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A SEM Analysis of Factors Influencing Knowledge Sharing among Research Teams in Heilongjiang's Educational Institutions

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ABSTRACT

This study aimed to identify and examine the key factors influencing knowledge transfer within university research teams, develop a structural equation model (SEM) that illustrates the relationships among the identified influencing factors, and propose evidence-based strategies for enhancing the efficiency and effectiveness of knowledge transfer by drawing on the SEM findings and integrating insights from focus group discussions with research team members and policy stakeholders. This research elucidates the relationships among these variables. Drawing from a stratified random sample of 501 valid research teams from public and private universities in Heilongjiang Province, the study integrates both qualitative and quantitative data to assess six latent variables: knowledge characteristics (KC), sharing channels (KSC), sharing environment (KSE), knowledge providers (KP), knowledge recipients (KR), and the level of knowledge sharing (KSL). The SEM results demonstrate in the equation of KSL = 0.81KC + 0.94KSC + 0.95KSE + 1.01KP + 0.86KR, showing all five latent variables positively and strongly influence Knowledge Sharing Level (KSL), with Knowledge Providers being the most influential. Knowledge Sharing Environment and Channels also contribute significantly, while Knowledge Recipients and Knowledge Characteristics have strong supporting roles. These findings underscore the multifactorial nature of knowledge sharing, highlighting the importance of proactive contributors, supportive environments, and effective knowledge absorption mechanisms. It can be applied that factors such as trust atmosphere, leadership support, knowledge integration ability, and knowledge-sharing willingness significantly enhance the efficacy of knowledge exchange. The findings offer practical insights into improving collaborative research practices and advancing institutional innovation capacity. The study concludes by proposing actionable strategies for university administrators and policymakers to foster a more conducive environment for knowledge transfer in academic settings.

Keywords: Knowledge Sharing, Structural Equation Modeling, University Research Teams, Knowledge Transfer

With the ongoing advancement of the knowledge economy, knowledge sharing has become a fundamental driver of technological innovation and societal development (Wang & Wang, 2012). In this context, higher education institutions are central hubs for knowledge creation and dissemination. Among them, university research teams serve as the critical engines for scientific output, innovation, and practical application. Particularly in the education sector, these teams are increasingly engaging in technology transfer and interdisciplinary collaboration, responding to the growing national demand for academic excellence and applied innovation. Despite this progress, research teams face mounting challenges that hinder efficient knowledge sharing. Fragmented communication across disciplines, underdeveloped incentive systems, and the limited exchange of tacit knowledge all restrict the collaborative potential of academic groups (Anders, 2023). As research teams evolve into more interdisciplinary and innovation-driven units, understanding the mechanisms and conditions that support knowledge sharing becomes vital not only to improve the performance and competitiveness of individual teams but also to contribute to the broader development of the knowledge economy and national educational progress (Davenport & Prusak, 1998).
However, the current landscape reveals significant gaps and barriers. First, most research teams operate without a comprehensive framework for analyzing knowledge-sharing dynamics. Prior studies tend to focus narrowly on

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isolated variables, failing to capture the multifaceted nature of knowledge exchange in academic environments (Anders, 2023). Second, disciplinary silos obstruct communication, as variations in vocabulary, methodology, and research paradigms between fields complicate collaboration (Nonaka & Takeuchi, 1995). Third, existing evaluation systems prioritize individual achievements over collaborative contributions, discouraging team-oriented knowledge sharing (Davenport & Prusak, 1998). Fourth, tacit knowledge, deeply embedded in individual experience and difficult to codify, remains underutilized due to the inherent challenges in its articulation and transfer (Polanyi, 1966). Lastly, traditional analytic tools fall short in capturing the complex, multilevel interactions involved in knowledge sharing, limiting the explanatory power of prior research (Hair et al., 2017). These issues underscore the necessity of developing a robust structural framework that integrates interdisciplinary theory, encourages collaborative culture, and utilizes advanced analytical methods such as Structural Equation Modeling (Hair et al., 2017). Doing so will allow for a deeper understanding of knowledge-sharing processes and enable the formulation of targeted strategies to foster innovation. This study, therefore, aims to examine the causal mechanisms influencing knowledge sharing among university research teams, particularly in the education sector, to inform practical interventions and enrich theoretical foundations in knowledge management within academia.

The research objectives are to 1) identify and examine the key factors influencing knowledge transfer within university research teams, including internal team dynamics, organizational culture, knowledge characteristics, and transfer channels, to understand their impact on knowledge flow and absorption, 2) develop a structural equation model (SEM) that illustrates the relationships among the identified influencing factors and to assess the model's validity, fit, and explanatory power regarding knowledge transfer processes, and propose evidence-based strategies for enhancing the efficiency and effectiveness of knowledge transfer by drawing on the SEM findings with research team members and policy stakeholders. Therefore, the research framework can be conducted as shown in Figure 1.

