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Social network analysis based on collaborative innovation performance impact factors of assembled construction industrial park

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Abstract: *In order to improve the current situation that innovation in the construction industry is relatively lagging behind, this paper investigates the key influencing factors that affect the collaborative innovation performance of the assembly construction industrial park. Based on the research of previous literature, this paper sorts out the factors affecting the collaborative innovation among innovation subjects in the assembly construction industry, and lists the influencing factors affecting the innovation performance of the industrial park by combining the characteristics of the assembly construction industry, constructs a social network analysis model among the influencing factors through the obtained data, and finally analyzes them by UCINET 6.0 software. The research results show that six factors, namely innovation resource investment, willingness to cooperate, knowledge conversion rate, participants' ability and quality, standardization degree and alliance organization management, are the key factors influencing the collaborative innovation performance of the assembly construction industrial park.*

Keywords: *assembly building; collaborative innovation performance; social network analysis*

1. Introduction

The traditional on-site casting method will cause the problems of large construction waste emission, dust and noise pollution.[1] In order to solve these problems, respond to the call of green economy and realize the modernization of construction industry, the assembled building was born. By integrating the resources and knowledge of the whole industry chain, it can realize the production of energy-saving, environment-friendly and sustainable green buildings.[2] The modernization of the construction industry not only involves design enterprises, component manufacturers, transportation enterprises and construction enterprises in the industry chain, but also requires close contact with innovation subjects in the innovation chain such as universities and research institutes to realize the collaborative innovation between "industry, academia, research and application"[3]. The formation of assembled construction industrial park can make full use of industrial and innovation resources, and has a positive leading and promoting effect on the realization of construction industry modernization [4]. This paper analyzes the factors influencing the collaborative innovation performance of the assembly building industrial park through social network analysis, and provides guidance for the assembly building industrial park to improve its collaborative innovation capability.

2. Selection of factors influencing collaborative innovation in assembly building industrial park

The assembled building industrial park is a manifestation of the building modernization industry agglomeration. Since the building modernization industry alliance is an industrial innovation alliance that has emerged in recent years, there are still few studies on the influencing factors of collaborative innovation in building modernization industry alliance compared with other industry alliances. Ma Hui et al.[3] argue that the key influencing factors of collaborative innovation in construction industry alliances are innovation resource input, knowledge sharing, knowledge transfer, and trust degree, etc. Ma Zhiliang et al.[5] believe that the greening of the construction industry cannot be separated from intelligent construction, and that digitalization should be fully utilized to create a modern construction system for the construction industry. Liu Qian et al.[6] believe that the formation of digital production line will help to improve the level of refinement of the construction industry, and then promote the synergistic development of intelligent construction and greening of the construction industry. From the perspective of key customers, Weyi He et al.[7] found that the design side is the most influential and innovative key

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customer of green technology transformation enterprises, and plays a pivotal role. Weiyi He et al.[7] also found that the influencing factors that have a significant role in the design side's willingness to adopt green technologies are: perceived usefulness, ease of use, risk, employee innovation, product modularity, and organizational allocation.

Although there are not many research results on the influence factors of collaborative innovation in the assembly construction industrial park, there are relatively more relevant studies on the influence factors of collaborative innovation, and their research results have implications for the collaborative innovation in the assembly construction industrial park. More scholars have analyzed the influence factors of collaborative innovation from the perspective of knowledge management. According to Zheng Jun et al.[8] , "knowledge gatekeepers" continuously transform heterogeneous knowledge from outside the cluster to the local cluster for use through transferring, sharing and integrating behaviors in the process of knowledge management. Zhou Dasen et al.[9] argue that heterogeneous resources can be acquired through alliances, and through the sharing of information, talents, knowledge and other resources of each innovation body, collaborative innovation can be carried out, and new combinations can be formed by combining the resources of the enterprise to improve the innovation performance of the enterprise. He Xinjie et al.[10] conducted a study on the innovation performance of alliance enterprises from the perspective of knowledge collaboration - knowledge flow, interactive learning and knowledge sharing.

