jiao-jiao Yin and Ying-chun Wang

111 Research on the Selection of Project Management Mode for Non-Business Urban Infrastructure Construction 1055
 Xin Sun and Hong Ke

112 Study on the Dynamic Game Problem of Indemnificatory Apartment Construction Based on System Dynamics 1065
 Yong Li, Ge Huang, Ya-qin Qu and Hui Xiong

113 The Design and Implementation of Petrochemical Enterprise’s Safety Management Informatization System Based on WEB. . . 1077
 Yun-juan Liu, Wei-tao Liu and Jian-jun Shen

114 The Relationship Studies of Commercial Banks Customer Service Systems Customer Perceived Value, Customer Satisfaction and Customer Loyalty 1087
 Ting Lei and Cunlin Li

115 Time Series Data Modeling and Application 1095
 He Gao, Xiao-li Cai and Yu Fei

**116 Trilateral Game-Based Research on Low-Carbon Logistics
 Development Mode 1103**
 Feng-hua Gao and Rui-hua Gao

**117 Reform and Innovation of Development of Enterprise
 Electronic Commerce in Management 1111**
 Yan Li

**118 The Effect of Brand Image on Online Service Failure:
 Basing on Mainland China Online Retailing 1121**
 Jun-feng Liao and Lin-lin Zhong

**119 The Study of Knowledge Management in Chinese Enterprises
 Overseas M&As 1131**
 Jia-kang Wang, Xue-meng Guo and Hong-chang Li

**120 The Study on Innovative Talents Training Model Based
 on the Tacit Knowledge 1143**
 Xue-fei Zhang, Hong-na Tian and Rong-lin Wang

**121 Sports Marketing is a Weapon to Strengthen the Brand
 Value for Modern Enterprise 1149**
 Peng-hui Liu and Li Gao

**122 A Solution Procedure for the Capacitated Vehicle Routing
 Problem with Three-Dimensional Loading Constraints
 in Online Supermarket Delivery 1159**
 Min-fang Huang and Yuan-kai Zhang

**123 A TOPSIS Method Based on Triangle Fuzzy Number
 for Trust Evaluation in E-Commerce System 1167**
 Dan Li

**124 Cold-Start Collaborative Filtering Based on User Registration
 Process 1175**
 Peng-yu Zhu and Zhong Yao

**125 Design and Implementation of Distribution Management
 System Based on the Ceramics E-Business Platform 1187**
 Fu-bao He, Yi-lai Zhang and Hua Huang

126 The Impacts of Virtual Community’s Online Word-of-Mouth on Consumer’s Intention 1195
 Yi-ling Zhang

127 A Study on the Adoption Factors of Cell Phone Video Call Technology 1201
 Bo Zhang and Hao Jin

128 The Research on Scheduling Model of Online Service in Electronic Commerce: Perspective of the Service Profit Chain 1213
 Mi-yuan Shan, Xue-lin Zhou and Ren-long Zhang

129 A Study of the Network Externality Effects on the Online Group Buying 1225
 Zhenli Bi and Bin Shi

130 Data Mining Techniques Applied in the Financial Industry . . . 1237
 Liang Huo, Tao Wang and Liu Yang

131 Evaluation of Hospital Competitiveness in Jiangxi Province Based on the Cluster Analysis 1245
 LiQing Li and Lei Xia

132 Study on BPR of Small to Medium Enterprise Based on E-Commerce 1251
 Rong-fu Zhou

133 Research on Relationship Between Academic Achievement and Efficiency Consciousness of IE Students Based on SPSS. . . 1259
 Jin-yuan Zhong, Kai-hu Hou, Xiao-li Zhu, Cai-xia Zhang and Li-hua Chen

134 Application Research of Modified K-Means Clustering Algorithm 1269
 Guo-li Liu, You-qian Tan, Li-meì Yu, Jia Liu and Jin-qiao Gao

135 College Admission Mode of Multiple Choices Based on Internet 1281
 Zhao-tong Wu, Li-ping Fu and Rui-xue Zhao

136 Application of Weighted Fuzzy Clustering Method to Supplier Selection Under E-Business 1293
Yan Yang, Wei-ping Yang and Yao Liang