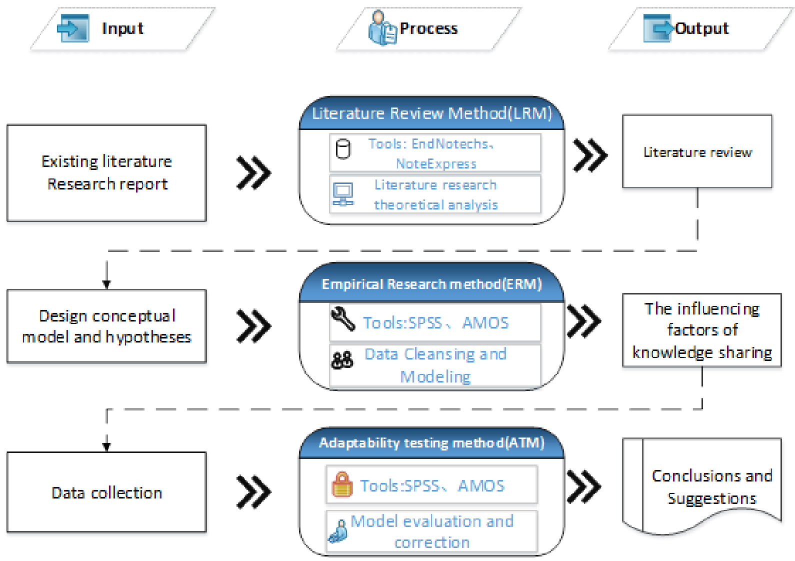

Figure 1: The theoretical research framework

1. LITERATURE REVIEW

The literature on knowledge sharing within academic research teams reveals a dynamic and multifaceted landscape. Knowledge, as a construct, has been variously defined across disciplines, encompassing data, information, experience, values, and contextual understanding (Davenport & Prusak, 1998). From philosophical origins in Plato's notion of knowledge as the pursuit of absolute truth, to cognitive perspectives from Piaget emphasizing its construction through interaction, the evolution of knowledge theory has laid a robust foundation for understanding its transfer. In the field of management science, knowledge is seen not merely as static information but as an evolving resource essential for innovation and decision-making. University research teams serve as vital nodes within the knowledge economy, where sharing practices directly influence research outputs, collaboration, and institutional impact. The nature of knowledge—whether tacit, explicit, complex, or context-dependent—shapes how easily it is

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transferred and absorbed within teams. The need for effective mechanisms and models that capture the unique attributes of knowledge in academic environments has led researchers to explore the antecedents and barriers to sharing within these institutions.

The factors influencing knowledge sharing span multiple dimensions. At the individual level, motivation, trust, and personal attitudes significantly affect willingness to share. Lin (2007) found that both intrinsic and extrinsic motivators, including recognition, career advancement, and altruism, can enhance employees' intention to engage in knowledge sharing. Similarly, transformational leadership has been shown to cultivate an environment conducive to open communication and knowledge exchange (Masa'deh, Obeidat, & Tarhini, 2016; Sirathanakul et al., 2023). At the team level, communication climate, psychological safety, and interpersonal trust play pivotal roles. In academic contexts, hierarchical cultures and competitive publishing norms often inhibit collaboration, reinforcing knowledge hoarding behaviors (Lo & Tian, 2020). At the organizational level, structural factors such as incentive systems, leadership engagement, and institutional culture define the infrastructure that supports or impedes sharing. A study by Nguyen (2020) emphasized that organizational culture amplifies or constrains intrinsic motivations, suggesting that aligning institutional values with individual goals is critical for sustained engagement. Eventually, after studying the related research, the factors influencing the knowledge sharing level can be concluded as shown in Figure 2.

