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Knowledge Management for Technological, Product and Industry Collaboration in China

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Abstract

This study aims to empirically validate a link between the three aspects of knowledge management (KM) to three aspects of innovation capability. Knowledge production, transformation, and knowledge diffusion are the three components of knowledge management. Product innovation, technological innovation, and industry chain cooperation are the three types of innovations which apply to the innovation ecosystem. Using social media and e-mail channels WeChat and QQ, the study collected data from 404 samples. They represent a range of the industry characteristics in the innovative ecosystems of China: leadership role, job title, career age, business establishment years, number of staff engaged in technology and R&D, current stage of business development, industry location, and type of business. Structural equation modeling (SEM) produced support for the proposed theoretical concepts which link KM to innovation. It is believed that this study is the first to investigate how KM supports innovation within the innovation ecosystems in China.

Keywords: *Innovation ecosystem, knowledge management, knowledge innovation, collaborative innovation*

1. Introduction

China's different industries and firms have been collaborating on innovation activities due to the pervasiveness of globalization and China's entry and active engagement in international trade organizations in recent decades (Li et al., 2022). Technological and product innovations are essential components of China's innovation ecosystem. Platform technology, such as the Alibaba platform system, encourages widespread product innovation and collaboration among suppliers and intermediary channels, such as third-party logistics. All of these have contributed to the Chinese internet retailing industry and the rapid expansion of markets (Wang and Coe, 2021).

In the evolving context, the innovation ecosystem helps enterprises acquire leverage potential innovations more quickly. "There are still several shortcomings when studying the innovation ecosystem," Arenal et al. (2022) writes, "especially due to an inability to provide a structured analysis of these interactions among the stakeholders within the ecosystem and their dynamics, and to depict the causal path to enhance innovative activities" (p. 4). Thus, in the innovation ecosystem framework, there is an empirical shortfall between a firm's knowledge management capabilities and its innovation capabilities.

The primary goal of this study is to provide a comprehensive overview of current research in innovation ecosystems and knowledge management by employing bibliometric maps, as guides, and to propose a hypothetical relationship which links three aspects of knowledge management to three aspects of innovation capability. Knowledge production, transformation, and diffusion are the three components of knowledge management. Product innovation, technological innovation, and industry chain cooperation capability are the three types of innovative capability that comprise the innovation ecosystem.

While a study of the literature can be used to conceptualize the proposed research goal, a questionnaire-based survey of industry stakeholders in China will generate primary data with which to validate empirically a conceptual model.

2. Literature Review

The bibliometric map presented in Figure 1 is based on a co-citation strength study of 2,000 articles imported from Sciencedirect.com databases using the keywords "innovation ecosystem and knowledge management." The map presents four clusters:

- The *green* cluster deals with broader social, ecological issues (Elliot et al., 2022) involving services such as urban drainage systems (Johnson and Geisendorf, 2022).
- The *red* cluster, the prime focus of this study, is the innovation ecosystem.
- The development of contemporary science (*yellow* cluster) serves as an essential link between ecosystem services and the innovation ecosystem.

- Both the innovation ecosystem and the clusters of ecosystem services need constant technology adoptions and 'green' innovations for sustainability. These are shown as *blue* clusters. (Al-Obadi et al., 2022; Kalisz et al., 2022)

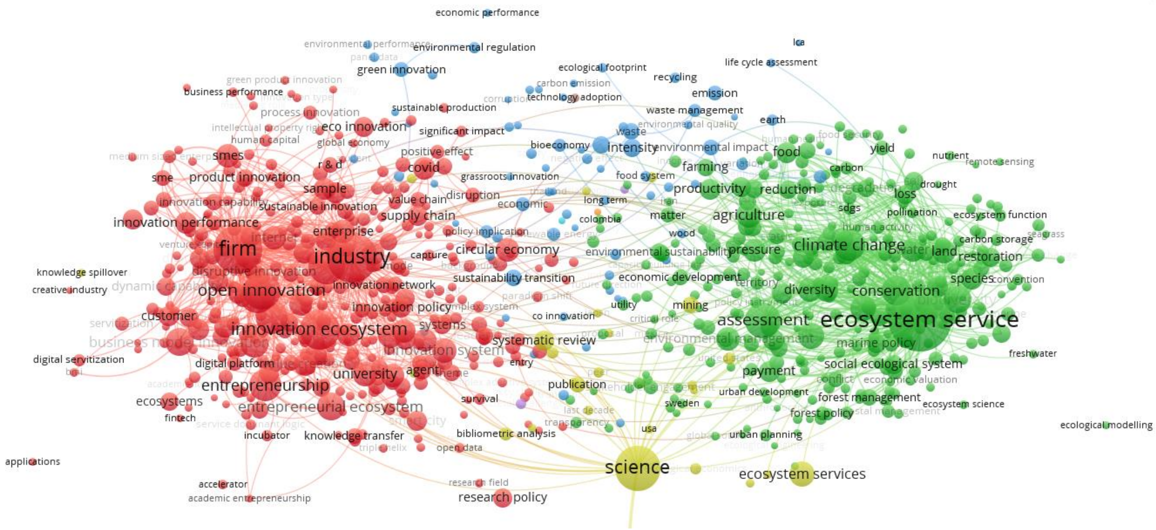

Figure 1: A Bibliometric Map Developed by Using Sciencedirect.com and Keywords "Innovation Ecosystem and Knowledge Management"