137 Magazine Design Based on the Characteristics of Image Transmission in the Information Era. 1301
Kun-peng Jiang and Zhong-yang Li

138 Research on Application Integration Solutions of Enterprise Information System Based on Web Services. 1309
Yan-hui Hou, Min Hao, Wei Wang, Hong-tao Yue and Yong-jun Ding

139 The Design and Application of the Framework of Coal Mine Comprehensive Information System Based on 3DGIS . . . 1319
Bin Wen, Rui-xin Zhang, Chong-de Lin, Ming-liang Wang and Quan-guang Ba

140 Analysis of Problems on Network Education Resources Construction. 1329
Yong Zhang

141 Discussions on the Curriculum Integration of Architectural Technology and Design 1337
Jin Zhang

142 Teaching Practice for Resource-Based Collaborative Learning in Information Technology Environment 1345
Xiao-qin Zhang

143 Dimension of Information Attainment of Senior Manager Under the Background of Fusion of Informatization and Industrialization. 1353
Xue-fei Chang and Yu-fang Chao

144 A Study of the Upgrading Paths of Industrial Clusters from the Global Value Chains Perspective. 1363
Wen-yan Lai

145 Analysis on the Effect of the National Essential Medicine System in Rural Township Health Clinics: Based on the Survey Data from Rugao City in Jiangsu Province 1373
Ming-fang Wang

146 Cloud Platform Framework of Lifetime Cycle Assessment for Engineering Materials 1381
 Li-jun Zhang, Wei-dong Zhang, Xin Aixinjueluo, Peng Shi and Yi-bo Ai

147 Decisive Factors Influencing Establishment of Long-Term Mechanism of College-Enterprise Cooperation and Corresponding Counter-Measures. 1391
 Shui-gen Zhu

148 The Regional Emerging Strategic Marine Industries Evaluation: A Case of Tianjin Binhai New Area 1403
 Jian Li and Ying Wang

149 Study on the Relationship Between Familiness and Performace of Family Business. 1409
 Yan-shuang Li and Yong Wang

150 Advisers Troop Construction in Working-Practice in Collaboration Education Between Universities and Enterprises 1417
 Peng-hui Zhang, Hua-li Yu, Juan Wang and Xiao-shun Zhao

151 Study on Using Public–Private Partnerships to Develop Management and Recycling of Demolition Waste. 1425
 Gang Chao, Deng-yue Li and Mei-hua Qiu

152 Research and Exploration of International Industrial Engineering-Oriented Talents Cultivation Mode 1435
 Guang Cheng, Xiu-fang Sun and Ai-ping Yang

153 An Empirical Study on the Relationships Between Entrepreneur and SMEs’ Vitality 1443
 Feng-hai Zhang, Xiao-wei Ma, Wei-hua Yang and Yue-kui Xu

154 Public–Private Partnership: The New Phenomenon 1453
 Sonali Chakravarti Banerjee and Arundhati Bhattacharyya

155 Efficiency Evaluation of Industry-University-Research Institute Collaboration: A Case Study of Suzhou 1463
 Meng Dai, Chi Wang, Xiao-ran Hu and Chengyang Xie

156	Research on Benefit Distribution Model of Industry Technology Alliance	1471
	Bin Dai	
157	Industry Standard Modular Innovation Trap: Causes and Avoiding Strategies	1479
	Jun Liang	
158	Effect of Foreign Direct Investment on Industrial Innovation: An Empirical Research on the Equipment Manufacturing Industry in China	1487
	Xu-sheng Chen, Hong-qi Wang and Yun Zhong	
159	Over-Education, Knowledge Unemployment and Economic Growth	1497
	Jun Liang, Yang Zhou and Jiao Cai	
160	The Advantage of Using the Electric Vehicles	1507
	Yue-ying Yang, Di Liu, Jun Meng, Xu Li, Ting-ting Shang and Jian-xin Hu	
161	Multi-Objective Production Planning Considering Partner Selection for Networked Manufacturing	1519
	Zhi-xiang Chen and Li Li	
162	Employee Assistance Program: A New Means of China Enterprise Management of Innovation	1529
	She-hong Liang, Lin Wang, Kan Shi and Peng Gao	
163	The Development Countermeasures Research of China's High-End Equipment Manufacturing Industry	1537
	Gui-bin Men, Yan Li and Yi-xiu Liu	
164	Service-Oriented Manufacturing and the Servicizing Transformation of Chinese Manufacturing Industry	1547
	Jun Liang and Ting-ting Huang	
165	The Upgrading Resistance and Countermeasures of Chinese Manufacturing Industry Foundry Mode	1557
	Ying-chun Song	

