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# The Influencing Factors of the Technology Standard Alliance Collaborative Innovation of Emerging Industry

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**Abstract:** As the important carrier for patent sharing, joint creation and application promotion, the industrial technology standard alliance has increasingly become the main organization pattern for technology standardization around the world. Particularly, technology standard alliance collaborative innovation is more conducive to accelerate the independent innovation pace and technology standard internationalization process of emerging industries in China. Based on analyzing the connotation, characteristics and influencing factors of technology standard alliance collaborative innovation, this paper puts forward the research hypothesis and theoretical framework of alliance collaborative innovation, and then uses a questionnaire survey and a Structural Equation Model to test the influencing factors and their effect path through 196 technology standard alliance enterprises samples. The results indicate that compared with strategy collaboration and process collaboration, patent collaboration has more significant positive impacts on alliance innovation performance; further, resource integration, knowledge sharing and revenue distribution, become the main influencing factors of alliance collaborative innovation. Finally, this paper proposes the mechanism framework of technology standard alliance collaborative innovation, which provides effective reference for strengthening the technology standard alliance collaborative innovation management of emerging industry.

**Keywords:** technology standard alliance; collaborative innovation; emerging industry; strategy collaboration; process collaboration; patent collaboration

## 1. Introduction

With the rapid development of the new technology revolution and knowledge economy, the competitive landscape of global technology innovation is not only limited to product and technology competition, but also extended to technology standard competition around independent intellectual property rights [1–3]. The technology standard has become a powerful tool for industrial innovation and competition in the world. Mastering the technology standard means to master the initiative and even the control right in the competition. Particularly in the emerging industry, the technology standard is of great overall strategic significance [4–6]. Emerging industries, based on major technological breakthroughs and major development needs, play an important role in guiding and driving the overall economic society and its sustainable development [7]. Since the 1980s, the world's emerging industry presents the development trend of technology integration, systematization and networking. In a specific area of emerging industry, such as the new generation of mobile communication networks, hybrid electric vehicles, multiple technologies, multiple products and multiple services constitute

a complex integration system, which can only be at the maximum efficiency when the system's elements are mutually compatible and connected to each other. The technology standard makes this possible. However, the emerging industrial technologies have obvious characteristics such as complexity, integration, high-end frontier, etc. [8], their technology standards are still immature and urgently need cooperative research and development (R&D) as well as collaborative promotion. The industrial technology standard alliance is a typical organization form for formulating and promoting a specific industrial technology standard, in which the industrial leading enterprises and affiliated enterprises as well as the universities and research institutes will join up to put together their own patents, proprietary technologies, copyrights, trademarks, technical know-how and other intellectual property rights into the "patent pool" through a series of agreements and contracts, and establish a formal organization in charge of the unified development, certification, licensing and other operation management of the "patent pool" [9,10]. The patent pool creates a license income system based on exclusive patent for alliance partners with "technology patenting, patent standardization and standard internationalization". It is beneficial to eliminate the licensing obstacles in patent implementation through interests sharing among alliance partners, and effectively promote the innovation enthusiasm of alliance partners. Those alliance members with licensing barriers and rights abuse in patent implementation, are bound to exit the patent pool because of excessive rights abuse constituting illegal monopoly, finally drowned in the wave of technology standard competition [11]. The technology standard is a kind of normative document which is formulated and approved by the alliance standards committee according to the prescribed procedures, including the qualitative description of main technology function and the quantitative specification of the main technical parameter index, which provides rules for industrial technology innovation activities and can be reused within the alliance [12]. The technology standard alliance is a typical kind of industry alliance formed by the interaction and connection of various innovation cooperative relations. It focuses on standard technology research and development, technology patenting, patent standardization and technology standard industrialization, taking industry related technologies as link and jointly advancing technology standard formulation and promotion as goal. For example, the foreign GSM Alliance, Bluetooth SIG, Wi-Fi Alliance, MPEG-2 Alliance, etc., and China's TD-SCDMA Alliance, IGRS Alliance, AVS Alliance, RFID Alliance, etc., have achieved patent sharing and joint creation through multi-agent cooperation, and promoted technology standard development and application to accelerate technology standardization progress [13,14]. It follows that the industrial technology standard alliance has become the main mode of technology standardization around the world.

The collaborative innovation of the technology standard alliance has great significance to accelerating the independent innovation pace and technology standard internationalization process of emerging industries. "Synergy" in systems science refers to the mutual cooperation and interaction between system elements or subsystems, which makes the whole system from disorder to order, finally form a stable state and amplification effect [15]. Based on the common interests of all parties, taking resource sharing and complementary advantages as the premise, collaborative innovation can promote the effective integration of innovation elements by reasonable work division to achieve overall synergetic effects through complex nonlinear interaction [16,17]. The technology standard alliance collaborative innovation of emerging industry requires the standardization leading enterprises, associated enterprises, participating enterprises and universities as well as research institutes within the alliance to input their superior resources and capabilities, and then carry out cooperation innovation and coordinated development around a series of processes including standard research and development, industrialization and marketization. It depends on the synergy and competition of the elements such as strategy, objective, main body, resources, environment, etc., and becomes apparent under the effective support of government, standardization organizations, industry associations and other relevant organizations, which could jointly promote and enhance the innovation performance and competitive advantages of the industrial technology standard alliance.