Some scholars have researched the performance of collaborative innovation from the perspective of the risks and factors affecting collaborative innovation. Wu Weihong et al.[11] constructed a risk research framework of "input-process-output" and summarized six types of risks, such as innovation factor input risk, resource sharing risk and benefit distribution risk, which have significant negative effects on innovation performance. Lv Pu et al.[12] constructed a collaborative innovation model based on relative risk sharing between core enterprises and related supporting enterprises and the benefit distribution mechanism based on the difference in the degree of risk taking between supporting enterprises and core enterprises in the industrial chain. Li Lin et al.[13] established a set of collaborative innovation performance evaluation index system based on three aspects: cooperation and cooperation degree among collaborative innovation subjects, capacity of collaborative innovation and mechanism of collaborative innovation. Zhao Bingyuan et al.[14] found that the input of research personnel, the participation of innovation demand subjects, the input of research funds and the innovation market environment had significant effects on the performance of collaborative innovation. Wu Zhongchao et al.[15] found that the influencing factors of regional innovation performance are knowledge transformation efficiency, knowledge spillover effect, information platform construction level, infrastructure construction level, and the efficiency of R&D funds usage. Jingjing Bai et al.[16] found that enterprises' own strength, government-related policies and enterprise cooperation partners all influence the development of this innovation network and its innovation performance at different levels and in different degrees.

In summary, scholars have provided insights on the factors influencing collaborative

Innovation performance. However, the actual situation of collaborative innovation in construction industrial parks is not considered, and the unique factors influencing collaborative innovation performance based on construction industrial parks, such as the application of BIM, standardized design of components, and the degree of standardization of industrial guidelines, are not considered.

2.1 Literature review of factors influencing collaborative innovation performance

In this paper, we have sorted out the literature on the influencing factors of collaborative innovation in recent years, summarized the influencing factors mentioned in each paper, as shown in Table 1, and extracted the influencing factors that appear more frequently, as shown in Table 2.

After sorting through the literature, more than 50 influencing factors were obtained, excluding similar influencing factors, such as government support and government behavior orientation, collaborative partnership and subject willingness to cooperate, etc. In addition, some influencing factors are more abstract, such as enterprise cooperation drive. In addition, some influencing factors are more abstract, such as enterprise cooperation drive, which is actually the factor that drives enterprises to collaborative innovation, and can be replaced by easier to understand indicators such as market demand, government guidance, and resource sharing. After extracting, analyzing, synthesizing and transforming the influencing factors that appear more frequently, a total of 16 influencing factors were obtained. As shown in Table 2.

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Table 1: Influencing factors of collaborative innovation obtained through literature review

References	Influencing Factors
Ma Hui et al.[3]	Degree of industrial agglomeration, investment in innovation resources, degree of knowledge sharing, number of intellectual property rights, degree of technological progress, efficiency of knowledge transfer, stock of knowledge
Zheng Jun et al.[8]、[10]	Knowledge absorption, knowledge translation, knowledge diffusion, knowledge flow, interactive learning, knowledge sharing
Wu Weihong et al.[11]	Innovation factor input risk, moral risk, resource sharing risk, organizational synergy risk, market environment risk, benefit distribution risk
Zhao Bin Yuan et al.[14]	Scientific research personnel investment, the degree of participation of innovation demand main body, research funding investment, innovation market environment, supporting enterprise cooperation efficiency
Wu Zhongchao et al.[15]	Knowledge conversion rate, knowledge spillover effect, level of innovation infrastructure construction, efficiency of R&D funds usage, degree of informatization
Park Jingjing et al.[16]	Enterprise own conditions, government policy support, enterprise partner ability quality
Yu Liping and others[17]	Government R&D investment intensity, market structure, enterprise scale, enterprise development speed, enterprise profit level
Jiang Xinghua[18]	Personnel management system, synergy mechanism, cooperative enterprise conditions, synergy partnership, government policy support
Xie Weiqun et al.[19]	Innovation spirit, human capital, knowledge stock, training of innovation talents, construction of results transformation platform, incentive mechanism, construction of interdisciplinary cross platform, level of institutional arrangement, intellectual property protection mechanism
Li Yan et al.[20]	Geographical proximity, local economic development level, research output level, research input level, human capital, industrial structure
Zheng Rong et al.[21]	Subject willingness to cooperate, ability and quality of cooperative enterprises, construction of alliance service system, degree of integration of alliance enterprises, organization and management
Nguyen Binh Nam et al.[22]	Collaboration willingness, collaboration ability, trust level, communication frequency, cooperation efficiency, cultural similarity, benefit distribution mechanism, incentive mechanism, responsibility and power distribution mechanism, external market environment, policy support