166 Analysis on Innovative Factors of Influencing Medium and Small Sized Enterprises for Mining Equipment Manufactures 1567
 Tong-hua Mou, Chi-dan Ni and Fang Du

167 Resolving Complex Management Problems on the Basis of TOC Thinking Process and TRIZ Innovation 1581
 Sheng-long Jin

168 Geographical Distribution of FDI-Based Innovation Activities in China: The Innovation Issues 1589
 Hong-ru Wu

169 Innovative Roles of Brand Community Members: A Typology Based on Cluster Analysis 1597
 Xiao-chuan Wang

170 Organizational Innovative Climate, Innovative Behavior and the Mediating Role of Psychological Capital: The Case of Creative Talents 1607
 Li-wei He

171 Research on Collaborative Innovation Mechanism of SMEs 1617
 Qiu-ming Yang

172 Research on the Relationship Between Enterprise Innovation and the Formation of Core Competitiveness 1625
 Zhu Xin

173 An Application of Patent Strategy in Medium-Small Enterprises Product Innovation Process 1633
 Jiang-tao Zhan and Jia Yan

174 The Empirical Study on Influencing Mechanism of Firm’s Entrepreneurial Behavior in Manufacturing Clusters 1641
 Zheng Ye and Ning Cai

175 The Research on Enterprises Organizational Innovation Path Factors Impact on the Organizational Innovation Decision-Making 1649
 Peng Wang and Chun-sheng Shi

**176 Theoretical Perspective in Innovation Management
Implementation: A Literature Review 1657**
Ming-zhu Zhu

**Erratum to: Research on Factors Composition Model
of Independent Innovation Capability for High-Tech Enterprises
Based on Factor Analysis. E1**
Xiang-dong Li, Shu-qiang Wang, Ling Ma,
Shu-cheng Luo and Shuo Wang

Chapter 1

Research on Self-Organization Evolution Mechanism of Knowledge Capital in High-Tech Virtual Industry Cluster

Chang-yuan Gao and Xiao-yan He

Abstract The main purpose of this paper is to find a way to develop high-tech virtual industry cluster (HTVIC). Considering HTVIC knowledge capital (HKC) as the order parameter, the paper establishes a self-organization model for HKC and analyzes its evolution rules based on potential function by self-organization theory. Lastly, the research draws a conclusion that HKC is a self-organization system and evolves from a disordered state to an ordered state, and even to a more orderly state to realize transition. Therefore, the institution regulation should be set up to reinforce the evolutionary order of HKC, so as to promote the development of HTVIC.

Keywords HKC · HTVIC · Potential function · Self-organization

1.1 Introduction

High-tech industry cluster which is often in the form of high-tech park in practice in China, has become an important factor to promote regional economic development. However, lack of contact and innovation (YuJiang 2008), lock-in effect (Wang and Yan 2009) and other issues have become obstacles for the further development. Virtual industry cluster (Molina and Ponguta 1997) is a cross-

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organizational form of cooperation which is proposed in recent years. Virtual means the clusters is no longer subject to geographical restrictions, that is to say, the members will compete and cooperate in the way of organization adjacency. Moreover, Intelligent Platform will be the main contact way instead of usual information technology and network. A recent study shows that it is beneficial to give full play to the advantages of industrial clusters by the way of virtual, and overcome the side effects caused by geographic concentration (Nicolai 1996). Therefore, the development of high-tech virtual industry cluster (HTVIC) can solve above-mentioned problems of high-tech industry cluster, and promote its sustained, healthy and rapid development.

HTVIC is a loose organization (Gao and Du 2010) for the purpose of providing high technology products and services, which is composed of high-tech enterprises, research institutes, intermediaries and government from different geographic regions. As knowledge capital has been the dominant factor to create value, the research on evolution mechanism of KC in HTVIC will contribute to capture the overall variation of HTVIC, and will have a great guiding significance for the theory and practice.