In view of the above, this paper studies the influencing factors of technology standard alliance collaborative innovation of emerging industry, aiming at identifying the key elements and their interactions of alliance collaborative innovation. It provides theoretical guidance and effective reference for establishing systematic, scientific management methods of alliance collaborative innovation, which has important practical significance for further improving the alliance collaborative innovation performance and accelerating the technology standardization process of emerging industry.

## 2. Literature Review

The technology standard alliance refers to an alliance organization in which multiple owners of standard-related technologies or patents integrate the patented technologies into the perfect technology standard through sharing technology with each other, and uniformly license the patents outward [18,19]. Taking the standard formulation and application promotion as the fundamental goal, the technology standard alliance is beneficial to promote the exchange of patents and technical information or know-how other than patents, spread the research and development risks, and reduce the costs of patent licensing transactions inside and outside the alliance [20]. Collaborative innovation of the technology standard alliance is a cycle process with multi-agent participation and multi-stage operation, influenced by many factors. So far, domestic and foreign scholars mainly study the influencing factors of alliance collaborative innovation from the perspectives of social networks, knowledge management, partner selection and relationship and so on.

Based on the social network perspective, Gloor et al. (2008) revealed the positive role of the collaborative innovation network structure in the cooperation process by studying the relationship between social network structure and individual as well as organizational performance [21]. Knowledge sharing in interorganizational networks, institutional networks and internetworks is an important factor affecting collaborative innovation [22,23]. Brennan et al. (2010) pointed out that the collaborative innovation network mode could provide more efficient services for multi agents through the cooperation relationship among the multiple stakeholders [24]. Davis and Eisenhardt (2011) indicated that efficient collaborative innovation involves not only multiple alliances, but also the cooperative complementarities among alliance partners [25]. Chen et al. (2013) found out that the interdependence and interaction among various components in the supply chain network structure are the important factors for promoting internal collaborative innovation [26].

Based on the knowledge management perspective, Wu and Gu (2012) thought that knowledge collaboration is the necessary approach to improve the collaborative innovation ability of the industry–university–research alliance, while knowledge sharing and knowledge innovation are the key elements for the successful operation of alliance collaborative innovation [27]. Bucic and Ngo (2012) believed that knowledge-based competition is the main reason leading to collaboration between cooperative partners or even competitors [28]. Luo et al. (2016) constructed the theoretical analysis framework of "relationship coupling–process interaction–knowledge aggregation" of industry–university alliance organizational synergy [29]. The important indication of the innovation output and innovation capability of the industrial technology standard alliance is the ownership and the autonomy of intellectual property rights [30,31]. Technological standards are increasingly becoming the key to alliance innovation management. Starting with the technology standards development process legally in the United States, Hemphill and Tommas (2007) explored the impact of technology standards on innovation progress during the development process and put forward that participants and information technology are important factors affecting the collaborative innovation of the technology standard alliance [32]. Wang et al. (2015) concluded that the patent licensing scheme, patent revenue distribution, patent identification and evaluation have the most significant effect on the patent collaboration of the technology standard alliance through multiple-regression analysis [33].

Meanwhile, some other scholars have studied alliance innovation performance. The ability difference and the relationship between alliance partners are the important factors affecting alliance performance [34]. Lee et al. (2013) thought that matching process of enterprises with different

industrial alliance organizations would have different impacts on their innovation performance due to technological innovation level differences [35]. Lavie et al. (2012) studied the effect of organizational differences between alliance partners on alliance performance [36]. Heimeriks and Duysters (2007) uncovered how differences in sources of alliance capabilities explain performance heterogeneity [37]. Luo and Deng (2009) proposed that the benefits and costs brought about by the similarity between alliance partners should be simultaneously balanced for alliance establishment and innovation performance improvement [38]. As to the conditions for joining technology standard alliance, cooperation willingness is the basis for alliance partner selection. However, it is clear that the similarities and differences between knowledge, technology, capacity, resources and organizational and cultural characteristics between alliance members should be considered and balanced comprehensively. With patent network evolution, alliance partners have to devote themselves to technology standard development and promotion as well as resource sharing and knowledge collaboration with alliance members [39,40]. Knowledge sharing, learning and transfer in alliance are beneficial to reducing technology standard innovation cost especially the risk from technology uncertainty and market uncertainty, improving alliance innovation performance [41]. Moreover, Faems et al. (2012) suggested that large-scale, centralization and customized management of alliance portfolios would affect alliance innovation performance [42]. Lin et al. (2012) studied the influence of the three indexes including the proportion of R&D alliances in alliance portfolios, technology distance and R&D intensity on alliance performance [43], which showed that alliance performance would reach a peak when both the technology distance between alliance partners and the proportion of R&D alliances in alliance portfolios were at a medium level. In addition, Faems et al. (2007) proposed an interfirm knowledge transfer model in R&D relationships [44]. Based on the assumptions of Hitt et al. (2002) and Palmer and Barber (2001), as well as the relevant views of other scholars, Galati and Bigliardi (2019) explored the impact of social capital, governance relationship and alliance scope on innovation performance from a comprehensive perspective [45–47].In summary, domestic and foreign scholars have conducted a lot of research on the collaborative innovation of the industry–university–research alliance, but there is still a lack of systematic research on the influencing factors of the technology standard alliance collaborative innovation of emerging industry. The technology standard alliance of emerging industry not only has features of high investment, high risks and uncertainties as emerging technologies, but also the characteristics of leading, strategic and property rights as technology standards, as well as the diversification behavior pattern such as multi-agent negotiation and cooperation game. Therefore, the alliance strategy goal, innovation process, patent collaboration and so on should be considered comprehensively for the collaborative innovation management of the technology standard alliance. On the basis of a literature review and concept definition, this paper first proposes the theoretical framework and research hypothesis for the factors influencing the technology standard alliance collaborative innovation of emerging industry, then measures the effect path of influencing factors on alliance innovation performance, and finally puts forward the strategies and suggestions for establishing the collaborative innovation mechanism of the technology standard alliance, which has great significance to improving the collaborative innovation management level of the technology standard alliance of emerging industry.

