

DEVELOPMENT OF INDUSTRY-EDUCATION
COOPERATION MANAGEMENT MODEL
TO ENHANCE STUDENT COMPETENCE IN SICHUAN

FU XIANQUAN

A thesis submitted in partial fulfillment of the requirements for Doctor of
Philosophy Program in Technology and Innovation Management

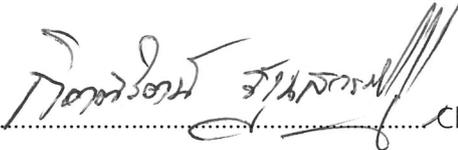
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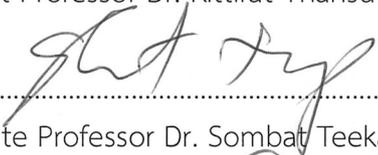
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to Enhance Student Competence in Sichuan

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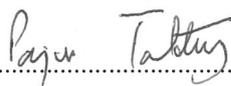
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Thesis	Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan
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ABSTRACT

The study on "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan" has 4 specific objectives: 1) To identify current problems, opportunities, and key success factors of industry-education cooperation. 2) To evaluate appropriate elements for industry-education cooperation management model to enhance student competence in Sichuan. 3) To design an effective industry-education cooperation management model to enhance student competence in Sichuan. 4) To evaluate the industry-education cooperation management model to enhance student competence in Sichuan. Objective 1 research method uses literature survey and use the result for design a questionnaire to survey 21 experts' opinion, and interview 5 experts to confirmed. Objective 2 uses structured in-depth interview method to interview 11 project coordinators from 6 industry-education cooperation projects. Objective 3 Invite 21 experts feedback to build a graphical model. Objective 4 uses 5 experts to evaluate the model based on CIPP evaluation principle.

The results revealed that:

1. The current problems are lack of coordination, lack of supportive cooperative environment, imperfect policies and systems, insufficient resource sharing, inadequate organizational support, communication and coordination hindered, benefits not effectively matched and low-level and superficial cooperation. Opportunities are strong policy support, modern industrial development, increasing demand for highly skilled personnel, development of modern vocational education systems, educational positioning in vocational education, and integrated development. Key success factors are university resource investment, industry resource investment, government support intensity, social industrial structure, technological innovation and transformation, policies and institutions, resource sharing mechanisms, organizational support mechanisms, communication and cooperation mechanism, and interest balance mechanism.

2. The lessons learned of coordinators in industry-education cooperation projects emphasize that the mechanism is the most critical both problems and key success factors. Industry always considers specific industry needs as the most important factor, followed by industry-academy-research cooperation, and student practical abilities. While universities pay more attention to cooperation mechanism, cooperation models, and cooperation projects.

3. The designed industry-education cooperation ecosystem model to enhance high-skilled personnel cultivation. The government, universities and industries have high impact on technological innovation development which result to student working competency.

4. Evaluation of the industry-education cooperation management model to enhance student competence in Sichuan was unanimously agreed by all experts.

Keywords: Industry-Education Cooperation, Management Model, Sichuan, Vocational College Student, Competence

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Wish Alma mater better and better tomorrow!!

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Chapter 1

Introduction

Rationale

Industrial restructuring inevitably brings changes to the employment environment. According to data from the International Labour Organization (2019), many countries are actively investing in training and education to enhance the adaptability and competitiveness of their workforce, in response to the industrial structural adjustments driven by technological changes. Since the 18th National Congress of the Communist Party of China, the country's economic development has entered a new stage, with strategic economic restructuring and transformation accelerating. With the release of the "14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives Through the Year 2035" (referred to as the "Plan"), China's economic development is shifting towards high-quality growth, and the industrial structure is undergoing further transformation and upgrading. According to the official website of the Chinese government (2021), to support the changes in industrial structure, the Chinese government has initiated the "Skill China Action," which is expected to add more than 40 million highly skilled personnel during the 14th Five-Year Plan period.

The changes brought about by industrial restructuring pose new requirements for vocational education and highly skilled personnel cultivation:

First, students need to possess the competencies, knowledge, and skills to adapt to emerging industries and professions, thereby increasing their competitiveness in the job market. The U.S. Bureau of Labor Statistics (2020) found that students who actively adapt to environmental changes are more likely to find ideal job opportunities, while those who struggle to adapt may face unemployment or job difficulties. According to the U.S. Bureau of Labor Statistics (2021), students with high adaptability are more likely to find employment after graduation, with higher salary levels. Jenkins (2019) pointed out that employers are more inclined to hire

employees who can quickly adapt to new work environments, technologies, and challenges.

Second, there are new demands for student competence. The "Recommendations of the Central Committee of the Communist Party of China on Formulating the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Goals for 2035" emphasizes the need to stimulate innovation and cultivate innovative, applied, and skilled personnel. With the rapid digital transformation, the rapid development of artificial intelligence, and the acceleration of industrial transformation and upgrading, many new occupational positions have emerged in modern manufacturing and modern service industries that require higher levels of theoretical knowledge and practical skills.

Last, student career development must align with the needs of industry development. Fehr(2000) argued that the cultivation of student competence should closely align with the demands of industry development to meet evolving industry needs, ensuring that students can successfully integrate into the workplace after graduation. Education that aligns with industry requirements can significantly increase students' employment rates and career development opportunities (U.S. Department of Education, 2019). Furthermore, students with highly skilled are more likely to stand out in the workplace and secure promotions and higher salaries (U.S. Bureau of Labor Statistics, 2021). Stuart (2020) considers the problem of student vocational capability development from an international perspective on industrial development transformation, stating that students with such skills are more likely to excel in the international job market, offering broader career development opportunities (Stuart, 2020; International Labour Organization, 2019).

The industry-education cooperation is an important approach to enhance student competence. Industry-education cooperation in countries such as Germany, the United Kingdom, the United States, Australia and Japan have greatly promoted industrial and socio-economic development. In 2019, the "National Pilot Implementation Plan for the Cooperation of Industry and Education" issued by the National Development and Reform Commission and others clearly stated that "deepening the reform of integrating industry and education as a strategic task to promote the structural reform of the supply side of human resources," thus elevating the cooperation of industry and education to a national strategic level. According to the "China Education Statistical Yearbook" published by the Chinese Ministry of Education in 2021, the cooperation of industry and education has improved students' vocational abilities, boosted the competitiveness of Chinese industries, and supported sustainable economic growth. However, Huang (2022) found that problems such as low satisfaction among vocational colleges, employing industries, and students in the current practice of cultivating key competencies of vocational students, as well as a mismatch between the quality of vocational highly skilled personnel cultivation and societal demands, still exist.

Therefore, vocational colleges urgently need to optimize the management mechanisms for industry-education cooperation to adapt to changes in the industry and enhance student competency development. This is not only a new requirement posed by socio-economic development but also an inevitable choice for vocational colleges to enhance internal management strategies and enhance competitiveness. Consequently, in-depth analysis of the problems, opportunities, and success factors in industry-education cooperation management practices, followed by the construction of a model for industry-education cooperation management to enhance student abilities, has become an urgent problem to solve in order to enhance the efficiency of university/college-industry cooperation management and the quality of vocational highly skilled personnel cultivation.

Research Question

How to develop an effective industry-education cooperation management model to enhance the student competence in Sichuan?

Objectives

1. To identify current problems, opportunities, and success factors in the industry-education cooperation.
2. To evaluate appropriate elements for industry-education cooperation management model to enhance student competence in Sichuan.
3. To design an effective industry-education cooperation management model to enhance student competence in Sichuan.
4. To evaluate the industry-education cooperation management model to enhance student competence in Sichuan.

Scope of the Research

Content

This research study is development of industry-education cooperation management model to enhance the student competence in Sichuan. There are 4 steps in the process: Step 1 To identify current problems, opportunities, and success factors in the industry-education cooperation practice. Step 2 To evaluate appropriate elements for industry-education cooperation management model. Step 3 To design an effective industry-education cooperation management model. Step 4 To evaluate the industry-education cooperation management model to enhance student competence in Sichuan.

The Variable

The Variable of the main problems of industry-education cooperation

Through literature review, scholars generally believe that there are 8 main variables in the problem of industry-education cooperation: The Lack of Cooperation in industry-education cooperation Participant Relationships. Lack of Favorable Collaborative Environment Support. Imperfect Policies and Systems. Insufficient Resource Sharing. Inadequate Organizational Assurance. Communication and Cooperation Hindered. Ineffective Matching of Interests. Low-Level and Superficial Cooperation.

The Variable of opportunities in industry-education cooperation

Through literature review, the variables for industry-education cooperation opportunities mainly include 6 aspects: Strong Policy Support. Modern Industrial Development Currently. Increasing Demand for highly skilled personnel. Development of Modern Vocational Education Systems. Educational Positioning in Vocational Education. Integrated Development of Industry and Education.

The Variable of key success factors in industry-education cooperation

Through literature review, the key success factor variables for industry-education cooperation can be summarized as follows: University Resource Investment. Industry Resource Investment. Government Support Intensity. Social Industrial Structure. Technological Innovation and Transformation. Policies and Institutions. Resource Sharing Mechanism. Organizational Assurance Mechanism. Communication And Cooperation Mechanism. Interest Balance Mechanism.

Location: Sichuan province, China

Time: The research time is from January 2023 to December 2023

Advantages

1. To enhance student competence and support their career development. Research on the industry-education cooperation management model helps universities(colleges) better assist students in their career development. Through cooperation with industries, universities(colleges) can provide more practical experiences and career guidance to help students better prepare for the workplace.

2. To enhance the quality of vocational education. An effective industry-education cooperation management model helps vocational colleges better manage and organize activities with industry partners. Through efficient management, it ensures an improvement in educational quality, enabling students to better adapt to real-world vocational demands.

3. To optimize educational resources. Optimizing the management model helps universities(colleges) more effectively allocate resources, including faculty, facilities, and curriculum development, ensuring that resources are utilized to their fullest potential. This, in turn, enhances the efficiency and effectiveness of education.

Definition of Terms (Keyword, Variable)

Industry-education cooperation: Industry-education cooperation refers to the alignment and cooperation of the industrial sector with the educational sector (Lu, 2019). In this context, it involves the establishment of a cross-organizational framework and operational mechanism between institutions like Luzhou Vocational and Technical College and over 30 Industries such as Luzhou Laojiao Co., Ltd. and Shoulv Jianguo Hotel Management Co., Ltd. This cooperation facilitates the sharing of resources between universities and industries, joint nurturing of students, and collaborative development, ultimately better meeting the demands of both the highly skilled personnel supply side and the demand side (Li, 2022).

Industry-education cooperation Management Model: The industry-education cooperation management model refers to the collaborative management approach between Luzhou Vocational and Technical College and partner industries aimed at enhancing the quality of education and fostering individuals who can meet industry demands (Karmaker et al., 2017). This model facilitates students' better adaptation to the job market (Sánchez-Galán et al., 2019).

Students: In this study, students refer to three-year diploma students from vocational colleges in Sichuan Province who receive skill, knowledge, and quality training in their respective professional fields.

Student Competence: This study primarily pertains to students' working competency. It involves teaching practices and reforms based on real industry projects through the industry-education cooperation model. The goal is to enhance students' skills, knowledge, and qualities in their relevant professional domains, enabling them to effectively tackle complex engineering problems, technological challenges, and industry requirements in the workplace and prepare them adequately for their future careers.

University Resource Investment: University resource investment refers to the foundational conditions of Luzhou Vocational and Technical College (Tao et al., 2017), the awareness of industry-education cooperation (Rybnicek et al., 2019), as well as the allocation of human, financial, and material resources within the university (Ramli, M. F. et al., 2021).

Industry Resource Investment: Industry resource investment pertains to the nature and scale of 6 industries, including Luzhou Laojiao Co., Ltd., Shoulv Jianguo Hotel Management Co., Ltd., Otis Elevator Management (Shanghai) Co., Ltd., Sichuan Bashu Haoli Food Co., Ltd. Wal Mart (Sichuan) Department Store Co., Ltd. Tang Dynasty Laojiao (Group) Co., Ltd. It also involves their concepts of industry-education cooperation (Shen et al., 2018) and the allocation of human, financial, and material resources (Nsanzumuhire, S. U. et al., 2020).

Government Support Intensity: Government support intensity primarily refers to the roles and support provided by the government at both the provincial and municipal levels, as well as relevant departments in areas such as policy, finance,

taxation, and industry cooperation (Collier et al., 2011; de Medeiros et al., 2012; Hemmert et al., 2014; Muscio & Vallanti, 2014; Myoken, 2013; Scofield, 2013; Sohar, 2013).

Social Industry Structure: The industry structure significantly impacts market potential, including consumption, income, and the labor market, and it also mutually influences regional specialization and highly skilled personnel development. It provides essential external conditions and demand environment for industry-education cooperation (Ankrah & Al-Tabbaa, 2015; Hadjimanolis, 2006). This primarily encompasses industrial composition, platform carriers, and cultural ambiance (Yu et al., 2020).

Technological Innovation and Transformation: Technological innovation and transformation represent the external technological support environment that industry-education cooperation faces, including highly skilled personnel requirements and the conversion of technological achievements.

Policies and Institutions: The institutional environment includes the rules and behavioral norms of industry-education cooperation activities, encompassing national macro policies and regulations, local support or regulations, legal restrictions, micro-institutional arrangements, and specific measures (Șerbănică, 2011).

Resource Sharing Mechanism: Resource sharing mechanisms are operational approaches that facilitate the effective flow and complementary function of resources in school-Industry cooperation. Placing advantageous resources on an open and shared platform benefits industry-education cooperation (Xie, 2019; Sun et al., 2021), particularly regarding the content and extent of resource sharing.

Organizational Support Mechanism: The organizational support mechanism is the cross-boundary organizational structure and operational approach established to achieve industry-education cooperation. Government networks (Rampersad, 2015), public funding (Piva & Rossi-Lamastra, 2013), and human resources play a crucial role in collaborative projects. It primarily includes financial support, personnel support, and necessary incentive and penalty mechanisms.

Communication and Cooperation Mechanism: The communication and Cooperation mechanism is the operational approach that ensures the full expression

of the interests and demands of all parties, emphasizing common understanding and communication frequency, which is essential for establishing positive expectations (Albat et al., 2020). It primarily includes information communication channels, frequency, and cooperation governance mechanisms.

Interest Balancing Mechanism: The interest balancing mechanism involves the institutionalized arrangements for the distribution, compensation, and regulation of interests among various stakeholders. Achieving a win-win situation through balanced interests is crucial for industry-education cooperation (Hong et al., 2010). This encompasses interest distribution, cost sharing, and compensation.

Expert survey: The research invited 21 experts reaching consensus in several rounds of questionnaire surveys, allows experts to utilize their knowledge and experience while maintaining independence, alleviating the group pressure of face-to-face interactions.

CIPP Evaluation Model: The research used the CIPP (Context, Input, Process, Product) evaluation model, with feedback and evaluation provided by 5 experts for the created industry-education cooperation model, offering timely and effective decision-making information for model improvements.

Research Framework

Research on develop of industry-education cooperation management model to enhance the student competence in Sichuan. Research framework is shown in Figure 1.1.

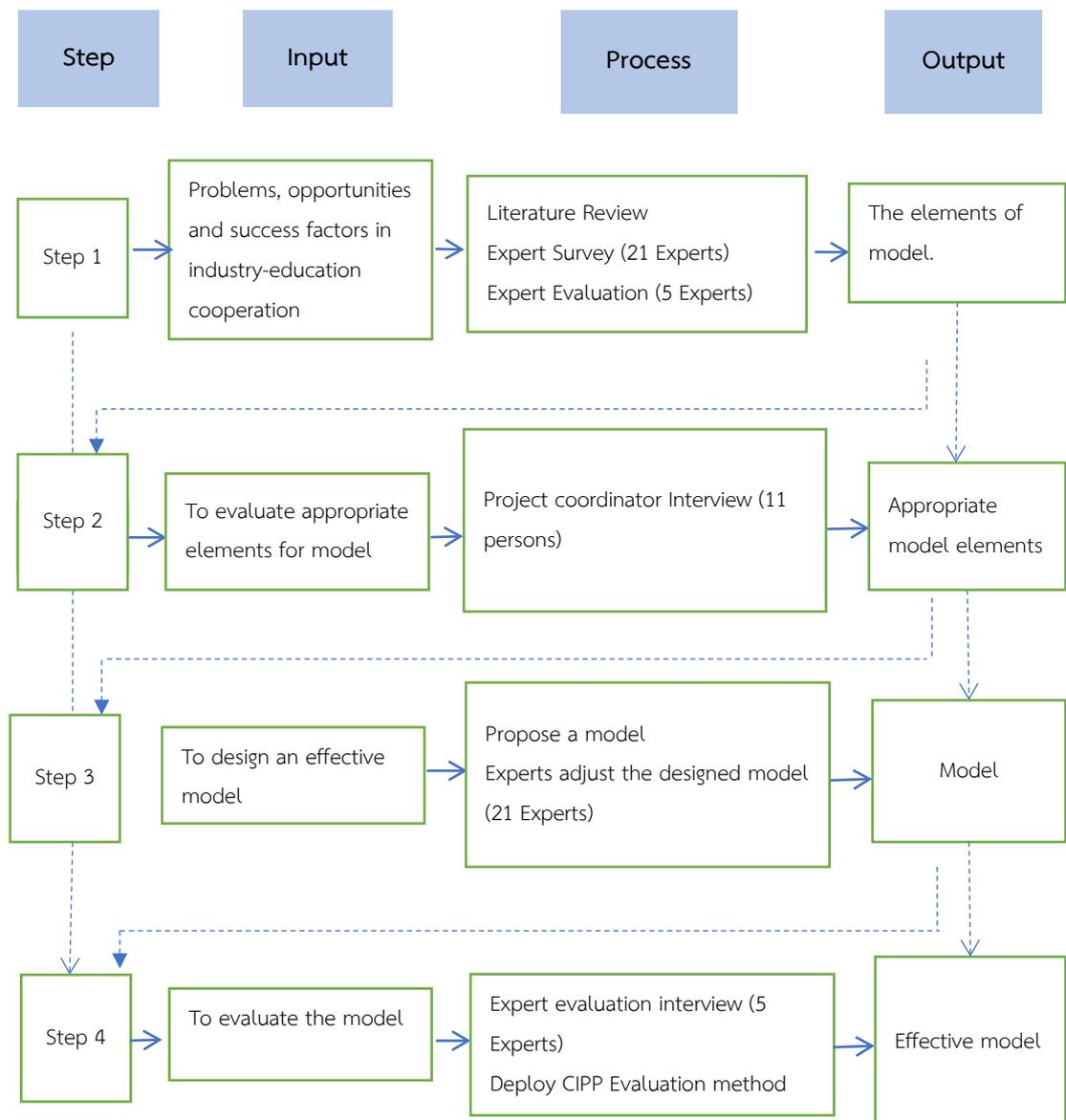


Figure 1.1 Research framework

Chapter 2

Literature Review

By looking up the viewpoints and conclusions of a large number of existing studies, this literature review combs and evaluates the literature related to the research topic, which helps to further clarify the scope of this research and the significance of the research question, accumulate experience for the research design of subsequent papers, and provide a solid theoretical foundation for this research. The literature review subtopics of this study are as follows:

1. The main problems of industry-education cooperation
2. Opportunities in industry-education cooperation
3. Key success factors in industry-education cooperation
4. The theory for designing industry-education cooperation management models
5. Methods for designing and evaluating industry-education cooperation models.

1. The main problems of industry-education cooperation

Industry-education cooperation is a crucial means of supporting socio-economic development and fostering industrial innovation. It represents a key initiative in the ongoing educational reforms of higher vocational colleges. In 2019, the State Council of China issued the "National Vocational Education Reform Implementation Plan," which explicitly proposes a transformation of vocational education from emulating the conventional educational model to a distinct type of education characterized by active participation from industries and clear professional features. Deepening the cooperation of industry and education, and facilitating the seamless connection of the education chain, highly skilled personnel chain, industry chain, and innovation chain, are urgent imperatives for advancing the structural reform of the supply side of human resources. Nevertheless, despite over a decade of exploration in the field of industry-education cooperation, domestic higher vocational education in China still faces the following problems.

1.1 Lack of Coordination in industry-education cooperation

Government, industries, and universities often have different needs and priorities, which can lead to inconsistencies in ideology and goals in industry-education cooperation. This can result in difficulties coordinating cooperation plans, primarily manifested in the following aspects.

Lack of coordination in industry-education cooperation is primarily reflected in differences in ideology. Universities and colleges tend to emphasize the "education" aspect of industry-education cooperation while neglecting the "industry" component, leading to insufficient synergy and interaction with the industrial sector (Tang, 2019). Industries aim to maximize profits and are more interested in acquiring highly skilled personnel rather than nurturing it (Fu, 2015). Industries can absorb highly skilled personnel but are not obligated to support education focused on industry-academic cooperation (Xie, 2022). The primary purpose of running a industry is profit, and many industries believe that engaging in industry-education cooperation can disrupt production schedules and increase the investment of human and material resources (Zhuo, 2022).

Lack of coordination in industry-education cooperation leads to inconsistent cooperation objectives. Different interest demands among cooperation participants result in divergent cooperation objectives. The government mainly pursues the maximization of public interests, while industry industries aim for profit maximization, and vocational colleges focus on students' employment and the university's survival and development (Wang, 2019). The primary mission of vocational colleges is teaching, with a value orientation of bridging the gap for student development. Industries participating in vocational education are most interested in obtaining high-quality human resources and reducing the cost of highly skilled personnel selection and training (Wang, 2020).

1.2 Lack of Supportive Cooperative Environment

University degree programs do not align with local industries. Industries are not particularly enthusiastic about collaborating with universities, and universities lack the support of industries. As a result, the design and development of programs fail to keep pace with the evolving demands of emerging industries (Shi, 2019). There is a

deficiency in the consideration of the broader market environment, industrial structure, and meeting societal needs in program design (Huang, 2021). The program offerings are relatively outdated, unable to meet the current industry requirements, and there is a significant mismatch between program structures and industrial structures. Additionally, the scale of programs is severely disconnected from the scale of industries, resulting in a professional landscape that cannot adequately support the highly skilled personnel needs of the regional industrial economy (Dai, 2023).

Industry-education cooperation lacks alignment between content and its delivery mechanisms. The educational content is not closely tied to actual needs and employment, lacking timely updates to the curriculum based on industry developments. The curriculum system is incomplete, and there's a lack of a mechanism for setting up new programs (chen et al., 2023). Furthermore, universities, in order to meet the stringent criteria for industry-education cooperation in program assessment, haphazardly form partnerships with large industries that may be geographically distant from the institution, without the necessary platform support, thus affecting the effectiveness of cooperative education outcomes (du et al., 2018).

Insufficient Technological Achievement and Transformation. When it comes to enhancing research capabilities and the capacity for societal service, achieving the ultimate transformation of research outcomes into productivity, driving enterprise transformation and technological advancement, more often than not, there is a sense of helplessness, indicating problems related to inadequate technological innovation capabilities and insufficient research outcome transformation (Yang, 2020). There is a lack of in-depth technological research and minimal involvement in technology alliances and outcome transformation between industries and universities (Ouyang, 2022). The insufficient cultivation of highly skilled personnel for strategic emerging industries has impacted the transformation of higher vocational education and local industrial development (Wang, 2018).

1.3 Imperfect Policies and Systems

Lack of Legal and Regulatory Safeguards for industry-education cooperation. Currently, there is a lack of comprehensive and detailed government policies and

measures, with some policies lacking complete support and being insufficiently detailed, resulting in limited operability (Pei et al., 2019). While the government has introduced documents like the "Promotion Measures for University-Industry Cooperation in Vocational Universities," these measures primarily emphasize the macro-level, and specific supporting regulations are absent (Zhao, 2020; Liu et al., 2022).

Lack of Effective Supervision and Evaluation for industry-education cooperation. Government monitoring functions in industry-education cooperation have not been fully realized (Du et al., 2018). They have failed to develop feasible guidance based on the characteristics of vocational education and current national policies, and have not established relevant coordinating management bodies (Yao, 2019). There is still a lack of incentive mechanisms to mobilize industry participation in industry-education cooperation, and there is no supervisory mechanism in place for exiting from industry-education cooperation (Yu, 2023). Government evaluation standards for industries and universities are incomplete, and the evaluation mechanisms are not well-established, particularly concerning the effectiveness of industry-education cooperation, which directly affects the depth of such cooperation (Chu et al., 2022).

Institutional Factors Inhibit the Enthusiasm for industry-education cooperation. The top-down administrative management system in higher education directly determines the institutional values, which focus on operating the institution for the supervisory authorities rather than for society and the market (Yang, 2018). The educational system of universities tends to prioritize internal development over contributing to economic growth, which becomes a bottleneck hindering industry-education cooperation (Ma, 2018). The incomplete institutional framework for industry-education cooperation results in insufficient cooperation of the teaching staff, low enthusiasm for industry participation in industry-education cooperation, and inadequate implementation of industry-education cooperation policies (Sun, J., & Yao, X., 2022). Unfavorable institutional conditions limit the independence and flexibility of development for vocational colleges, making it challenging for them to make substantial progress (Strampel K, 2017).