The capability theme is a rising star in the "innovation ecosystem" cluster, represented by theories with particular emphases, for instance: value creation, business model innovation, knowledge management, dynamic capability, competitive advantage, sustainable innovation, innovation capability, and innovation performance. The capability-based view (CBV) of competition can be reckoned as an extension of resource-based view (RBV), and researchers suggest also the dynamic capability aspect, which requires organizations in the innovation ecosystem to demonstrate capability of sensing, seizing, and reconfiguration for dealing with opportunities and challenges (Elroanta and Turunen, 2015). Knowledge is a critical resource, leading to a close connection to another theoretical invention known as knowledge-based view (KBV) (Teece et al., 1997). From the perspective of strategic management, organizations should exploit the available knowledge for realizing benefits in the markets (Fenford, 2013: 181).

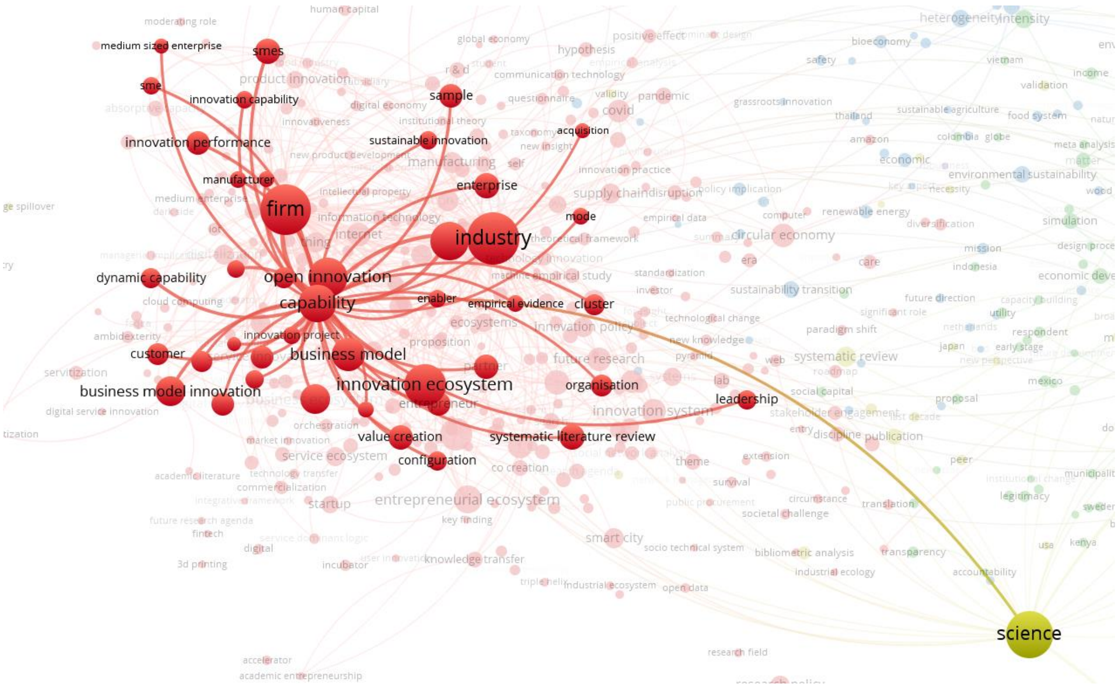

Figure 2: Bibliometric Map of the Innovation Ecosystem

The term "ecosystem", first coined in academic literature in the mid-1990s by James Moore (Moore, 1993), is now strategically and operationally associated with business landscapes. These require distributive value creators who collaborate, create, and exchange values. It has become a trendy type of business system nowadays (Ates, 2022). Collaborative innovation generation bring about a competitive advantage which enterprises in the innovation ecosystem can anticipate having (Ates, 2022). Because the path to an invention is complicated, punctuated by hurdles, failures, dangers, and barriers (Ates, 2022), an open innovation scheme has gained widespread acceptance (Altman and Tushman, 2017).

Manufacturing industries in China have used the upper and lower value-added chains in products and services as an endogenous innovation effort to boost global competitiveness (Al-Sayed and Yang, 2020). The small and medium (SEM) enterprises take advantage of the ecosystem benefits of a multilateral structure of partners in value creation and production (Adner, 2017). SMEs recognize that their smaller size, in comparison to larger companies, necessitates them to explore innovation advantage through the development of technological innovation capabilities. This entails the purchase and use of external company resources (Song, 2022). The research work of Adner (2017), Al-Sayed and Yang (2020), and Song (2020), inspired this present study which aimed to establish a cause-effect link between RBV/KBV and CBV in the innovation ecosystem of China.