## 3. Theoretical Framework and Hypotheses

The essence of the technology standard alliance collaborative innovation of emerging industry is a joint value creation process through communication interaction and resource integration between different innovation bodies such as enterprises, universities, research institutes, governments, standardization organizations and intermediaries, etc. [48,49]. The technology standard alliance collaborative innovation of emerging industry is influenced by many factors, while there is not strict corresponding relation but a kind of nonlinear mapping relationship between influencing factors and innovation performance. This complex correlation affects the effectiveness of the technology standard alliance collaborative innovation of emerging industry [50]. Based on analytical paradigm

"elements–conduct–performance" analytical paradigm, this paper constructs the influencing factors model of the technology standard alliance collaborative innovation of emerging industry and then further illuminates the key elements of alliance collaborative innovation and their influencing mechanism on alliance innovation performance.

### *3.1. Synergy Elements at the Strategic Level*

Strategic collaboration is the premise and basis for the technology standard alliance collaborative innovation of emerging industry. The technology standard alliance is the sum of all the relationship paradigms formed by the strong and weak connections between all the alliance members [51,52]. Strategic collaboration is embedded in the complex alliance innovation network [53,54]. Based on the evolution characteristics and law of strategic objectives, alliance culture, technology difference and cooperation mode of alliance collaborative innovation, the alliance can continuously absorb the internal and external advantageous resources and accumulate collaborative innovation experience in an open and dynamic network relationship, which is beneficial to accelerating alliance collaborative innovation, improving its technology standardization capabilities, and realizing the overall strategic goal of alliance innovation as well as enhancing the comprehensive advantage of the technology standard alliance of emerging industry [34,55]. The strategic collaboration under the collaborative innovation mode is not a single dimension collaboration, but a network system which includes the multi-dimensional integration of strategic target collaboration, culture collaboration and subject collaboration [56]. As the prerequisite of process collaboration and patent collaboration, strategic collaboration can determine the long-term development direction and strategic goal of technology standard alliance, and drive culture collaboration and subject collaboration in alliance, so that the overall alliance innovation performance could be improved. If the strategic targets of alliance members are inconsistent or the linkage relationship between them is inelastic, or the alliance organization mode has remained unchanged for a long time, the flexible needs for alliance innovation to respond to the external dynamic and complex environment cannot be met, and even the strategic collaboration mechanism of alliance innovation may become rigid, which will result in the gradual loss of the competitive advantage of the alliance and even lead to alliance disintegration [57,58]. It can be seen that enhancing the strategic collaboration level of alliance innovation is an important prerequisite for improving the technology standard alliance innovation performance of emerging industry.

Accordingly, the following hypotheses are proposed:

**Hypothesis 1 (H1).** *In the collaborative innovation process of the technology standard alliance of emerging industry, strategic collaboration has a positive impact on alliance innovation performance.*

**Hypothesis 1a (H1a).** *Target collaboration has a positive impact on the strategic collaboration of the technology standard alliance of emerging industry.*

**Hypothesis 1b (H1b).** *Culture collaboration has a positive impact on the strategic collaboration of the technology standard alliance of emerging industry.*

**Hypothesis 1c (H1c).** *Subject collaboration has a positive impact on the strategic collaboration of the technology standard alliance of emerging industry.*

### *3.2. Synergy Elements at the Process Level*

Process collaboration is the core and operation guarantee for the technology standard alliance collaborative innovation of emerging industry. The essence of process collaboration is based on the vertical and horizontal integration in the technology standard alliance collaborative innovation of emerging industry. On the one hand, the collaborative innovation process of the technology

standard alliance includes technology patenting, patent standardization, standard productization and commercialization. Collaboration among each link is a necessary condition to realize the alliance collaborative innovation goal and constantly improve alliance innovation performance. On the other hand, each link of alliance collaboration innovation needs to decompose innovation tasks, integrate innovation resources, and include knowledge transfer and sharing, as well as process optimization and schedule control. Process collaboration is essentially accompanied by the integration of complementary technology advantage and intellectual property right resources as well as the multiple task coordination and multiple link connection [59], which makes for activating the resource stock of alliance members, stimulating their cooperation innovation potential, and improving the activity of alliance network nodes [60,61]. Only based on continuously optimized knowledge sharing [62–64], resource integration [65,66], task coordination [67,68], process optimization [69], and process monitoring [70,71] of alliance innovation can the intellectual property right goal and fundamental mission of alliance collaborative innovation be achieved, providing an inexhaustible impetus for constantly improving the technology standard alliance innovation performance of emerging industry.