1.4 Insufficient Resource Sharing

Both universities and industries have not adequately engaged in resource sharing. Companies have not made substantial contributions in terms of program design, highly skilled personnel development, hardware and financial investment, and technology research and application (Chen, Fan, Huang, 2020). Resource allocation and utilization within the industry-education cooperation system are not particularly efficient (Liu, 2018). Superficial industry-education cooperation is evident, with universities sometimes having unclear roles for external training facilities, often limiting them to mere internship locations. Some companies are still restricted to providing certain material resources. Achieving deep-seated goals of resource co-construction, co-sharing, and collaborative highly skilled personnel cultivation remains a challenging task (Yu Jing, 2023).

1.5 Inadequate Organizational Support

The lack of necessary organizational support significantly affects the effectiveness of industry-education cooperation (Xie, 2022). The absence of a scientifically structured and long-term support mechanism results in shortcomings in the development and implementation of related policies (Yu, 2023; Yao, 2019). Hua Hu, in their 2018 study, also points out inadequate coordination, inconspicuous support effects, and a lack of organizational support in the development of industry-education cooperation. Support and safeguards for industry-education cooperation are shallow, with insufficient financial backing (Luo, 2018). The absence of essential financial support makes it difficult for universities and industries to ensure long-term, in-depth cooperation or may lead to cooperation being superficial and merely symbolic (Ouyang, 2022).

1.6 Communication and Coordination Hindered

There is a problem in industry-education cooperation where the ability to communicate and resolve conflicts between universities and industries is insufficient (Tuen, 2016). Currently, there are still situations where the channels of cooperation between universities and industries are not always smooth (Pan et al., 2019). Communication often remains at a superficial level, lacking depth in coordination and making it difficult to obtain in-depth information. During the transmission of content

and execution information, there is a phenomenon of "information isolation" (Shen, 2021). Inadequate communication and coordination mechanisms mean that companies cannot uniformly arrange teaching content and schedules for university teachers, which can impact the highly skilled personnel development (Shen, 2021). Therefore, there is a need for a communicator or relationship builder in industry-education cooperation, linking university research with the industrial sector and ensuring smooth information exchange between both parties (Asmara, A et al., 2020).

1.7 Ineffective Matching of Interests

Problems related to interest distribution and compensation exist in industry-education cooperation, making effective cooperation and commitment of all interested parties crucial (Arthur-Mensah, N., 2020). The alignment of key interests in industry-education cooperation is ineffective, as the respective interests of universities and industries are not fully realized. This often leads to industry-education cooperation remaining superficial, without the ability to maintain long-term, sustained cooperative relationships, and makes it challenging to achieve effective industry-education cooperation (Shi, 2019). Both universities and industries have failed to establish a sustainable cost-sharing and interest distribution mechanism, which hinders the high-quality advancement of industry-education cooperation (Peng, 2019).

1.8 Low-Level and Superficial Cooperation

The inherent characteristics and conditions of vocational colleges constrain industry-education cooperation. Most vocational colleges lack distinct educational characteristics, making it difficult to appeal to industries. Additionally, due to poor educational conditions, inadequate teaching resources, and average educational quality, it is challenging to attract the attention and investment of high-quality industries (Chen, 2021).

Vocational colleges' self-established training facilities often fall short of achieving genuine industry-education cooperation. In most cases, these training facilities follow a self-established model, with a relatively low proportion being hosted by industries and open to the public. These facilities often have relatively outdated equipment and management practices, resulting in graduates having insufficient practical and professional skills (Huang et al., 2023).

To address resource shortages, vocational colleges may often simplify the alignment of programs with professions or even specific job positions (Tian, 2021), or they may focus on student placement or work experience-oriented models (Busby, 2005). Some colleges engage in industry-education cooperation primarily to address problems related to teaching staff and the lack of practical training facilities (Yu, 2023).

Industries may lack innovative thinking and long-term planning, which can lead to a lack of fundamental awareness of the importance of industry-education cooperation and limited involvement in the highly skilled personnel cultivation. The depth and breadth of industry-education cooperation may not be sufficient (Wu, 2018). Cooperative companies often explore highly skilled personnel development primarily from the perspective of their own development, and their connection to short-term market demands is usually stronger. They tend to focus solely on immediate economic benefits and lack long-term cooperation objectives (Lu et al., 2023).

Industries may prioritize their own production efficiency and may not fully incorporate the university's highly skilled personnel development plans into their value chain. They may view universities merely as units providing labor for their production and growth (Zhao, 2020). Due to differing interests between universities and industries, cooperation may often be hampered by concerns, leading to a "coexistence without harmony" situation (Lu et al., 2023).

Low-level cooperation in industry-education cooperation often remains limited to surface-level activities such as factory visits, training, and practical experiences. It fails to establish effective, in-depth cooperation in areas like student development objectives, program design, curriculum development, technological cooperation, personnel exchanges, and highly skilled personnel evaluation criteria. This results in poor stability and sustainability, with a short-term and intermittent nature to the cooperation (Zhu, 2022), aligning with the findings of Raihan, A. (2014). During the industry-education cooperation process, employees responsible for curriculum at companies are often not scholars, which can result in a lower quality of

student experience, lower task complexity, and challenges in building systematic industry experience (Solnet, D et al., 2007).

The main problems of industry-education cooperation as show table 2.1.

Table 2.1 The main problems of industry-education cooperation

Scholar	1	2	3	4	5	6	7	8
Xie Jianhong (2022)	●	●		●	●	●		●
Yu Li (2023)	●		●	●	●			●
Yao Yinglu (2019)	●	●	●	●		●	●	
Shi Wei (2019)	●	●		●	●	●	●	●
Yang Xiaoying (2020)	●	●	●	●			●	
Ouyang Wenjie (2022)		●	●	●	●	●		●
Rufai, A. U, et al. (2015)	●		●		●	●	●	
Taran Thune (2016)	●	●	●		●		●	●
Wierik M L, et al. (2017)	●		●	●		●	●	
Total	8	6	7	7	6	6	6	5

1 - Lack of Coordination in industry-education cooperation (8)

2 - Lack of Favorable Collaborative Environment Support (6)

3 - Imperfect Policies and Systems (7)

4 - Insufficient Resource Sharing (7)

5 - Inadequate Organizational Assurance (6)

6 - Communication and Coordination Hindered (6)

7 - Ineffective Matching of Interests (6)

8- Low-Level and Superficial Cooperation (5)

2. Opportunities in industry-education cooperation

With the construction and development of modern industrial systems, countries worldwide are placing a significant emphasis on developing human resources through the cooperation of industry and education. This approach has led to several opportunities and trends as follows.

2.1 Strong Policy Support

Within China, in 2017, the "Several Opinions of the State Council on Deepening the Cooperation of Industry and Education" was issued, which aimed to gradually increase the participation of industry industries in educational programs and promote university-enterprise cooperation in nurturing highly skilled personnel. This document, issued at the State Council level, is widely regarded as one of the most important policies for vocational education and industry-education cooperation (Xie, 2023). Subsequently, the national government introduced a series of more targeted and guiding policies and related supporting documents, including the "Measures for Promoting Industry-Education Cooperation in Vocational Universities" by six departments (2018), the "Implementation Measures for Building industry-education cooperation Industries (Trial)" (2019), the "National Pilot Program for industry-education cooperation" (2019), the "National Vocational Education Reform Implementation Plan" by the State Council (2019), the "Action Plan for Improving the Quality of Vocational Education (2020-2023)" by nine departments (2020), the "Opinions on Promoting the High-Quality Development of Modern Vocational Education" by the Central Committee of the Communist Party of China and the State Council (2021), and the "Regulations on the Management of Internships for Vocational University Students" by the Ministry of Education (2022). The national policy direction favors the development of industry-education cooperation.

Local governments are also implementing specific measures according to their own circumstances to promote the high-quality development of industry-education cooperation. For example, Sichuan Province aims to achieve comprehensive cooperation of education and industry within approximately ten years, fully implement the university-enterprise cooperation mechanism, improve and perfect demand-driven highly skilled personnel development models, and

significantly enhance the contribution of vocational education to economic development and industrial upgrading. Jiangsu Province has made industry-education cooperation a critical component of its initiatives for building innovative cities, counties (cities), and towns. Guangdong Province has included industry-education cooperation in the performance evaluation system for universities, promoting the precise alignment of academic disciplines and industrial needs in the Guangdong-Hong Kong-Macao Greater Bay Area. Hunan Province aims to continuously deepen industry-education cooperation, and by 2025, it intends to establish a pattern of mutually beneficial development between regional industries and education, optimize the educational and industrial structures, and synchronously plan and implement regional economic and social development alongside industry-education cooperation.

In recent years, countries around the world have been increasing their policy support for vocational education to promote the alignment of education with industry development. For instance, the United States government has provided financial support through legislation such as the "Perkins V Act" (2018) to drive vocational education and foster cooperation with industries. The government also encourages partnerships between universities and industries to meet skills demands (Hahn et al., 2019). Germany's "dual system" encourages students to alternate between university and on-the-job learning, with the government providing regulations and policy frameworks to promote industry-education cooperation (Müller, 2020). The Australian government, through its "Financial Support Plan," encourages universities to establish partnerships with industries to ensure students gain practical experience. The government also provides subsidies to support apprentice training (Vailasseri et al., 2021). The Japanese government has implemented a series of policies, including providing research and development funding for industry-education cooperation and supporting technological innovation. This helps ensure that vocational education remains in line with market demands (Suzuki, 2021).

2.2 Modern Industrial Development Currently

China is experiencing rapid economic and technological growth, while traditional industries are undergoing transformation and upgrade. Strategic emerging industries require continuous nurturing. In various sectors of China's industrial development, including manufacturing, modern services, cultural and creative design, and emerging industries, there is an urgent need for a substantial number of highly skilled and innovative personnel. This necessitates the accelerated development of technical and highly skilled personnel who possess cutting-edge knowledge, the ability to use new technologies, and a capacity for innovation and hands-on skills (He, et al., 2023). To achieve this, we should align with the demands of the times and actively promote industry-education cooperation, fostering market-oriented approaches to boost modern industrial development.

Presently, with the emergence of new industries, new formats, new technologies, and new models, international competition is intensifying. Germany has introduced Industry 4.0, the United States has launched the "Advanced Manufacturing" plan, and Japan and South Korea are advancing their levels of automation. This has led to an even greater demand for highly skilled personnel. The European Commission has also emphasized that "the development of technical skills determines Europe's productivity" and has continually refined education and enhanced vocational education systems to bolster its international competitiveness. These development experiences provide profound insights for us to advance industry-education cooperation and actively construct a modern vocational education system that is in harmony with it, further optimizing the internal configuration of vocational education to promote modern industrial development (Liu, 2019).

2.3 Increasing Demand for Highly Skilled Personnel

In March 2021, China issued the "Outline of the Fourteenth Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through the Year 2035." China has entered the phase of high-quality development, implementing a new era strategy to build a strong nation of highly skilled personnel, promoting the construction of a strong manufacturing and quality nation,

strengthening the training of innovative, applied, and bolstering the ranks of high-skilled personnel.

The globalization of the world economy, the increasingly borderless nature of the workforce, and the reduction of barriers to immigration and emigration have fueled a "highly skilled personnel war." Chand et al. (2019), in their study of immigration policies in the United States, Canada, and Australia, found that these three countries ranked among the top 15 most attractive destinations globally, attracting two-thirds of the world's skilled immigrants.

Ewers (2022) delineated new trends in global human capital mobility, indicating that existing skilled migration primarily revolves around global highly skilled personnel flow between traditional destinations in Europe and North America. In emerging economies in South Asia, Southeast Asia, and the Arabian Peninsula, there is a need to reevaluate existing approaches and enhance competitiveness in light of the evolving global competition for highly skilled personnel.

Farndale (2021) noted that, due to changes in the global macro-environment, high-tech companies with a significant demand for high-skilled STEM (Science, Technology, Engineering, and Mathematics) personnel are facing human resource constraints. Applying collaborative coevolutionary reasoning, the author suggests linking the macro-environment with corporate strategies, identifying urgent adjustments in highly skilled personnel, and addressing the increasingly severe shortage of STEM personnel associated with deglobalization.

2.4 Development of Modern Vocational Education Systems

Smith and Johnson (2019) emphasize that the development of modern vocational education systems is primarily driven by the rapid changes in technology and the market. This means that the education system must become more flexible to adapt to these ever-changing skill requirements. The accelerated pace of change necessitates that vocational education systems become more adaptable to ensure that students can meet industry demands upon graduation.

Brown (2020) underscores the importance of industry cooperation in modern vocational education. Close alignment with industry ensures that students acquire skills that are in line with market demands. This cooperation not only makes

education more practical but also provides students with opportunities for cooperation with the industry, enabling them to gain real-world experience. By partnering with industries, universities can better understand market needs and adjust their curricula to ensure that students graduate with practical, actionable skills.

Saleh (2017) highlights the potential impact of industry-education cooperation on reducing youth unemployment rates. By offering training that matches actual vocational requirements, students are more easily integrated into the workforce, reducing unemployment rates. This integrated education model not only equips students with practical skills but also provides them with better employment opportunities, contributing to sustainable social and economic development.

Bai (2023) suggests that industry-education cooperation involves the deep cooperation of the industrial and educational chains, with the primary task of nurturing highly skilled personnel that meets diverse industry needs. As China accelerates its industrial upgrading and economic restructuring, the demand for high-quality technical and skilled personnel becomes increasingly urgent, making industry-education cooperation a critical measure for building a modern vocational education system.

Lu (2023) emphasizes that in response to global development trends and the practicalities of economic and social development, China needs to achieve technological innovation and industrial transformation and upgrade to enhance its core competitiveness. Higher vocational education must align highly skilled personnel development with industrial upgrading and development, and industry-education cooperation has become the necessary path to construct a modern vocational education system, innovate highly skilled personnel cultivation models, improve the technological innovation system, and thereby promote industrial transformation and upgrading.

2.5 Educational Positioning in Vocational Education

Barus et al. (2021) argue that vocational education emphasizes skills training to equip students with the skills required in specific professional fields. Industry-education cooperation can better meet this characteristic, ensuring that students possess practical skills upon graduation.

Karunaratne et al. (2019) point out that vocational education typically includes practical projects and internship opportunities that allow students to engage in workplace tasks firsthand. Industry-education cooperation projects can establish partnerships with internship organizations and companies to provide students with practical experience in real workplace environments.

Beer et al. (2020) stress that vocational education can be flexibly adjusted according to market demand and technological changes. This flexibility necessitates the use of the industry-education cooperation model, as it can quickly adapt to new vocational requirements.

Billett (2020) contends that vocational education focuses on solving real-world problems, enabling students to address various workplace challenges. Industry-education cooperation, through collaborative education, can effectively help students apply the knowledge they have learned to solve actual industrial problems in real work environments.

2.6 Integrated Development of Industry and Education

The Chinese government has been actively promoting the integrated development of industry and education in recent years. Xu et al. (2023) emphasize the importance of building industry-education consortia, establishing a win-win cooperation ecosystem, creating a community of industry-education cooperation, and simultaneously advancing professional development in line with industry growth. This approach effectively enhances the capabilities of vocational education services for high-end industries.

Germany has long been regarded as a model with its dual education system, which combines academic and vocational training. According to Brown et al. (2020), the model of industry-education cooperation ensures that students gain both academic knowledge and practical skills. This model presents opportunities for industry-education cooperation, allowing students to better adapt to the demands of the job market while promoting the cooperation of academic and vocational training.

Sublett et al. (2021) found that Canada has made significant progress in integrating industry and education, covering a wide range of sectors, including technology, manufacturing, and services. This approach provides students with

training that aligns with market demands, thereby increasing their employment opportunities.

The U.S. government actively advocates for the integrated development of industry and education, with individual states focusing on establishing industrial education partnerships. These partnerships aim to foster cooperation between universities, higher education institutions, and industries, covering internships, apprenticeship programs, and cooperative projects in various ways to ensure that students graduate with skills demanded by the market, facilitating seamless alignment between industry and education (Perry, 2023).

Opportunities in industry-education cooperation as show table 2.2.

Table 2.2 Opportunities in industry-education cooperation

Scholar	1	2	3	4	5	6
Hahn et al. (2019)	●		●		●	●
He et al. (2023)	●	●	●			●
Li et al. (2023)	●	●	●	●		
Ewers (2022)	●	●	●			
Dandan (2023)		●	●	●	●	
Karunaratne et al. (2019)	●	●	●		●	●
Xu et al. (2023)	●	●	●	●	●	●
Perry (2023)	●		●			●
Total	7	6	8	3	4	5

- 1- Strong Policy Support (7)
- 2- Modern Industrial Development Currently (6)
- 3- Increasing Demand for Highly Skilled Personnel (8)
- 4- Development of Modern Vocational Education Systems (3)
- 5- Educational Positioning in Vocational Education (4)
- 6- Integrated Development of Industry and Education (5)

3. Key success factors in industry-education cooperation

The factors influencing industry-education cooperation are diverse. According to Liu et al. (2015), industry-education cooperation is affected by factors within universities and industries, as well as coupling factors between them and external environmental factors. Qiu (2011) asserts that any of the three main actors, namely universities, industries, and the government, are constrained by the other actors and external circumstances, categorizing the factors affecting industry-education cooperation into external environmental factors and internal mechanisms. Gümüşay et al. (2018) primarily position barriers to industry-education cooperation at institutional boundaries, distinguishing between internal influencing factors and external influencing factors. Fu Xinmin (2015) employs a two-dimensional classification method to categorize factors influencing industry-education cooperation, suggesting that these factors can be divided into macro and micro factors, internal and external factors, necessity and supportive factors, among others. Therefore, factors influencing industry-education cooperation can be screened from various perspectives, including stakeholders, the environment, operational mechanisms, and more.

3.1 University Resource Investment

Universities are key players in industry-education cooperation. According to Duo et al. (2015), based on a nationwide survey of vocational universities, they propose that factors such as the educational level and location significantly influence industry-education cooperation. Tao et al. (2017) conducted research and found that factors like the university's location, educational quality, and institutional nature have a notable impact on industry-education cooperation. Fu (2015) and Wu et al. (2014) suggest that factors affecting industry-education cooperation include the quality of highly skilled personnel cultivation at the university, the university's capacity to serve industry industries, and its organizational research and development capabilities. Additionally, the level of resources invested by the university in industry-education cooperation, including cost input and effort, also affects the extent of industry-education cooperation. Therefore, key university factors influencing industry-

education cooperation encompass the university's awareness, foundational conditions, educational standards, and resource allocation.

3.2 Industry Resource Investment

Industries are essential participants in industry-education cooperation. According to Shen et al. (2018), when analyzing the actual willingness of Chinese industries to engage in industry-education cooperation, they argue that cultural factors such as an enterprise's strategic awareness of industry-education cooperation, social responsibility, and risk tolerance influence industry-education cooperation. Wang (2019) asserts that enterprise investment in funds, equipment, research personnel, and the establishment of practical training facilities are essential indicators reflecting the degree of industry-education cooperation. It is evident that key enterprise factors influencing industry-education cooperation include the enterprise's perception of industry-education cooperation, its nature and size, and resource allocation.

3.3 Government Support Intensity

The government serves as a supporting stakeholder in industry-education cooperation. Kozlinska (2012) argues that the government is the most influential force in the success or failure of industry-education cooperation. In general, industry-education cooperation relies to a large extent on government support (Collier et al., 2011; Medeiros et al., 2012; Hemmert et al., 2014; Muscio & Vallanti, 2014; Myoken, 2013; Newberg & Deng, 2002; Schofield, 2013; Sohail, 2013). Shen et al. (2017) conducted empirical research on the government's role in industry-education cooperation and found that government influence on industry-education cooperation is affected by factors such as inadequate preferential support, complex application procedures for incentive policies, challenging implementation specifics, a lack of a unified vocational skills standards system, and a shortage of corresponding evaluation systems. This highlights the dependency of industry-education cooperation development on the role played by the government.

3.4 Social Industrial Structure

The social industrial structure provides crucial external conditions and demand environment for industry-education cooperation. (Ankrah & AL-Tabbaa, 2015; Hadjimanolis, 2006) found that market potential has a certain impact on industry-education cooperation. According to Yu et al. (2020), the industrial structure is interdependent with regional program offerings and highly skilled personnel cultivation. Zhang (2020) analyzed a growing trend in recent years, known as industry-education cooperation parks, which involve multiple stakeholders, including government, universities, and industries, with the fundamental task of nurturing technical and skilled personnel, combining various societal functions into a unified organizational platform. Tu et al. (2018) proposed that the degree of industry-education cooperation primarily depends on the alignment of program offerings with the industrial structure. Therefore, the social environment's impact on industry-education cooperation includes factors such as industrial structure, platform structures, and cultural atmosphere.

3.5 Technological Innovation and Transformation

Technological innovation and transformation represent the external technological support environment that industry-education cooperation faces. Tangible and intangible indicators such as patent numbers (Xia et al., 2014), the quantity of scientific articles (Salimi & Rezaei, 2016), high-tech manufacturing and exports (Aiello et al., 2019), intellectual property income (Valentin & Jensen, 2007), and ICT service exports (Hwang, 2020) are frequently mentioned in the context of industry-education cooperation. Liu Jun (2018) pointed out that using big data technology facilitates the seamless alignment of information on labor market demands, teaching processes, and production processes, ensuring that the highly skilled personnel cultivation meets the requirements for technical and skilled personnel in the internet era. Liu et al. (2017) analyzed the technical aspects of industry-education cooperation and introduced "six new" technologies into universities, enhancing students' technical thinking, competence, and skills. Therefore, the technological environment's impact on industry-education cooperation includes factors such as the demand for technical personnel and technology transfer.

3.6 Policies and Institutions

Policies and institutions are the rules and behavioral guidelines governing industry-education cooperation, providing the necessary external supportive environment for effective industry-education cooperation. Lack of local support (Șerbănică, 2011) or regulatory and legal constraints (Arvanitis et al., 2008; Attia, 2015; Hadjimanolis, 2006) may have a negative impact on cooperation. Liu (2019) suggested that macro policies represent a crucial external factor influencing industry-education cooperation. Li et al. (2021) argued that institutional arrangements, such as policies promoting industry-education cooperation and the establishment of industry-education-integrated industries, affect the direction and implementation strategies of industry-education cooperation. Sun et al. (2021) noted that the existing institutional framework for industry-education cooperation in local universities is overly broad, and institutional innovation is challenging, serving as a constraining factor in the development of industry-education cooperation. Therefore, the institutional environment's impact on industry-education cooperation includes factors such as macro policies and regulations, as well as micro-level institutional measures.

3.7 Resource sharing mechanism

Resource sharing mechanism is the operational approach for achieving the effective flow of resources and mutual complementation of functions. Crucial to industry-education cooperation is unrestricted access to libraries, laboratory spaces, and similar infrastructure (Boardman & Bozeman, 2015) or technological equipment (Arvanitis et al., 2008). Xie (2019) and Sun et al. (2021) propose placing the advantageous resources of the industry-education cooperation entities on an open and shared platform. They suggest that resources such as human resources, information, equipment, physical space, research outcomes, and other resource types should be shared and allocated uniformly based on the actual needs of the stakeholders, including government, universities, and industries. Therefore, the impact of the resource sharing mechanism on industry-education cooperation mainly concerns the content and extent of resource sharing and utilization.

3.8 Organizational support mechanism

Organizational support mechanism refers to the cross-sector organizational structure and its operational methods established by universities, industries, government departments, and social organizations to facilitate industry-education cooperation. Government networks (Rampersad, 2015), public funding (Piva & Rossi-Lamastra, 2013), or tax incentives (Bodas Freitas et al., 2013) can promote the development of industry-education cooperation. Human resources play a crucial role in the successful implementation of industry-education projects (Albats et al., 2020). Typically, the effectiveness and quality of cooperation strongly depend on the available resources of the partners. He et al. (2021) presented the organizational form of the industry-education cooperation community, where knowledge production activities related to highly skilled personnel cultivation, technological research and development, and outcome transformation are integrated. They highlight the application of a value-sharing mechanism based on the social exchange principle to stimulate the vitality of industry-education cooperation entities by maintaining a balance between inputs and outputs among the stakeholders. Therefore, the impact of the organizational support mechanism on industry-education cooperation mainly includes factors such as financial support, personnel support, and necessary incentive and penalty mechanisms.

3.9 Communication and cooperation mechanism

Communication and cooperation mechanism is the operational approach that allows stakeholders to fully express their interests and demands. In the pursuit of improvement, collaborative efforts and the implementation of each other's experiences and feedback are beneficial for both universities and companies (Ryan, 2009). Albats et al. (2020) emphasize the importance of establishing a common understanding and the frequency of communication. Mutual communication (accurate, comprehensive, timely, and regular) is also conducive to fostering positive expectations about partners' future behaviors, especially when the partnership is still relatively new (Bstieler et al., 2017). Zhu (2016) developed a conceptual model and conducted empirical research, concluding that the communication mechanism significantly influences industry-education cooperation behavior. Xi (2018) suggests

that social organizations that perform the coordinating function of industry-education cooperation can substantially reduce the execution and supervision costs associated with industry-education cooperation. Consequently, the impact of the communication and cooperation mechanism on industry-education cooperation includes factors such as information communication channels, frequency, and cooperation governance mechanisms.