The present study rarely combines HTVIC with knowledge capital, existing research on Multi-agent knowledge capital is in two major ways: Anssi and Marja (2007), Pirjo (2008), Wang and Chen (2010) and Wang et al. (2009) study the subject from a regional perspective; Li (2011) from the angle of alliance. But current research mainly emphasizes the value contribution of knowledge capital to regional and union, ignoring the interaction of the Multi-agent knowledge capital.

Self-organization theory, particular Synergetics, reveals that how elements interact to form the order parameter, and then form ordered structure of system under certain external conditions. HTVIC is more a spontaneous formation of members to adapt to the external environment. In this process, a large of members interacts on each other to form goodwill, brand, the organizational system and other knowledge capital of cluster, and continuously implement value-creating function. Obviously, the appreciation of HTVIC knowledge capital (HKC) is the result from self-organization motion of the subsystem. The self-organization is the essential character, so the paper can preferably reveal the appreciation of HTVIC knowledge capital from the point of view of the interaction between multi-agent knowledge capitals with self-organization theory.

The paper, firstly, defines the concept of HKC, and then analyzes four-dimensional structure of it. Secondly, the paper elaborates the self-organization characteristics and establishes the self-organization equation. Thirdly, the ordered parameter is recognized, and the paper proclaims the self-organization evolution mechanism of HKC on the basis of potential function. The purpose of this paper is to grasp the evolution law of HKC on the whole, and through the realization of HKC appreciation to finally promote the development of HTVIC.

1.2 The Dimensional Structure of HKC

Knowledge capital is pointed out for the first time in 1969 by Galbraith. Later, some of scholars such as Stewart (1994), Edvinsson and Sullivan (1996), Sveiby (1997), Feng et al. (2006), Li (2011) did research on this.

HTVIC is a loose organization which means it is across the organization boundary, and it can be argued that HTVIC also has knowledge capital. There are two levers: cluster lever (HTVIC knowledge capital) and member lever(member knowledge capital). Members knowledge capital (MKC) is like enterprise knowledge capital, so this article does not make the research on it. HTVIC knowledge capital (HKC) is the general name of knowledge elements and ability which can create value for HTVIC, reflecting collective intelligence in the competition and cooperation of all the members, made up of three elements: HTVIC human capital, HTVIC organization capital and HTVIC relationship capital. That is to say, MKC interact with each other and assemble in the virtual space to form HKC.

HKC is the product of self-organization coming from the members' mutual collaboration in the form of elements. Meanwhile, it may possess overall capabilities that the members don't own to create value so that the value-creation by it is greater than total value-creation by members. From the view of the members, the dimensional structure of HKC can be expressed as:

HKC = F (high technology enterprise knowledge capital, research institutes knowledge capital, intermediaries knowledge capital, government knowledge capital).

F means the interaction between MKC and the centralization process, four dimensions means four kinds of member. In each dimension, human capital is the initiative of the value creation, while organization capital and relationship capital guarantee the role of human capital. The three key elements interact with each other to make each member has the following value-added function.

1.3 Self-Organization Model

The formation of HKC is the response of the members to external environment for the purpose of the increment in value. In the process, the interaction of MKC formed ordered structure, function and behavior, which is indeed a self-organized process, with dissipation structure characteristics.

Different MKC can be viewed as the subsystem, the interaction between subsystems can bring about the value-creation. S indicates the state variable HKC, E , R , I and A respectively indicates the state variables of each dimension. Using self organization Dynamics equations, the dimensional structure of HKC can be expressed as the following:

$$dS/dt = -kS + \beta(E, R, I, A) + G \quad (1.1)$$

Make random external force $G = g \cdot S$, g represents the control parameters to promote the evolution of the system, $-\beta S^3$ represents the interaction between subsystems (four dimensions), Eq. (1.1) can be written as:

$$dS/dt = (-k + g)S - \beta S^3 \quad (1.2)$$

Above equations show the evolution process of HKC with time. The original state k , random outside force g and the mutual relationship between subsystems are the key factors to the formation and evolution of HKC.