As previously discussed, organizational capability is a concept that has its intellectual roots in the resource-based view (RBV), which can be viewed as a bundle of heterogeneous resources and capabilities, as pointed out by Adaku, Ankrah, and Ndekugri (2021), for example. Every part of that bundle originates from knowledge – the foundation of all of the resources. Similarly, the source of organizational capability is knowledge. As a result, this study assumes a causal relationship between knowledge and innovation. Sousa-Ginel, Franco-Leal, and Camelo-Ordaz (2021) highlight a similar idea. They state that "the major source of innovation is the capacity to produce, transform, and use knowledge in response to environmental changes" (p. 2).

In addition, as noted in Skare and Soriano (2021), knowledge diffusion is vital. The participating members can quickly absorb and internalize the shared knowledge, and turn it into many advantages (Schneider et al., 2019; Skare and Soriano, 2021). Firms leverage the innovation ecosystem in order to build competitive advantages (Xie and Wang, 2020). Without market knowledge, however, organizations cannot swiftly adapt their performances (Dondapati et al. 2022). It was Chaithanapat et al. (2022) who discovered a link between demand-side knowledge management and innovation quality.

Drawing from the foregoing review of relevant literature, the following hypotheses are derived. This stud aims to empirically validate each in the context of the innovation ecosystem in China.

H1: Technological innovation capability is significantly predicted by knowledge generation, knowledge transformation, and knowledge diffusion.

H2: Product innovation capability is significantly predicted by knowledge transformation capability, knowledge transformation capability, and knowledge diffusion.

H3: Knowledge dissemination, transformation, and diffusion significantly predict the collaborative innovation of upstream and downstream industrial chain.

Figure 3 depicts the conceptual model that integrates the three hypotheses, which links knowledge management capability to innovation capability.

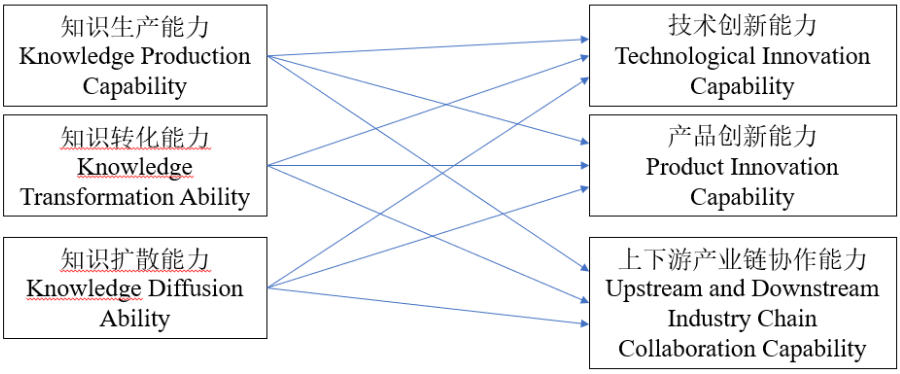

Figure 3: The Conceptual Model

3. Research Method

3.1 Questionnaire Design

The survey instrument, shown in Table 1, results from a multi-stage development process. In the first stage, items of the questionnaire were developed based on findings from the literature review. Second, the items were reviewed by an expert panel (Krueger et al., 2017), which included five senior managers who agreed on the scope for each dimension in KM and innovation, with consensus rate over 90%. A test run with 35 randomly chosen managers was carried out to explore the level of reliability, which was confirmed by a level of 0.70 (Hair et al., 2006). Table 1 shows the survey questions which met these criteria.

Table 1: Survey Instrument

Factors	**Component index**	**Item number**	**Questionnaire questions**
Knowledge Management	**Knowledge production (Enterprise knowledge collection, integration and**	V11	Knowledge exchange and collaboration among enterprises, experts, partners and universities
		V12	Core Technology Capability of System Knowledge Management: Big Data, Artificial Intelligence, Cloud

	collaborative function building)		Computing, Knowledge Management Technology and System Selection, Maintenance, Iterative Upgrading Capability
		V13	Evaluation of Knowledge Base Construction, Knowledge Transfer, Management and Application in Innovation Ecosystem
		V14	Construction of Innovative Ecological Chain Team: Maintenance and Construction of External Experts, Upstream and Downstream Cooperative Enterprises and User Team
	Knowledge diffusion **(Knowledge exchange, sharing)**	V21	Communication between business system and knowledge management system in enterprise: matching degree of knowledge and business scene, knowledge sharing, knowledge collaboration and rule building of common project and technology development.
		V22	Management of Common Projects of Ecological Members: Project Problems, Demonstration, Cooperation, Division of Labor, Solutions, Shared Results, Norms (Mechanisms)
		V23	Process management of cooperation and knowledge exchange among ecological members: including business flow formulation and specification, knowledge assessment,

			problem solving process management, etc.
		V24	Learning, Communication and Knowledge Management of Ecosystem Members: Business Collaboration in the Process of Business Collaboration in Learning and Communication, Knowledge Innovation Mechanism, Assessment Mechanism and Incentive Mechanism to Encourage Knowledge Output
	Knowledge Transformation	V31	Leading and Participation of Industrial Ecological Research Projects: Project Diversity, Innovation Enthusiasm of Scientific Researchers, Project Knowledge Transformation
		V32	Operational results outputs: programme level, technical level and use demand coherence, industry recognition
		V33	Knowledge iteration: company product development related technical information, update iteration, new knowledge generation efficiency
		V34	Internal and External Knowledge Transformation: Intellectual Property, Results Description, Product Quality Inspection Report, Technical Contract, Cooperation Agreement, etc.
		V35	Span Restructuring Ability of Knowledge: Restructuring Ability of