3.10 Interest balance mechanism

Interest balance mechanism refers to the institutionalized arrangements for interest allocation, compensation, and regulation among the various stakeholders. Seeking a win-win situation with balanced interests on both sides is of paramount importance. Cooperation partners can achieve common objectives by sharing a mutual understanding of the goals and concretizing precise strategies throughout the cooperation process (Hong et al., 2010). It should also be noted that cooperation partners often hold unrealistic expectations about cooperation outcomes or have different senses of urgency (Attia, 2015). Peng (2019) argues that each industry-education cooperation stakeholder has its own interests, and the interest distribution mechanism is a crucial factor for deepening industry-education cooperation. Zhang et al. (2021) propose establishing mechanisms for sharing benefits and bearing risks to enhance the agency relationship between universities and industries during industry-education cooperation practices. Thus, the impact of the interest balance mechanism on industry-education cooperation mainly involves factors related to interest distribution, cost-sharing, and compensation. As show table 2.3.

Table 2.3 Key success factors in industry-education cooperation

Scholar	1	2	3	4	5	6	7	8	9	10
Rybnicek et al. (2019)	●	●	●	●		●	●	●	●	
Shen et al. (2018), (2023)	●	●	●	●	●	●	●	●	●	●
Ćudić et al. (2022)	●	●	●		●	●		●	●	
Rybnicek et al. (2019)	●	●	●	●	●	●	●	●		●
Nsanzumuhire et al. (2020)	●	●	●	●	●		●		●	
Tseng et al. (2020)	●	●	●			●		●	●	●
Ramli et al. (2021)	●	●	●	●		●		●		●
Pertuz et al. (2021)	●	●	●	●	●	●	●	●	●	●
Østergaard et al. (2022)	●	●		●		●			●	●
Baleeiro et al. (2023)	●	●		●	●		●			●
Kleiner et al. (2022)	●	●	●		●	●		●		
Bertolett et al. (2021)	●	●	●		●	●		●		
Gioanes (2019)	●	●			●		●		●	●
Figueiredo et al. (2020)	●	●	●	●	●	●	●	●	●	●
Awasthy et al. (2020)	●	●	●		●	●	●		●	●
Enke. et al. (2021)	●	●		●				●	●	
O'Dwyer et al. (2023)	●	●	●		●	●	●		●	
Sjöö et al. (2019)	●	●		●			●			●
Puerta et al. (2020)	●	●	●			●		●		●
Bastos et al. (2021)	●	●	●		●	●		●	●	
Total	20	20	15	11	13	15	11	13	13	12

1- University Resource Investment (20)

2- Industry Resource Investment (20)

3- Government Support Intensity (15)

4- Social Industrial Structure (11)

5- Technological Innovation and Transformation (13)

6- Policies and Institutions (15)

7- Resource Sharing Mechanism (11)

8- Organizational Assurance Mechanism (13)

9- Communication And Coordination Mechanism (13)

10- Interest Balance Mechanism (12)

4. The theory for designing industry-education cooperation management models

4.1 Triple Helix Theory

The Triple Helix theory provides a theoretical model for the interactions among entities in industry-education cooperation. Henry Etzkowitz and Loet Leydesdorff are the pioneers of the Triple Helix innovation theory paradigm.

4.1.1 Origin and Development of the Triple Helix Theory

The Triple Helix model was initially used by Linus Pauling and Robert B. Corey to explain the structure of DNA. As mentioned in Fang Weihua's (2003) research, geneticist Richard Lewontin employed the metaphor of the Triple Helix to model the relationship between genes, organisms, and the environment in the field of genetics. In response to the convergence and cross-fertilization between academia, industry, and government, Etzkowitz and Leydesdorff introduced the Triple Helix model of the "college-industry-government" relationship. The Triple Helix represents the transformation of relationships among universities, industries, and governments, as well as the changes occurring within each domain.

Etzkowitz (1998) suggests that the development of the Triple Helix model involves four stages:

Internal Transformation within Each Helix: Universities play a central role, not only in highly skilled personnel cultivation and scientific research but also in applying knowledge to practical production.

Influence of One Helix on Another: For instance, government policies on technology transfer are influenced by input from universities and their representatives. Government establishes rules to gain intellectual property rights from government-funded research and then encourages the transfer of technology within universities.

Interaction among the Three Helices Creates a New Network and Organization: Universities, industries, and governments can brainstorm new ideas to fill gaps. This interaction leads to the formation of novel concepts and bridges between the three entities.

Recursive Effects of the Triple Helix Model: These effects extend beyond the individual helices and have an impact on larger societal groups. They also influence science itself.

Zhao et al. (2020) identified three structural types of the Triple Helix model, reflecting the industry-education-government relationships under different institutional arrangements. The first type is the State Intervention Model, as shown in Figure 2-1 (a). In this structure, the government encompasses both the University and industry, directing the relationship between the two. The second type is the Laissez-Faire Model, as depicted in Figure 2-1 (b). In this structure, the government, University, and industry are separate entities, with more competition than Cooperation among them. The third type is the Overlapping Model, as illustrated in Figure 2-1 (c). In this structure, government, industry, and education overlap, interact, and integrate. This model emphasizes both bilateral and trilateral Cooperation relationships.

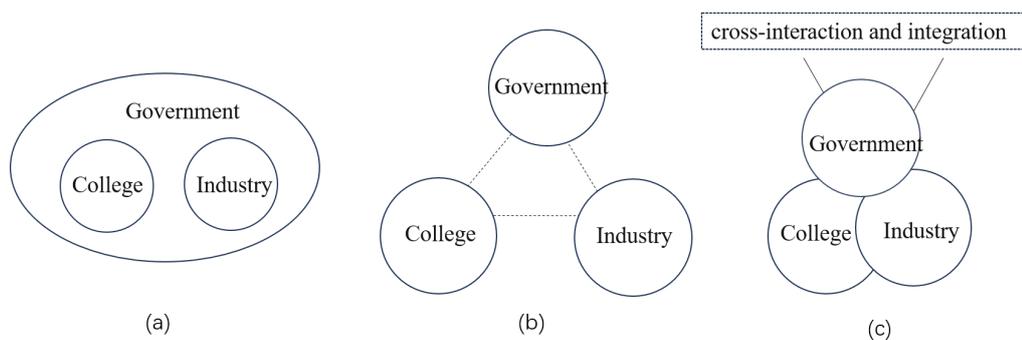


Figure 2-1 Triple Helix Structure Model

Figure 2.1 Triple Helix Structure Model

Zhuang (2018) argues that the current relationships among universities, industries, and government departments have exhibited a trend of mutual intersection and convergence. In the innovation system, a new institutional structure driven by systemic forces has emerged. This institutional network forms a spiral-like pattern where the scientific chain, production chain, and administrative chain are intertwined.

Lang (2023) points out that within the Triple Helix model, universities, industries, and government departments collectively create an innovation environment conducive to knowledge production and transformation. While there is functional overlap among universities, industries, and government departments, each helix has its own "core area" and "peripheral field" within its institutional scope. For instance, universities have their "core area," allowing them to maintain relative independence from other institutions, while their "peripheral field" enables them to engage in extensive interactions with industries and government departments.

4.1.2 Main Points of the Triple Helix Theory

As the roles of universities, such as entrepreneurs or innovators, continue to strengthen, the distance between universities and industry has been steadily diminishing. Concurrently, government support for universities has been on the rise, and the mutual dependencies between universities and the government have become more pronounced, especially when industry is involved. Bilateral relationships are gradually giving way to trilateral relationships. It is important to clarify that the intention of the Triple Helix model is not to transform universities into industries or governments into commercial entities. On the contrary, since each party possesses capabilities from the other two sides, they all maintain their original roles and unique characteristics.

4.1.3 Application of Triple Helix Theory

Based on the Triple Helix theory, vocational colleges, industries, and government are the core elements for implementing industry-education cooperation. They intertwine and exhibit a relationship structure that reflects mutual spiraling. Additionally, they each play distinct societal roles within the ecosystems they collectively construct. The core value of the Triple Helix theory lies in breaking down

traditional organizational boundaries and functional divisions. Vocational colleges, as institutions for knowledge production and Internal Transformation within Each Helix: Universities play a central role, not only in highly skilled personnel cultivation and scientific research but also in applying knowledge to practical production, have increasingly blurred their boundaries with industries. Vocational colleges, industries, and government, not only interact through indirect relationships but also through direct ones. They permeate and merge within the Cooperation management models and innovation mechanisms, with each entity playing its respective role within the industry-education cooperation ecosystem. They independently assume their rights, responsibilities, and obligations while also fulfilling certain functions of the other two entities. It is the interplay between these three entities, their role overlaps, and their collaborative interactions that drive continuous evolution in their internal functions, forming a triadic network and a co-existing structure. This overall trend resembles an "ascending triple helix."

4.2 Ecological Systems Theory

The Ecological Systems Theory provides an analytical framework for the study of cooperative models of industry-education cooperation, with Tansley and Jorgensen being representative figures in its development.

4.2.1 Origin and Development of Ecological Systems

In 1935, the renowned British ecologist Stanley proposed the concept of an "ecosystem." Clements (1916) defined an ecosystem as "a physical system that includes not only various organisms but also all the physical factors that make up the environment of a biological community in the broadest sense." Reviewing relevant studies, Xiao (2018) found that scholars like the Odum brothers (H.T. Odum and E.P. Odum), Patten, and Jorgensen further advanced the concept of ecosystems. Jorgensen et al. (2013) viewed ecosystems from a systemic perspective, considering them organic wholes formed by the interactions of many organisms. These components are interconnected into an ecologically networked system characterized by mutual cooperation and Cooperation.

4.2.2 Basic Principles of Ecosystem

Ecosystem is a product of the combination of ecology and system science. It possesses attributes of ecology and emphasizes the scientific perspective of systems theory. Jorgensen (2017) identifies the following characteristics of ecosystem content:

Wholeness: Ecosystems are integrated wholes composed of biological components and their environmental surroundings within a specific spatial context.

Openness: Ecosystems maintain multiple channels of communication and exchange with their external environment, as well as within their internal components, both among living organisms and between living and non-living components.

Connectivity: Biological and non-biological components within ecosystems are interconnected through networks, enabling mutualistic symbiosis and collaborative development.

Complexity: Ecosystems tend to exhibit multidimensional network structures due to the multitude of components and intricate relationships.

Stability: Ecosystems self-regulate during their operation to maintain the stability of their elements and structures.

4.2.3 Application of Ecosystem Theory

From an ecosystem perspective, the development of industry-education cooperation resembles the evolution of natural ecosystems. On one hand, the various entities engage in mutual bargaining and cooperation, while on the other hand, they interact and influence one another within their external environment. Drawing a conceptual analogy to natural ecosystems, the industry-education cooperation ecosystem is a complex artificial ecosystem formed by the organic coupling of entities such as vocational colleges, industries, government, and the broader societal external environment through nonlinear mechanisms.

4.2.3.1 Structural Elements

According to the fundamental principles of ecosystem ecology, an ecosystem's components mainly consist of ecological entities, ecological environment, and ecological mechanisms. The industry-education cooperation

ecosystem is a functional unit formed by the cooperation between vocational colleges and industries, involving the sharing and cycling of resources. It can be regarded as an organic whole in the social environment where industries and vocational colleges exist and develop within a certain industrial scope. Within this ecosystem, they mutually influence and interact through the exchange, sharing, endogenous development, transformation, and application of resources.

Huo (2019) suggests, the industry-education cooperation ecosystem is an organic whole formed by the coupling of cooperation entities and the external environment through non-linear mechanisms. Thus, it can be seen that the industry-education cooperation ecosystem is a complex artificial ecosystem, and following the principles of biomimicry, it consists of ecological entities, ecological environment, and ecological mechanisms.

According to the Triple Helix theory, government, vocational colleges, and industries are the core entities in industry-education cooperation. The industry-education cooperation ecosystem primarily consists of economic, social, technological, and institutional environments. The mechanisms within the industry-education cooperation ecosystem, known as the operational mechanisms, refer to the processes and methods of interaction and regulation among various elements during the cooperation process. These mechanisms encompass resource-sharing mechanisms, communication and cooperation mechanisms, interest-balancing mechanisms, and organizational support mechanisms.

4.2.3.2 Industry-education Cooperation Core Entities

Li et al. (2019), based on the Triple Helix theory, constructed the industry-education cooperation ecosystem and analyzed the relationship structure and role positioning of vocational colleges, industries, and government in industry-education cooperation.

Mao et al. (2019) introduced the ecological concept of symbiosis into industry-education cooperation research, building a symbiotic system involving applied undergraduate institutions, industries, and government. They emphasized that local government, applied undergraduate institutions, and industries are the three most important entities in industry-education cooperation.

Zeng (2021), after analyzing the experiences of countries such as the United States, Germany, and Australia in the field of vocational education and industry-education cooperation systems and mechanisms, proposed that China should establish a three-party ecosystem for industry-education cooperation involving the government, universities, and industries.

Chen (2022), in the three-helix structure of the industry-education cooperation ecosystem, suggests that the government serves as the "helm" for social public interests, taking on roles such as overall planning, organizational guidance, service provision, and assessment supervision in industry-education cooperation.

Liu et al. (2020) believe that the government's interests can only be realized when attached to certain entities. Local government interests can be categorized into the personal interests of local government officials, institutional interests of local governments, and shared interests within the jurisdiction of local governments.

Xie (2021) proposes that vocational colleges are the main institutions for highly skilled personnel cultivation, with teaching being the key to cultivation. Curriculum forms the foundation of teaching. Vocational colleges should collaborate with industries and industries to design curriculum content and systems based on job processes, and strengthen innovation, entrepreneurship, and practical teaching content.

Du (2018) argues that vocational colleges are open systems and rely on external resources for development. Industries provide real production scenarios, which are indispensable resources in the process of highly skilled personnel cultivation in vocational colleges.

Qu (2021) suggests that in the three-helix structure of the industry-education cooperation ecosystem, industries, as the training entities, should integrate their employment needs in the production and operational processes into the highly skilled personnel cultivation of vocational colleges.

According to the Triple Helix theory and as illustrated in Figure 2-2, clarifying the roles of government, vocational colleges, and industries in each element can fully harness their core roles in industry-education cooperation. This contributes to driving innovation, improving educational quality, cultivating highly skilled personnel,

promoting industrial upgrading and competitiveness, and, simultaneously, facilitating economic growth and social development, ultimately achieving mutual benefits and goals.

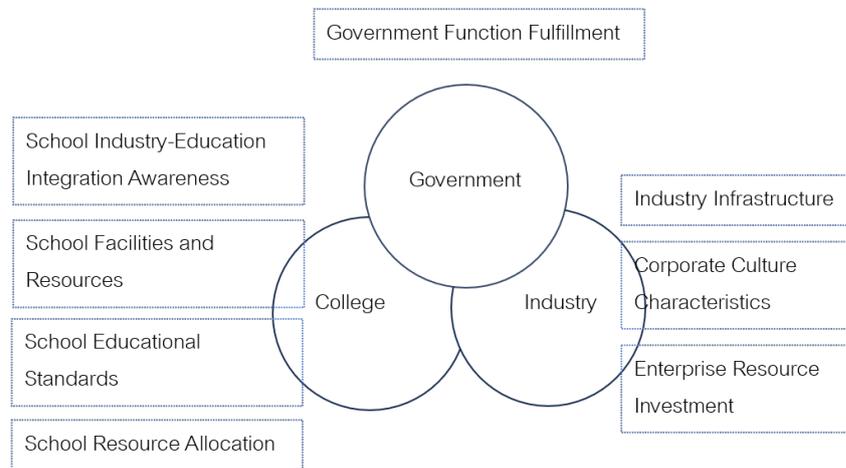


Figure 2.2 Interaction among Industry-Education Cooperation Entities

4.2.3.3 Industry-Education Cooperation Ecological Environment

Mao et al. (2019) analyzed the symbiotic environment of industry-education cooperation using the PESIN tool from strategic management. This symbiotic environment encompasses the political and legal environment, economic environment, socio-cultural environment, international environment, and natural environment.

Liu (2019) believes that the external influencing factors on vocational education industry-education cooperation primarily include macro-policy environment, regional economic development environment, socio-cultural environment, and scientific and technological environment.

Nsanzumuhire (2020) suggests that the environmental categories of industry-education cooperation systems include economic, social, industrial, policy, cultural, and natural environments.

Ling et al. (2019) pointed out that the external environment of the industry-education cooperation ecosystem includes elements such as political systems, cultural technology, regional transportation, economic levels, industrial development, and laws and regulations.

Lv et al. (2019) believe that the study of vocational education and industry-education cooperation problems should encompass macro-environmental aspects such as economics, politics, culture, society, and institutions. Specifically, the industry-education cooperation ecological environment mainly includes the economic environment, social environment, technological environment, and institutional environment.

Zhang (2020) proposed that due to differences in resource endowments, technological conditions, and consumer demands across regions, their industrial structure levels also vary. The upgrading of industrial structure primarily depends on innovation-driven and highly skilled personnel-driven factors, which pose practical requirements for regional industry-education cooperation development. In other words, the evolution of the triple helix among local governments, industries, and vocational colleges not only aims to achieve collaborative education but also to foster collaborative innovation and promote the transformation of industries from low to high technological levels.

Fang (2022) provided statistics indicating that there are more than 180 normative documents related to "industry-education cooperation" in China. The main goals of industry-education cooperation policies are to promote the linkage between the education chain, highly skilled personnel chain, industry chain, and innovation chain, advance collaborative education between universities(colleges) and industries, technology transfer, and results transformation, and drive regional industrial and economic development.

The industry-education cooperation ecosystem is a functional unit formed by the cooperation among government, vocational colleges, and industries, facilitating resource sharing and circulation. The social environment, institutional environment, and technological environment constrain the cooperation of industry and education, which in turn is used to impact the surrounding environment, promoting social development, institutional improvement, and technological innovation, as illustrated in Figure 2-3.

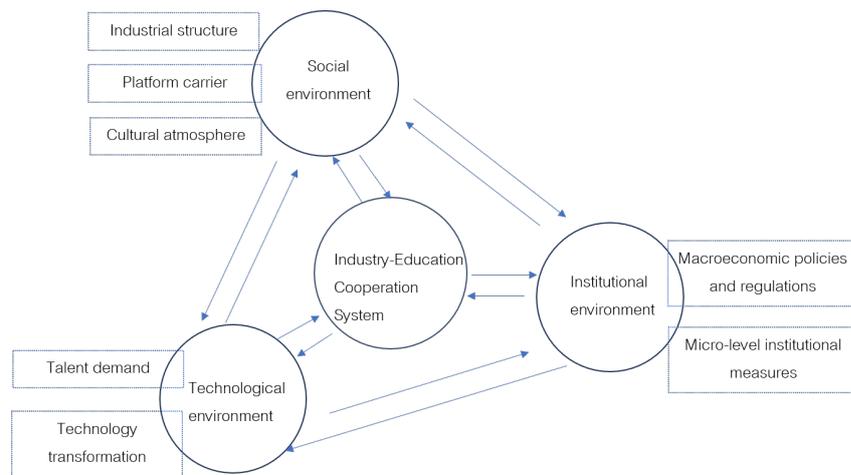


Figure 2.3 Interactions in Industry-Education Cooperation Environment

4.2.3.4 Industry-Education Cooperation Operating Mechanisms

Li et al. (2019) proposed that the operating mechanism of industry-education cooperation in vocational colleges revolves around constructing an ecological recycling system that aligns professional chains with industrial chains, course content with vocational standards, and teaching processes with production processes. To deepen industry-education cooperation in vocational colleges, it is crucial to establish a safeguard mechanism for the educational ecological environment. This involves the government providing platforms and actively enhancing cooperation efforts, vocational colleges adjusting their structures to meet development needs proactively, and industries aligning with education and participating in the cultivation of vocational highly skilled personnel.

Gu et al. (2021) suggest that the foundation of industry-education cooperation lies in a trust mechanism, where values are recognized through trust, resources are shared through trust, and highly skilled personnel cultivation is linked through trust.

Cai et al. (2019) argue that promoting the development of industry-education cooperation in applied colleges requires refining cooperation mechanisms. This includes advancing Cooperation mechanisms, enhancing dialogue and communication between industry and education, and strengthening guarantee mechanisms to promote normative and effective institutional development.

Xie (2019) states that to advance and deepen industry-education cooperation, it is necessary to establish mechanisms for shared resource construction and information communication. Creating an open, shared, transparent, and convenient platform for industry-education cooperation resources allows educational and industrial systems to share and access resources efficiently.

Zhang (2019) suggests that using legal stability, enforceability, and normativity can regulate and resolve conflicts of interest among industry-education cooperation entities. This helps promote fair competition among entities within the industry-education cooperation system. In summary, the analysis of the industry-education cooperation operating mechanism can be approached from four aspects: resource sharing mechanisms, communication and cooperation mechanisms, interest balance mechanisms, and organizational support mechanisms. as shown in Figure 2-4.

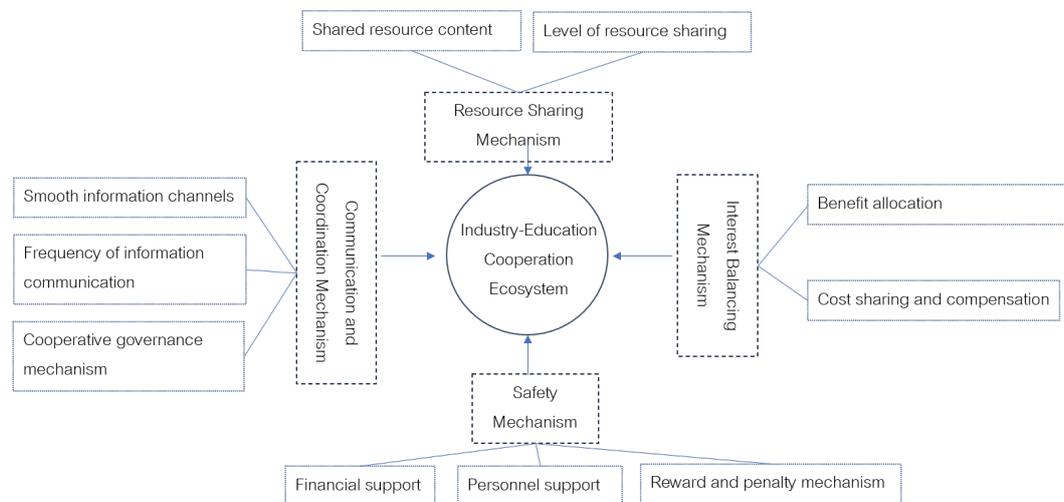


Figure 2.4 Industry-Education Cooperation Operation Mechanism

The Theory of industry-education cooperation management model as show table 2.4.

Table 2.4 Theory of industry-education cooperation management model

Scholar	Triple Helix Theory	Ecosystem Theory
Zhao (2020)	●	
Zhuang (2018)	●	
Lang (2023)	●	
Bednarzewska. (2021)	●	
Wang et al. (2023)	●	
Etzkowitz et al. (2017)	●	
Mandrup et al. (2017)	●	
Yoda et al. (2020)	●	
Li et al. (2022)	●	●
Mao et al. (2019)	●	●
Zeng (2021)	●	●
Chen (2022)	●	●
Qu (2021)	●	●
Liu (2019)	●	●
Nsanzumuhire(2020)		●
Lüet et al. (2019)		●
Xie (2019)		●
Golja et al. (2018)		●
Ji et al. (2023)		●
Cukurova et al. (2019)		●
Mulder et al. (2022)		●
Shaochun et al. (2022)		●
Peters et al. (2021)		●
RONGRONG et al. (2023)		●
Li et al. (2022)		●
Total	14	17

Conclusion:

In this section, we have explored the application of ecosystem theory and the Triple Helix theory in our research. Ecosystem theory emphasizes the interactions and influences among entities, environment, and mechanisms. The Triple Helix theory emphasizes the roles of government, universities, and industries as key actors. The industry-education cooperation ecosystem is a complex artificial ecosystem, an organic whole formed and influenced by interactions between actors and their external environment through specific mechanisms. Analyzing and defining the ecological entities, environment, and mechanisms form the analytical framework for the industry-education cooperation ecosystem model.

5. Methods for designing and evaluating industry-education cooperation models

5.1 Expert survey

Expert survey method was established by the Rand Corporation in the United States in 1946. It is essentially a feedback anonymous inquiry method, and its general process is based on a certain systematic program, using experts to anonymously express their opinions. Through several rounds of iterative expert opinion consultation, induction, and modification, reliable research results are formed based on experts reaching a basic consensus (Grime et al., 2016).

5.1.1 The characteristics of the method

Anonymity: All members of the expert group do not meet directly when using this method, but communicate through correspondence, which can eliminate the influence of authority. This is the main feature of this method. Anonymity is an extremely important characteristic of the method, where experts engaged in prediction do not know who else is participating in the prediction, and they exchange ideas in a completely anonymous manner. The later improved allowed for expert meetings for thematic discussions.

Feedback: This method requires 3-4 rounds of information feedback, allowing both the investigation team and the expert group to conduct in-depth research in each feedback, so that the final result can basically reflect the basic ideas

and understanding of the information of the experts, making the result more objective and reliable. Communication among group members is achieved by answering the organizer's questions, and it usually takes several rounds of feedback to complete the prediction.