2.2 Analysis of factors influencing collaborative innovation of industrial clustering in the context of construction industry

2.2.1 Information level

For a longer period of time, China's construction industry has mainly relied on the manual operation at the construction site. According to the whole life cycle theory, the construction cycle is divided into five stages: design, production and transportation, construction, operation and recycling, with obvious boundaries between different stages and often lacking effective communication. The realization of construction industry modernization is not only the horizontal synergy of the industry chain, but also the vertical synergy of the industry chain. Through the collaborative innovation of upstream and downstream enterprises in the industry chain, such as the design side, component production and processing side, logistics side and on-site construction side, the synergy of all aspects of design, production and assembly construction is realized. In view of this, to improve the level of informationization and build an information platform, through the application of Internet technology, construction enterprises can quickly and efficiently converge data and information from different departments and even outside the enterprise, and conduct professional and detailed but comprehensive and accurate data and information analysis[23] . The application level of information technology by upstream and downstream enterprises in the industry chain reflects the informationization level of enterprises to a certain extent, which affects the information sharing and communication efficiency in the process of collaborative innovation, and thus has an impact on the performance of collaborative innovation.

2.2.2 Degree of standardization

To achieve modernization of construction, modern management mode should be applied. Unlike the rough production of traditional buildings, assembled buildings require standardized architectural design and modular, factory-based component production to achieve generalization of building components and assembly of on-site construction. The traditional manufacturing industry has a high degree of industrialization and has formed more complete industry standards. The construction industry is less industrialized than other manufacturing industries, and has not yet formed a unified national standard. Industrial standards are beneficial to the professional division of labor in the industry, improve the degree of specialization and increase the efficiency of industrial production. In view of this, industrial alliances can develop their own standards as a basis that can be referred to and followed, thus promoting the industrialized development of the construction industry. Therefore, the degree of standardization of industrial alliances will have a positive impact on the collaborative innovation performance of construction industry alliances.

2.2.3 Industry aggregation degree

Knowledge innovation and technological innovation in the construction industry is different from ordinary manufacturing industry, which has the characteristics of large investment in R&D and involves various enterprises in the vertical of industrial chain. The development of industrial clustering is conducive to the intensive and optimal allocation of economic factors, the mutual collaboration among enterprises and industries, the sharing and recycling of resources, and is an effective way to promote the integration of informationization and industrialization, achieve industrial restructuring and rational layout, and transform the mode of economic development. The purpose of forming industrial alliance is also to realize mutual collaboration among enterprises and to bring into play the effect of "1+1>2". Therefore, the aggregation of the construction industry has a driving effect on the R&D investment and resource integration of the construction industry, which in turn affects the performance of collaborative innovation.

2.3 Factors influencing the collaborative innovation performance of the assembly building industrial park

Combining the factors influencing the performance of industrial collaborative innovation obtained from the literature review and the factors influencing the collaborative innovation of the construction industry alliance obtained from the analysis of this paper, we summarize the factors influencing the collaborative innovation of the assembly building industrial park

Table 2: Influencing factors and codes for collaborative innovation in the assembled building industrial park

Code	Influencing Factors	Literature Sources
A1	Innovation resource input	[3][11][14][15][17][20][21]
A2	Willingness to cooperate	[11][14][16][18][19][21][22]
A3	Knowledge Conversion Rate	[3][8][10][15][20]
A4	Knowledge Sharing	[3][8][10][11]
A5	Participant competencies	[16][17][18][21]
A6	Government Action Orientation	[16][17][18][19]
A7	Innovation Awareness	[8][10][14][19]
A8	Trust level	[11][18][21][22]
A9	Affiliate Organization Management	[11][18][21]
A10	Market Demand	[11][14][17]
A11	Knowledge Stock	[3][19]
A12	Benefit distribution mechanism	[11][22]
A13	Heterogeneity among innovation subjects	[8][10]
A14	Level of informatization	The analysis obtained in this paper
A15	Degree of standardization	The analysis obtained in this paper
A16	Industry Aggregation	The analysis obtained in this paper

3. Construction and analysis of social network model

3.1 Social network model of the factors influencing collaborative innovation performance

Social network analysis (SNA) is a research method for quantitative analysis of social relationships and social structures by means of mathematical methods and graph theory, which is widely used in

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management and other fields. It is a method to establish social networks by identifying the relationships between actors and using data visualization to identify the key factors and interrelationships of the network.