			Knowledge Resources in Response to Technological and Market Changes
Innovative capability of businesses	**Technological innovation**	V41	Industry-university-research cooperation of enterprises: cooperation frequency and cooperation mode diversity
		V42	Investment in generic technology research: financial investment, human investment, areas of generic technology alignment; focus on key materials, core components, basic processes, basic industrial software and quality technology foundation, etc.
		V43	Enterprise' s continuous innovation capability: the year of R&D investment and the stability of senior scientific and technological personnel
		V44	Technology and innovation support in the field of technology research: enterprises can quickly obtain relevant technology or innovation support from universities or research institutions through industrial innovation ecology
	Product invention	V51	Intellectual property ownership of products: invention patents, software indigenous rights, technical advantages and sustainability
		V52	Industry chain cultivation of core competitiveness: industrial cluster agglomeration development, product innovation power.

		V53	Popularity of new products and services: source of profits
		V54	Speed of launch of new products and services
	Collaborative Innovation of Upstream and Downstream Industry Chain	V61	Industry chain industry chain advantages: from R & D to manufacturing, design, market development of industrial chain innovation advantages
		V62	The acquisition of various demands through the collaboration of industrial chain: market demand, customer demand, and dynamic changes of window
		V63	Industry Chain Technology Research: Enterprises can Joint Technology Research Action with Upstream and Downstream Enterprises and Research Institutions
		V64	Market technology and innovation support: In the case of rapid changes in the market environment, members of the enterprise industry chain (upstream and downstream) provide technology or innovation support.

3.2. Data Collection

The industries chosen for this study require a high level of knowledge. Technological innovation, product innovation, and upstream and downstream industrial innovation are essential to these industries. In the industrial context, stricter standards for knowledge management are required at various levels of the organization. High-end equipment manufacturing (aerospace, marine, and high-end energy equipment, for example), vehicle manufacturing, automobile parts manufacturing, heavy machinery manufacturing, household electrical appliance manufacturing, electronic information, new energy, material industry, and biological pharmaceuticals, are the industries chosen for this study. Respondents were primarily businesses with visible upstream and downstream industrial chain structures, as well those engaged in more creative activities.

The respondents held various roles, such as entrepreneurs, senior enterprise management, R&D technology experts, and staff from the enterprises' external cooperation department. WeChat and QQ programs were employed.

3.3 Sample Size

Given 25 observable variables (the measurement items), Hair et al. (2006) recommends 25X10 = 250 sample size suitable for structural equation modeling (SEM) analysis. In addition, based on a 95 per cent confidence level and a 5% precision, with equaled p and q distribution, a sample size of 385 is appropriate. Thus

$$n = \frac{Z^2pq}{e^2} = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = 385 \qquad (1)$$

The survey was completed in May 2022, with 500 questionnaires distributed, 442 collected, and 38 unqualified questionnaires discarded. The questionnaire had an effective recovery rate of 80.8 per cents.

4. Results

The profiles and variable descriptions are given in the Appendix. A valid 404 samples were used for the statistical analysis. The profiles are:

- Some 76% of the participating companies believe they leaders in the innovation ecosystem
- Of the participants, 59.16% could be classified as 'basic' managers, 32.43% as middle managers and 8.42% as senior managers.
- Career length: the majority (62.62%) had over seven years of career experiences; 47.52% had 3-7 years of experience.
- The majority of business establishments (50.74%) had been operating for over 30 years, 18.56% for 11-20 years and 16.09% for 21-30 years. The remaining 9.9% for 6-10 years, and 4.7% for 2-5 years.
- The staff distribution was quite equally distributed (see the Appendix for details).
- With respect to the business development stage, 3.47% were at the entrepreneurial stage, some 3.47% were at the bottleneck (declining)

stage. High speed and mature stage businesses had nearly equal percentages, 40.10% and 39.85%, respectively.

- The industry types were relatively equal: high-end equipment manufacturing, automobile manufacturing, and material engineering, at 18.07%, 11.39%, and 11.39%, respectively. The remainders were below 10% (see the Appendix table).
- In terms of business ownership, 67.33% (the majority) were state-owned enterprises, followed by private enterprises at 23.27%.

4.1. Reliability and Validity Assessment

Table 2 provides robust evidences for the validity and reliability of the survey instrument (Hair et al., 2006):

- Cronbach's alpha exceeds the 0.80 threshold.
- Given sampling adequacy, KMO > 0.7-0.8, measurement item loading > 0.5, total variance explained (TVE) > 0.5, one-dimension construct from the assessment of exploratory factor analysis (EFA), the analysis confirms convergent validity.
- Given square root of TVE > cross-correlations coefficients, discriminant validity is supported.