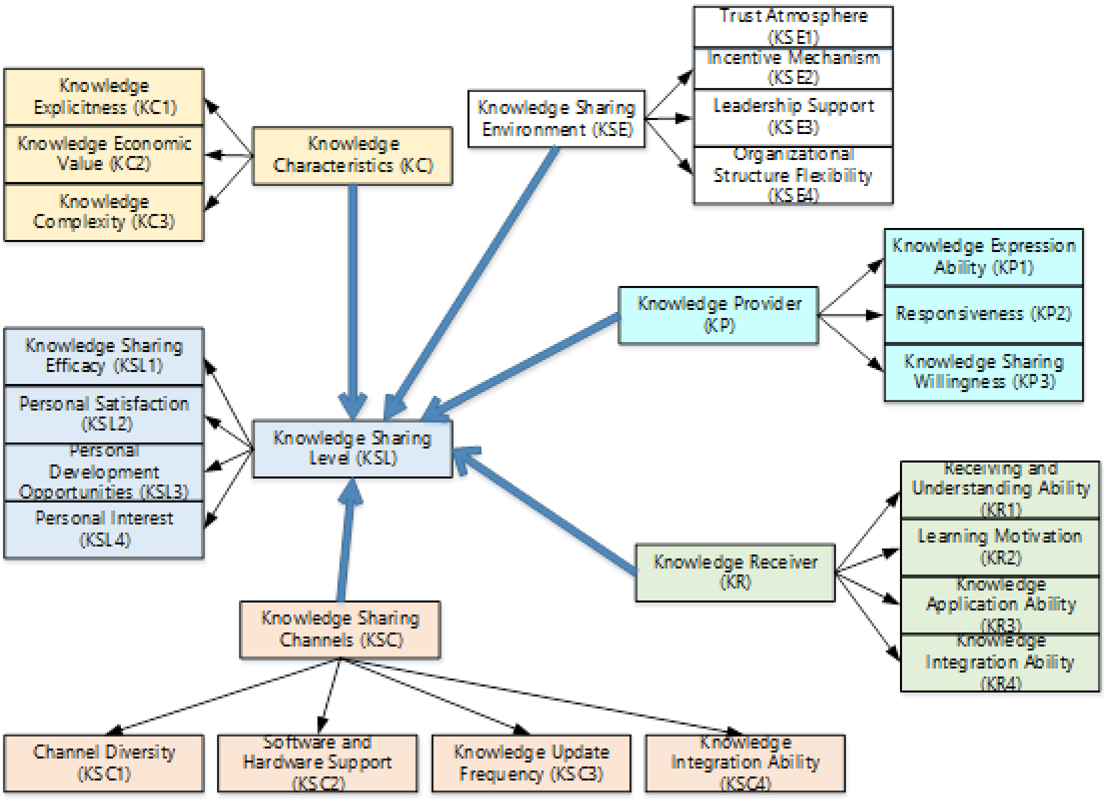

Figure 2: Factors influencing the knowledge sharing level

Figure 2 illustrates a comprehensive conceptual model that identifies and categorizes the key factors influencing the Knowledge Sharing Level (KSL) among university research teams. The model is structured around five core constructs: Knowledge Characteristics (KC), Knowledge Sharing Environment (KSE), Knowledge Provider (KP), Knowledge Receiver (KR), and Knowledge Sharing Channels (KSC), each supported by well-defined sub-variables. Knowledge Characteristics include explicitness, economic value, and complexity of knowledge, which affect the ease and value of sharing. The Knowledge Sharing Environment encompasses organizational trust, incentive mechanisms, leadership support, and flexibility of structure, highlighting the importance of contextual and cultural elements. Knowledge Providers contribute through their expression ability, responsiveness, and willingness to share,

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while Knowledge Receivers are measured by their understanding, motivation, application, and integration abilities—indicating their readiness to absorb and utilize shared knowledge. Meanwhile, Knowledge Sharing Channels are enhanced by the diversity of platforms, technological support, update frequency, and integration capacity, which act as the conduits for transferring knowledge effectively. Central to this model is the Knowledge Sharing Level, the primary dependent variable influenced by these five dimensions. The visual structure of the model reflects both the complexity and interdependence of these factors, offering a multidimensional approach for evaluating and improving knowledge-sharing practices in academic settings. This framework serves as a basis for empirical testing through SEM analysis and offers practical insights for enhancing institutional knowledge management strategies.

Technological tools and platforms further mediate knowledge-sharing behaviors. Digital repositories, collaborative platforms, and cloud-based document sharing systems are now ubiquitous in academic research settings. However, the literature indicates that the presence of technology alone does not guarantee effective sharing. Trust in systems, user competency, and the alignment of technological tools with workflow are essential for meaningful engagement (Almulhim, 2020; Wongmajarapinya et al., 2024). The rise of virtual teams during the COVID-19 pandemic highlighted both the potential and the challenges of online knowledge sharing. Natu and Aparicio (2022) observed that while digitalization increases accessibility, it also necessitates strong self-regulation and clear protocols to avoid information overload or fragmentation. Moreover, the quality of shared content—its accuracy, relevance, and applicability—affects the degree to which knowledge transfer translates into action or innovation. Thus, technological infrastructure must be embedded within a broader knowledge management strategy that includes training, evaluation, and adaptability.

Structural equation modeling (SEM) has become an increasingly popular method for analyzing knowledge sharing behaviors due to its ability to model complex, multivariate relationships. Researchers such as Kline (2015) have advocated for SEM's strength in integrating measurement models (confirmatory factor analysis) with structural models to test causal hypotheses. This approach is particularly valuable in the study of knowledge sharing, which involves latent variables such as trust, commitment, and perceived organizational support. For instance, studies using SEM have validated the role of leadership in shaping psychological climates that encourage sharing, as well as the mediating effects of organizational identification (Luo, 2023). By applying SEM in academic settings, researchers can test the direct and indirect relationships among knowledge providers, recipients, sharing channels, and environmental factors. This methodological rigor allows for a holistic understanding of the knowledge transfer process, providing empirical grounding for theoretical models and actionable insights for institutional improvement.

Emerging literature also reflects a growing interest in the role of cultural and contextual factors in shaping knowledge sharing in universities, particularly in non-Western contexts. In China, Confucian traditions emphasizing hierarchy and face-saving often conflict with Western ideals of egalitarian collaboration. This cultural tension can suppress open dialogue and discourage junior staff or students from contributing ideas (Ho, Kuo, & Lin, 2012). Al Hawamdeh and Al Qatamin (2021) highlight that collectivist values, while promoting team identity, may also limit individual expression unless trust and inclusivity are explicitly nurtured. Additionally, the competitive nature of academic funding and publication creates an environment where knowledge is seen as currency, further complicating sharing behavior. To address these barriers, scholars recommend culturally adaptive strategies, such as role modeling by senior academics, recognition systems for team contributions, and the cultivation of shared goals. Understanding these cultural nuances is vital for designing interventions that resonate with local values and institutional realities.