In the process of collaborative innovation in the assembly building industrial park, the performance of collaborative innovation is influenced by a variety of factors, and each of the influencing factors of collaborative innovation in the assembly building industrial park interacts with each other and is interrelated, and they jointly contribute to the performance of collaborative innovation. Therefore, the key to improve the performance of collaborative innovation in assembly building is to find the key factors and grasp the paths between the influencing factors. From the perspective of social network analysis, each influencing factor can be regarded as a network node, and the correlation between influencing factors can be regarded as a network linkage, so as to establish a social network of collaborative innovation influencing factors. In this study, we use the data obtained from the questionnaire to analyze the influence factors of collaborative innovation in the assembly building industrial park, and build a network with each influence factor as a network node, and the association relationship between each influence factor as a network node. The network is then used to mine the centrality characteristics of the network, analyze the intrinsic connections among the influencing factors and identify the key influencing factors.

3.2 Beijing Sumitomo National Assembly Building Industrial Park Empirical Analysis

3.2.1 Data collection and adjacency matrix construction

The 16 factors of collaborative innovation in assembly building industrial park summarized above were used as the network nodes of the social network, numbered A1~A16. First, five levels of association were set according to the degree of association from weak to strong (0,1,2,3,4), with 0 representing no association, 1 representing no association, 2 representing weak association, 3 representing medium association, and 4 representing strong association. The mean value of the 10 experts' scores was used as the correlation coefficient between the factors (the correlation coefficient between the indicator and itself was recorded as 0), and the correlation coefficient between two indicators constituted the adjacency matrix of the correlation network (due to the problem of space, only the adjacency matrix between the even number of influencing factors was shown in this paper). As shown in Table 3.

Table 3: Neighborhood Matrix of Influencing Factors for Collaborative Innovation in Beijing Sumitomo National Assembly Building Industrial Park

Factors	A2	A4	A6	A8	A10	A12	A14	A16
A2	0	3	1	3	0	2	0	1
A4	2	0	0	2	0	1	2	1
A6	3	1	0	0	3	1	1	1
A8	3	2	0	0	0	1	2	1
A10	2	1	1	1	0	1	1	1
A12	3	1	1	2	1	0	1	1
A14	2	3	1	1	1	1	0	1
A16	2	2	1	1	1	1	1	0

3.2.2 Data visualization and analysis

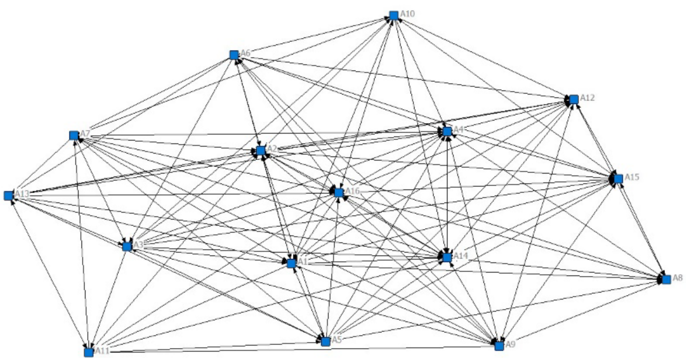

Figure 1: Relationship network of collaborative innovation influencing factors in the assembled building industrial park

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The data in the adjacency matrix are imported into Ucinet6 software, and the network constructed by the collaborative innovation influence factors of the assembly building industrial park is visualized by using the visualization function, and the relationship network diagram of the collaborative innovation influence factors is obtained, as shown in Figure 1. According to the network diagram of collaborative innovation influence factors in the assembly building industrial park, it can be found that each influence factor has a correlation relationship with each other.

3.2.3 Network Density

The network density can reflect the closeness of the association between the nodes in the network. Importing the data into Ucinet6, according to the results of network density analysis of Ucinet6 software, we can get: the network density of this network is 0.9542, which is denser, indicating that the collaborative innovation influencing factors in this network have a large degree of correlation with each other, and any change in the relationship between two influencing factors in the network may cause a large change in the network relationship graph. However, the network density analysis of this network diagram alone cannot accurately identify the key influencing factors and action paths, so it will be studied with the help of relevant indicators of individual network analysis.