Accordingly, the following hypotheses are proposed:

**Hypothesis 2 (H2).** *In the collaborative innovation process of the technology standard alliance of emerging industry, process collaboration has a positive impact on alliance innovation performance.*

**Hypothesis 2a (H2a).** *Knowledge sharing has a positive impact on the process collaboration of the technology standard alliance of emerging industry.*

**Hypothesis 2b (H2b).** *Resource integration has a positive impact on the process collaboration of the technology standard alliance of emerging industry.*

**Hypothesis 2c (H2c).** *Task coordination has a positive impact on the process collaboration of the technology standard alliance of emerging industry.*

**Hypothesis 2d (H2d).** *Process optimization has a positive impact on the process collaboration of the technology standard alliance of emerging industry.*

**Hypothesis 2e (H2e).** *Process monitoring has a positive impact on the process collaboration of the technology standard alliance of emerging industry.*

### *3.3. Synergy Elements at the Patent Level*

Patent collaboration is goal and effect reflection for the technology standard alliance collaborative innovation of emerging industry. Patent collaboration is a collaborative creation activity such as patent group layout, patent sharing, comprehensive integration and transformation application under technology standards, including patent evaluation and screening, patent licensing, revenue distribution and so on. Through determination of patent value, the necessary and non-essential patents, as well as the core and peripheral patents, should be identified to provide decision-making reference for alliance patent licensing and revenue distribution. Formulating a joint patent licensing scheme, especially selecting an appropriate patent licensing model, can avoid the conflicts from undefined patents and regulate the behavior of alliance members. The reasonable revenue distribution mechanism is helpful for coordinating the interest relationship among the alliance members, especially ensuring the interests of the core patentee, and maintaining the durability and stability of alliance cooperation. The patent licensing scheme and the patent revenue distribution scheme constitute the core content of the undefined intellectual property agreement of the technology standard alliance, which are the necessary guarantees for the alliance members to reduce the transaction cost, avoid the patent dispute and realize the patent

promotion and application [72–74]. Intellectual property right generation and standard identification and acquisition, as well as standard licensed application and promotion diffusion, are the external embodiment of alliance collaborative innovation in market competition [75–77]. Patent collaboration is the short-term effect on the account of the alliance collaborative innovation process or R&D mission objectives, while strategic collaboration is a long-term effect. There is no strict correspondence between them, but continuous cycle laws and a feedback path [78,79]. In the same cycle, strategic collaboration is the attribution of patent collaboration. Between the two consecutive cycles, the strategic collaboration in the latter cycle is the feedback effect result of the patent collaboration in the previous cycle. Therefore, patent collaboration plays an important role in improving the technology standard alliance innovation performance of emerging industry.

Accordingly, the following hypotheses are proposed:

**Hypothesis 3 (H3).** *In the collaborative innovation process of the technology standard alliance of emerging industry, the patent collaboration has a positive impact on alliance innovation performance.*

**Hypothesis 3a (H3a).** *Patent screening has a positive impact on the patent collaboration of the technology standard alliance of emerging industry.*

**Hypothesis 3b (H3b).** *Revenue distribution has a positive impact on the patent collaboration of the technology standard alliance of emerging industry.*

**Hypothesis 3c (H3c).** *Patent licensing has a positive impact on the patent collaboration of the technology standard alliance of emerging industry.*

According to the above research hypotheses, the theoretical framework of influencing factors of technology standard alliance collaborative innovation is constructed, as shown in Figure 1.

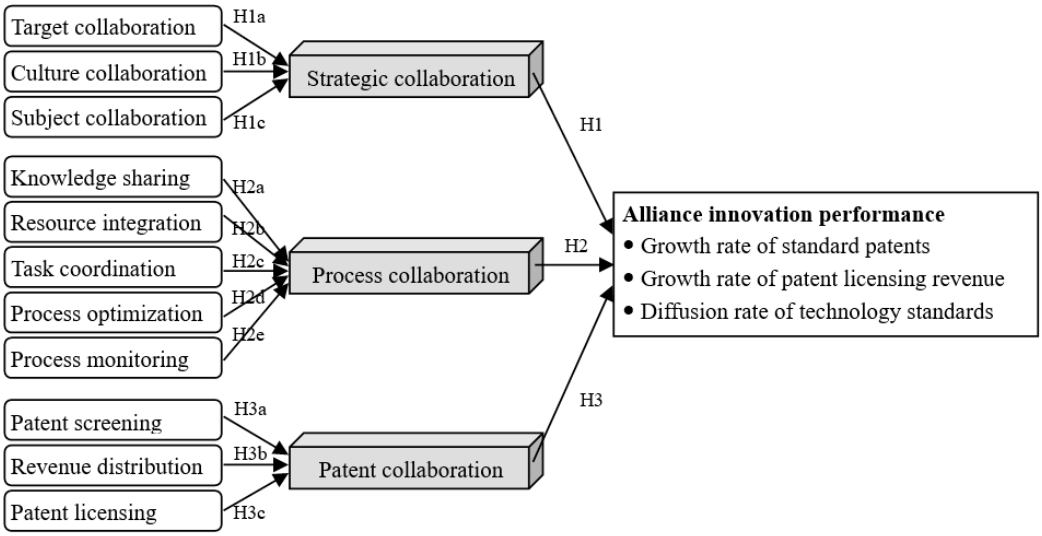


**Figure 1.** The theoretical framework of the influencing factors of alliance collaborative innovation.

## 4. Methodology

### *4.1. Methods and Variable Measurement*

When analyzing the influencing factors of the technology standard alliance collaborative innovation of emerging industry and their relationship, there may be some measurement errors, because many latent variables exist and the original data basically derived from the subjective responses of the technology standard alliance enterprises of emerging industry under investigation. The Structural