In summary, the literature affirms that knowledge sharing in university research teams is influenced by a complex interplay of individual, team, organizational, technological, and cultural factors. Motivation, trust, and leadership are consistently identified as central enablers, while barriers include weak incentive structures, disciplinary silos, and misaligned technologies. Structural equation modeling provides a robust analytical tool for exploring these interdependencies, enabling the construction of predictive models that inform strategic decisions. However, the effectiveness of such models depends on their sensitivity to contextual and cultural variables, particularly in regions like China where traditional norms and emerging reforms coexist. Moving forward, research must integrate qualitative and quantitative approaches to capture the full spectrum of knowledge sharing dynamics, and universities must commit to building environments that value transparency, inclusivity, and continuous learning. Only then can knowledge truly become a shared asset that drives innovation and societal advancement in higher education.

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2. METHODOLOGY

The study targets university science and technology research teams in Heilongjiang Province, an educational hub in Northeast China that hosts 39 undergraduate universities. These universities, ranging from public institutions like Harbin Institute of Technology and Northeast Agricultural University to private colleges such as Heilongjiang International University, provide a rich environment for academic inquiry. The research teams from these universities are characterized by diverse professional backgrounds, offering a representative landscape for investigating the factors influencing knowledge sharing. This variety ensures a more generalized understanding of knowledge-sharing dynamics across academic disciplines, institutional cultures, and organizational structures. The population comprises approximately 1,000 research teams, making them feasible to draw from a wide cross-section of contexts for robust analysis.

The study employed a stratified sampling strategy to capture proportional representation across public and private universities. A multi-stage approach was adopted to ensure both diversity and manageability of data collection. The sampling unit focused on research teams rather than individuals, with key informants including team leaders, senior researchers, and project coordinators, each selected based on their tenure, involvement in collaborative research, and publication history. A total of 501 valid responses were obtained for the quantitative component. This sampling strategy ensured triangulation of perspectives and enhanced the validity of findings.

The research followed a mixed-methods design, employing both quantitative and qualitative techniques. Quantitatively, data were collected using a structured questionnaire developed through literature review and expert validation. Variables such as knowledge providers, recipients, sharing environments, channels, and knowledge characteristics were operationalized using multi-item Likert-scale measures. The data were analyzed using Structural Equation Modeling (SEM) via AMOS to test the causal relationships and validate the hypothesized model. For the qualitative component, semi-structured interviews were transcribed and analyzed using content analysis through coding, theme extraction, and validation against literature to complement and deepen the quantitative results. The integration of methods provided a comprehensive understanding of the mechanisms underlying knowledge sharing in university research teams.

3. RESEARCH RESULTS

This section is quantitative-method results, respectively. Meanwhile, the first part consists of general information about the respondents, the results of factors, the analysis results, and the structural equation model of factors influencing knowledge sharing among research teams in Heilongjiang's Educational Institutions.

3.1 The results of general information about the respondents: The results were collected from 501 valid respondents in Heilongjiang's Educational Institutions. The results were about types of university, educational background, fields of study, team size, ages, position in the team, tenure in the team, and gender, respectively. The results are shown in Table 1.

Table 1 *General information about the respondents*

General information	Number of respondents (n=501)	Percentage (%)
University Type		
Private	254	50.70
Public	247	49.30
Educational Background		
Bachelor	45	8.98
Master	351	70.06
Doctorate and above	105	20.96
Fields of Study		
Liberal Arts	54	10.78
Science	214	42.71
Engineering	153	30.54
Interdisciplinary	79	15.77
Others	1	0.20

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Team Size		
Less than 10 members	97	19.36
11-20 members	235	46.91
21-30 members	132	26.35
More than 30 members	37	7.39
Age		
Less than 29 years old	21	4.19
30-39 years old	67	13.37
40-49 years old	284	56.69
50-59 years old	93	18.56
60 years old and above	36	7.19
Position in the team		
Research Assistant	36	7.19
General Researcher	135	26.95
Key Research Personnel	255	50.90
Tenure in the team		
Less than 5 years	47	9.38
5-10 years	66	13.17
11-15 years	195	38.92
16-20 years	117	23.35
More than 20 years	76	15.17
Gender		
Male	260	51.90
Female	241	48.10

Table 1 presents the general information of 501 respondents from educational institutions in Heilongjiang. More than half were from private universities, 50.70%, with the majority holding a master's degree, 70.06%. Most respondents specialized in science, 42.71%, and engineering, 30.54%. Teams typically had 11–20 members, 46.91%. Respondents were mostly aged 40–49 years, 56.69%, and held key research positions, 50.90%. Nearly 39% had 11–15 years of tenure in their teams, and 51.90% of respondents were male. These demographics reflect a highly educated, mid-career cohort engaged in substantial research activity.

3.2 The results of factors influencing knowledge sharing among research teams in Heilongjiang's universities are shown in Table 2.