3.3 Analysis of key influencing factors based on social networks

3.3.1 Point Degree Centrality Analysis

Table 4: Point-degree centrality of factors influencing collaborative innovation in assembled building industrial parks

Dimensionality	Point Degree Center Degree	Intermediate centrality
Innovation resource input	32	18.225
Willingness to cooperate	33	10.064
Knowledge Conversion Rate	22	6.960
Knowledge Sharing	22	3.965
Participant competencies	22	6.560
Government Action Orientation	17	4.214
Innovation Awareness	20	3.418
Trust level	15	0.343
Affiliate Organization Management	21	2.836
Market Demand	17	1.867
Knowledge Stock	14	2.601
Benefit distribution mechanism	19	1.855
Heterogeneity among innovation subjects	17	2.735
Level of informatization	22	6.773
Degree of standardization	18	7.571
Industry Aggregation	19	11.014
Average value	20.625	5.688

Point centrality refers to the number of points directly connected to a node in a social network. The larger the value of point centrality, the more nodes are connected to the point, and the more central the point is. Using the Ucinet6 software, according to the network→ Centrality→ Network→ Centrality→ Degree) to obtain the point centrality of each point. As shown in Table 4. The point degree centrality degree of six influencing factors, such as willingness to cooperate, innovation resource input, knowledge conversion rate, knowledge sharing, participant competence, standardization degree and alliance organization management , exceeds the average value of point degree centrality degree of 20.625 , which indicates that these factors are in the center of the relationship network diagram and have a great influence on the collaborative innovation performance of assembly building, and should be analyzed as important indicators. However, it is not enough to determine the key influencing factors based on the point degree centrality alone, because the point degree centrality can only indicate the importance of the influencing factors, but not the influence of other influencing factors.

3.3.2 Intermediate centrality analysis

Intermediate centrality represents the degree of influence of a node on other factors in this paper, and refers to the extent to which a point is located between two other points in the graph through which other nodes must "communicate". The larger the value of the intermediate centrality, the greater the degree to which the point is located between the other two points in the network diagram, i.e., the greater the degree of control over the other nodes, and the more pronounced the intermediary effect[24] . Using the Ucinet6 software, the intermediary effect is evident according to the network → Centrality → Freeman centrality→ Node centrality (Network→ Centrality→ FreemanBetweenness→ NodeBetweenness) is performed to obtain the intermediate centrality of each point. As shown in Table 4. Innovation resource investment, willingness to cooperate, knowledge conversion rate, participants' ability and quality, informationization level, standardization degree and industry aggregation exceed the mean value of intermediate centrality degree of 5.688, which means that the mediating effect of these seven influencing factors is more obvious and has a greater degree of influence on other factors.

Two methods of analyzing centrality, point degree centrality and intermediate centrality, were synthesized to list the indicators with high frequency, and six factors such as innovation resource input, willingness to cooperate, knowledge conversion rate, participants' ability and quality, standardization degree and alliance organization and management were identified as the key influencing factors of collaborative innovation performance in the assembly building industrial park.

3.4 Critical Impact Path

Table 5: Identification of key relationships in the relationship network of factors influencing collaborative innovation performance in the assembled building industrial park

Ranking	Relationships	Intermediate centrality of the line	Ranking	Relationships	Intermediate centrality of the line	Ranking	Relationships	Intermediate centrality of the line
1	Innovation resource input→ Participant competencies	7.033	11	Willingness to cooperate→ Sense of innovation	3.9	21	Informatization level→ Innovation Awareness	2.867
2	Knowledge stock→ Participant competencies	6.05	12	Heterogeneity among innovation subjects→ Innovation resource input	3.867	22	Participant competence→ Benefit distribution mechanism	2.833
3	Knowledge Conversion Rate→ Participant competencies	5.583	13	Benefit distribution mechanism→ Industry Aggregation	3.733	23	Knowledge Conversion Rate→ Innovation resource input	2.833
4	Knowledge Conversion Rate→ Market Demand	5.3	14	Knowledge stock→ Innovation Awareness	3.7	24	Level of trust→ Level of Informatization	2.826
5	Knowledge stock→ Willingness to cooperate	5.05	15	Industry Aggregation→ Knowledge Stock	3.41	25	Heterogeneity among innovation agents→ Knowledge stock	2.817
6	Industry Aggregation→ Market Demand	4.9	16	Willingness to cooperate→ Innovation resource input	3.286			
7	Willingness to cooperate→ Alliance Organization and Management	4.629	17	Knowledge Conversion Rate→ Degree of standardization	3.176			
8	Willingness to cooperate→ Government Behavior Orientation	4.586	18	Innovation Awareness→ Industry Aggregation	3.176			
9	Degree of standardization→ Market Demand	4.067	19	Willingness to cooperate→ Government Behavior Orientation	2.9			
10	Level of trust→ Innovation resource input	3.933	20	Awareness of innovation→ Participant competencies	2.893			