Statistical: The most typical group prediction result reflects the views of the majority, and the views of the minority can be summarized at most, but this does not indicate the different opinions of the group. The statistical answer is not like this, it reports a median and two quartiles, with half falling within the two quartiles and half falling outside the two quartiles. In this way, each viewpoint is included in such statistics, avoiding the disadvantage of the expert meeting method only reflecting the opinions of the majority.

5.1.2 Applications of the method

Due to the method typically selects authoritative experts in the relevant field and employs anonymous back-to-back multiple rounds of consultation, its research results have strong reliability and authority. For example, Dineke (2004) used the method to construct and validate a teaching competency model for university teachers. Marieke van der Schaaf (2005) also proposed evaluation criteria for assessing teacher research skills using the method.

5.2 SWOT Analysis Model

The history of SWOT analysis can be traced back to the 1960s and was initially proposed by American management scholar Albert S. Humphrey. Initially, it was used for a project at the Stanford Research Institute to evaluate strategic planning for companies. Over time, SWOT analysis has become a common tool used by industries, organizations, and governments to assess both internal and external environments. SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. Its principle lies in helping organizations gain a comprehensive understanding of their strategic position by analyzing these four aspects and providing a foundation for making informed decisions. SWOT analysis is typically presented in a matrix format, with Strengths, Weaknesses, Opportunities, and Threats listed separately for easy comparison and analysis. This framework aids organizations in intuitively identifying and managing their strategic factors. (See Figure 2.5)

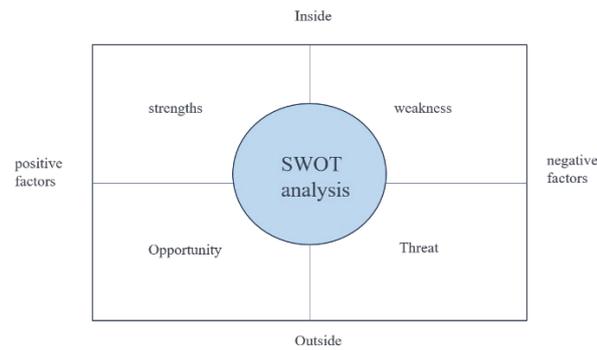


Figure 2.5 SWOT Analysis Model Diagram

5.3 CIPP Evaluation Model

5.3.1 Principles of the CIPP Evaluation Model

The CIPP model, initially proposed by American scholar Stufflebeam in 1971, was originally designed for evaluating educational problems but has since found applications in various fields, including social management, industry, and the military. The CIPP model comprises four components: Context Evaluation, Input Evaluation, Process Evaluation, and Product Evaluation. Its ultimate goal is not merely to prove a point but to bring about improvements. In other words, the use of the CIPP model is not solely for obtaining an evaluation outcome but for enhancing and refining the evaluated object (evaluation program).

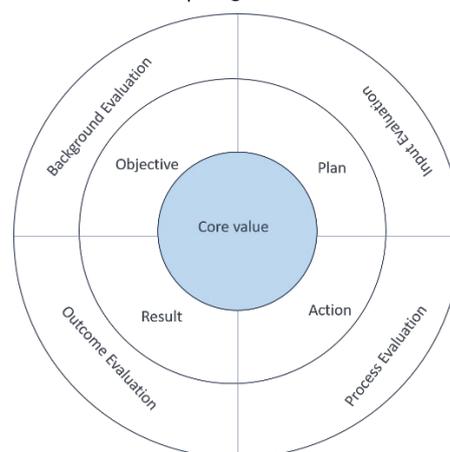


Figure 2.6 Core Components of the CIPP Model

The core components of the CIPP model are illustrated in Figure 2.6. In Context Evaluation, evaluators assess the needs, problems, favorable conditions,

opportunities, and relevant background conditions and dynamics. Input Evaluation involves determining and assessing alternative methods, assisting in program planning, and subsequently evaluating program plans, staffing, and budgeting to determine the feasibility and potential cost-effectiveness of meeting established needs and achieving expected goals. Process Evaluation entails monitoring, documenting, evaluating, and reporting on the implementation of program plans. Result Evaluation involves identifying and assessing costs and outcomes, including expected and unexpected results, as well as short-term and long-term outcomes.

In Figure 2.6, three concentric circles depict the fundamental elements of the CIPP model. The innermost circle represents the core values used to emphasize a given evaluation. The outer circle surrounding the core values is divided into four evaluation foci: objectives, planning, action, and results. The outermost circle is the evaluation type that corresponds to the four evaluation foci: Context Evaluation, Input Evaluation, Process Evaluation, and Result Evaluation. Goal setting tasks pose questions for Context Evaluation, providing information to confirm and improve objectives. Planning for improvement tasks raises questions for Input Evaluation, providing corresponding planning judgments and directions for improvement. Project actions pose questions for Process Evaluation, offering judgments on actions and reinforcing feedback for improvement. Achievements, lack of achievements, and side effects draw attention to Result Evaluation, ultimately leading to judgments on results and aiding in confirming needs for better outcomes.

5.3.2 Key Perspectives on the Application of the CIPP Evaluation Model

Based on the CIPP educational evaluation model, Yang (2019) conducted a survey and research on the implementation effectiveness of entrepreneurship education in vocational colleges in Jiangsu Province. This was achieved by developing questionnaires across dimensions such as philosophy and objectives (contextual level), organizational operations and educational resources (input level), curriculum and teaching (process level), and learning outcomes (results level).

Zhang (2019) introduced the CIPP evaluation model into the evaluation of on-the-job internship teaching in vocational colleges, emphasizing the process-oriented evaluation characteristics of the CIPP evaluation model, which align with the

evaluation needs of on-the-job internship teaching processes and feedback improvement mechanisms.

Ke (2019) established a "Context-Input-Process-Product" (CIPP) analysis framework for evaluating practical teaching in applied universities, asserting that the decision-oriented nature of the CIPP model aligns with the complexity and diversity of practical teaching objectives, and its process-oriented nature aligns with the dynamics and generative characteristics of practical teaching processes. Furthermore, its improvement function aligns with the improvement and feedback characteristics of practical teaching outcomes.

The Methods for designing and evaluating industry-education cooperation models as show table 2.5.

Table 2.5 Methods for designing and evaluating industry-education cooperation models

Scholar	Expert survey	SWOT Analysis	CIPP Evaluation
Fang et al. (2023)	●		
Bian et al. (2022)	●		
Liu et al. (2017)	●		
Theobald et al. (2021)	●		
RONGRONG (2023)	●		
Tian et al. (2023)	●		
Sindhvani et al. (2022)	●		
Tromp et al. (2022)	●		
Alinejad et al. (2020)	●		
Tsai (2017)	●		
Yi (2023)		●	

Table 2.5 (Continued)

Hu et al. (2019)		●	
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Guokun (2022)		●	
Zhang et al. (2021)		●	
Govender et al. (2015)		●	
Aziz et al. (2018)		●	
Basaran et al. (2021)			●
Sutadji et al. (2022)			●
Chen et al. (2021)			●
Wang (2023)			●
Lai et al. (2016)			●
W., & Dai, F. (2021)			●
Shi (2020)			●
Sylvia (2022)			●
Huang et al. (2021)			●
Fengmei et al. (2022)			●
Gao et al. (2022)			●
Total	10	6	11

Conclusion:

Applicability of expert survey in this study:

This article mainly uses the method to achieve Objective 3, by conducting 3 rounds of expert consultation, to establish a model for industry-academic cooperation management.

Applicability of SWOT Analysis to this Study

SWOT analysis provides a systematic, precise, and comprehensive understanding of the situation in question. It allows for the development of plans, strategies, and countermeasures based on the analyzed results, presenting characteristics such as organization, clarity, and ease of verification. Applying SWOT analysis to analyze the strengths, weaknesses, opportunities, and threats in the interplay and Cooperation processes among actors, the environment, and mechanisms within the industry-education cooperation Model can provide a basis for optimizing the model.

Applicability of the CIPP Evaluation Model to this Study

The process-oriented and improvement-oriented characteristics of the CIPP evaluation model make it suitable for assessing the mutual impact and Cooperation among actors, the environment, and mechanisms within the industry-education cooperation Ecosystem. It not only meets the need for measuring the development level of industry-education cooperation but also facilitates the establishment of feedback improvement mechanisms. Additionally, the CIPP evaluation model has diagnostic and improvement functions. It emphasizes the collection of diverse evaluation subjects' opinions and suggestions regarding industry-education cooperation, forming an effective feedback mechanism to provide timely and valuable decision-making information for model improvement. Therefore, the CIPP evaluation model provides a theoretical framework for evaluating the industry-education cooperation Model.

Chapter 3

Research Methodology

This research aims to develop industry-education cooperation management model for improving the student competence in Sichuan. The whole research process includes 4 steps:

1. To identify current problems, opportunities, and success factors in the industry-education cooperation.
2. To evaluate appropriate elements for industry-education cooperation management model to enhance student competence in Sichuan.
3. To design an effective industry-education cooperation management model to enhance student competence in Sichuan.
4. To evaluate the industry-education cooperation management model to enhance student competence in Sichuan.

The 4 steps of the research process can be summarized as Figure 3.1

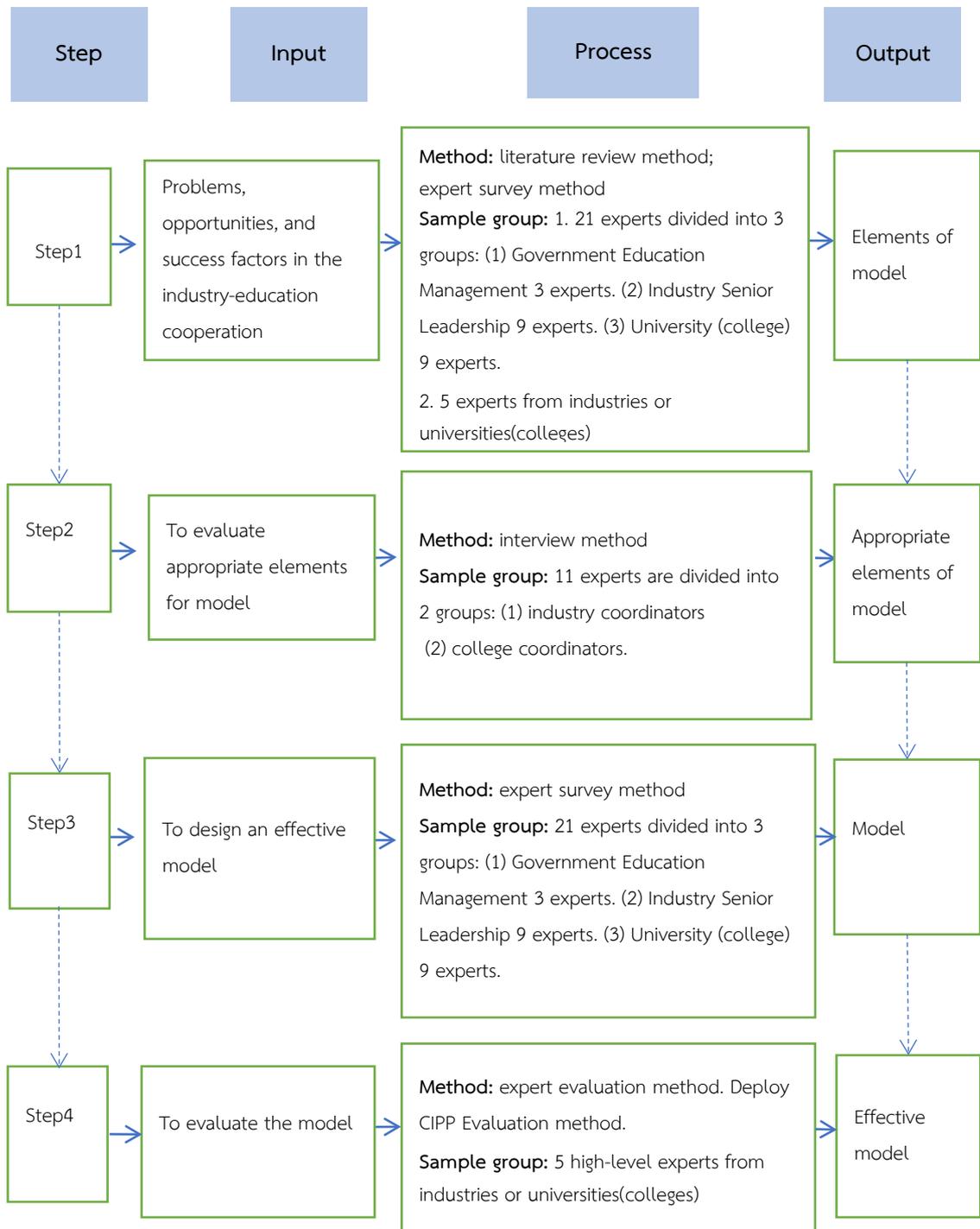
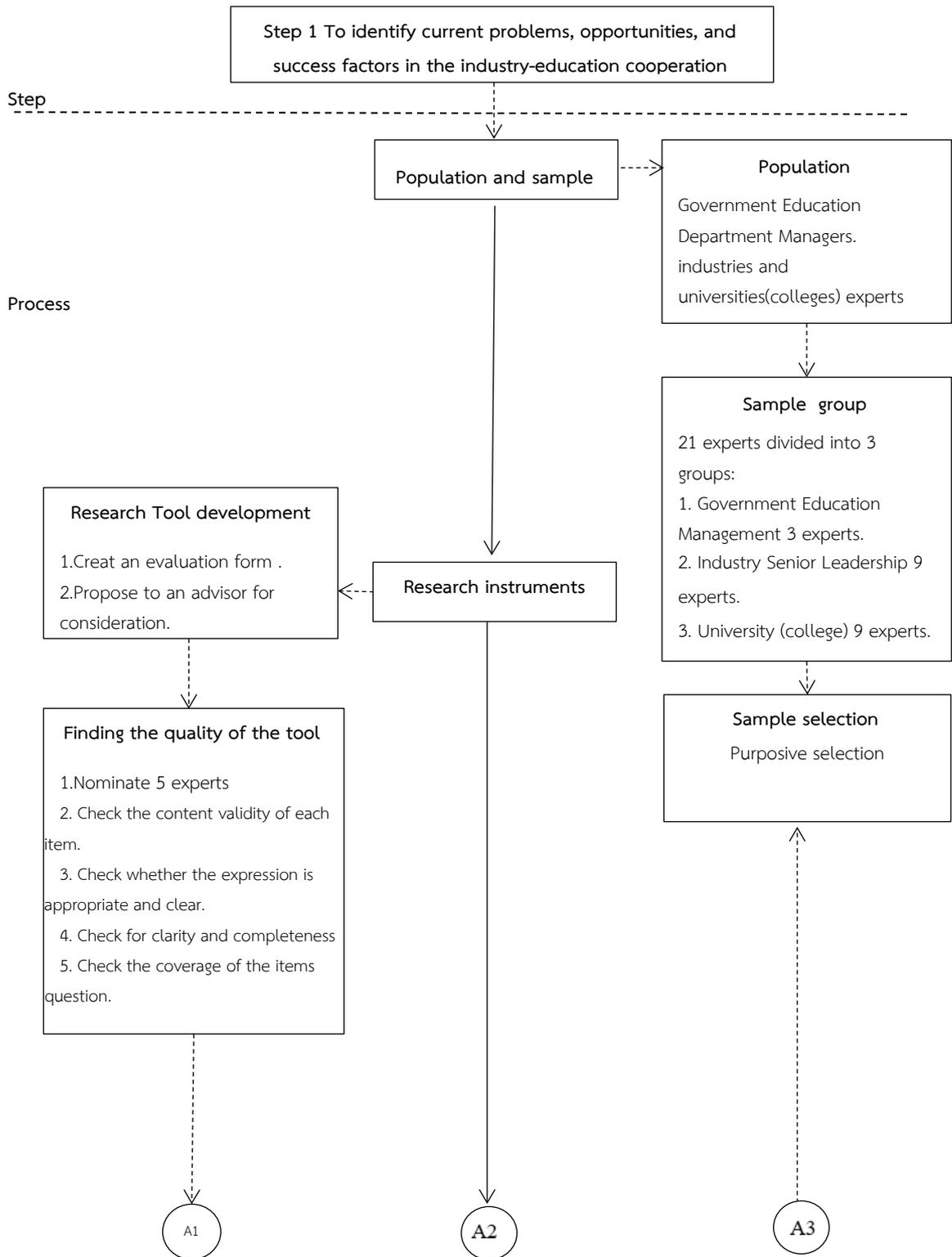


Figure 3.1 Research process.

Step 1 To identify current problems, opportunities, and success factors in the industry-education cooperation.



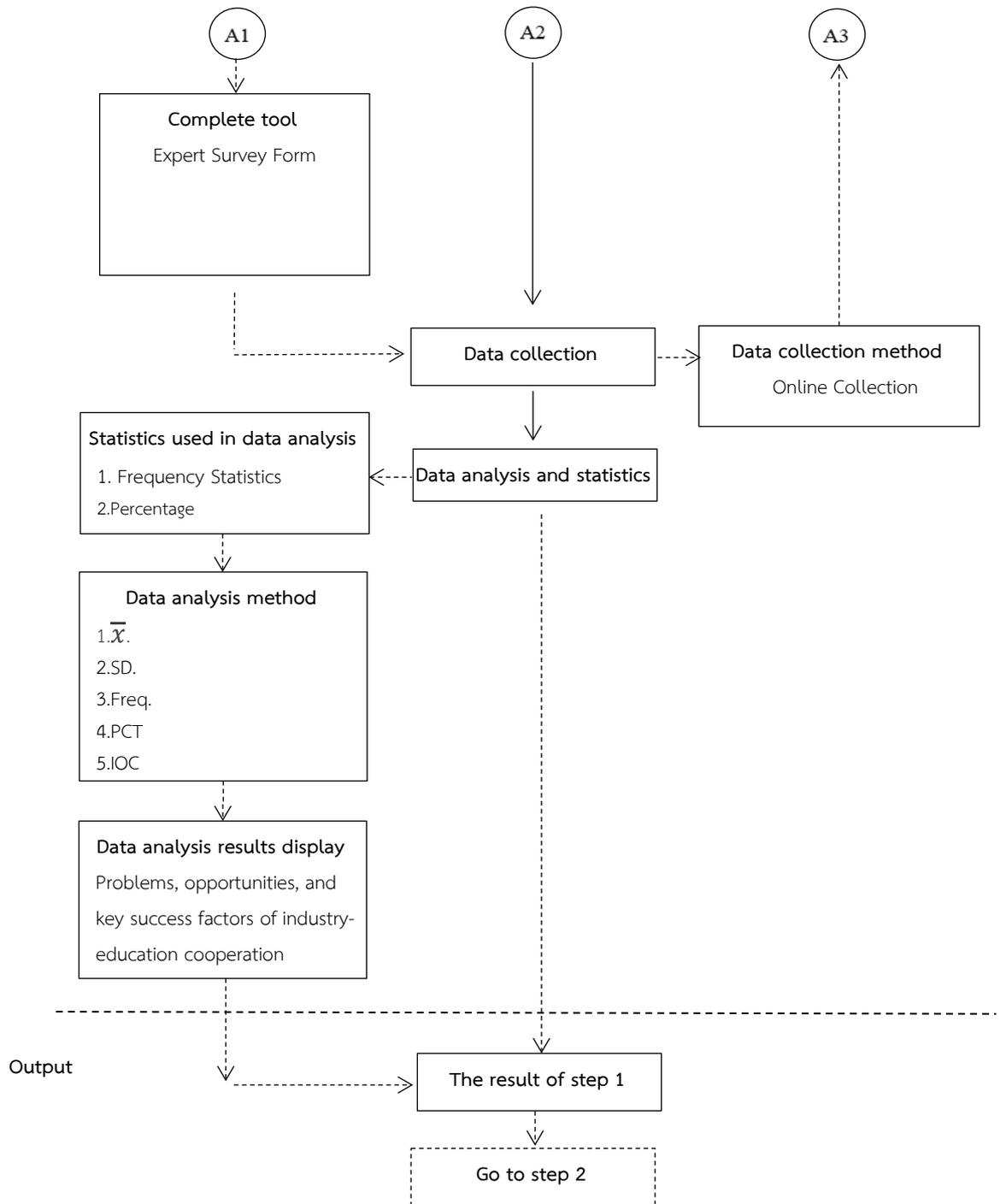


Figure 3.2 Details of the research process step 1

In this research study, the researcher has defined the characteristics of the research informant group. research tools data collection and data analysis in each step as follows.

Step 1 To identify current problems, opportunities, and success factors in the industry-education cooperation. as shown in Figure 3.

The population groups include 21 experts who are government education department managers. industries and universities(colleges) experts

The Sample Group

1. 21 experts to carry out the analysis work. Divided into 3 Groups together with:

(1) Government Educational Managers: 3 experts engaged in Government education management at Sichuan Provincial Education Department and municipal education bureaus, each with over 5 years of experience.

Number of 3 people

(2) Industry Experts: 9 experts holding positions such as manager, general manager, or chairman, each with over 10 years of experience in industry management.

Number of 9 people

(3) University Experts: 9 experts holding the title of professor in universities or having doctoral degree, each with over 10 years of experience in vocational education or management.

Number of 9 people

2. 5 experts to assess the survey questionnaire.

Working in universities(colleges) or Industries, proficient in questionnaire surveys, professorial or doctoral degree, with over 10 years of experience in vocational education or management.

Number of 5 people

Research Instruments

The tools used in this research is evaluation forms.

The procedure for creating the tool is shown below:

1. Pre-design the questionnaire. Based on literature review, design the questionnaire, including the topic title, research objectives, respondent backgrounds, specific detailed questions, and so on.

2. Expert assessment. Seek evaluations from 21 experts regarding the questions, using categories such as "agree," "disagree," or "partly agree," and have them provide explanations for "disagree" and "partly agree" responses.

3. Revise questions. Modify the assessment form based on feedback received from the expert assessments.

4. Seek expert opinions: Before formally initiating the survey, seek the opinions of 5 experts. Evaluate the effectiveness of each item, assess whether the wording is appropriate and clear, and ensure the content is comprehensive.

5. Revision: Modify and improve the assessment form based on expert opinions.

Data collection

1. Expert Evaluation. 21 experts with extensive knowledge and experience in government education management and industry-education cooperation are capable of providing valuable feedback on the proposed questions.

2. Expert Evaluation. 5 experts working in higher education institutions or corporations, specializing in questionnaire surveys, assess the survey form.

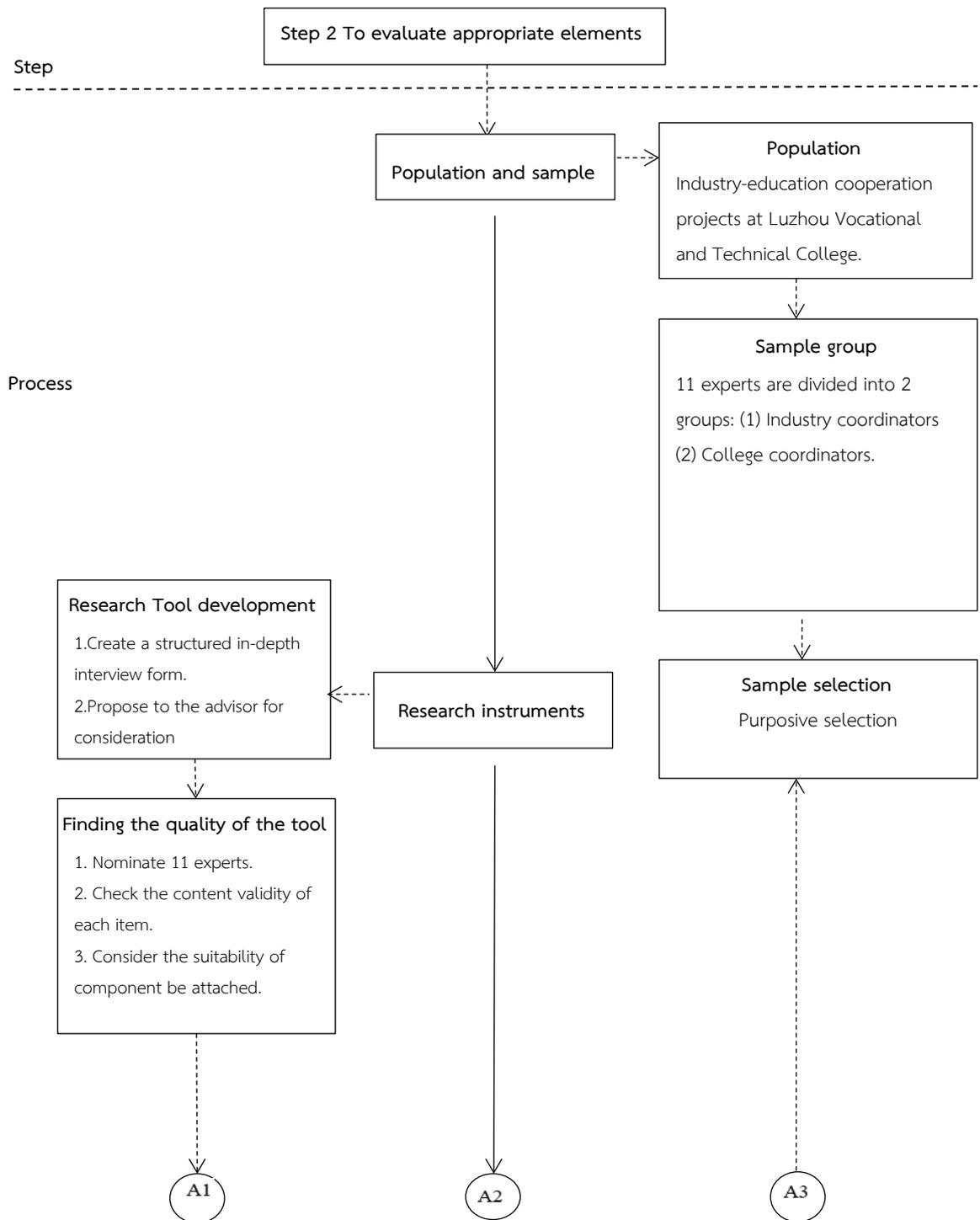
3. Online data collection: Through platforms such as Questionnaire Star, email, QQ, or WeChat.