Table 2: Reliability, Discriminant and Convergent Validity Assessments

	Alpha	KMO	TVE	V1	V2	V3	V4	V5	V6
Threshold	0.8	0.8	0.5						
V1	0.841	0.782	0.58	0.762					
V2	9.822	0.815	0.74	.782**	0.86				
V3	0.865	9.865	0.65	.718**	.751**	0.807			
V4	0.874	0.807	0.73	.649**	.644**	.728**	0.854		
V5	0.848	0.819	0.69	.643**	.659**	.743**	.802**	0.831	
V6	0.851	0.811	0.69	.649**	.638**	.748**	.792**	.753**	0.83

Note: V1 = Knowledge production, V2 = Knowledge diffusion, V3 = Knowledge transformation, V4 = Chain collaborative innovation, V5 = Technology innovation capability, V6 = Product innovation capability.

4.2. Comparative Analysis

There are some significantly essential comparative analyses. Shown in Figure 2 is the significant differences of KM and innovation efforts and performance in different stages of business development, and the shapes follow quite nicely the typical trend of a product life cycle. Asl-Najafi et al. (2022) share similar understandings that different product life cycle stages would need different levels of effort and coordination. In the case of this study, KM and innovation are examples of innovation ecosystems.

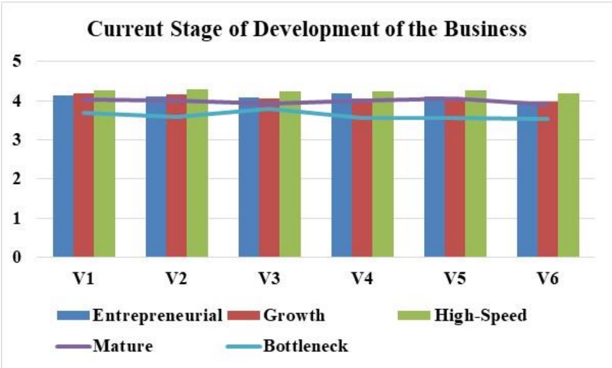

Figure 2: Current Stage of Development of a Company's Business

Industry ranking shows that appliances, auto parts manufacturing, new energy, and electronic information score among the top three in KM, innovation efforts and performances, partly reflecting the knowledge intensity of these industries which require extensive collaboration across the industry chains and also in product innovation (Dong et al., 2019).

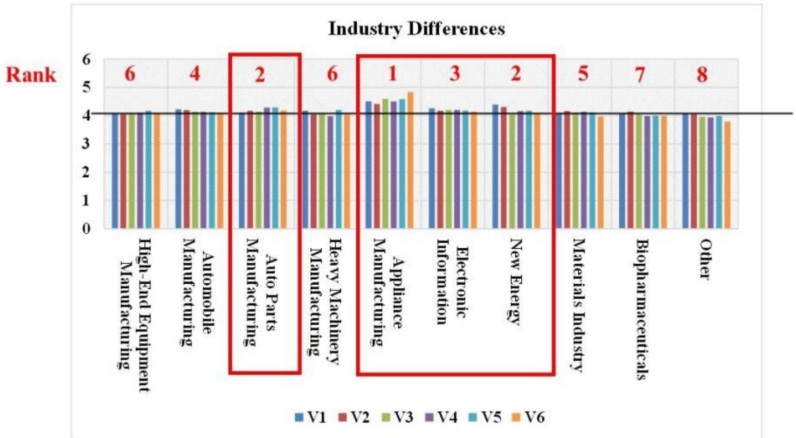

Figure 3: Industry Differences

From the angle of business nature, Sino-foreign joint ventures and cooperative enterprises stand out in terms of higher levels of KM, innovation efforts and performance.

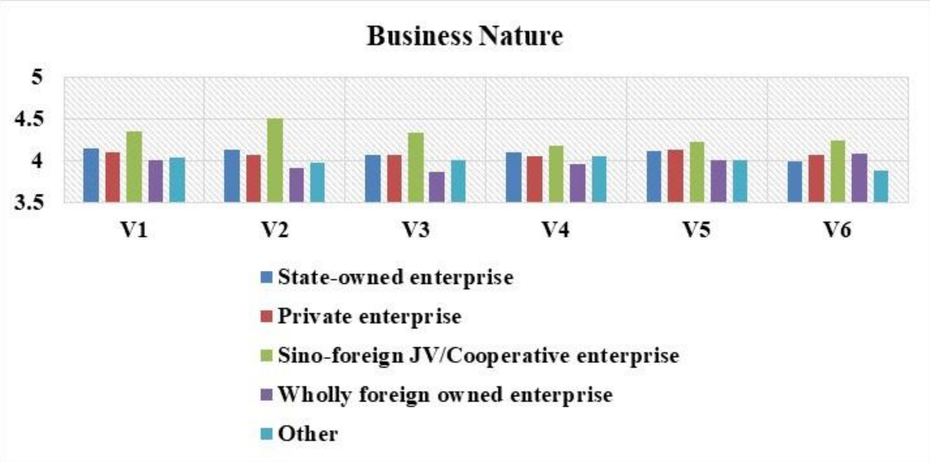

Figure 4. Business Nature

4.3. Structural Equation Analysis

SEM is a tool to validate the proposed conceptual model (Hair et al., 2006). The adequacy of the model is assessed using sample-size-independent fit indices: The comparative fit index (CFI), the Tucker-Lewis index (TLI), and the root mean square error of approximation, RMSEA (Lohbeck, Toth-Kiraly, and Morin, 2022). The SEM path structure is shown in Figure 5, and robust model fitting indexes are given in Table 3.