The identification of critical influence paths is achieved by the intermediate centrality of a line. The median centrality of a line is a measure of the degree to which a line lies in the "middle" of other lines in the diagram, and is a measure of the degree to which a two-point relationship controls the entire network.

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The greater the median centrality of a line in the network, the greater its ability to influence collaborative innovation performance and the greater the need to focus on improving it.[24] . Using Ucinet6 software to measure the intermediate centrality of the line, a 16*16 matrix was obtained, which had 149 values greater than 0. The top 10% of relationships were selected as the key relationships, as shown in Table 5.

The paths with greater centrality in the middle of the line are extracted from the table, and the paths with backward and forward connections are connected to obtain a critical impact path.

(1) Level of trust→ Innovation resource input→ Competence quality of participants→ Benefit distribution mechanism→ Degree of industry aggregation→ Market demand. The influence path shows that the degree of trust between industrial alliances will influence the amount of innovation resources invested, and after the innovation resources are invested, the competence quality of participants will influence the efficiency of using the invested innovation resources, and then influence the collaborative innovation performance. The fairness and equity of the benefit distribution mechanism will attract enterprises to participate in the collaborative innovation activities in the industrial park, increase the industrial scale and industrial aggregation, and thus drive the market demand.

(2) Heterogeneity among innovation agents→ Knowledge stock→ Willingness to cooperate→ Alliance organization management. Each innovation subject is an independent interest subject with its own heterogeneous characteristics. The diffusion and absorption of heterogeneous knowledge among subjects will promote the knowledge stock of the assembly building industrial park, and only when enterprises can acquire knowledge that cannot be acquired by individual innovation and achieve the goals that cannot be achieved by individual innovation in the process of participating in collaborative innovation will they enhance the willingness to cooperate with each other, thus forming an industrial alliance The alliance organization management is conducive to the system of alliance organization. Alliance organization management is conducive to the overall virtuous cycle development of the system of the alliance organization, thus improving the collaborative innovation performance of the assembly building industrial park.

4. Conclusion

Through the social network analysis method, the key influencing factors of collaborative innovation performance of assembly building industrial park are innovation resource input, willingness to cooperate, knowledge conversion rate, participants' ability quality, standardization degree and alliance organization management through network density, degree centrality, intermediate centrality and line of intermediate centrality. Therefore, we need to improve the investment of innovation resources, find partners with the same willingness to cooperate, and extremely high knowledge conversion rate to transform the scientific and technological achievements. Clarify the alliance organization and management process to improve the efficiency of communication.

References

[1] Wang J, Zhao Kida, Hu Zongyu. Current situation and reflection on the development of construction industrialization in China[J]. Journal of Civil Engineering,2016,49(05):1-8.
[2] Ji Xun. Construction industry modernization and construction industry development of new industry, new mode of exploration [N]. China Construction News,2015-09-25(006).
[3] Ma Hui, Wang Suzhen, Huang Mengjiao. Analysis of influencing factors of collaborative innovation of construction industry alliance based on social network analysis - taking Beijing-Tianjin-Hebei region as an example [J]. Science and Technology Management Research,2018,38(15):170-176.
[4] Yang, C. and Wang, W.. Research on wisdom construction promotion strategy based on the evolution of construction industry modernization technology[J]. China Soft Science,2018(08):18-30.
[5] Ma Zhiliang. Technological innovation thinking on the synergistic development of intelligent construction and building industrialization [J]. China Survey and Design, 2020(09):28-30.
[6] Liu Qian. Digital architecture: constructing a new engine for digital transformation of industry[J]. Software and integrated circuits,2020(09):28-29.
[7] He Weiyi, Zhai Yinan, Wang Jing. Green science and technology innovation and pushing synergistic mechanism:A key customer perspective[J]. Journal of Dalian University of Technology (Social Science Edition),2018,39(03):17-23.
[8] Zheng Jun, Zhang Fan, Wang Bingfu. Global pipeline, knowledge gatekeepers and strategic emerging industry cluster development--a case from IC industry cluster in Suzhou High-tech Zone[J]. Enterprise