Data analysis and statistics used in data analysis

1. Conduct descriptive statistical analysis based on the evaluation results of 21 experts, analyzing the \bar{x} , SD, Freq, PCT, and IOC values to understand the distribution and trends of expert opinions.

2. Based on the evaluation results of 5 experts, determine the IOC values to clarify the problems, opportunities, and success factors in industrial education cooperation.

Step 2 To evaluate appropriate elements for industry-education cooperation management model



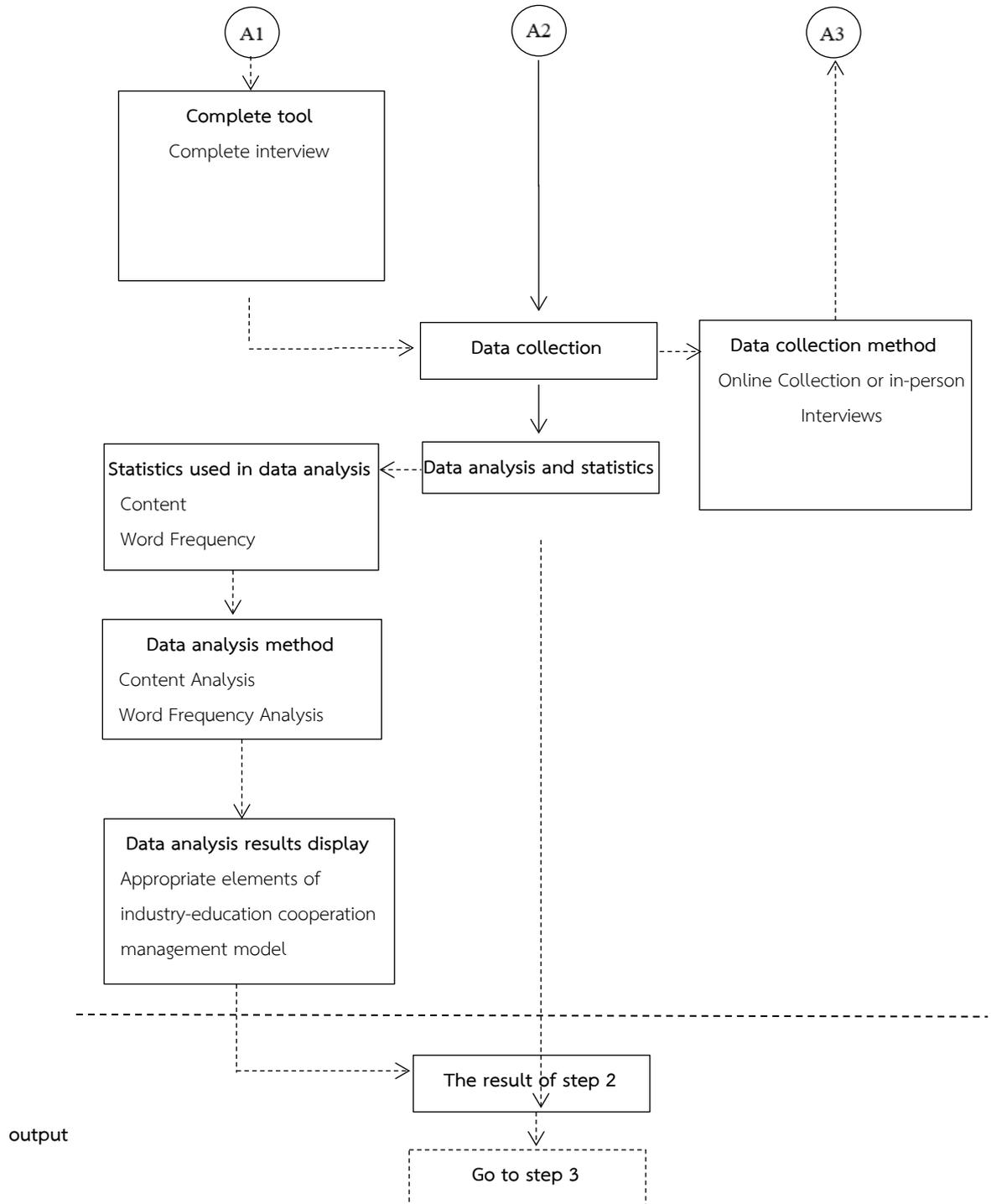


Figure 3.3 Details of the research process step 2

Step2.To evaluate appropriate elements for industry-education cooperation management model. as shown in Figure 3.3

The population groups include the industry-education cooperation projects initiated by Luzhou Vocational and Technical College.

The Sample Group

11 experts are divided into 2 groups:

1 Industry coordinators: The individual responsible for signing projects with the college and overseeing project implementation on the industry side.

Number of 6 people

2 Vocational College coordinators: The education professional at the vocational college responsible for signing projects with collaborating industries, conducting course instruction, and student development.

Number of 5 people

Research Instruments

The tools used in this research is structured in-depth interview

The procedure for creating the tool is shown below:

1. Based on the results of step 1, Prepare structured in-depth interview form.
2. Through interviews, gain problems, opportunities, and key success factors of industry-education cooperation in practice.

Data collection

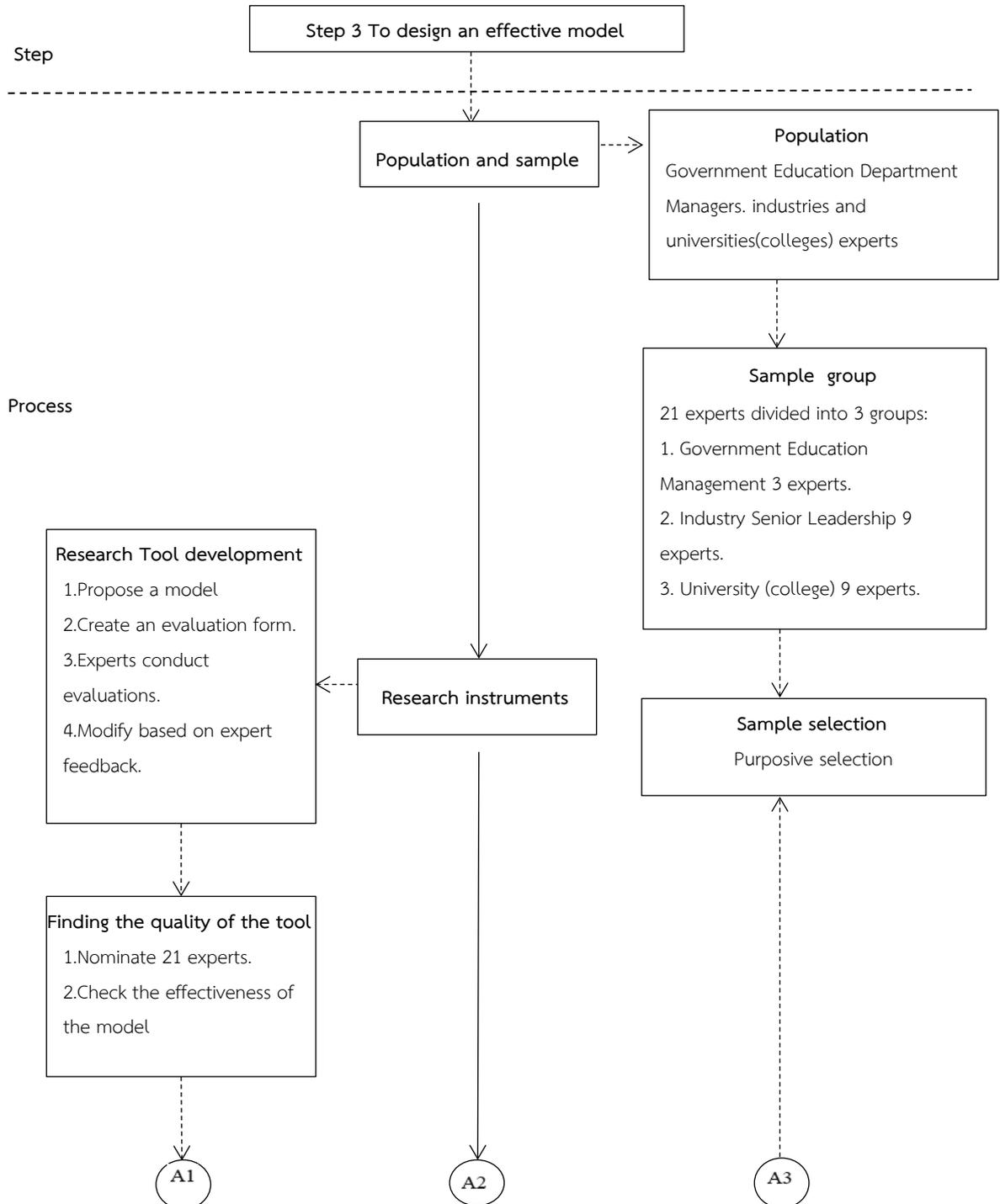
1. Conduct interviews with project coordinators either online or in-person.
2. The interview was assisted by recording, and other specific tools included voice recorder, laptop, paper and pen, invitation letters of interview.
3. According to principles of interviews and adjust according to the needs of the research. By collecting audio and handwritten notes for interviews.
4. According to the collected interview records of project coordinators, the opinions of 11 interviewees were summarized according to the interview outline, and the opinions were analyzed and summarized to identify the problems, opportunities, and key success factors in the industry-education cooperation.

Data analysis and statistics used in data analysis

1.Content Analysis Method: To summarize and condense key points and themes from project coordinators feedback, identifying and understanding the themes, patterns, and trends within it.

2.Word Frequency Analysis Method: To reveal important keywords within project coordinators feedback and determine the significance of specific vocabulary in this study.

Step 3 To design an effective industry-education cooperation management model.



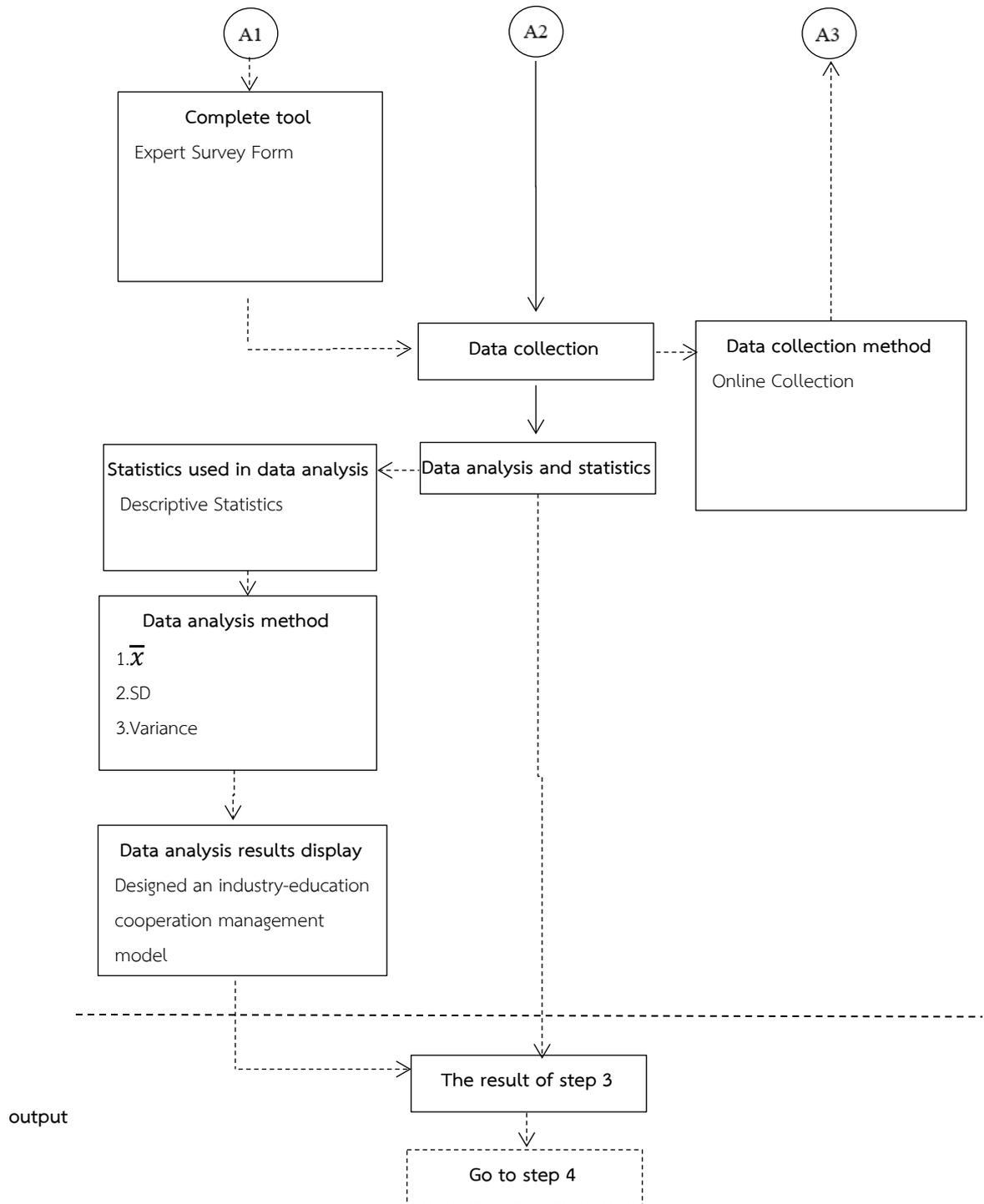


Figure 3.4 Details of the research process step 3

Step 3 To design an effective industry-education cooperation management model. as shown in Figure 3.4

The population groups include the industry-education cooperation management model.

The Sample Group

21 experts to carry out the analysis work. Divided into 3 Groups together with:

(1) Government Educational Managers: 3 experts engaged in government education management at Sichuan Provincial Education Department and municipal education bureaus, each with over 5 years of experience.

Number of 3 people

(2) Industry Experts: 9 experts holding positions such as manager, general manager, or chairman, each with over 10 years of experience in industry management.

Number of 9 people

(3) University Experts: 9 experts holding the title of professor in universities and having a doctoral degree, each with over 10 years of experience in vocational education or management.

Number of 9 people

Research Instruments

The tools used in this research are propose model and evaluation form.

The procedure for creating the tool is shown below:

1. Distribute questionnaires and invitations: Distribute the assessment forms and invitations to experts online. The questionnaire should include the research topic, research objectives, specific details, and questions.

2. Expert Survey: Request feedback from 21 experts regarding the questions. Use a scale of "Agree," "Disagree," and "Partly agree," and ask for explanations in cases of "Disagree" or "Partly agree."

3. Modify model: Modify the model based on feedback received from the expert survey.

Data Collection

1. Use the online platform to collect the expert's opinions selected through expert survey.

2. Conduct the survey. In each round, experts receive a summary of feedback from the previous round and are asked to re-evaluate the problems. Consensus is reached through several rounds of discussion, with experts gradually converging on their opinions. Ensure that each round of expert surveys is anonymous to minimize personal biases and influences. After each round, experts' feedback is compiled, personal identifying information is removed, and the aggregated results are fed back to the participants.

3. Analyze the results and achieve consensus. Analyze the results of each round to observe changes in expert opinions and the trend toward consensus. Consensus is typically reached after several rounds, until expert opinions converge.

4. Conduct three rounds of surveys. Terminate the expert survey when opinions stabilize or consensus is reached. At the conclusion, the final results and summary can be provided to the participants.

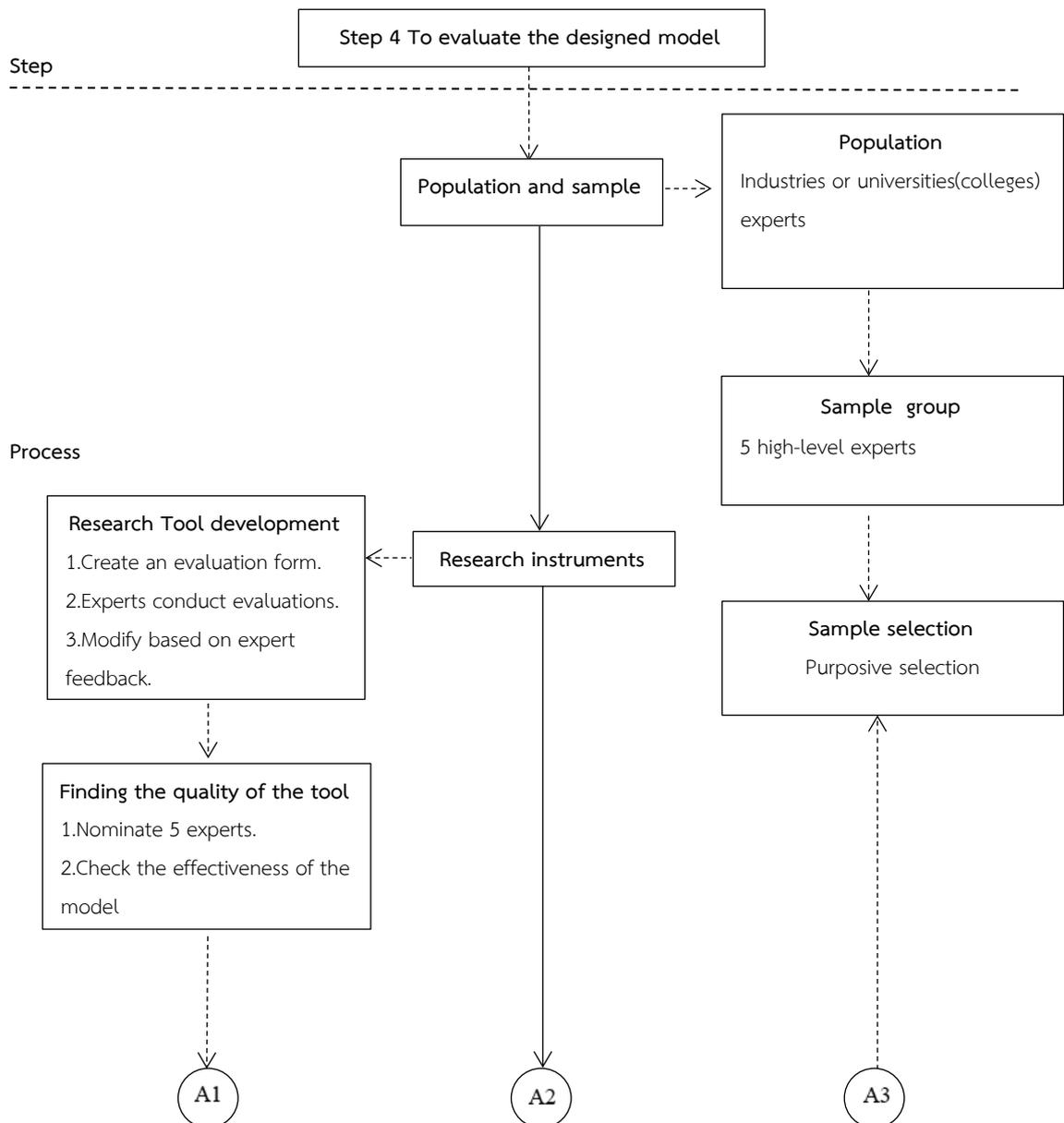
5. Summarize and apply. Interpret the results of the expert survey and design model based on the findings.

Data analysis and statistics used in data analysis

1. Mean and Standard Deviation Analysis: Analyze the mean and standard deviation of expert opinions to assess the consistency of evaluations from different experts in each round and whether expert opinions are diverging or converging.

2. Variance Analysis: Perform variance analysis on expert feedback to determine which factors significantly influence the differences in results, providing a basis for improving the model.

Step 4 To evaluate the industry-education cooperation management model for improving Student competence in Sichuan



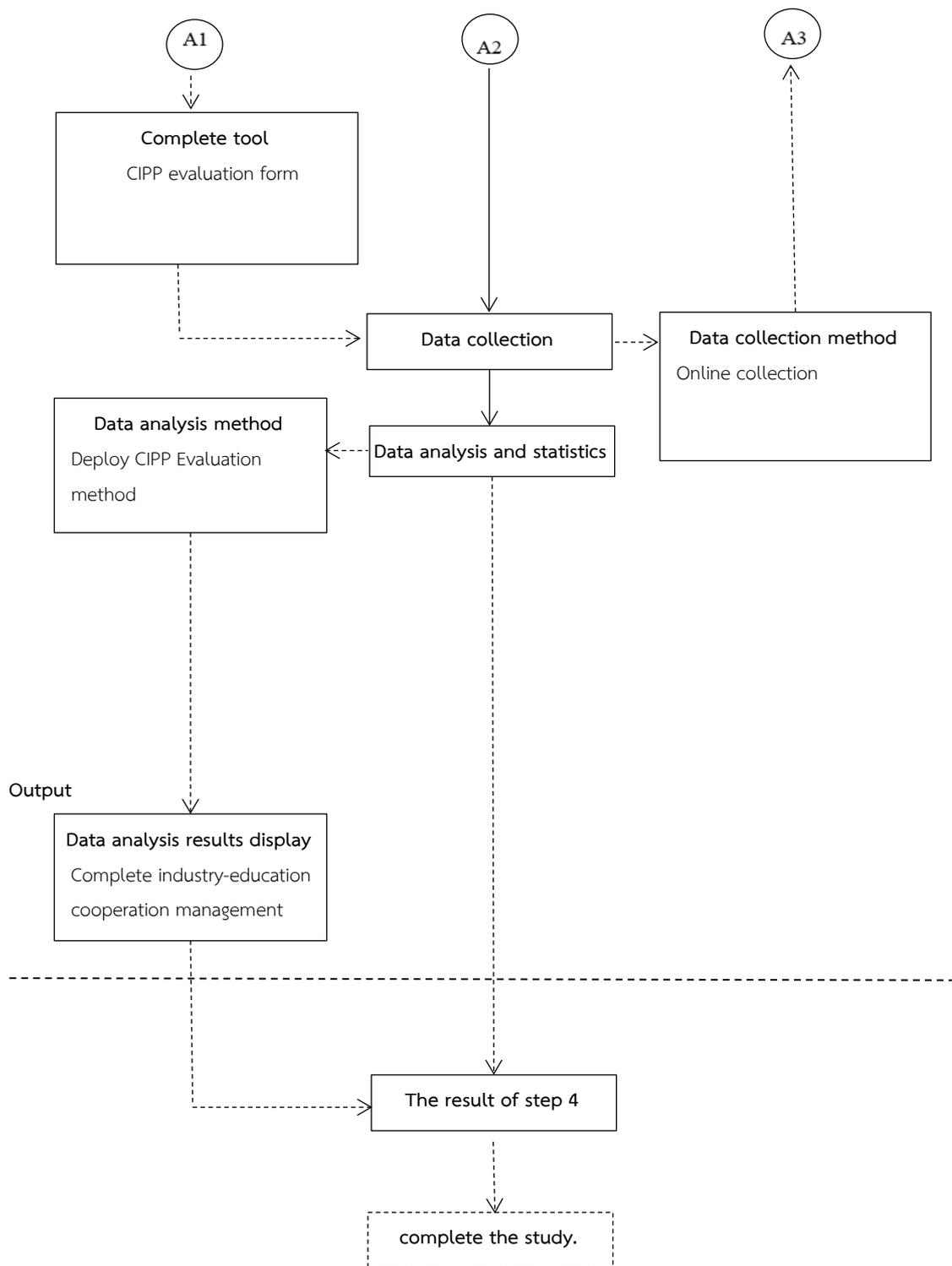


Figure 3.5 Details of the research process step 4

Step 4. To evaluate the industry-education cooperation management model for improving Student competence in Sichuan. as shown in Figure 3.5

The population groups include the design model.

The Sample Group select 5 experts are who engaged in industry-education cooperation research or excel in model research. professorial or doctoral degree, and having over 10 years of experience in vocational education or management.

Number of 5 people

Research Instruments

The tools used in this research is evaluation form.

The procedure for creating the tool is shown below:

1. Develop an evaluation interview form, including objectives and plans, the model's design process, and a description of model results.

2. 5 experts assess the model using the options "Agree," "Disagree," and "Partly agree," and provide explanations for "Disagree" and "Partly agree" choices.

3. Optimize the model based on feedback received from the expert survey.

Data collection

Data collection is the CIPP evaluation form.