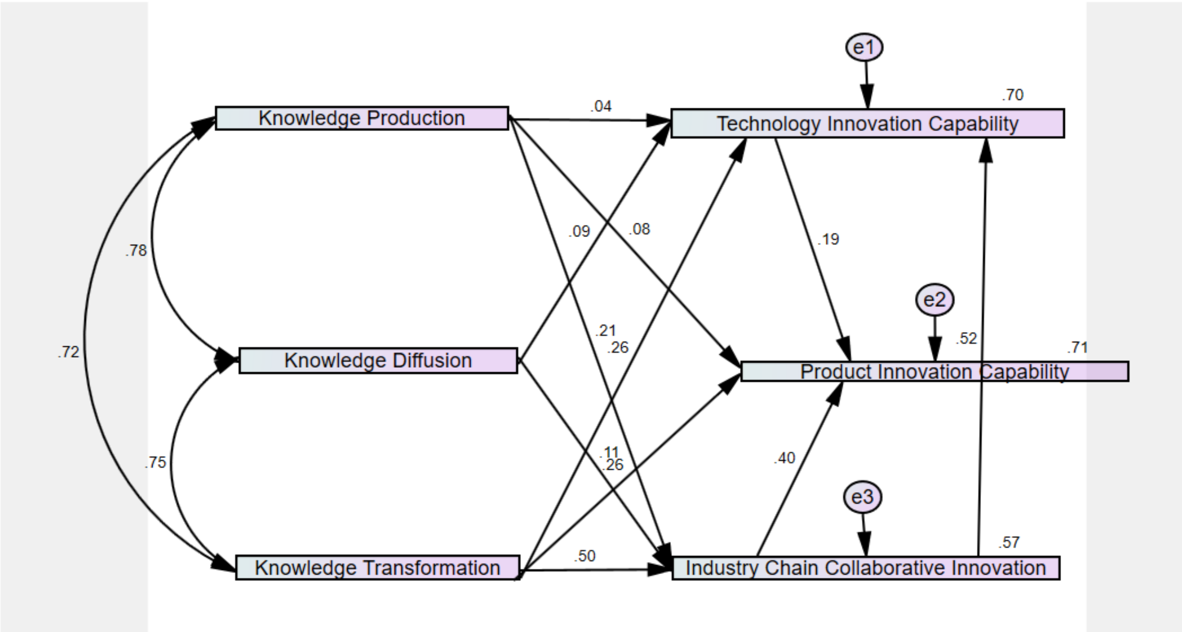

Figure 5: The Empirically Validated SEM

The SEM model fit indexes are shown in Table 3.

Table 3: The SEM Fit-Statistics

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	26	.022	1	.883	.022
Saturated model	27	.000	0		
Independence model	12	2077.043	15	.000	138.470

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	1.000	1.000	1.000	1.007	1.000
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.000	.000	.065	.929
Independence model	.584	.563	.605	.000

4.4. Hypotheses Assessment

Table 4 presents the SEM path regression coefficients (Sig. value) to assess the supportability for the three hypotheses stated in the literature review. The result reveals all three hypotheses are supported, except in H1, the statistical significance for knowledge production (generation) as the predictor for technology innovation capability is weak. In H2, knowledge diffusion is not a significant predictor for product innovation capability.

Table 4: Hypothesis Assessment

Hypothesis Path		Path Coefficient	Sig.	Hypothesis	Test Result
V3 (Knowledge Transformation)	→ V4 (Chain Corrative Innovation)	0.449	0.000	H3	Supported
V2 (Knowledge Diffusion)	→ V4 (Chain Corrative Innovation)	0.106	0.070		
V1 (Knowledge Production)	→ V4 (Chain Corrative Innovation)	0.208	0.001		
V1 (Knowledge Generation)	→ V5 (Technology Innovation Capability)	0.043	0.355	H1	Supported, except knowledge generation
V2 (Knowledge Diffusion)	→ V5 (Technology Innovation Capability)	0.091	0.061		
V4 (Chain Corrative Innovation)	→ V5 (Technology Innovation Capability)	0.524	0.000		
V3 (Knowledge Transformation)	→ V5 (Technology Innovation Capability)	0.262	0.000		
V3 (Knowledge Transformation)	→ V6 (Product Innovation Capability)	0.258	0.000	H2	Supported, except knowledge diffusion
V1 (Knowledge Production)	→ V6 (Product Innovation Capability)	0.084	0.038		
V4 (Chain Corrative Innovation)	→ V6 (Product Innovation Capability)	0.401	0.000		
V5 (Technology Innovation Capability)	→ V6 (Product Innovation Capability)	0.186	0.000		

* Additional path (not stated in literature review)

4. Discussion

This present survey targeted companies located within the innovative ecosystems in China. The distinctive characteristics of the companies are:

- 76% of them believe they are currently leaders in the innovative system
- Only 3.47% and 3.47% were at entrepreneurial and bottleneck stages of business, the remaining businesses were at growth, high-speed, and mature levels
- Most of the participating companies are state-owned enterprises, 67.33%, followed by 23.27% are private enterprises.