Equation Model is one of multivariate statistical analysis methods used for testing the relationship between observed variables and latent variables as well as between latent variables [80–82]. The scientificity and rationality of the constructed theoretical model can be verified through methods such as Factor Analysis or Path Analysis, etc., which can meet the needs of this research. In consequence, this paper constructs the influencing factors model of alliance collaborative innovation based on the Structural Equation Model method, and then carries out analysis and processing with LISREL software. Because the influencing effect of technology standard alliance collaborative innovation on alliance innovation performance is so ambiguous and difficult to be measured, a lot of manpower, material resources and financial resources will be expended inevitably for obtaining accurate measurements result. In comparison, the expert judgment method is more beneficial to making full use of the experts' alliance innovation management experience, and accurately reflecting and thoroughly grasping the overall situation of technology standard alliance collaborative innovation of emerging industry. Therefore, this paper uses the expert judgment method to measure the influencing relationship of the technology standard alliance collaborative innovation of emerging industry, which is not only scientific and reasonable, but also conductive to realizing the relative simplicity of data acquisition, model design and calculation process.

Based on the related literature analysis, 11 measurement indexes were designed for the three factors of strategic collaboration, process collaboration and patent collaboration of the technology standard alliance collaborative innovation of emerging industry. Meanwhile, measurement indexes were designed for alliance innovation performance after expert panel discussion. And then, target collaboration, culture collaboration and subject collaboration were used to describe the strategic collaboration of alliance collaborative innovation; the process collaboration of alliance collaborative innovation is divided into five key factors including knowledge sharing, resource integration, task coordination, process optimization and process monitoring; the patent collaboration of alliance collaborative innovation is measured through patent evaluation and screening, revenue distribution, patent licensing and so on. The collaborative innovation output of technology standard alliance is mainly reflected in the patents and benefits from the patent licensing and transformation into products [83], and so three indexes including the growth rate of standard patents, the growth rate of patent licensing revenue, and the diffusion rate of technology standards were selected to measure technology alliance innovation performance.

For the measurement of indexes, this paper uses a seven-point Likert scale, consisting of a set of statements about the attitudes or opinions toward a particular thing—7 indicates that the respondent "strongly agree" with this description, 6 indicates "agree", 5 indicates "partially agree", 4 indicates "no opinion", and 3 indicates "not completely agree", 2 indicates "disagree", and 1 indicates "strongly disagree". The scale from 7 to 1 indicates the decrease in agreement degree (or importance degree) in order. The respondent will choose a suitable scale according to personal experience and actual conditions.

### *4.2. The Samples and Data Collection*

This paper takes the enterprises participating in the technology standard alliance of the typical emerging industries in China such as a new generation of information technology, energy conservation and environmental protection, new energy and bio-pharmaceuticals industry as investigating objects—most of which have rich alliance collaborative innovation experience and have achieved a certain innovation performance. The survey started from the beginning of March 2013 and finished by the end of September 2013. A total of 318 questionnaires were issued and 235 questionnaires were returned, with the questionnaires had a recovery rate of 73.9%. On this basis, the collected questionnaires were numbered and checked comprehensively, and the questionnaires with obvious similar tendency, inconsistencies or missing items were considered invalid. After eliminating the incomplete and invalid questionnaires, 196 valid questionnaires were finally obtained, with an effective rate of 83.4%. The feature description of the sample enterprises is shown in Table 1.

**Table 1.** Feature description of sample enterprises.

| Sample Feature | Sample Description |
| --- | --- |
| Industry nature | Most of the samples are high-tech enterprises or strategic emerging enterprises, distributed in emerging industry fields such as high-end equipment manufacturing, a new generation of information technology, energy conservation and environmental protection, new energy and bio-pharmaceuticals, etc. |
| Total sales | The highest annual average sales is approximately 12 billion RMB, and the lowest is approximately 2.8 million RMB, with an average of 25 million RMB. |
| R&D personnel ratio | The maximum number of employees is approximately 50 thousand, at least 35 people, and the proportion of R&D personnel for all is above 30%. |
| R&D expenditure input intensity | In the sample enterprises, the R&D input intensity of 8 enterprises is more than 10%, the R&D input intensity of 21 enterprises is between (5%, 10%], the R&D input intensity of 42 enterprise is between (3%, 5%], the R&D input intensity of 116 enterprises is between (1%, 3%], and the R&D input intensity of 9 enterprise is lower than 1%. |
| Patent application quantity | In the sample enterprises, the number of patent applications per year is at most 100, and at least 0, but there are internal innovation activities. |
| New product sales ratio | The highest new products sales ratio is approximately 60%, the lowest is approximately 20%, and the average is 35%. |

The reliability and validity tests are designed to guarantee the stability or consistency of analysis results. This paper uses LISREL software to test the reliability and validity of the questionnaires. The reliability is measured by the reliability of individual items (namely $R^2$ value) and the composite reliability of latent variables. The result shows that the reliability of the individual items is greater than 0.5, while the composite reliability of the latent variables exceeds the measurement criteria 0.6, indicating that the questionnaires have good reliability.

## 5. Results and Discussion

Based on the research design, the 196 valid samples data is input to LISREL software, and then the basic goodness of fit, external quality as well as internal quality of the model are tested for the research hypotheses and theoretical model using the Maximum Likelihood (ML) estimation method. The influencing relation path diagram of the technology standard alliance collaborative innovation of emerging industry is shown in Figure 2.