1. Use the online platform to collect 5 expert's opinion.

2. Expert Assessment: Experts evaluate the model, and in each round, they receive a summary of feedback from the previous assessment and are asked to reevaluate these problems. Anonymity is ensured for each round of expert surveys to reduce personal bias and influence. The expert survey concludes when a consensus among the experts is reached. At the conclusion, the final results and summary can be provided to participants.

3. Summary and Application: Interpret the results of the expert survey and optimize the model based on the findings.

Data analysis and statistics used in data analysis

Using the CIPP model, conduct frequency statistics and analysis of evaluation data to determine the quality and rationality of the model design. Summarize expert suggestions to optimize the model.

Chapter 4

Results of Analysis

The research on “Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan” analyzed the following objectives and obtained results.

1.Result of Finding Objective 1: To identify current problems, opportunities, and success factors in the industry-education cooperation.

2.Result of Finding Objective2: To evaluate appropriate elements for industry-education cooperation management model to enhance student competence in Sichuan.

3.Result of Finding Objective 3: To design an effective industry-education cooperation management model to enhance student competence in Sichuan.

4.Result of Finding Objective 4: To evaluate the industry-education cooperation management model to enhance student competence in Sichuan.

The following results can be obtained based on the research design path and methods presented in Chapter 3.

Result of Finding Objective 1: To identify current problems, opportunities, and success factors in the industry-education cooperation.

Identify current problems, opportunities, and key success factors in industry-education cooperation through expert survey method. The personal information of 21 experts, including gender, organization, position, years of work experience, educational background, and professional title, as shown in Table 4.1.

Table 4.1 Personal Information of 21 Experts

Item	Personal Information	No. of People	%
Gender	Male	11	52.38
	Female	10	47.62
	Total	21	100.00
Unit	Ordinary higher education institution	0	0.00
	Higher Vocational College	9	42.86
	Industry	9	42.86
	Education Administration Department	3	14.28
	Total	21	100.00
	Position	University teacher	5
University administrator		4	19.06
Business administrator		9	42.86
Educational administration personnel		3	14.28
Total		21	100.00
Work experience	0-5 years	1	4.76
	6-10 years	2	9.53
	11-15 years	7	33.33
	more than 16 years	11	52.38
	Total	21	100.00
Level of Education	Associate's degree and below	1	4.76
	Bachelor's degree	12	57.14
	Master's degree	8	38.10
	Ph.D.	0	0.00
	Total	21	100.00

Table 4.1 (Continued)

Item	Personal Information	No. of People	%
Professional Title	Professor	5	23.81
	Associate Professor	6	28.57
	Lecturer	0	0.00
	Other	10	47.62
	Total	21	100.00

According to the Table 4.1, Among the 21 experts, there are 9 from higher vocational colleges, 9 from industries, and 3 from education administrative departments. There are more male experts than female experts, accounting for 52.38%. There are 5 teachers and 4 managers from higher vocational colleges. Except for one expert with a work experience of 0-5 years, all other experts have worked for more than 5 years, and among them, experts with over 16 years of work experience account for the largest proportion of 52.38%. In terms of educational level, most of the experts have a bachelor's degree or a master's degree, accounting for 57.14% and 38.10%, respectively. As for professional titles, professors, associate professors, and others account for 23.81%, 28.57%, and 47.62%, respectively. Among the experts from higher vocational colleges, all of them hold the titles of professor or associate professor.

Problems in the industry-education cooperation

Through a questionnaire survey of 21 experts, it was found that there are eight problems commonly agreed upon by experts in the industry-education cooperation. These problems include: lack of coordination in industry-education cooperation, lack of supportive cooperative environment, imperfect policies and systems, insufficient resource sharing, inadequate organizational support, communication and coordination hindered, benefits not effectively matched, and low-level and superficial cooperation. as shown in Table 4.2.

Table 4.2 The Current Problems in industry-education cooperation

No.	Detail Problems	N	\bar{x}	SD
1	Lack of Coordination in industry-education cooperation	21	0.635	0.671
2	Lack of Supportive Cooperative Environment	21	0.635	0.616
3	Imperfect Policies and Systems	21	0.841	0.463
4	Insufficient resource sharing	21	0.667	0.612
5	Inadequate Organizational Support	21	0.881	0.387
6	Communication and Coordination Hindered	21	0.905	0.366
7	Benefits not effectively matched	21	0.833	0.530
8	Low-Level and Superficial Cooperation	21	0.833	0.469

According to Table 4.2, the average values of the current problems in industry-education cooperation are all greater than 0.5, indicating that most experts hold a positive attitude towards these issues. Among them, the problem of “Communication and Coordination Hindered” is the most prominent, with the highest average score and the highest degree of expert consensus (\bar{x} = 0.905, SD = 0.366). Following this, there are problems of “Inadequate Organizational Support”, “Imperfect Policies and Systems”, “Low-Level and Superficial Cooperation”, “Benefits not effectively matched”, “Insufficient resource sharing”, and “Lack of Supportive Cooperative Environment”. The problem of “Lack of Coordination in industry-education cooperation” has the lowest score and shows significant differences among experts, the lowest degree of consensus (\bar{x} = 0.635, SD = 0.671).

Lack of Coordination in industry-education cooperation

Table 4.3 Lack of Coordination in industry-education cooperation

No.	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
1	Mismatched Goals among Government, Educational Institutions, and Industries in industry-education cooperation	21	15	71.43	0.619	0.653	0.533
2	Divergent Collaborative Philosophies between the University and the Industry	21	15	71.43	0.571	0.728	0.529
3	Divergent Value Orientations between the University and the Industry	21	17	80.91	0.714	0.628	0.657

21 experts on the three problems of “Lack of Coordination in industry-education cooperation”, the percentage of those who agree exceeds 70%, indicating a strong consensus among most experts. Among these problems, the third problem has the highest degree of expert consensus (PCT = 80.91%, IOC = 0.657), followed by the first problem (PCT = 71.43%, IOC = 0.533). The lowest degree of consensus is observed for the second problem (PCT = 71.43%, IOC = 0.529).

Lack of Supportive Cooperative Environment

Table 4.4 Lack of Supportive Cooperative Environment

No.	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
4	Mismatch between University Major Offerings and Local Industries	21	12	57.14	0.286	0.653	0.881
5	Lack of Alignment in Content and Infrastructure for industry-education cooperation	21	15	71.43	0.667	0.728	0.563
6	Insufficient Technology Transfer and Transformation between University and Industry	21	20	95.24	0.952	0.213	0.905

According to Table 4.4, The sixth problem has the highest degree of expert consensus (PCT = 95.24%, IOC = 0.213), followed by the fifth problem (PCT = 71.43%, IOC = 0.563). The lowest degree of consensus is observed for the fourth problem (PCT = 57.14%, IOC = 0.881).

Imperfect Policies and Systems

Table 4.5 Imperfect Policies and Systems

No.	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
7	Incomplete Legal and Regulatory Framework for industry-education cooperation	21	18	85.71	0.810	0.499	0.733

Table 4.5 (continued)

No.	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
8	Lack of Effective Oversight and Evaluation Mechanisms for industry-education cooperation	21	17	80.95	0.714	0.628	0.657
9	The constraints of the current educational administrative management system	21	21	100.00	1.000	0.000	1.000

According to Table 4.5, The ninth problem has the highest degree of expert consensus (PCT = 100%, IOC = 1.000), followed by the seventh problem (PCT = 85.71%, IOC = 0.733). The lowest degree of consensus is observed for the eighth problem (PCT = 80.95%, IOC = 0.657).

Insufficient Resource Sharing

Table 4.6 Insufficient Resource Sharing

No.	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
10	Teaching resources and content not built and shared	21	17	80.95	0.762	0.526	0.662
11	Facilities (spare), venues, etc. not jointly built and shared	21	15	71.43	0.667	0.563	0.548
12	Both universities and industries have not sent or trained teachers to each other	21	15	71.43	0.571	0.728	0.529

According to Table 4.6, The tenth problem has the highest degree of expert consensus (PCT = 80.95%, IOC = 0.662), followed by the eleventh problem (PCT =

71.43%, IOC = 0.548). The lowest degree of consensus is observed for the twelfth problem (PCT = 71.43%, IOC = 0.529).

Inadequate Organizational Support

Table 4.7 Inadequate Organizational Support

No.	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
13	Lack of necessary financial support	21	19	90.48	0.857	0.467	0.814
14	Lack of necessary personnel support	21	17	85.71	0.810	0.499	0.733
15	Lack of effective supervision mechanism	21	19	90.48	0.905	0.294	0.819
16	Teaching resources, lack of necessary incentive measures	21	20	95.24	0.952	0.213	0.905

According to Table 4.7, the sixteenth problem has the highest degree of expert consensus (PCT = 95.24%, IOC = 0.905), followed by the fifteenth problem (PCT = 90.48%, IOC = 0.819), and then the thirteenth problem (PCT = 90.48%, IOC = 0.814). The lowest degree of consensus is observed for the fourteenth problem (PCT = 85.71%, IOC = 0.733).

Communication and Coordination Hindered

Table 4.8 Communication and Coordination Hindered

No.	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
17	Insufficient depth of communication and coordination	21	19	90.48	0.905	0.294	0.819
18	Insufficient ability to communicate and resolve conflicts	21	20	95.24	0.905	0.426	0.905

According to Table 4.8, The average values of the two problems are close to 1, indicating that most experts tend to "agree". The IOC values for both problems are above 0.8, indicating a high level of consensus among experts. Specifically, the expert consensus for the eighteenth problem (PCT = 95.24%, IOC = 0.905) is higher than that for the seventeenth problem (PCT = 90.48%, IOC = 0.819).

Benefits not effectively matched

Table 4.9 Benefits not Effectively Matched

No.	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
19	Uneven distribution of benefits	21	19	90.48	0.857	0.467	0.814
20	Unbalanced cost sharing and compensation	21	19	90.48	0.810	0.587	0.819

According to Table 4.9, The average values of the two problems are above 0.8, indicating that most experts tend to "agree". The expert consensus for the twentieth problem (PCT = 90.48%, IOC = 0.819) is higher than that for the nineteenth problem (PCT = 76.19%, IOC = 0.657).

Low-Level and Superficial Cooperation

Table 4.10 Low-Level and Superficial Cooperation

No.	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
21	Poor stability and durability of industry-education cooperation	21	17	80.95	0.714	0.628	0.657
22	Insufficient connection between education chain, highly skilled personnel chain, industry chain, and innovation chain	21	20	95.24	0.952	0.213	0.905

According to Table 4.10, The average values of the two problems are above 0.7, indicating that most experts tend to "agree". The expert consensus for the twenty-second problem (PCT = 95.24%, IOC = 0.905) is higher than that for the twenty-first problem (PCT = 80.95%, IOC = 0.657).

Based on the consultation results of 21 experts, for problems with agreement percentages below 75%, namely questions 1, 2, 4, 5, 11, and 12, a qualitative research approach will be employed to further explore the reasons for significant differences.

After reviewing the feedback and explanations of each expert, it was found that:

For question 1, 4 experts chose to partly agree (0 points), explaining that due to different professional development needs, cooperation methods and goals may vary; one is an economic goal, the other is a technical goal; the goals are consistent; some goals are consistent. 2 experts chose to disagree (-1 point), explaining that the goals are relatively consistent, and the goals are basically the same.

For question 2, 3 experts chose to partly agree (0 points), explaining that due to different professional orientations, cooperation methods and concepts may vary; the concepts are consistent; some concepts are the same. 3 experts chose to disagree (-1 point), explaining that the cooperation concepts are basically the same; the concepts are basically the same; the concepts are negotiated before cooperation, so there is no difference.

For question 4, 4 experts chose to partly agree (0 points), explaining that they are matched and should set up majors more according to enterprise needs; some majors match the industry and some fit well. 5 experts disagreed (-1 point), explaining that higher education industries not only serve the local area; some majors match, some are basically matched, feel that the major setting is quite good, most match.

For question 5, 5 experts chose to partly agree (0 points), explaining that there may not be complete matching; most are matched; there are some matches; the degree of matching varies; try to match as much as possible to have corresponding carrier support. 1 expert chose to disagree (-1 point), explaining that they match.

For question 11, 5 experts chose to partly agree (0 points), explaining that there is some sharing; some projects have joint construction and sharing; some are jointly constructed and shared; there is currently some sharing; sharing is insufficient. 1 expert chose to disagree (-1 point), explaining that there is a lot of industry-education cooperation and cannot be fully shared.

For question 12, 3 experts chose to partly agree (0 points), explaining that there is occasional mutual training exchange; some majors are implemented; the school has certain management requirements, and teachers have limited class time. 3 experts chose to disagree (-1 point), explaining that there is mutual training exchange; some have been sent; some industries have them.

After further sorting out the explanations of the experts for the above six questions, it was found that there were absolute statements and lack of clarity in the design of the original research questions. Feedback was then individually sought from

the experts who had initially chosen either agreement or disagreement. The results of this feedback as show in Table 4.11.

Table 4.11 The results of the adjusted expressions for the six questions

No.	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
1	Goals among Government, Educational Institutions, and Industries are not completely consistent in industry-education cooperation	21	21	100.00	1.000	0.000	1.000
2	The cooperation philosophy is not completely the same between University and the Industry	21	20	95.24	0.952	0.213	0.905
4	Some universities major offerings are not well matched with local industries.	21	21	100.00	1.000	0.000	1.000
5	The content and Infrastructure are not completely matched for industry-education cooperation	21	20	95.24%	0.952	0.213	0.905
11	Facilities(spare), venues, etc. have not been fully co-constructed and shared.	21	21	100.00	1.000	0.000	1.000
12	Both universities and industries have not fully sent or trained teachers to each other	21	21	100.00	1.000	0.000	1.000

According to Table 4.11, The results of the adjusted expressions for the four questions (1, 4, 11, and 12) were unanimously agreed upon by all experts (PCT=100%, \bar{x} =1.000, SD=0.000, IOC=1.000). For the two questions (1 and 5), although there was not complete agreement, a relatively consistent consensus was formed overall (PCT=95.24%, \bar{x} =0.952, SD=0.213, IOC=0.905).

Table 4.12 Analysis of the Current Problems in industry-education cooperation After Adjustment

Problems	\bar{x}	SD	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
Lack of Coordination in Industry-Education Cooperation	0.889	0.383	Goals among Government, Educational Institutions, and Industries are not completely consistent in industry-education cooperation	21	21	100	1.000	0.000	1.000
			The cooperation philosophy is not completely the same between University and the Industry	21	20	95.24	0.952	0.213	0.905
			Divergent Value Orientations between the University and the Industry	21	17	80.95	0.714	0.628	0.657
Lack of Supportive Cooperative Environment	0.968	0.174	Some universities major offerings are not well matched with local industries.	21	21	100	1.000	0.000	1.000
			The content and Infrastructure are not completely matched for industry-education cooperation	21	20	95.24	0.952	0.213	0.905

Table 4.12 (Continued)

Problems	\bar{x}	SD	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
			Insufficient Technology Transfer and Transformation between University and Industry	21	20	95.24	0.952	0.213	0.905
Imperfect Policies and Systems	0.841	0.463	Incomplete Legal and Regulatory Framework for industry-education cooperation	21	18	85.71	0.810	0.499	0.733
			Lack of Effective Oversight and Evaluation Mechanisms for industry-education cooperation	21	17	80.95	0.714	0.628	0.657
			The constraints of the current educational administrative management system	21	21	100.00	1.000	0.000	1.000
Insufficient Resource Sharing	0.921	0.304	Teaching resources and content not built and shared	21	17	80.95	0.762	0.526	0.662
			Facilities (spare), venues, etc. not jointly built and shared	21	21	100.00	1.000	0.000	1.000

Table 4.12 (continued)

Problems	\bar{x}	SD	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
			Both universities and industries have not sent or trained teachers to each other	21	21	100.00	1.000	0.000	1.000
Inadequate	0.881	0.387	Lack of necessary financial support	21	19	90.48	0.857	0.467	0.814
Organizational Support			Lack of necessary personnel support	21	18	85.71	0.810	0.499	0.733
			Lack of effective supervision mechanism	21	19	90.48	0.905	0.294	0.819
			Teaching resources, lack of necessary incentive measures	21	20	95.24	0.952	0.213	0.905
Communication and Coordination	0.905	0.366	Insufficient depth of communication and coordination	21	19	90.48	0.905	0.294	0.819
Hindered			Insufficient ability to communicate and resolve conflicts	21	20	95.24	0.905	0.426	0.905
Benefits not Effectively Matched	0.833	0.530	Uneven distribution of benefits	21	19	90.48	0.857	0.467	0.814
			Unbalanced cost sharing and compensation	21	19	90.48	0.810	0.587	0.819

Table 4.12 (continued)

Problems	\bar{x}	SD	Detail Problems	N	Freq	%	\bar{x}	SD	IOC
Low-Level and Superficial Cooperation	0.833	0.469	Poor stability and durability of industry-education cooperation	21	17	80.95	0.714	0.628	0.657
			Insufficient connection between education chain, highly skilled personnel chain, industry chain, and innovation chain	21	20	95.24	0.952	0.213	0.905

According to Table 4.12, 21 experts hold a positive attitude towards the existing problems in industry-education cooperation. The top three problems ranked by the average scores are “Lack of Supportive Cooperative Environment” (\bar{x} =0.968, SD=0.174), “Insufficient Resource Sharing” (\bar{x} =0.921, SD=0.304), and “Communication and Coordination Hindered” (\bar{x} =0.905, SD=0.366). The lowest scored problems are “Benefits not effectively matched” and “Low-Level and Superficial Cooperation” (\bar{x} =0.833), but there is a larger difference in expert opinions on “Benefits not effectively matched” (SD=0.530) than “Low-Level and Superficial Cooperation” (SD=0.469).

Comparing the expert conclusions, there are certain differences in the views of university expert groups, enterprise expert groups, and government expert groups on the current problems of industry-education cooperation. As show in Table 4.13.

Table 4.13 Comparison of Results from Different Expert Groups

No.	problems	University Expert Group		Industry Expert Group		Government Expert Group	
		Mean-value	Standard Deviation	Mean-value	Standard Deviation	Mean-value	Standard Deviation
1	Lack of Coordination in industry-education cooperation	0.926	0.256	0.815	0.480	1.000	0.000
2	Lack of Supportive Cooperative Environment	0.963	0.181	1.000	0.000	0.889	0.272
3	Imperfect Policies and Systems	1.000	0.000	0.630	0.615	1.000	0.000
4	Insufficient resource sharing	0.927	0.240	0.889	0.385	1.000	0.000

Table 4.13 (continued)

No.	problems	University Group		Expert Industry Group		Expert Government Group	
		Mean-value	Standard Deviation	Mean-value	Standard Deviation	Mean-value	Standard Deviation
		5	Inadequate Organizational Support	0.972	0.157	0.778	0.521
6	Communication and Coordination Hindered	1.000	0.000	0.778	0.533	1.000	0.000
7	Benefits not effectively matched	1.000	0.000	0.612	0.753	1.000	0.000
8	Low-Level and Superficial Cooperation	0.889	0.445	0.723	0.533	1.000	0.000

According to Table 4.13, the consistency among the university expert group's opinions on the eight problems existing in industry-education cooperation is relatively high ($\bar{x} > 0.850$, $SD < 0.500$). Among them, there is a unanimous agreement on 3 problems: imperfect policies and systems, poor communication and coordination, and an ineffective matching of interests ($\bar{x} = 1.000$, $SD = 0.000$). The consistency among the enterprise expert group's opinions on the current problems in industry-education cooperation is lower than university expert group, especially regarding the ineffective matching of interests ($\bar{x} = 0.612$, $SD = 0.753$) and imperfect policies and systems ($\bar{x} = 0.630$, $SD = 0.615$), where there is significant disagreement among experts. The reason for the low consistency in the ineffective matching of interests may be due to differences in the actual benefits distribution among different industries, resulting in varying expert conclusions. The reason for the low consistency in imperfect policies and systems may be due to most of the policies and systems related to industry-education cooperation coming from the education field, leading to varying levels of

understanding among different companies. The government expert group unanimously agrees on six of these problems ($\bar{x}=1.000$, $SD =0.000$), but there is some disagreement regarding inadequate organizational support ($\bar{x}=0.917$, $SD =0.236$) and a lack of favorable support from the cooperative environment ($\bar{x}=0.889$, $SD =0.272$).

Opportunities in industry-education cooperation

Table 4.14 Opportunities in industry-education cooperation

Opportunities	Detail Questions	N	Freq	%	\bar{x}	SD	IOC
Strong policy support	Do you agree that a series of policies and documents, as well as specific measures taken by local governments, that have been intensively introduced and promoted at a high level by the state, are conducive to promoting high-quality development of industry-education cooperation?	21	20	95.24	0.952	0.213	0.905
Modern Industrial Development	Do you agree that as China accelerates the construction of a modern industrial system, traditional industries are facing transformation and upgrading, which provides good opportunities for promoting industry-education cooperation?	21	21	100.00	1.000	0.000	1.000

Table 4.14 (continued)

Opportunities	Detail Questions	N	Freq	%	\bar{x}	SD	IOC
Increasing Demand for Highly Skilled Personnel	Do you agree that industry-education cooperation is a key measure to implement the "Skills China Action" implementation plan and achieve the goal of adding over 40 million highly skilled personnel during the 14th Five Year Plan period?	21	21	100.00	1.000	0.000	1.000
Development of Modern Vocational Education Systems	Do you agree that industry-education cooperation is an inevitable path to comprehensively integrate the structural elements of the industrial demand side with the modern vocational education system of highly skilled personnel cultivation supply side?	21	21	100.00	1.000	0.000	1.000
Educational Positioning in Vocational Education	Do you agree that industry-education cooperation is the basic mode of vocational education, a prominent type of characteristic, and an inevitable choice for high-quality development?	21	21	100.00	1.000	0.000	1.000

Table 4.14 (continued)

Opportunities	Detail Questions	N	Freq	%	\bar{x}	SD	IOC
Integrated Development of Industry and Education	Do you agree to build an integrated industry education community based on the industry-education cooperation, which can better promote the deepening and implementation of industry-education cooperation?	21	21	100.00	1.000	0.000	1.000

According to Table 4.14, Opportunities for the current in industry-education cooperation have designed 6 questions to consult with 21 experts. Except the first question ($\bar{x}=0.952$, $IOC=0.905$) were unanimously agreed upon by all experts, others are in full agreement ($PCT=100\%$, $\bar{x}=1.000$, $SD=0.000$, $IOC=1.000$). Overall, regarding the current opportunities for industry-education cooperation, although there is a slight variation in the first question, the standard deviation is still relatively small ($SD=0.213$). It can be seen that the opinions of the 21 experts are highly consistent overall, forming a relatively consistent consensus.

The key success factors in industry-education cooperation

The analysis of the key success factors in industry-education cooperation

Table 4.15 The analysis of the key success factors in industry-education cooperation

No.	Detail questions	N	\bar{x}	SD
1	University Resource Investment	21	1.000	0.000
2	Industry Resource Investment	21	0.937	0.237
3	Government Support Intensity	21	1.000	0.000
4	Social Industrial Structure	21	1.000	0.000
5	Technological Innovation and Transformation	21	1.000	0.000
6	Policies and Institutions	21	1.000	0.000
7	Resource sharing mechanism	21	1.000	0.000
8	Organizational support mechanism	21	1.000	0.000
9	Communication and cooperation mechanism	21	1.000	0.000
10	Interest balance mechanism	21	1.000	0.000

According to Table 4.15, 21 experts towards the key success factors affecting industry-education cooperation are very positive, with a high level of consensus and a relatively consistent conclusion ($\bar{x}>0.900$, $SD<0.237$). This confirms the previous literature review.

Among the 10 factors, except for the factor of enterprise resource investment ($\bar{x}=0.937$, $SD=0.237$), all experts unanimously agree on the importance of university resource investment, government support, social industrial structure, technological innovation and transformation, policies and regulations, resource sharing mechanism, organizational guarantee mechanism, communication and coordination mechanism, and benefit balance mechanism ($\bar{x}=1.000$, $SD=0.000$) as shown in Table 4.15.

Specific Analysis of Key Success Factors in industry-education cooperation

A total of 28 questions were designed around the 10 key success factors of industry-education cooperation and provided to 21 experts for consultation. The results as shown in Table 4.16.