The data support the three hypotheses H1, H2 and H3, except for the role of knowledge generation to explain technology innovation capability was not significant. Similarly, knowledge diffusion to explain product innovation was not significant. The logics of the hypotheses confirms that knowledge management is a predictive base for innovation in the participating companies in the innovative ecosystem. The same logic is noted in Herkerma (2003) and du Plessis (2007), which define innovation as a knowledge process aimed at creating new knowledge geared towards the development of commercial and viable solutions.

Apart from the empirical support for the hypotheses, there are many other valuable insights generated from ANOVA and t-tests. There are significant statistical differences for KM and innovation capabilities for the different stages of development of the business. It is apparent that the companies at the bottleneck or decline stages have the lowest level of KM and innovation.

The collaborative innovation spirit of the industry chain within the ecosystem is vital, shown by the additional SEM paths. A similar understanding is empirically supported in Kucharska and Bedford (2020), with the following argument: collaboration throughout the organization enables learning and changes in behavior.

Sino-foreign joint ventures (JV) and cooperative enterprises score relatively better in KM and innovation when compared to state-owned enterprises, private enterprises, and wholly foreign owned enterprise. Thus, with knowhow and capital transferring (Bai, Lu, and Tao, 2010), that is, sharing rule governing the distribution of profits among JV partners (Gattai & Natale, 2013), especially knowledge (Ott, Liu and Buck, 2014), it is expected the Sino-Foreign JVs will last longer and perform better (Ott et al., 2014).

Home appliance manufacturing ranks No. 1 for effort and performance in KM and innovation when compared to other industries. Considering a very active market, the retail market in China, appliance manufacturers, such as Haier Group, Midea Group, and Gree Electronics, have made significant progress in terms of the innovation ecosystems concept, using mechanisms of market-product capability upgrading to prevent them from stepping into the declining or bottleneck stage (Guo and Zheng, 2019). This present study shows that the companies in the declining stage have lower levels of KM and innovation.

As per the significant differences of KM and innovation in the different business phases, this study shares a similar finding made by Asl-Najafi et al. (2022): different coordination strategies are needed for different stages of product life cycle.

5.1. Implications

Judging by the significant roles of KM to support innovation within the innovative ecosystems, including as drivers for growth of organizations, the present study demonstrates that companies within the innovative ecosystem need to build a knowledge-driven culture. A proactive inculcation of new culture will prevent organizational inertia which can quietly kill the innovative spirit and growth potential of organizations (Ashok et al., 2021). Looking back to RBV which was discussed in the literature review section, knowledge management is a crucial resource for value creation and competitive advantage (Nwankpa et al., 2022).

The study identified a stronger effort and performance in KM and innovation for Sino-Foreign JVs. This confirms the role that knowledge has played in promoting their longevity for reasons this study infers from Ott et al. (2014): through KM, it provides an avenue to shrink culturalal distance, and thus, enables more joint venture efforts, leading to longevity.

5.2. Conclusion

In sum, this study reveals that companies in innovative ecosystems exploit knowledge management and the collaborative innovation capability of the industry chains (both upstream and downstream) to their innovative advantages. Without constant KM efforts, a practice which consists of production, diffusion and transformation of knowledge, organizations will tend to feel or go down to a declining state faster than the companies in other stages of business development, such as entrepreneurship, high-growth, and mature level. Thus, in a world where disruptive changes in work processes are the norm (Cillo et al., 2021), innovation and KM should be prioritized, as empirically evidenced in this study.