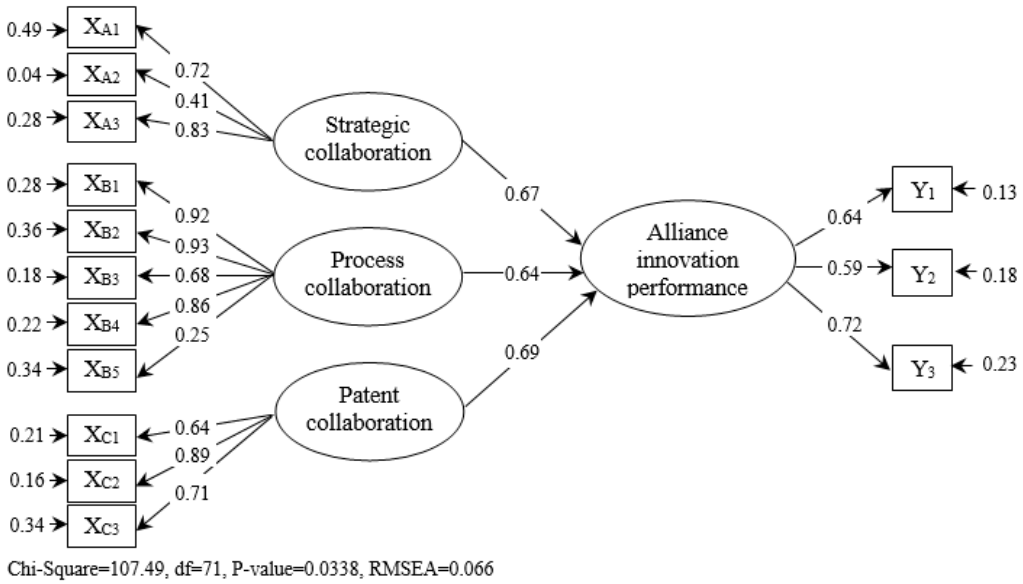


**Figure 2.** Action relation path of the influencing factors of alliance collaborative innovation.

According to the running results of LISREL software, the chi-squared value of the model is 107.49, the degree of freedom (df) is 71, the P value is less than 0.05, and the root mean square error of approximation (RMSEA) is 0.066. Obviously, the chi-square value reaches a significant level, indicating that the null hypothesis should be rejected, and the hypothesis model does not match the actual data. The normed chi-square (NC) is 1.51 (between 1 and 3), which shows that the model need not be modified. The RMSEA is 0.066 (greater than 0.05 and less than 0.08), indicating that the model's goodness of fit is reasonable. However, the load of variable $X_{A2}$ and $X_{B5}$ did not reach the standard (between 0.5 and 0.95), and its parameters did not reach a significant level (the absolute value of t is less than 1.96). According to the above model data, this model is considered to be further modified to improve its overall goodness of fit.

Since the load of variable $X_{A2}$ and $X_{B5}$ does not meet the basic testing standards, this paper tries to remove these two factors to modify the initial model. The modified identification model for the interaction relation between the influencing factors of technology standard alliance collaborative innovation of emerging industry is shown in Figure 3. As seen in the modified model, the chi-squared value is 75.44, the degree of freedom (df) is 48, the P value is 0.06, and the RMSEA is 0.051. Obviously, the chi-square value does not reach a significant level, the normed chi-square (NC) is 1.57 (between 1 and 3), and the RMSEA is less than 0.08 and close to 0.05, which indicates that the null hypothesis can be accepted, the hypothesis model matches the actual data, and the model's overall goodness of fit is better.

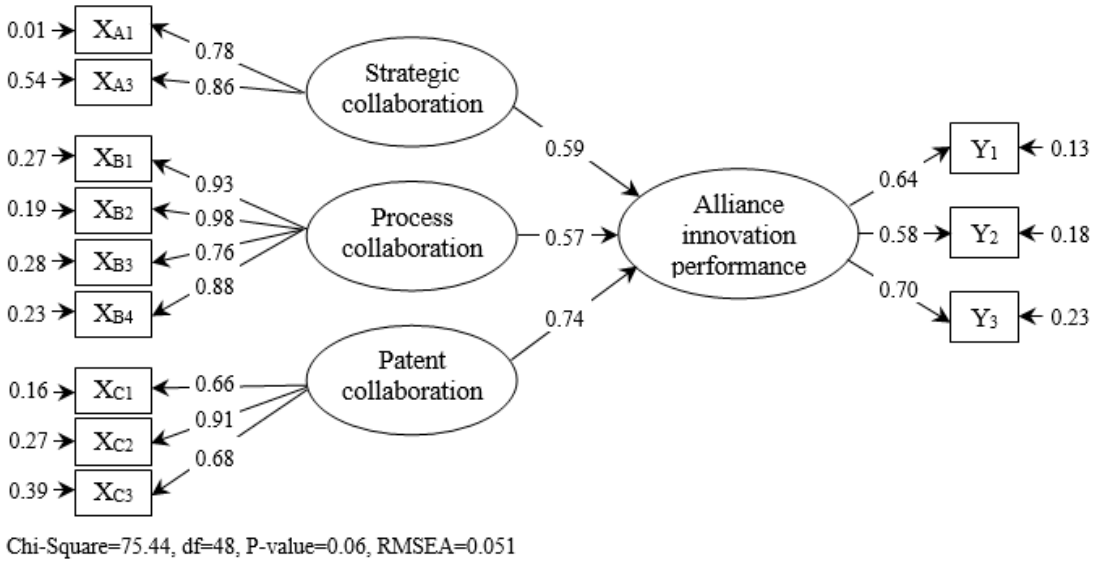


**Figure 3.** Modified model for action relation between influencing factors of alliance collaborative innovation.

The basic goodness-of-fit test result of the modified model is shown in Table 2. There is no negative error variation in the modified model, and the factor loads are between 0.5 and 0.95, without significant standard error, which shows that the modified model is basically adaptive. The inner quality test result of the modified model is shown in Table 3. It can be seen that all the indicators meet the fit criteria, indicating that the model has good goodness of fit, and it is credible.