Table 4.16 Specific Analysis of Key Success Factors in industry-education cooperation

Success Factors	\bar{x}	SD	Detail questions	N	Freq	%	\bar{x}	SD	IOC
University Resource Investment	1.000	0.000	The university has a sense of industry-education cooperation	21	21	100.00	1.000	0.000	1.000
			The university possesses the capability for industry-education cooperation in its educational operations	21	21	100.00	1.000	0.000	1.000
			The university has the basic conditions for industry-education cooperation	21	21	100.00	1.000	0.000	1.000
			The university has invested resources in industry-education cooperation	21	21	100.00	1.000	0.000	1.000
Industry Resource Investment	0.937	0.237	Industries have a concept of industry-education cooperation	21	18	85.71	0.857	0.350	0.743
			The nature and scale of the enterprise itself	21	21	100.00	1.000	0.000	1.000
			Industries invest resources in industry-education cooperation	21	20	95.24	0.952	0.213	0.905

Table 4.16 (continued)

Success Factors	\bar{x}	SD	Detail questions	N	Freq	%	\bar{x}	SD	<i>IOC</i>
Government Support Intensity	1.000	0.000	The government formulates policies and regulations for industry-education cooperation	21	21	100.00	1.000	0.000	1.000
			Government supervision of the implementation process of industry-education cooperation	21	21	100.00	1.000	0.000	1.000
			Quality supervision and evaluation of industry-education cooperation by the government	21	21	100.00	1.000	0.000	1.000
Social Industrial Structure	1.000	0.000	Matching Industrial Structure with University Professional Structure	21	21	100.00	1.000	0.000	1.000
			Provincial and municipal industry-education cooperation platform carriers	21	21	100.00	1.000	0.000	1.000
			Social recognition of vocational education for cultivating highly skilled personnel	21	21	100.00	1.000	0.000	1.000
			Social media promotion and reporting on industry-education cooperation	21	21	100.00	1.000	0.000	1.000

Table 4.16 (continued)

Success Factors	\bar{x}	SD	Detail questions	N	Freq	%	\bar{x}	SD	IOC
Technological Innovation and Transformation	1.000	0.000	The demand of technological change for the cultivation of highly skilled personnel	21	21	100.00	1.000	0.000	1.000
			Application and transformation of new technological achievements	21	21	100.00	1.000	0.000	1.000
Policies and Institutions	1.000	0.000	Implementation of the national, provincial, and municipal industry-education cooperation system	21	21	100.00	1.000	0.000	1.000
			Proper measures taken to promote industry-education cooperation projects	21	21	100.00	1.000	0.000	1.000
Resource Sharing Mechanism	1.000	0.000	Resource flow and functional complementarity between universities and industries	21	21	100.00	1.000	0.000	1.000
			Resource sharing between universities and industries	21	21	100.00	1.000	0.000	1.000
Organizational Support Mechanism	1.000	0.000	industry-education cooperation with financial guarantee	21	21	100.00	1.000	0.000	1.000
			industry-education cooperation with personnel guarantee	21	21	100.00	1.000	0.000	1.000

Table 4.16 (continued)

Success Factors	\bar{x}	SD	Detail questions	N	Freq	%	\bar{x}	SD	IOC
			industry-education cooperation has a reward and punishment mechanism	21	21	100.00	1.000	0.000	1.000
Communication And Cooperation Mechanism	1.000	0.000	Cooperation between universities and industries has a coordinated governance mechanism	21	21	100.00	1.000	0.000	1.000
			Smooth communication channels between universities and industries	21	21	100.00	1.000	0.000	1.000
			Appropriate frequency of information communication between universities and industries	21	21	100.00	1.000	0.000	1.000
Interest Balance Mechanism	1.000	0.000	Reasonable distribution of benefits between universities and industries in industry-education cooperation	21	21	100.00	1.000	0.000	1.000
			Universities and industries have cost sharing and compensation in industry-education cooperation	21	21	100.00	1.000	0.000	1.000

According to Table 4.16, 21 experts have a highly consistent view on the key success factors for industry-education cooperation, with 100% agreement on 26 questions. Among them, there are slight differences in the attitudes towards two questions, " Industries have a concept of industry-education cooperation " (PCT=85.71%, IOC=0.743) and " Industries invest resources in industry-education cooperation " (PCT=95.24%, IOC=0.905). But overall, the experts' attitudes are very positive, and the general consensus tends to be consistent.

Confirm the problems, opportunities, and key success factors of industry-education cooperation

Provide the original questionnaire on industry-education cooperation problems, opportunities, and key success factors, as well as the analysis results and the revised questionnaire after qualitative analysis, to 5 experts in the fields of production and education cooperation, technological innovation and management, data analysis, etc. The 5 experts will independently check the effectiveness, appropriateness, clarity, and completeness of each question's expression, and evaluate them with full agreement (1 point), partial agreement (0 point), or disagreement (-1 point) (Table 4.17).

Table 4.17 Confirm the problems, opportunities, and key success factors of industry-education cooperation

Aspects Evaluated	Evaluate the Content	N	Freq	%	\bar{x}	SD	IOC
Question Validity	The questions are closely aligned with the research objectives, and the quantity is reasonable.	5	5	100.00	1.000	0.000	1.000

Table 4.17 (continued)

Aspects Evaluated	Evaluate the Content	N	Freq	%	\bar{x}	SD	IOC
Clarity of Expression	The expressions are appropriate, clear, and unambiguous.	5	5	100.00	1.000	0.000	1.000
Completeness of Content	The content is relatively comprehensive, covering issues related to industry-education cooperation.	5	5	100.00	1.000	0.000	1.000
Procedural Regularity	The processes of data collection, analysis, and questionnaire revision are standardized.	5	5	100.00	1.000	0.000	1.000
Effectiveness of Conclusions	The conclusions drawn regarding the current issues in industry-education cooperation are effective.	5	5	100.00	1.000	0.000	1.000

According to Table 4.17, The problems, opportunities, and key success factors in industry-education cooperation have received unanimous approval from all experts (PCT=100%, IOC=1.000), indicating the validity of the conclusions.

Result of Finding Objective 2: To evaluate appropriate elements for industry-education cooperation management model to Enhance Student Competence in Sichuan.

Used structured in-depth interview method, interviewed with the industrial project coordinators and college project coordinators of six industry-education cooperation projects at Luzhou Vocational and Technical College. Evaluate the factors of the management model for industry-education cooperation and initially construct a management model to enhance student competence in Sichuan.

Analysis of the interview with the college coordinators of the industry-education cooperation projects

The results of the interview with the college coordinators of the industry-education cooperation projects were analyzed through co-occurrence analysis content codes and cluster coding analysis. As shown in Table 4.18.

Table 4.18 Co-occurrence analysis of the results of the interview with the college coordinators

	industry- education cooperation Problems Gr=5	industry- education cooperation opportunities Gr=5	industry- education cooperation key success factors Gr=6	Lessons Learned from industry- education cooperation Gr=4
● Innovation Spirit Gr=7	1	2	3	1
● Cooperation Model Gr=15	5	2	5	3
● Cooperation Project Gr=14	4	3	4	3
● Technical Support Gr=4	1	1	1	1

Table 4.18 (continued)

	industry- education cooperation Problems Gr=5	industry- education cooperation opportunities Gr=5	industry- education cooperation key success factors Gr=6	Lessons Learned from industry- education cooperation Gr=4
●Interest				
Adjustment Gr=9	5	0	3	1
●Highly Skilled				
Professionals Cultivation Gr=7	2	2	2	1
● Practical				
Factors Gr=5	1	2	1	1
● Market Demand				
Gr=8	2	1	3	2
●Coordination				
Mechanism Gr=14	4	2	5	3
●Policy and				
Institution Gr=6	3	1	2	0
●Resource				
Elements Gr=9	3	2	3	1
●Organizational				
Guarantee Gr=8	4	1	2	1

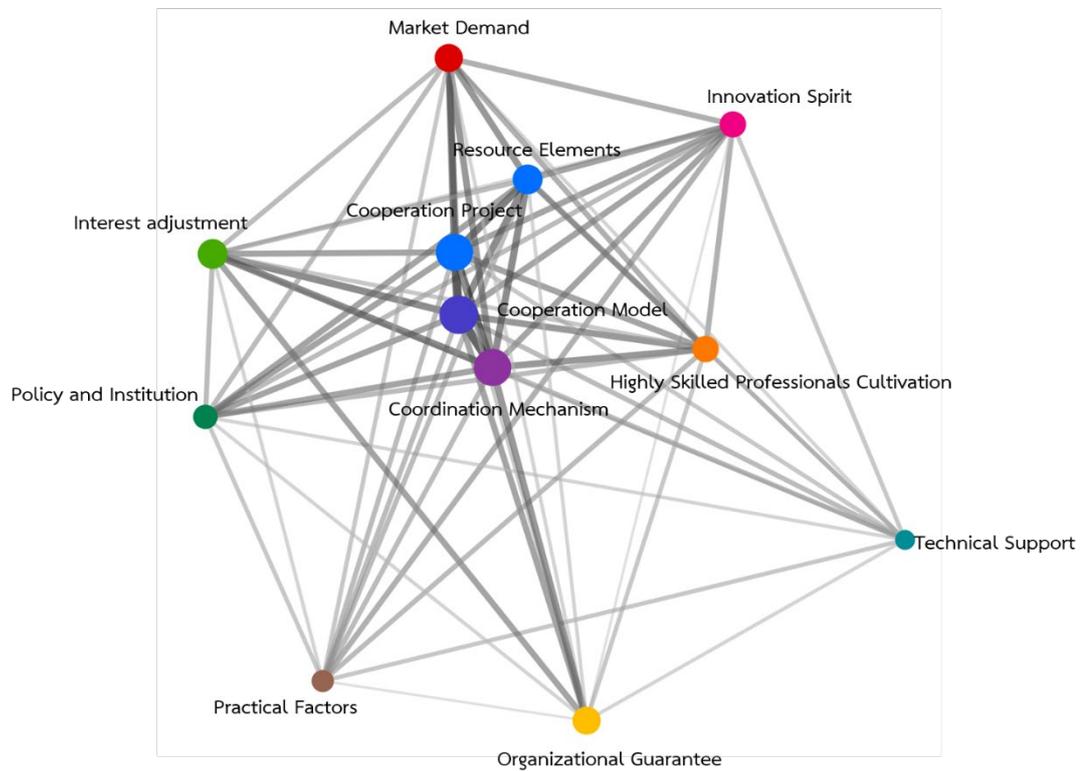


Figure 4.1 Word cloud of co-occurrence analysis of interview results for the college coordinators

The results show that in the practice of industry-education cooperation, college coordinators believe that “Cooperation Model” “Cooperation Project”, and “Coordination Mechanism” are the most critical factors. (Table 4.18, Figure 4.1)

industry-education cooperation current problems

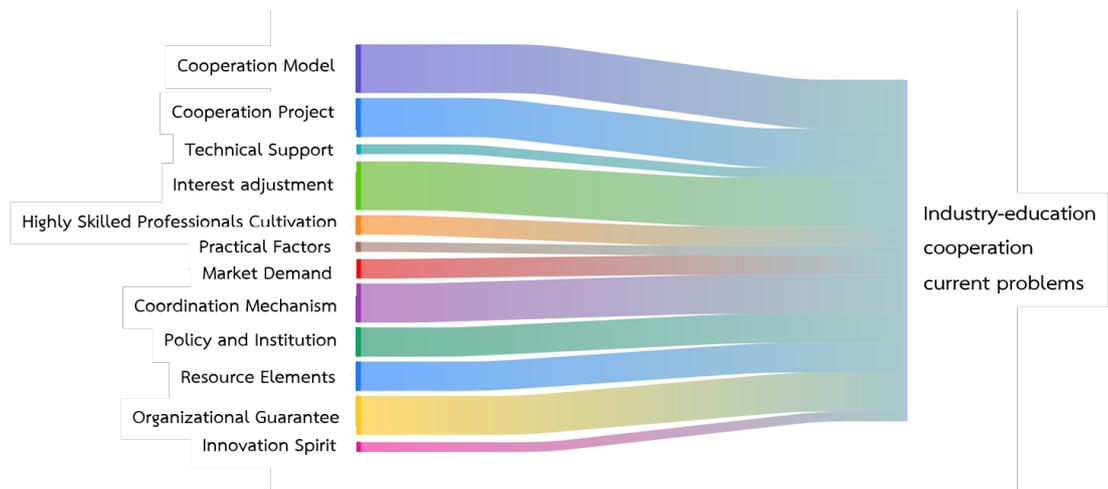


Figure 4.2 Sankey diagram of coding results of interview with the problems for the college coordinators

The college coordinators of the industry-education cooperation believe that the main problems in industry-education cooperation are “Cooperation Model”, “Interest adjustment”, “Coordination Mechanism”, and “Organizational Guarantee”. (Figure 4.2)

industry-education cooperation Opportunities

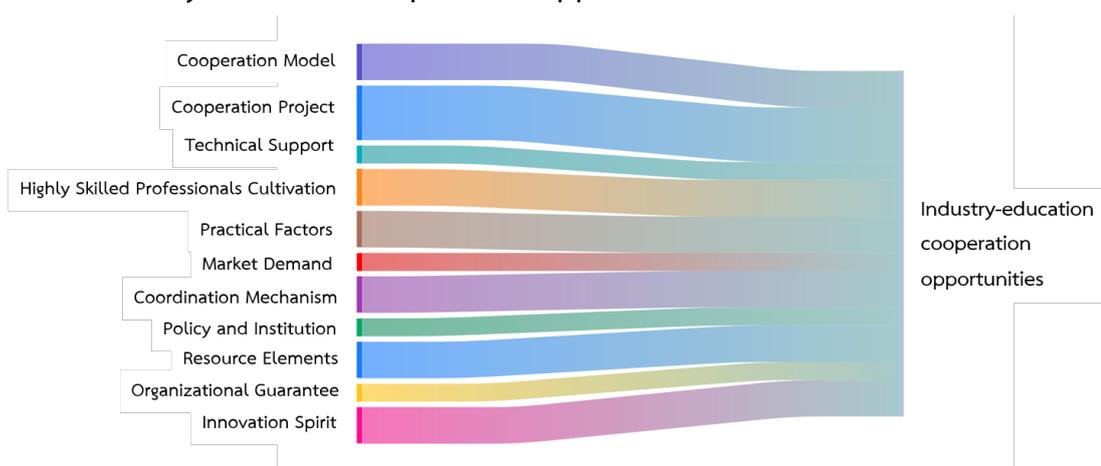


Figure 4.3 Sankey diagram of coding results of interview with the Opportunities for the college coordinators

The results indicate that the college coordinators of the industry-education cooperation perceive the primary opportunity is “Cooperation Project”. (Figure 4.3)

industry-education cooperation key success factors

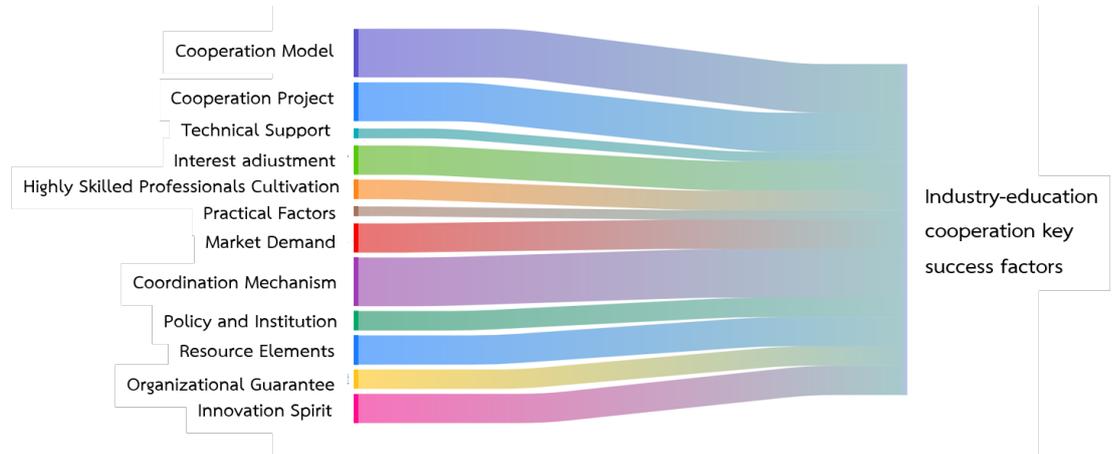


Figure 4.4 Sankey diagram of coding results of interview with the key success factors for the college coordinators

The results indicate that the college coordinators of the industry-education cooperation consider the primary success factors in current industry-education cooperation to be the “Cooperation Model”, “Coordination Mechanism”, followed by “Cooperation Project” (Figure 4.4).

Lessons Learned from industry-education cooperation

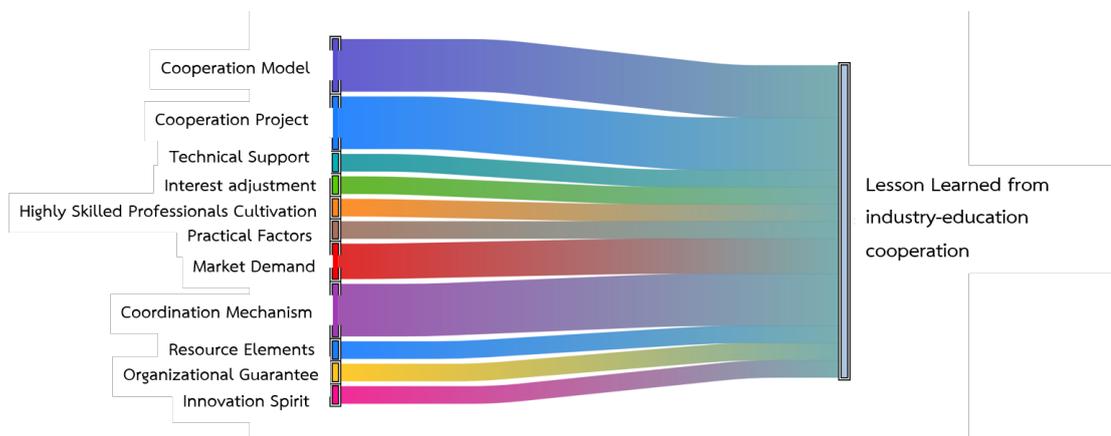


Figure 4.5 Sankey diagram of coding results of interview with the lessons learned for the college coordinators

The results indicate that the college coordinators of lessons learned from industry-education cooperation primarily involve “Cooperation Project”, “Coordination Mechanism” followed by “Cooperation Model”, and “Market Demand” (Figure 4.5).

Analysis of the interview with the industry coordinators of the industry-education cooperation projects

The results of the interview with the industry coordinators of the industry-education cooperation projects were analyzed through co-occurrence analysis content codes and cluster coding analysis. As shown in Table 4.19.

Table 4.19 Co-occurrence analysis of the results of the interview with the industry coordinators

	industry- education cooperation Problems Gr=7	industry- education cooperation opportunities Gr=7	industry- education cooperation key success factors Gr=7	Lessons Learned from industry- education cooperation Gr=7
● Industry- Academia-Research Cooperation Gr=19	5	5	6	3
● Industrial Development Gr=10	3	2	2	3
● Highly Skilled Professionals Gr=12	2	3	4	3
● Cooperation Mechanism Gr=20	4	3	7	6
● Technological Innovation Gr=12	1	5	3	3
● Benefit Adjustment Gr=8	3	0	4	1
● Industry Needs Gr=24	6	6	6	6
● Practical Skills Gr=16	5	5	3	3

Table 4.19 (continued)

	industry- education cooperation Problems Gr=7	industry- education cooperation opportunities Gr=7	industry- education cooperation key success factors Gr=7	Lessons Learned from industry- education cooperation Gr=7
● Coordination				
Mechanism Gr=7	3	0	2	2
● Student				
Employment Gr=16	5	4	3	4
● University Needs Gr=14	4	2	5	3
● Policy System Gr=4	1	0	1	2
● Resource				
Elements Gr=12	4	2	3	3

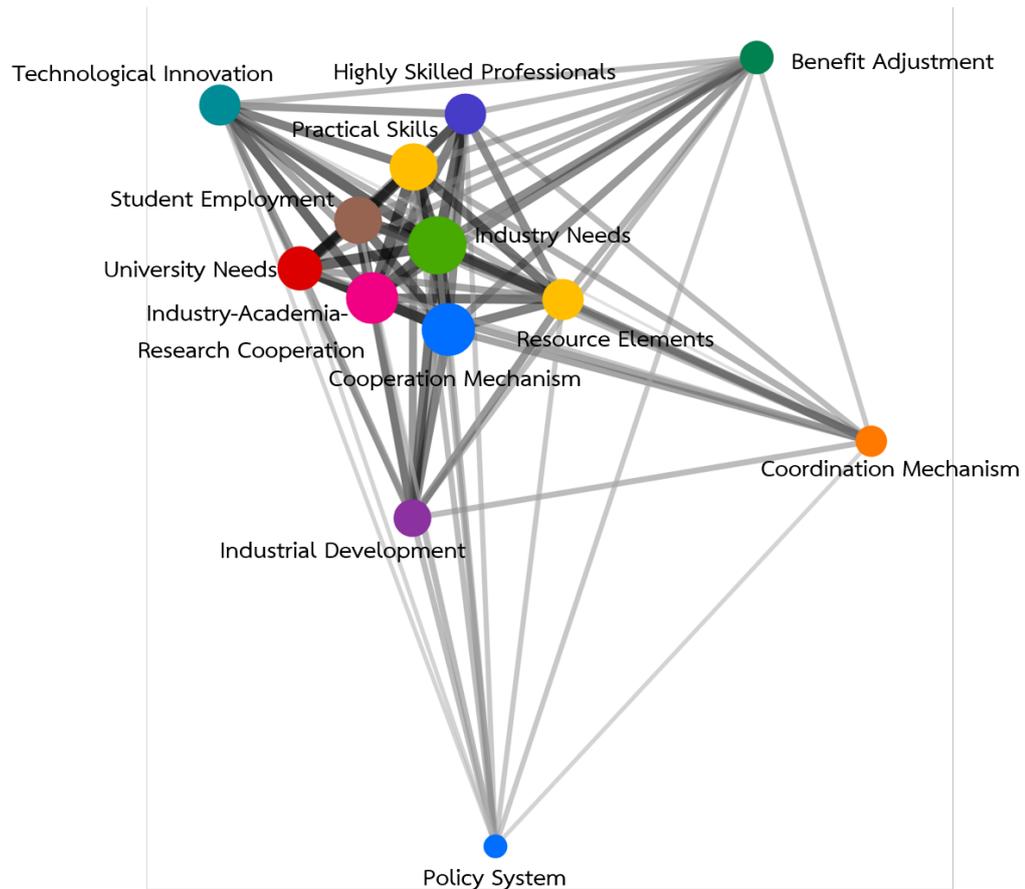


Figure 4.6 Word cloud of co-occurrence analysis of interview results for the industry coordinators

The results show that in the practice of industry-education cooperation, the industry coordinators believe that “Industry Needs” as the most important factor, followed by “Cooperation Mechanism” and “Industry-Academia-Research Cooperation”. (Table 4.19, Figure 4.6)

industry-education cooperation current problems

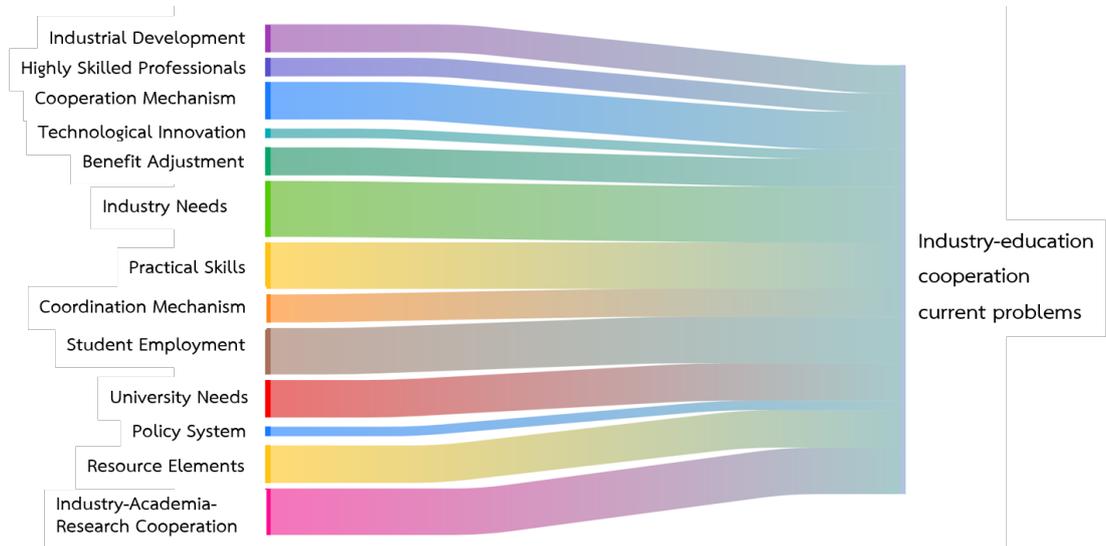


Figure 4.7 Sankey diagram of coding results of interview with the problems for the industry coordinators

The industry coordinators of the industry-education cooperation believe that the main problems in industry-education cooperation is “Industry Needs”, followed by “Industry-Academia-Research Cooperation” “Practical Skills”, and “Student Employment”. (Figure 4.7)

industry-education cooperation Opportunities

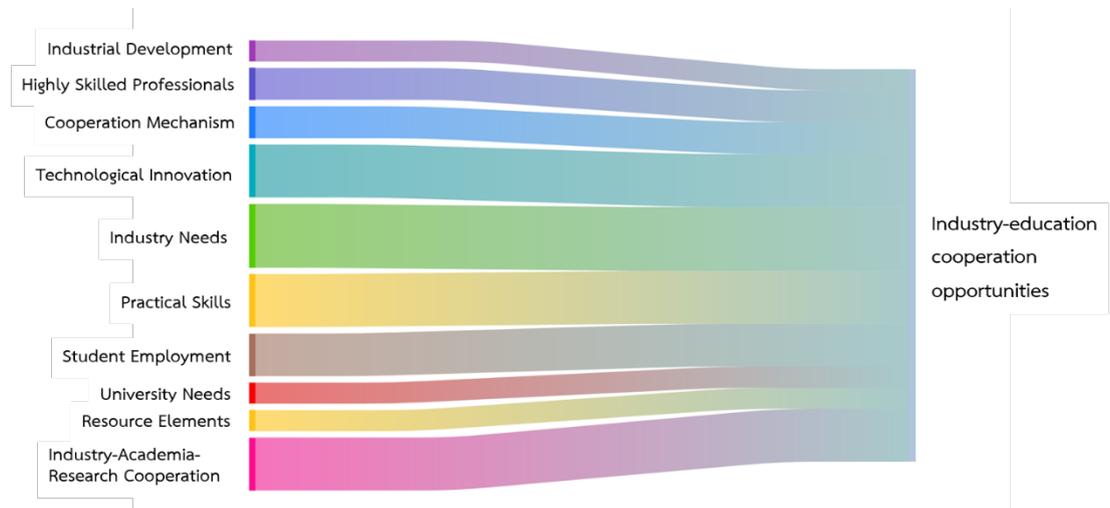


Figure 4.8 Sankey diagram of coding results of interview with the Opportunities for the industry coordinators

The results indicate that the industry coordinators of the industry-education cooperation perceive the primary opportunity is “Industry Needs”, followed by “Industry-Academia-Research Cooperation” “Practical Skills”, and “Technological Innovation”. (Figure 4.8)

industry-education cooperation key success factors

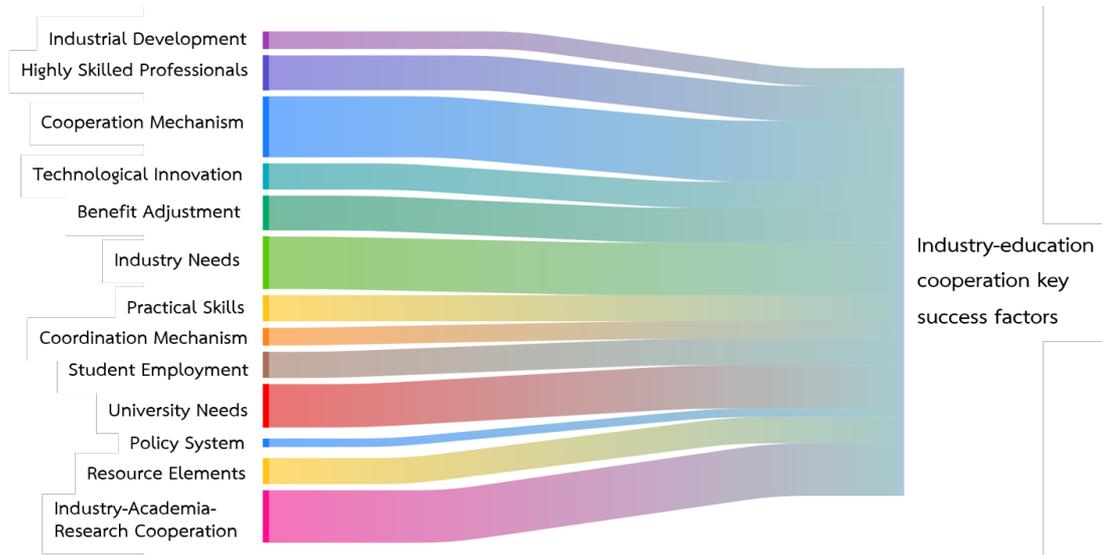


Figure 4.9 Sankey diagram of coding results of interview with the key success factors for the industry coordinators

The results indicate that the industry coordinators consider the primary success factors in current industry-education cooperation to be the “Cooperation Mechanism”, followed by “Industry Needs”, and “Industry-Academia-Research Cooperation” (Figure 4.9).