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APPENDIX

ANOVA AND T-TEST RESULTS

		No	Percentage	V1	V2	V3	V4	V5	V6
Innovation Ecosystem Leadership	Leader	307	75.99%	4.2467	4.2134	4.1928	4.1954	4.2305	4.123
	No	97	24.01%	3.799	3.8557	3.7175	3.7629	3.768	3.683
	t			0	0	0	0	0	0
	Sig.			0.000	0.000	0.000	0.000	0.000	0.000
Job Title	Basic	239	59.16%	4.1025	4.1192	4.0519	4.0492	4.0596	3.9676
	Middle	131	32.43%	4.1508	4.1031	4.116	4.1279	4.1889	4.0515
	Senior	34	8.42%	4.3529	4.2794	4.1235	4.25	4.2721	4.2353
	F			2.535	1.048	0.55	1.915	2.731	2.614
	Sig.			0.081	0.352	0.577	0.149	0.066	0.074
	Correlation			.100*				.115*	.110*
				* Correlation is significant at the 0.05 level (2-tailed).					
Career Age	1-3	49	12.13%	4.2194	4.3061	4.1551	4.2092	4.1837	4.051
	3-7	192	47.52%	4.1373	4.1152	4.1118	4.0931	4.0686	3.9779
	7 Above	253	62.62%	4.1245	4.0978	4.0506	4.0682	4.1275	4.0267
	F			0.491	2.16	0.778	1.07	0.571	0.258
	Sig.			0.613	0.117	0.46	0.344	0.565	0.772
Business Establishment Years	2-5	19	4.70%	4.1974	4.1579	4.0842	4.2632	4.1711	4.0789
	6-10	40	9.90%	4.275	4.1938	4.19	4.1188	4.1063	4.0625
	11-20	75	18.56%	4.2167	4.1933	4.016	4.1467	4.08	4.06
	21-30	65	16.09%	4.0808	4.0615	4.0277	4.0192	4.1077	4
	30 Above	205	50.74%	4.0976	4.1085	4.0956	4.0732	4.1354	3.9927
	F			1.218	0.519	0.662	0.801	0.138	0.237
	Sig.			0.302	0.722	0.619	0.525	0.968	0.917
Staff Number Engaging in Technology, R&D	100 Below	69	17.08%	3.9493	4.0725	3.9159	4.0399	4	3.837
	100-200	56	13.86%	4.125	4.1071	4.1036	4.0536	4.0848	4.0938
	200-300	41	10.15%	4.122	4.0244	4.0439	3.9756	3.9939	3.8963
	300-500	59	14.60%	4.1568	4.1314	4.0407	4.0932	4.1441	3.9915
	500-800	37	9.16%	4.0811	4.0743	3.9351	4.0068	4.027	3.9527
	800-1000	30	7.43%	4.325	4.2667	4.2933	4.2667	4.3	4.275
	1000 Above	112	27.72%	4.2299	4.1875	4.1893	4.1652	4.2254	4.1004
	F			2.076	0.695	2.448	1.142	1.715	2.289
	Sig.			0.055	0.654	0.025	0.337	0.116	0.035
	Correlation			.146**	0.076	.137**	0.093	.131**	.122*
				** Correlation is significant at the 0.01 level (2-tailed).					
				* Correlation is significant at the 0.05 level (2-tailed).					
Current Stage of Development of the Business	Entrepreneurial	14	3.47%	4.1429	4.1071	4.0714	4.1964	4.1071	3.9821
	Growth	53	13.12%	4.1934	4.1651	4.0679	4.0613	4.0236	3.9717
	High-Speed	162	40.10%	4.2733	4.2888	4.2497	4.2314	4.2748	4.1941
	Mature	161	39.85%	4.0262	4.0031	3.937	3.9985	4.0463	3.9012
	Bottleneck	14	3.47%	3.6964	3.5893	3.8	3.5714	3.5536	3.5357
	F.			5.456	6.83	6.209	5.863	6.066	6.113
	Sig.			0.000	0.000	0.000	0.000	0.000	0.000
Industry	High-End Equipment Manufacturing	73	18.07%	4.0685	4.0514	4.0658	4.1027	4.1747	4.0993
	Automobile Manufacturing	46	11.39%	4.2283	4.1957	4.1478	4.1413	4.125	4.0489
	Auto Parts Manufacturing	28	6.93%	4.1071	4.1696	4.1429	4.2857	4.2946	4.1786
	Heavy Machinery Manufacturing	10	2.48%	4.175	4.05	4.08	3.975	4.2	4.05
	Appliance Manufacturing	3	0.74%	4.5	4.4167	4.6	4.5	4.5833	4.8333
	Electronic Information	51	12.62%	4.2598	4.1716	4.1961	4.1961	4.1814	4.1471
	New Energy	22	5.45%	4.3977	4.3068	4.0455	4.1591	4.1705	4.0909
	Materials Industry	46	11.39%	4.0815	4.1576	4.1087	4.1359	4.1196	3.9674
	Biopharmaceuticals	36	8.91%	4.0833	4.1458	4.0444	3.9861	4.0069	4
	Other	89	22.03%	4.0646	4.0478	3.9551	3.9382	3.9888	3.7921
	F			0	0	0	0	0	0
	Sig.			0	0	0	0	0	0
Business Nature	State-owned enterprise	272	67.33%	4.1498	4.1369	4.075	4.1029	4.1176	3.9917
	Private enterprise	94	23.27%	4.0984	4.0745	4.0702	4.0585	4.133	4.0718
	Sino-foreign JV/Cooperative enterpri	16	3.96%	4.3594	4.5156	4.3375	4.1875	4.2344	4.25
	Wholly foreign owned enterprise	6	1.49%	4	3.9167	3.8667	3.9583	4	4.0833
	Other	16	3.96%	4.0313	3.9688	4.0125	4.0469	4	3.875
	F			0.84	2.028	0.927	0.275	0.32	0.919
	Sig.			0.501	0.09	0.448	0.894	0.864	0.453