In self-organization theory, the potential function is used to study the structure, performance and evolution behavior of the system. If there is a function $V(x)$, when $V'(x) = -dx/dt$, $V(x)$ is the potential function of the dynamics equations (JianXiong and Wang 2008). Combined with (1.2), then

$$V'(S) = -dS/dt = -(-k + g)S + \beta S^3 \quad (1.3)$$

Integrating the Eq. (1.3) on both ends, we can get the following potential function.

$$V(S) = -(-k + g)\frac{1}{2}S^2 + \frac{\beta}{4}S^4 \quad (1.4)$$

Minimum value of $V(S)$ is the stability point, which shows the system is in stable state, including disorder and low-level order. Maximum of $V(S)$ is unstable state which forebodes new state, containing evolution and degradation.

1.4 Self-Organization Evolution Mechanism

1.4.1 The Order Parameter Characteristics of HKC

According to synergetics, the order parameter is the product of coordination and competition which measures the macro state of the system Cyrille and Gerard (2009). When HTVIC is not formed, the enterprise and relevant organizations in different regions will realize appreciation independently. At this time, HKC is equal to zero. After the HTVIC is formed, MKC cooperate with each other in the form of elements to shape HKC. Due to the influence of the external environment, the subsystems conduct the cooperative movement under the control of HKC for the aim of realizing the maximization of value-creation. That means the orderly structure is generated. HKC is a macro parameter to describe HTVIC, generating from scratch, and indicating the formation of new structures through Slaving Principle. So, it is in line with the order parameter characteristics, and HKC is indeed the order parameter. In synergetics, the order parameter determines the development direction of the system. When HKC is in the positive evolution direction, HTVIC will evolve. On the contrary, it will degenerate.

1.4.2 The Evolution Mechanism Based on Potential Function

According to the curve determined by Eq. (1.4), there are the following two kinds of situations in the evolution which are shown in Fig. 1.1:

When $(-k + g) < 0$, HKC is like a particle in curve I which always shocks near the stable point of the potential function. This shows that the potential energy is weak and the synergy between subsystems is poorer. So HKC does not perform the function of order parameter, and can't development the new structure.

When $(-k + g) > 0$, there appears two extreme value point of potential function as $V(S_1)$ and $V(S_2)$, and two energy valley in two sides of the balance point, such as the curve III. Under the random external force and synergistic effect of subsystems, the particle will appear on any extreme points at the same probability. This shows that there are two states to choose. At this time, the potential energy is stronger and the synergy between subsystems becomes more powerful. HKC play the role of order parameter to promote the system to new orderly structure, and in turn control the behavior of subsystems.

When $(-k + g)$ is from negative to positive, the curves of potential function experience the change of I -II -III, which explains the change of systems status. In critical condition, due to outside fluctuation force and synergistic effect, the state changes from curvet curve III, and the stable point changes from $(S_0, 0)$ into $(S_1, V(S_1))$ and $(S_2, V(S_2))$. That indicates there is more than one possible evolution state. When outside force or the size or rate of HKC is determined, only one way can be selected. Namely, symmetry is broken after non-equilibrium phase transition. That means the orderly structure of system is turned up.

The equilibrium position S can be described as function $(-k + g)$ as shown in Fig. 1.2. When $(-k + g) < 0$, there is a stable solution $(S_0, 0)$ which shows the