Table 2 *Mean, standard deviation, and variance of factors influencing knowledge sharing among research teams in Heilongjiang's universities*

Factors	Mean	S.D.	Variance
Knowledge Sharing Efficacy (KSL1)	4.60	.704	.496
Personal Satisfaction (KSL2)	4.54	.696	.484
Personal Development Opportunities (KSL3)	4.56	.703	.494
Personal Benefits (KSL4)	4.68	.704	.495
Explicitness of Knowledge (KC1)	4.53	.697	.485
Economic Value of Knowledge (KC2)	4.55	.660	.436
Complexity of Knowledge (KC3)	4.69	.627	.393
Diversity of Sharing Channels (KSC1)	4.56	.698	.487
Software and Hardware Support (KSC2)	4.52	.728	.530
Frequency of Knowledge Updates (KSC3)	4.60	.696	.484
Knowledge Integration Ability (KSC4)	4.58	.715	.511
Trust Atmosphere (KSE1)	4.61	.698	.487
Incentive Mechanisms (KSE2)	4.46	.805	.649

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Leadership Support (KSE3)	4.60	.707	.500
Flexibility of Organizational Structure (KSE4)	4.63	.730	.532
Knowledge Expression Ability (KP1)	4.56	.701	.491
Responsiveness (KP2)	4.55	.678	.460
Willingness to Share Knowledge (KP3)	4.67	.670	.449
Reception and Understanding Ability (KR1)	4.53	.702	.493
Learning Motivation (KR2)	4.55	.664	.440
Knowledge Application Ability (KR3)	4.55	.678	.460
Knowledge Integration Ability (Receiver) (KR4)	4.59	.700	.489

There are 6 latent factors, six latent variables: knowledge characteristics (KC), sharing channels (KSC), sharing environment (KSE), knowledge providers (KP), knowledge recipients (KR), and the level of knowledge sharing (KSL). Table 2 presents descriptive statistics for six main factors influencing knowledge sharing: knowledge sharing level, knowledge characteristics, sharing channels, sharing environment, knowledge providers, and knowledge recipients. For the knowledge sharing level, the highest mean was recorded for personal benefits at 4.68, followed by knowledge sharing efficacy at 4.60, indicating that individual incentives and perceived gains strongly influence participation in knowledge sharing. Personal development opportunities and satisfaction also scored high, reflecting those personal motivations are central to the overall sharing behavior.

In the category of knowledge characteristics, the complexity of knowledge had the highest mean of 4.69, suggesting that respondents recognize the intricacy of the knowledge they work with. The economic value of knowledge followed with a mean of 4.55, while explicitness of knowledge, though still relatively high at 4.33, had the lowest score among this group, pointing to potential challenges in clarifying and articulating knowledge effectively.

Sharing channels were evaluated across four sub-factors, where frequency of knowledge updates and diversity of sharing channels both achieved a mean of 4.60, underscoring the importance of consistent and varied dissemination methods. Software and hardware support received a slightly lower mean of 4.52, and flexibility of organizational structure showed the highest score in this category at 4.63, emphasizing the role of adaptable environments in facilitating knowledge exchange.

Within the knowledge sharing environment, trust atmosphere and leadership support scored highly at 4.61 and 4.60, respectively, revealing their importance in creating a climate conducive to sharing. Incentive mechanisms had a slightly lower mean at 4.46, suggesting that formal rewards or structures might not yet be fully optimized. Nonetheless, the environment overall appears supportive and well-perceived by the participants.

Knowledge providers were rated on knowledge expression ability, responsiveness, and willingness to share knowledge. Willingness to share emerged as a dominant trait with a mean of 4.67, indicating strong commitment from providers. Responsiveness and expression ability also scored well above 4.50, highlighting their readiness and capability to convey knowledge effectively.

For knowledge recipients, knowledge integration ability had the highest mean at 4.59, followed by reception and understanding ability at 4.53. Learning motivation and knowledge application ability also scored similarly at 4.55, demonstrating that recipients are generally motivated, capable, and willing to absorb and apply the knowledge shared. Collectively, these results confirm that each factor plays a vital role in fostering a successful knowledge-sharing environment within research teams.

3.3 The analysis results and the structural equation model of influencing knowledge sharing among research teams in Heilongjiang's universities, based on the estimation results shown in Figure 3.

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Figure 3 *Structural equation model analysis of factors influencing knowledge sharing among research teams in Heilongjiang's universities*