**Table 2.** Basic goodness-of-fit test of the modified model.

| Evaluation Item | Test Result Data | Fit Judgment |
|---|---|---|
| Whether there is no negative error variation | All are positive | Yes |
| Whether the factor load is between 0.5 and 0.95 | Between 0.58 and 0.98 | Yes |
| Whether there is no significant standard error | None | Yes |

**Table 3.** Inner quality test of the modified model.

| Evaluation Item | Test Result Data | Fit Judgment |
|---|---|---|
| The estimated parameters all reached a significance level | T value between 9.28 and 24.39 | Yes |
| The reliability of individual items is higher than 0.50 ($R^2$) | All are positive and greater than 0.50 | Yes |
| The average extracting variation of latent variables is greater than 0.50 | Between 0.68 and 0.77 | Yes |
| The composite reliability of latent variables is greater than 0.60 | Between 0.83 and 0.93 | Yes |
| The absolute value of the standardized residual is less than 2.5 | The absolute value is less than 2.5 | Yes |
| The modification index is less than 3.84 (MI) | The MI value is less than 3.84 | Yes |

Comparing the modified model with the previous model about the expected cross-validation index (ECVI) and non-centrality parameter (NCP), it is generally believed that the theoretical model with a lower ECVI value and NPC value is better than other models. The ECVI value and NPC value of the previous model were, respectively, 1.47 and 31.49. Meanwhile the ECVI value and NPC value of the modified model were respectively 1.14 and 27.44. Therefore, the modified model is more consistent with the sample data than the previous model.

Moreover, the relationship coefficients of the observed variables to latent variables all reached a significant level ($t > 1.96$), indicating that the observed variables could reflect the corresponding latent variables well. The path coefficients of the external latent variables to the internal latent variables also reached a significant level, indicating that the external latent variables could effectively reflect the internal latent variables. In addition, the standardized measurement error in the model also reached a significant level, which conforms to the theoretical hypotheses. In conclusion, the modified model is acceptable, having the validity of overall construction.

It can be seen from the empirical analysis results that the strategic collaboration, process collaboration and patent collaboration of the technology standard alliance of emerging industry have significant influence on alliance innovation performance. Compared with strategic collaboration and process collaboration, patent collaboration has the most significant impact on the innovation performance of technology standard alliance, reaching 0.74. Further, the patent collaboration of alliance innovation is most affected by revenue distribution, 0.91, followed by patent licensing, 0.68, and patent screening, 0.66. It was not easy to find that the revenue distribution-patent collaboration path is the leading factor influencing the collaborative innovation performance of technology standard alliance. The results show that improving patent collaboration level will be more conducive to promoting alliance patent sharing and collaborative creation and speeding up technology standard formation and application, as well as improving the innovation performance of the technology standard alliance. At the level of observed variables, alliance resource integration, knowledge sharing, and revenue distribution have the most obvious impact on alliance collaborative innovation. The influence coefficient of resource integration on the process collaboration of alliance innovation is 0.98, followed by knowledge sharing, 0.93. It can be seen that the key elements such as resource integration, knowledge sharing and revenue distribution play an important role in improving alliance innovation performance through the strategic collaboration, process collaboration and patent collaboration of the technology standard alliance.

## 6. Conclusions

On the basis of the literature research and questionnaire survey, this paper verifies the effect path of influencing factors of alliance collaborative innovation on the technology standard alliance innovation performance in emerging industry. Taking the evolution process of alliance collaborative innovation as the main line, the mechanism framework of technology standard alliance collaborative innovation is constructed, as shown in Figure 4. From the collaborative innovation process perspective of the technology standard alliance of emerging industry, the relationship between strategy collaboration,

process collaboration and patent collaboration is progressive and in-depth layer by layer. Strategic collaboration is the foundation and direction of alliance collaborative innovation activities. The alliance strategy guides the collaborative innovation process, while the high synergy of the alliance innovation process is conducive to producing a large number of innovative achievements, which are mainly reflected in patents and their transformation and application. The higher the strategic collaboration and process collaboration degree of alliance innovation, the more efficient the alliance patent outputs and their comprehensive application will be.