ISSN 2616-5902 Vol. 4, Issue 19: 138-146, DOI: 10.25236/AJBM.2022.041917

Economics,2021,40(03):24-32.
[9] Zhou Dasen, Shi Pengfei, Geng Biao, Li Xingming. Research on the collaborative innovation path of science and technology-based micro and small enterprises--based on the perspective of strategic alliance [J]. Resource Development and Market,2021,37(10):1200-1208.
[10] He XJ, Li N, Wang YAO. System dynamics analysis of innovation performance enhancement of alliance firms--based on knowledge synergy perspective [J]. Journal of System Science, 2021, 29(03): 125-130. System dynamics analysis of innovation performance enhancement of alliance enterprises--based on knowledge synergy perspective
[11] Wu Weihong, Zhao Kun, Zhang Aimi. A study on the path of the role of corporate collaborative innovation risk on innovation performance[J]. Scientific Research Management, 2021,42(05):124-132.
[12] Lv Pu, Ma Kexin. Research on the benefit distribution mechanism of cluster supply chain collaborative innovation based on relative risk sharing[J]. Operations Research and Management,2 020, 29(09): 115-123.
[13] Li L, Attack Y. Research on the design and application of collaborative innovation performance evaluation index system for research projects[J]. Science and Technology Progress and Countermeasures, 2014, 31(01):123-129.
[14] Zhao Bingyuan. Analysis of factors influencing the collaborative innovation performance of Beijing, Tianjin and Hebei--based on the spatial Durbin model [J]. Business and Economic Research, 2021(01): 162-166.
[15] Wu, C. Chao. Network structure, innovation infrastructure and regional innovation performance - an analysis based on network DEA multiplier model [J]. Journal of Beijing Jiaotong University (Social Science Edition), 2021,20(02):79-89.
[16] Jingjing Bai, Junfeng Li. An empirical study on the correlation between innovation network and innovation performance of enterprises within industrial clusters--An example of Anhui Gogou cable industry cluster [J]. World Geography Research,2021,30(01):157-166.
[17] Yu L. P., Fang J. X., Wang Zuogong. Factors influencing the depth of collaborative innovation in high-tech industries and its industry comparison--Aerospace and computer and office industries as an example [J]. Journal of Guangdong University of Finance and Economics,2017,32(05):12-21.
[18] Jiang, X. H.. Research on the factors influencing the performance of collaborative innovation in higher education [J]. Research and Development Management,2018,30(06):138-143.
[19] Xie Weiqun, Huangfu Yang, Yu Liying. Factors influencing the performance of collaborative innovation in universities from the perspective of value co-creation [J]. China University Technology, 2020(04): 22-26.
[20] Li Y, Ye Q. Study on the evolution of inter-city collaborative innovation network in Zhejiang Province and its influencing factors--based on the perspective of innovation network [J]. Lanzhou Journal, 2021(10): 49-64.
[21] Zheng R, Sun X. Han, Wei M. Zhu, Chang Z. Yu. A study on the factors influencing the operation of industrial think tank alliance based on rooting theory [J]. Intelligence Science,2020,38(12):51-56.
[22] Ruan, Ping-Nan, Wei, Yun-Feng, Zhang, Guo-Hong. Research on the factors influencing innovation synergy in corporate innovation networks [J]. Science and Technology Management Research, 2016, 36(21): 1-5+11.
[23] Cao Xiaoju, Guo Guangfeng, Zhang Lei. Research on optimization measures of modern construction engineering management from the perspective of informationization [J]. China Management Informatization, 2020, 23(22):83-84.
[24] Liu Jun. Lecture Notes on Holistic Network Analysis: A Practical Guide to UCINET Software [M]. Shanghai: Gezhi Press, 2009.