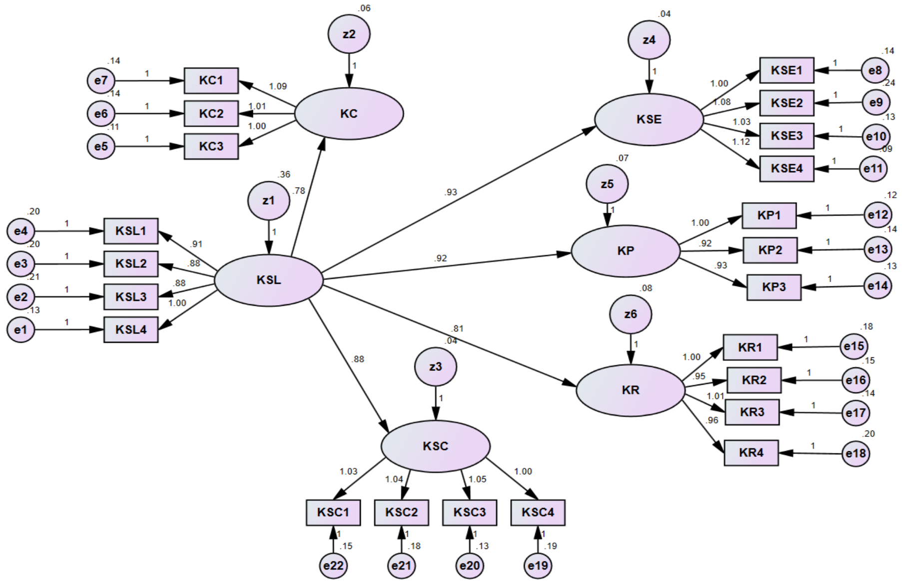

Figure 3 presents the structural equation model depicting the causal relationships between five latent variables—Knowledge Characteristics (KC), Knowledge Sharing Channels (KSC), Knowledge Sharing Environment (KSE), Knowledge Providers (KP), and Knowledge Recipients (KR)—and their influence on Knowledge Sharing Level (KSL) among research teams in Heilongjiang universities. The standardized path coefficients indicate that KP has the strongest positive effect on KSL with a coefficient of 0.93, followed by KSE at 0.92, KR at 0.91, KSC at 0.88, and KC at 0.78. Each latent variable is measured through multiple indicators with factor loadings ranging from 1.00 to 1.13, showing strong relationships between observed and latent constructs. This model emphasizes the multidimensional nature of knowledge sharing, with particular emphasis on provider behavior and environmental support.

The results of the structural equation model analysis of factors influencing knowledge sharing among research teams in Heilongjiang's universities were checked with the model fit index shown in Table 3.

Table 3 *Model fit index of the pre-modifying model of factors influencing knowledge sharing among research teams in Heilongjiang's universities*

Index	Criteria	Scores	Results
χ^2 Test	p>0.05	0.017	Not Acceptable
CFI	≥0.95	0.922	Acceptable
GFI	≥0.90	0.830	Not Acceptable
AGFI	≥0.90	0.789	Not Acceptable
TLI	≥0.90	0.911	Acceptable
RMSEA	<0.08	0.086	Acceptable (Marginal)
RMR	<0.80	0.022	Acceptable

Table 3 shows the model fit indices for the pre-modified structural model. The Chi-square (χ^2) test yielded a p-value of 0.017, which is below the acceptable threshold of 0.05, suggesting that the model does not achieve a perfect fit. However, other indices present a mixed picture. The Comparative Fit Index (CFI) is 0.922, and the Tucker-Lewis Index (TLI) is 0.911, both close to the desired threshold of ≥0.95 and indicating a good fit. The Goodness-of-Fit Index (GFI) scored 0.830, and the Adjusted Goodness-of-Fit Index (AGFI) scored 0.789, both of which are below the acceptable cutoff of ≥0.90, suggesting some limitations in overall model adequacy. The Root Mean Square Error of

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Approximation (RMSEA) was 0.086, slightly above the recommended maximum of 0.08, indicating a marginal fit. Nevertheless, the Root Mean Square Residual (RMR) was 0.022, well within the acceptable range of <0.08, demonstrating low residual error. In summary, while the model shows a reasonably good fit in some metrics, it requires modification to improve overall validity and consistency with the data.

Overall, the model demonstrates a fair but improvable fit, warranting potential adjustments for stronger model validity, therefore, the model must be modified.

After modifying the Optimized Structural Equation Model, the structural equation model above didn't pass the criteria of the model fit indices, so the model was modified repeatedly until the results passed the modification indices. The results of the model and its model fit index are shown in Figure 2 and Table 4 below.

Figure 4 *Optimized Structural Equation Model of factors influencing knowledge sharing among research teams in Heilongjiang's universities*