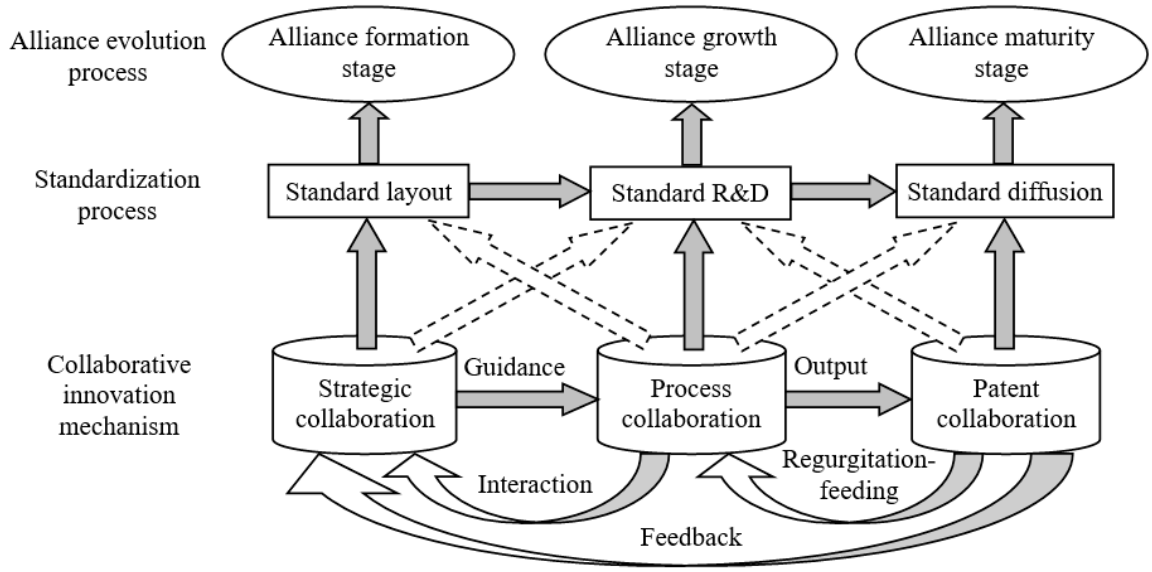


**Figure 4.** Mechanism composition of technology standard alliance collaborative innovation of emerging industry.

(1) Establishing the strategic collaboration mechanism of technology standard alliance innovation. On the one hand, this is to strengthen strategic content collaboration between alliance members, such as strategic targets, strategic planning, key tasks, etc., in order to establish the alliance partnerships and cooperation networks. On the other hand, this is to strengthen strategic element collaboration including innovation subject, innovation culture, etc., so as to jointly provide the foundation and premise for alliance collaborative innovation. The strategic collaboration mainly corresponds to the technology standard alliance formation stage, the main task of which is selecting an alliance strategic partner. On this basis, alliance members cooperate to convert technology rights into intellectual property rights, and then effectively integrate them to formulate technology standards. Therefore, alliance members should be promoted to consult and negotiate on issues such as patent group layout, indicating the direction for alliance collaborative innovation and technology standardization.

(2) Establishing the process collaboration mechanism of technology standard alliance innovation. Through the modularization decomposition and cohesion of alliance innovation tasks, the technology standard alliance should strengthen innovation resource integration and sharing, optimize the collaborative innovation process, and promote internal and external learning as well as innovation process monitoring and management, to realize alliance innovation process collaboration, which is the core link and key content of alliance collaborative innovation. Process collaboration mainly corresponds to the technology standard alliance growth stage, the main task of which is technology standard research and development. Therefore, the alliance members should be promoted to give full play to their respective advantages and characteristics, and utilize the internal and external resources effectively, to work together for achieving the strategic goal of the technology standard alliance.

(3) Establishing the patent collaboration mechanism of technology standard alliance innovation. Patents and technology standards are important achievements and constitutive requirements of the technology standard alliance collaborative innovation of emerging industry. Patent collaboration

determines whether the goal of alliance technology standardization can be realized smoothly. Relying on the technology standards established by the alliance, its competitive advantage originates from the level of alliance patent collaboration. So, it is an inevitable choice to speed up the alliance collaborative innovation process and enhance the competitive advantage of technology standards. Therefore, the alliance should carry out collaborative innovation activities focusing on patent group layout, such as patent evaluation and screening, patent licensing, patent sharing and patent transformation and application. Patent collaboration mainly corresponds to the technology standard application and diffusion stage. Hence, the revenue distribution mechanism of alliance members should be established urgently in order to provide the premise and guarantee for alliance standard industrialization and innovation performance improvement. At the same time, with the standard patent licensing mode changing from patent sharing only among the patent pool members within the alliance to preferential patent licensing within the industrial scope by sharing industrial resources, it is more necessary to give full play to the regurgitation feeding effect of patent collaboration on the technology standard alliance collaborative innovation of emerging industry, continuously improving the competitive advantage of the alliance technology standards.

This paper analyzes the influencing factors of the technology standard alliance collaborative innovation of emerging industry, aiming to reveal the interrelationship of alliance collaborative innovation elements and the mechanism affecting them and promote the optimized distribution and effective integration of alliance resources using the specific norms and institutional guidance, so that the alliance will develop towards the state with a reasonable structure, harmonious relationship, efficient operation and outstanding innovation performance. The government will play an important role in guiding and supporting the technology standard alliance collaborative innovation of emerging industry. (a) Formulating technology standard development plans or special actions plan for emerging industry, to encourage technology standard alliance establishment and promote alliance collaborative innovation. (b) Establishing science and technology programs to provide direct subsidies or indirect compensation to guide standard technology research and development, technology patenting, patent standardization and technology standard industrialization in the patent pool. (c) Providing the relevant science and technology services and platform support for the collaborative innovation of the technology standard alliance to improve innovation performance and reduce the innovation cost. (d) Implementing government procurement policy to affect user expectations, to take preferential market distribution, procurement subsidies, partial fee reduction and other measures to stimulate demand. Through the combination of different innovation elements and environment, the regional structure influences the effect of innovation resource sharing and exchange in the alliance network. It not only provides the alliance with the opportunity to access diverse innovation resources, but also improves knowledge transfer efficiency among alliance members, which is conducive to knowledge creation within the alliance. Through systematic planning and design, this paper formulates a scientific management mechanism and puts forward a set of systematic alliance collaborative innovation management methods, providing a decision-making reference and effective support for the technology standard alliance collaborative innovation of emerging industry.

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