Fig. 1.1 Potential function curve

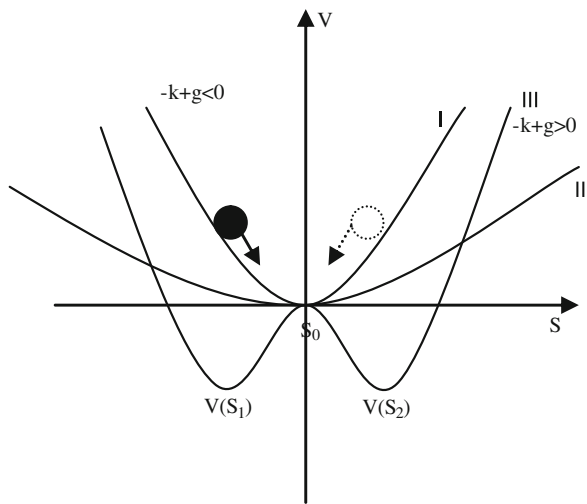
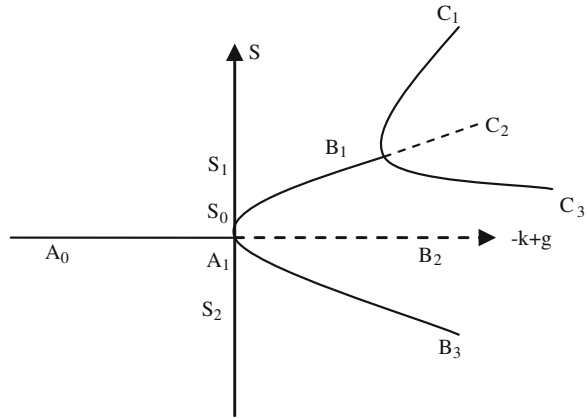


Fig. 1.2 $S \sim -k + g$ function



system is in a steady state; When $(-k + g) > 0$, the original stable solution change into $(S1, v(S1))$ and $(S2, v(S2))$, which says the bifurcate appears. $A1$ is bifurcation point, and $A0-A1$ is non-equilibrium linear regions. At this moment, the change trend of the system gets enhancement. $A1-B2$ means unstable nonlinear relationship which shows there are two evolution directions of the system, including $A1-B1$ branch and $A1-B3$ branch, determined by the change of the size or rate of HKC. When it is in any branch, due to another change of external environment or the size or the rate of HKC, new fluctuation and new bifurcation point turn up, which forms the leap development of the system.

1.5 Conclusion

HKC is the order parameter, the evolution of which determines the status of HTVIC system. So, it is necessary to start from HKC for the development of HTVIC. According to self-organization theory, taking HKC as a self-organization system, the paper establishes self-organization model to reveal the key effective factors on its evolution, and then reveals the transition evolution law that HKC evolves from disordered state to ordered state, and even to the further orderly state based on potential function.

Therefore, in practice, the external conditions should be constantly improved to make HTVIC to achieve critical state and produce order parameter (HKC). Simultaneously, the external institution regulation should be established to foster expected HKC. When HKC can control the independent movement of the sub-systems, under the guidance of HKC, HTVIC will achieve its orderly structure, namely the value-added. As HKC is formed upon self-organization motion, the external institution regulation should be in line with the evolution law rather than function as outside force, aiming to promote the rapid formation of HKC and better play the role of order parameter.

Meanwhile, because there are a variety of options for the evolution directions of HKC on request of different value added, the establishment of institution regulation can enhance HKC and push forward positive evolutionary order of HKC, which in order to promote the healthy development of the HTVIC. When the trend of degenerated order appears, we should take measures to prevent the emergence of the critical point to keep continuous development of HTVIC, or we should induce the emergence of new order parameter to drive the transition of the system. Inally, you are responsible for language as editors will not check it. Do a spell and grammar check. This is available in Word. If English is not your native language, get a professional proof-reader to help if possible.

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Chapter 2

A Fuzzy Multi-Attribute Decision-Making Method for Partner Selection of Cooperation Innovation Alliance

Dan Li

Abstract The technological cooperation activities among enterprises, universities and research institutes are considered be necessary for accessing complementary technological resources and improving the technology innovation capability. One of the important approaches to cooperation is constructing cooperation innovation alliance. But cooperation innovation alliances are risky. How to choose the right partners and improve the efficiency of cooperation innovation is the question many enterprises concerned with. So the decision-making model of partner selection in cooperation innovation alliance is proposed in this paper, and an index system is set up. It is a fuzzy multiple attribute decision-making problems. And then a fuzzy multiple index decision-making method basing on TOPSIS is proposed. Finally, an example is shown in detail.

Keywords Cooperation innovation · Multi-attribute decision making · Partners selection · TOPSIS · Triangular fuzzy number

2.1 Introduction

With the rapid development of information technology, enterprises need to improve the technology innovation capability and sustain knowledge competitive advantage. But it is difficult for an enterprise to master all of the knowledge required and to realize technological innovation independently because there is a lack of resources, technology, skills or finances. It leads enterprises to search

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