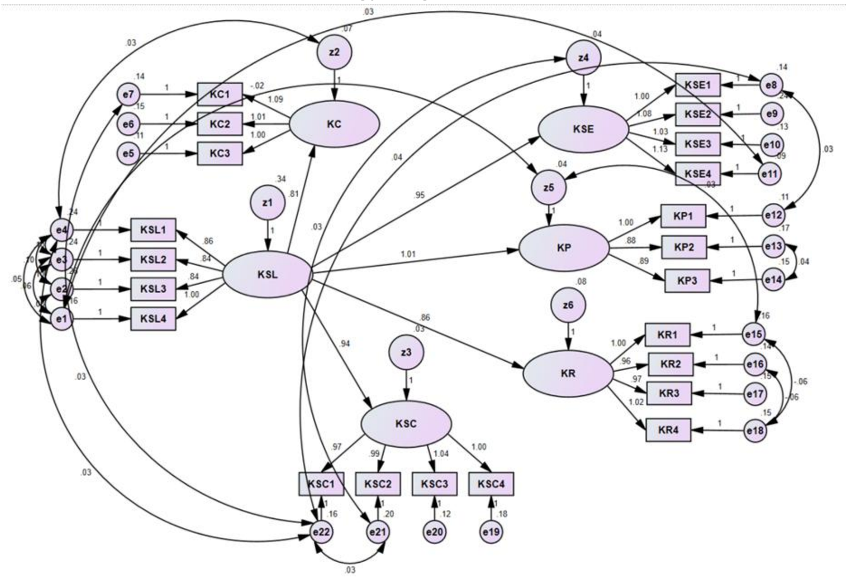

Figure 4 illustrates the modified structural equation model for the factors influencing knowledge sharing among research teams in Heilongjiang's universities. This revised model refines the relationships between the five exogenous latent variables and the endogenous latent variable. The standardized path coefficients show that KP has the strongest direct influence on KSL with a value of 1.01, followed by KSE at 0.95, KR at 0.86, KSC at 0.94, and KC at 0.34. Each latent construct is measured using several observed indicators, with factor loadings ranging from 0.97 to 1.13, reflecting high internal consistency and strong validity of the measurement model. Compared to the pre-modified version, this revised model exhibits enhanced structure, allowing for improved explanation of knowledge sharing behavior. It demonstrates that all five factors contribute significantly, and the overall model accounts for a substantial amount of variance in the knowledge sharing construct.

Table 4 *Model fit index of the after-modifying model factors influencing knowledge sharing among research teams in Heilongjiang's universities*

Index	Criteria	Scores	Results
χ^2 Test	p>0.05	0.430	Acceptable
CFI	≥0.95	0.977	Excellent
GFI	≥0.90	0.928	Acceptable
AGFI	≥0.90	0.902	Acceptable
TLI	≥0.90	0.971	Excellent
RMSEA	<0.08	0.049	Good Fit
RMR	<0.80	0.013	Good Fit

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Table 4 summarizes the model fit indices for the after-modifying model. The Chi-square (χ^2) test yields a p-value of 0.430, which exceeds the minimum threshold of 0.05, indicating a statistically acceptable model fit. The Comparative Fit Index (CFI) is 0.977, exceeding the recommended value of 0.95, and shows excellent model fit. The Goodness-of-Fit Index (GFI) stands at 0.928, surpassing the acceptable threshold of 0.90. Similarly, the Adjusted Goodness-of-Fit Index (AGFI) is 0.902, indicating strong model fit when adjusted for model complexity. The Tucker-Lewis Index (TLI) is 0.971, further confirming that the revised model fits the data well. The Root Mean Square Error of Approximation (RMSEA) is 0.049, comfortably below the cut-off of 0.08, showing good approximation in the population. Lastly, the Root Mean Square Residual (RMR) is 0.013, well below the threshold of 0.80, indicating a minimal average residual. All fit indices in Table 4 meet or exceed recommended values, confirming that the post-modified model offers excellent fit and represents a valid and reliable structure for explaining knowledge sharing behavior.

Moreover, the revised structural equation model demonstrates a strong and well-fitting framework for understanding the factors influencing knowledge sharing among research teams in Heilongjiang's universities. The structural equation can be represented as:

$$\mathbf{KSL = 0.81KC + 0.94KSC + 0.95KSE + 1.01KP + 0.86KR}$$

Furthermore, the equation analysis of the structural equation model (SEM) for factors influencing knowledge sharing among research teams in Heilongjiang's universities can be described as follows:

1. KP (Knowledge Providers, $\beta = 1.01$): This is the strongest predictor, meaning the behaviors, competencies, and willingness of individuals who share knowledge significantly impact the overall level of knowledge sharing. Empowering providers through incentives, recognition, and skill development is critical.
2. KSE (Knowledge Sharing Environment, $\beta = 0.95$): A collaborative, trusting, and well-supported environment strongly enhances sharing. Leadership support, a culture of openness, and transparent communication channels as the key elements.
3. KSC (Knowledge Sharing Channels, $\beta = 0.94$): The availability, diversity, and usability of communication and technology platforms directly affect how efficiently knowledge flows. Investing in user-friendly digital tools and standardized documentation systems improves effectiveness.
4. KR (Knowledge Recipients, $\beta = 0.86$): The absorptive capacity, learning motivation, and comprehension abilities of recipients are also essential. Recipients need training in listening, synthesizing, and applying shared knowledge to maximize the benefit.
5. KC (Knowledge Characteristics, $\beta = 0.81$): The explicitness, relevance, and complexity of knowledge impact sharing. The more organized and understandable the content, the more easily it can be shared and applied.

4. The application of the SEM for knowledge sharing among research teams in Heilongjiang's universities

To enhance the effectiveness of knowledge sharing among university research teams, it is essential to translate the findings from the structural equation model into actionable strategies. The model shows five critical factors: knowledge providers, sharing environment, sharing channels, recipients, and knowledge characteristics, influencing knowledge sharing levels significantly. The following suggestions offer targeted, evidence-based approaches to strengthen each factor and promote a collaborative, innovative research culture.

1. Training and Development for Providers: Prioritize workshops and incentives to enhance expression, responsiveness, and willingness to share knowledge. Since KP has the highest impact, even small improvements yield large results.
2. Strengthen Knowledge Sharing Environment: Encourage leadership to create trust-based cultures, ensure recognition for collaborative efforts, and design policies that reward sharing, not just individual achievement.
3. Invest in Sharing Infrastructure: Develop centralized digital platforms, encourage cross-platform integration, and provide technical support to maximize the effectiveness of KSC.
4. Empower Recipients: Offer seminars on critical thinking, synthesis skills, and domain literacy so that knowledge recipients can absorb and apply what they receive.
5. Enhance Content Quality: Promote the usage of templates, visual aids, and simplified documentation for making complex knowledge more accessible and shareable.

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This equation provides a diagnostic and strategic framework for university administrators and team leaders to enhance a knowledge-sharing culture, which in turn boosts research output, innovation, and institutional competitiveness.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study constructed and validated a structural equation model to investigate the key factors influencing knowledge sharing among university research teams within the education industry. The model incorporated five primary latent variables: Knowledge Characteristics (KC), Knowledge Sharing Channels (KSC), Knowledge Sharing Environment (KSE), Knowledge Providers (KP), and Knowledge Recipients (KR), with Knowledge Sharing Level (KSL) as the dependent outcome. The empirical findings, supported by SEM analysis, revealed that all five variables exert a strong and statistically significant positive influence on KSL. Specifically, KP emerged as the most influential factor, with a path coefficient of 1.01, underscoring the critical role of providers' competencies, willingness, and communication abilities. KSE and KSC followed closely, with coefficients of 0.95 and 0.94, respectively, highlighting the importance of a supportive organizational culture and the availability of diverse and effective knowledge-sharing mechanisms. KR and KC also contributed meaningfully, suggesting that absorptive capacity and the intrinsic qualities of knowledge significantly affect sharing outcomes. These findings align with prior literature emphasizing the importance of internal motivation, communication, and institutional environments in facilitating knowledge exchange (Nonaka & Takeuchi, 1995; Park & Kim, 2018; Raza & Awang, 2020). Besides, this study's emphasis on the role of environmental and interpersonal dynamics in knowledge sharing by adapting their SEM structure and validation methods reinforces the reliability of these findings, and can hand to the stakeholders' practical strategies for enhancing institutional knowledge flows practically that is relevant to the socio-cultural factor (Wang, et al. 2025). Moreover, the study expands on the SECI and five-stage knowledge transfer models by integrating quantitative evidence through SEM, providing a robust analytical framework for academic settings. The strong model fit indices and reliability metrics affirm the model's empirical rigor and theoretical validity. From a practical standpoint, the research provides valuable insights for academic institutions aiming to improve research productivity and innovation by emphasizing capacity building for knowledge providers, fostering organizational trust and support, and enhancing technical infrastructures for knowledge dissemination. By bridging theoretical constructs with empirical validation, this study contributes to the advancement of knowledge sharing theory and to actionable strategies for educational policy and research team management. Future research should explore longitudinal data and cross-cultural validation to broaden the model's applicability and ensure sustained innovation in university research ecosystems.

5.2 Recommendations

5.2.1 Recommendations for applying the model to stakeholders: To effectively apply the proposed model of knowledge sharing, universities and stakeholders must prioritize six key strategies. First, enhancing the capabilities of knowledge providers is essential; institutions should offer targeted training programs that strengthen researchers' skills in communication, responsiveness, and knowledge articulation, especially since knowledge providers demonstrated the strongest influence on knowledge sharing levels. Second, creating a supportive sharing environment is critical; academic leaders must foster a culture of trust, openness, and collaboration by implementing leadership support structures and fair reward systems. Third, institutions should modernize and unify their digital infrastructures, such as research databases, knowledge repositories, and collaboration platforms, to streamline and facilitate efficient knowledge exchange. Fourth, interdisciplinary collaboration should be actively encouraged through cross-functional projects and integrated research initiatives, allowing knowledge to be shared beyond disciplinary boundaries. Fifth, motivating knowledge recipients through workshops and capacity-building programs will improve their ability to absorb, integrate, and apply effectively shared knowledge. Finally, standardizing knowledge documentation practices using templates and structured archiving methods will enhance the clarity and usability of complex information, supporting better knowledge management and institutional memory across research teams. These strategies collectively enable a more robust and effective knowledge-sharing culture within academic institutions.

5.2.2 Recommendations for further study: To build upon the validated knowledge-sharing model, future research studies should consider several strategic directions. Long-term research methods are important for observing how

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knowledge-sharing behaviors and their influencing factors change over time in academic research teams, which provides a deeper understanding of these changes. Cross-cultural comparative studies should be conducted to examine the model's applicability across different institutional and cultural contexts, such as Western universities or other Chinese provinces, enhancing its generalizability. The role of digital transformation also warrants investigation, particularly how advanced technologies like artificial intelligence, big data analytics, and blockchain shape knowledge-sharing systems and collaboration structures. Expanding stakeholder perspectives by including postgraduate students, external research collaborators, and higher education policymakers can provide a more holistic understanding of knowledge transfer mechanisms and challenges. Furthermore, examining mediating and moderating variables, such as organizational commitment, funding levels, or team size, can enrich the model and reveal complex interaction effects. Lastly, incorporating tacit knowledge dynamics into future studies is crucial, especially in science and technology fields where unarticulated experiential knowledge plays a central role. Understanding how tacit knowledge is shared, codified, and leveraged could greatly improve academic collaboration and innovation outcomes.

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