Lessons Learned from industry-education cooperation

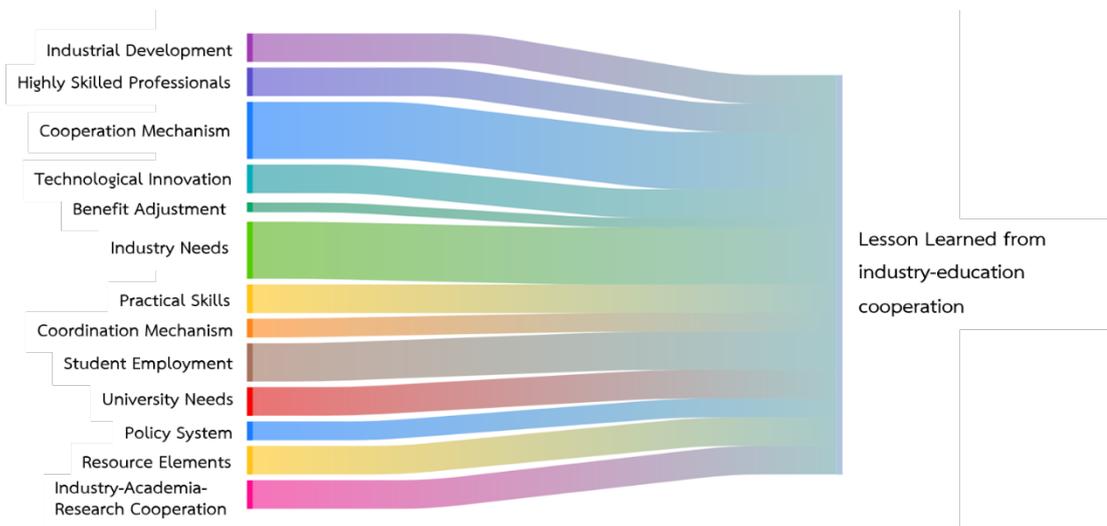


Figure 4.10 Sankey diagram of coding results of interview with the lessons learned for the industry coordinators

The results indicate that the industry coordinators of lessons learned from industry-education cooperation primarily involve the “Cooperation Mechanism”, and “Industry Needs” (Figure 4.10).

The overall analysis of the interview results with the coordinators of the industry-education cooperation

The interview results of the coordinators in the industry-education cooperation were subjected to co-occurrence analysis of interview content codes. As show in Table 4.20.

Table 4.20 The overall analysis of the interview results with the coordinators of the industry-education cooperation

Code Name	industry-education cooperation Problems		industry-education cooperation opportunities		industry-education cooperation key success factors		Lessons Learned from industry-education cooperation		Total	
	University	Industry	University	Industry	University	Industry	University	Industry	University	Industry
	●Innovation Spirit	1		1		1		1		1
●Cooperation Mechanism (Model)	5	4	2	3	5	7	3	6	15	20
●Cooperation Project	4		3		4		3		14	
●Technical Support (Technological Innovation)	1	1	1	5	1	3	1	3	4	12
●Interest Adjustment	5	3	0	0	3	4	1	1	9	8

Table 4.20 (continued)

Code Name	industry-education cooperation Problems		industry-education cooperation opportunities		industry-education cooperation key success factors		Lessons Learned from industry-education cooperation		Total	
	University	Industry	University	Industry	University	Industry	University	Industry	University	Industry
	●Highly Skilled Professionals (Cultivation)	2	2	2	3	2	4	1	3	7
●Student (Practical) Skills	1	5	2	5	1	3	1	3	5	16
●Industry (Market) Needs	2	6	1	6	3	6	2	6	8	24
●Coordination Mechanism	4	3	2	0	5	2	3	2	14	7
●Policy and Institution	3	1	1	0	2	1	0	2	6	4
●Resource Elements	3	4	2	2	3	3	1	3	9	12

Table 4.20 (continued)

Code Name	industry-education cooperation Problems		industry-education cooperation opportunities		industry-education cooperation key success factors		Lessons Learned from industry-education cooperation		Total	
	University	Industry	University	Industry	University	Industry	University	Industry	University	Industry
	●Organizational Guarantee	4		1		2		1		8
●Industry-Academia-Research Cooperation		5		5		6		3		19
●Industrial Development		3		2		2		3		10
●University Needs		4		2		5		3		14
●Student Employment		5		4		3		4		16

According to Table 4.20, coordinators emphasize that the cooperation mechanism is the most crucial aspect in the practice of industry-education cooperation. The cooperation mechanism is both a problem and a key success factor. Technological innovation development led industries to always prioritize Industry (Market) Needs, focusing on industry-academy-research cooperation, student (practical) ability, student employment, etc.; while universities pay more attention to cooperation models and cooperation projects.

Building an industry-education cooperation Ecosystem Model

Based on the results of objective 1 and the findings from this section's interviews, a comprehensive analysis of the problems, opportunities, and success factors of industry-education cooperation is conducted. Using system thinking, building an industry-education cooperation Ecosystem Model (Figure 4.11).

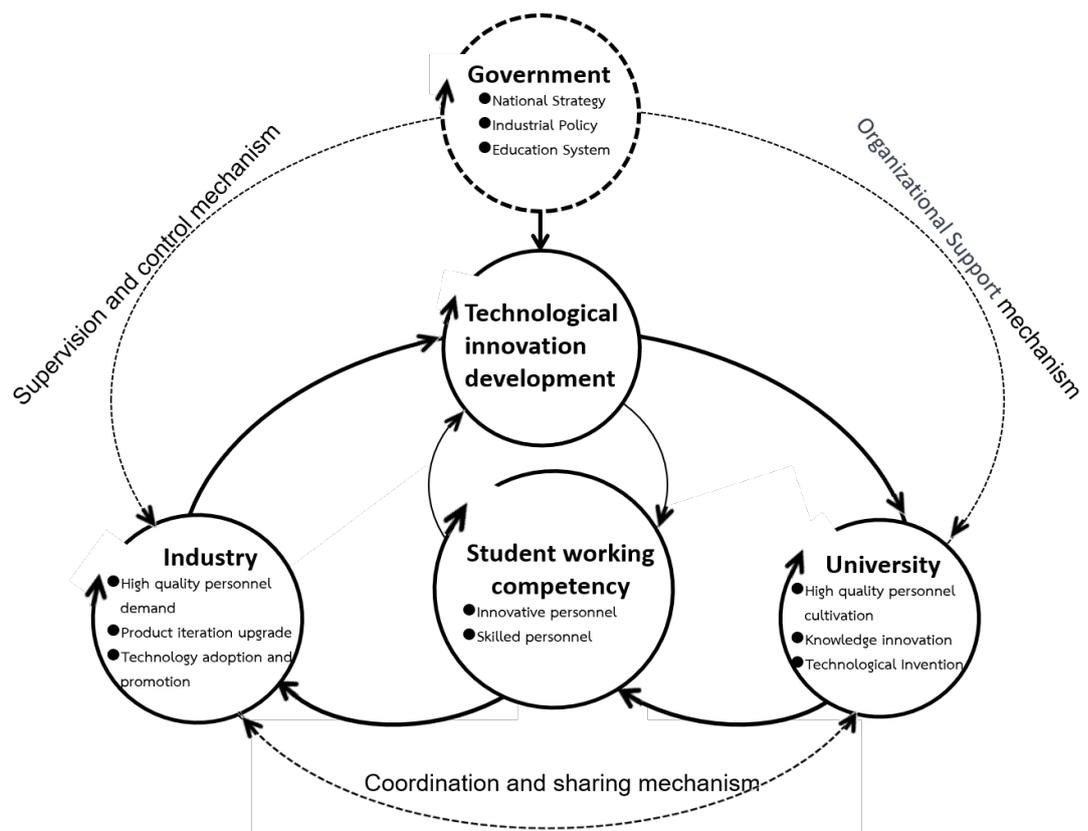


Figure 4.11 Industry-education cooperation Ecosystem Model Diagram

Model diagram description:

1. In the diagram, "→" represents direct one-way interaction, and "----->" represents indirect one-way interaction.

2. In the diagram, "→" represents strong interactions, and "→" represents weak interactions.

3. In the diagram, "⊙" represents an open system with direct effects, and "⊙" represents an open system with indirect effects.

Model Explanation:

1. The industry-education cooperation ecosystem model is a relatively fixed and inclusive system formed by the fusion of relevant subjects and elements. The construction of this model aims to provide practical support and platform supply for the cultivation of high-skilled personnel.

2. The government, universities and industries have high impact on technological innovation development which result to student working competency. The government not directly participate in student working competency but acts on universities and industries through supervision regulation mechanisms and organizational guarantee mechanisms, promoting the establishment of coordination and sharing mechanisms among universities and industries to jointly carry out student working competency.

3. Student working competency is the regulatory variable in the positive relationship among the government, industries, and technological innovation development. Technological innovation development are key factors driving social progress and economic development, while industries are important components of the economy, and highly skilled personnel drive technological innovation development. Therefore, the cultivation and rational allocation of high-skilled personnel can form a virtuous circle among the government, industries, technological innovation development, promoting the overall development of society.

4. There is a positive feedback relationship among technological innovation development, universities, industries, and student working competency. Technological innovation development constitutes the industry-education cooperation ecological environment, which restricts the specifications of highly skilled personnel cultivation. Universities need to conduct industry-academy-research cooperation based on the needs of industries, collaboratively cultivating innovative and skilled personnel required by industries.

5. There is a positive relationship among the government, universities, student working competency, and technological innovation development. The government supports universities in developing highly skilled personnel through policies and resources, and the excellent highly skilled personnel cultivated by universities play a role in technological innovation development, thereby forming a virtuous circle that jointly promotes social progress and development.

Result of Finding Objective 3: To design an effective industry-education cooperation management model to Enhance Student Competence in Sichuan.

Invited 21 experts to evaluate the industry-education cooperation ecosystem model. Among them, there are 9 experts from universities, 9 from industries, and 3 from government administrative departments. 21 expert consultation forms were issued, and all of them were recovered with a recovery rate of 100%. This indicates a highly positive attitude and a high level of participation from the experts.

First Round Expert Evaluation of the industry-education cooperation Ecosystem Model

21 experts were invited to evaluate the model based on their academic expertise and experience. The options were "agree," "partly agree," or "disagree". If choosing "partly agree" or "disagree," provide explanations or clarifications. Refer to 4.21, and 4.22 for details.

Table 4.21 Results of the First Round Expert Evaluation of the Industry Education cooperation Ecosystem Model

Assessment Items	N	Freq	%	\bar{x}	SD
Industry Education Cooperation Ecosystem Model	21	18	85.71	0.857	0.350

Table 4.22 Detail results of the First Round Expert Evaluation of the industry-education cooperation Ecosystem Model

Assessment Items	Expert Number	Expert Identity	Effective			
			Agree	Partly Agree	Disagree	Expert Explanation
Industry- Education Cooperation Ecosystem Model	1	University	●			
	2	University	●			
	3	University		●		<p>1. Universities not only cultivate student working competency, but also urgently need industry backgrounds personnels have strong working competency to participate in university teaching.</p> <p>2. The industry needs highly skilled personnels with strong working competency, and highly skilled personnels in industry also flow back to universities to support higher education.</p> <p>3. There should be two-way arrows between universities and student working competency, industries and student working competency.</p>

Table 4.22 (continued)

Assessment Items	Expert Number	Expert Identity	Effective			
			Agree	Partly Agree	Disagree	Expert Explanation
Industry-Education Cooperation Ecosystem Model	4	University	●			
	5	University		●		Further refine the model, especially strengthen the research on the interaction mechanism among various subjects, further improve the relationship among industries, student working competency, universities, and technology in the diagram (such as the supervision and regulation of government to industries in the diagram), and enhance the practicality of the model.
	6	University		●		This study is mainly aimed at vocational education, so "Skilled Professionals" corresponds to the requirements of the state for the training of "High-quality technical and skilled Professionals" in vocational education. It is suggested that it be expressed as "High-quality technical and skilled Professionals".

Table 4.22 (continued)

Assessment Items	Expert Number	Expert Identity	Effective			
			Agree	Partly Agree	Disagree	Expert Explanation
Industry- Education Cooperation Ecosystem Model	7	University	●			
	8	University	●			
	9	University	●			
	10	Industry	●			
	11	Industry	●			
	12	Industry	●			
	13	Industry	●			
	14	Industry	●			
	15	Industry	●			
	16	Industry	●			
	17	Industry	●			
18	Industry	●				

Table 4.22 (continued)

Assessment Items	Expert Number	Expert Identity	Effective			
			Agree	Partly Agree	Disagree	Expert Explanation
	19	Government Administration Department	●			
	20	Government Administration Department	●			
	21	Government Administration Department	●			

According to Table 4.22, among the 21 experts, 3 university experts chose "partly agree" and provided explanations. The industry expert group and the government administrative expert group agreed unanimously. This indicates that the overall coordination among expert opinions is relatively high.

Based on the first round of expert opinions, the industry-education cooperation ecosystem model was revised, optimized, and improved. Refer to 4.12 for details.

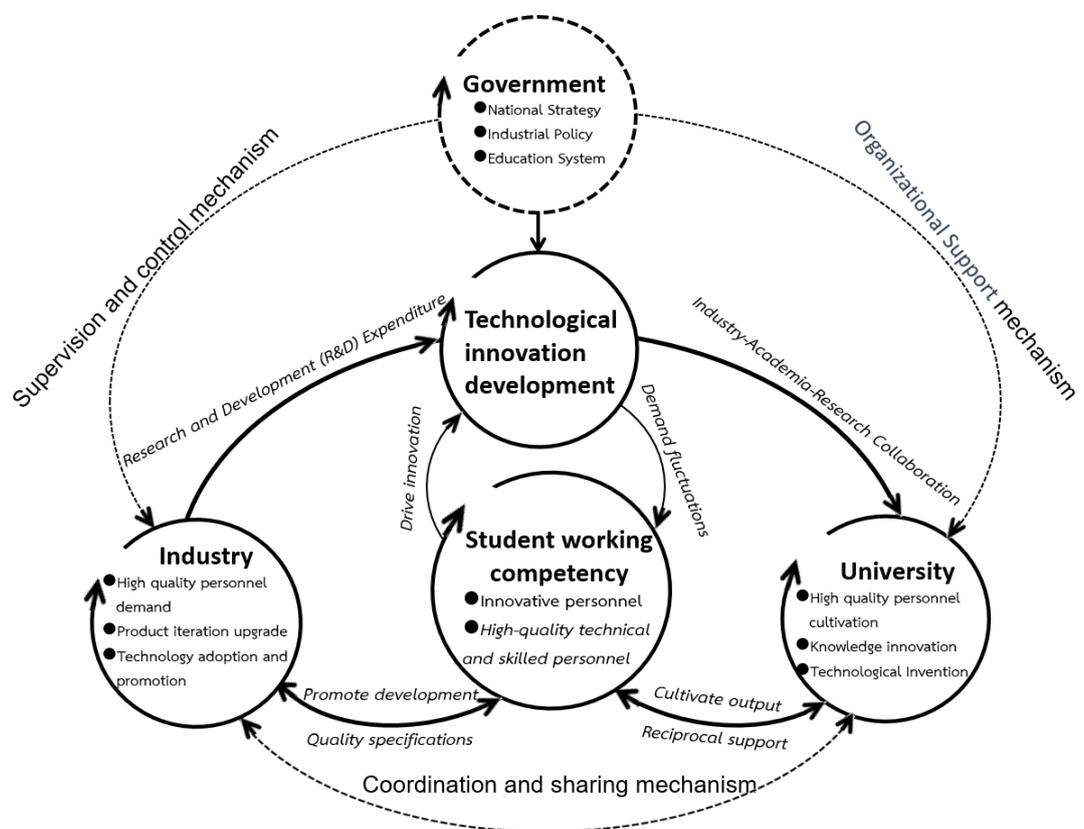
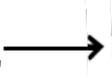
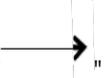


Figure 4.12 Revised industry-education cooperation Ecosystem Model Diagram

(The *slash* part represents the revisions)

Model diagram description:

1. In the diagram, "  " represents direct one-way interaction, and "  " represents indirect one-way interaction.
2. In the diagram, "  " represents strong interactions, and "  " represents weak interactions.
3. In the diagram, "  " represents an open system with direct effects, and "  " represents an open system with indirect effects.
4. In the diagram, "  " represents direct two-way interaction.

Explanation of the Revised Model:

1. The model further clarifies the logical relationship among the government, industries, universities, technological innovation development, and student working competency. Student working competency are the core of the industry-education cooperation model, acting as the regulating variables in the positive relationships among the government, industries, universities, technological innovation development.

2. The model adds two-way arrows between universities and student working competency, industries and student working competency. Emphasize the direct and mutual interaction between universities, industries, and student working competency in the context of industry-education cooperation. Universities play a crucial role in cultivating innovative, highly skilled personnel with strong working competency can drive industry development. Meanwhile, strong working competency high-quality technical and highly skilled personnel in industries also flow back to universities to support higher education. Two-way arrows between universities and student working competency, industries and student working competency.

3. The model further refines and strengthens the interaction mechanisms among various entities, supplementing and enhancing the interaction relationships and mechanisms among student working competency,

technological innovation development, universities, and industries. This strongly echoes the conclusion found in Research Goal 2 that "industries and universities both emphasize that cooperation mechanism is crucial in industry-education cooperation practices. Cooperation mechanism is not only a problem but also a key success factor." This enhances the practicality of the model.

The second round of expert evaluation for the industry-education cooperation Ecosystem model

21 experts to re-evaluate the model based on their academic expertise and experience. As show in Table 4.23.

Table 4.23 Results of the second round of expert evaluation for the industry-education cooperation Ecosystem model

Assessment Items	N	Freq	%	\bar{x}	SD
Revised industry-education cooperation Ecosystem Model	21	21	100.00	1.000	0.000

According to Table 4.23, in this round of expert consultations, all experts unanimously agreed that the concentration reached 100%. This indicates that experts highly recognize the industry-education cooperation Ecosystem model.

Result of Finding Objective 4: To evaluate the industry-education cooperation management model to enhance student competence in Sichuan.

Using the CIPP evaluation model, we invited five experts with extensive experience in industry-education cooperation research or expertise in model research to assess the model. The options are "agree," "partly agree," or "disagree," corresponding to scores of 1, 0, and -1, respectively. If choosing "partly agree" or "disagree," provide explanations or clarifications. The list of experts is included in the appendix. Refer to Table 4.24 for the evaluation results.

Table 4.24 CIPP Evaluation Model Expert Evaluation Results

CIPP Evaluation	Evaluation Aspect	Specific Evaluation Contents	Effective			
			Agree	Partially Agree	Disagree	Explanation or Suggestions
Context Evaluation	Background and Purpose	Do you agree that the background and purpose of this model are clear and can effectively enhance the student working competency?	5	0	0	
		Do you agree with the role of technological innovation development in this model?	5	0	0	
	Industry-Education Cooperation Entities	Do you agree that the design of this model takes full account of the roles of industries, universities, and the government in the industry-education cooperation?	5	0	0	
		Do you agree that this model takes into account the needs and expectations of all entities involved in the industry-education cooperation?	5	0	0	

Table 4.24 (continued)

CIPP Evaluation	Evaluation Aspect	Specific Evaluation Contents	Effective			
			Agree	Partially Agree	Disagree	Explanation or Suggestions
		Do you agree that this model effectively reflects the roles and levels of participation of all entities involved in the industry-education cooperation?	5	0	0	
Input Evaluation	Problem Analysis	Do you agree that the problems in the industry-education cooperation have been fully considered?	5	0	0	
		Do you agree that the formulation of the question has taken into account the diverse perspectives of industry, university, and government?	5	0	0	

Table 4.24 (continued)

CIPP Evaluation	Evaluation Aspect	Specific Evaluation Contents	Effective			
			Agree	Partially Agree	Disagree	Explanation or Suggestions
	Success Factors Analysis	Do you agree that the summarized success factors fully consider the diversity and complexity of the industry-education cooperation?	5	0	0	
		Do you agree that the cooperation mode (mechanism) of industry-education cooperation plays a key role in the success of the ecosystem of industry-education cooperation?	5	0	0	
Process Evaluation	Cooperation Mechanism	Do you agree that the cooperation mechanism between the government, universities, and industries in this model has received sufficient attention?	5	0	0	

Table 4.24 (continued)

CIPP Evaluation	Evaluation Aspect	Specific Evaluation Contents	Effective			
			Agree	Partially Agree	Disagree	Explanation or Suggestions
		Regarding the emphasis on the cooperation model (mechanism), do you think this model fully considers the actual needs and expectations of universities and industries?	5	0	0	
		Do you agree with the design of the supervision regulation mechanism, organizational guarantee mechanism, and coordination and sharing mechanism in the model?	5	0	0	
	Feasibility of Model Implementation	Do you agree that this model has strong practicality and executability?	5	0	0	
		Do you agree with the design of the relationships between the various elements in the model?	5	0	0	

Table 4.24 (continued)

CIPP Evaluation	Evaluation Aspect	Specific Evaluation Contents	Effective			
			Agree	Partially Agree	Disagree	Explanation or Suggestions
Product Evaluation	Model Feedback and Improvement	Do you agree that the feedback mechanism designed in this model is flexible and practical enough?	5	0	0	
		Do you agree that the adjustment and improvement design of this model can improve its applicability?	5	0	0	
	Model Effectiveness	Do you agree that the results of the interviews with industry-education cooperation coordinators largely align with the conclusions of the expert evaluation for objective 1, increasing confidence in the success of the model?	5	0	0	

Table 4.24 (continued)

CIPP Evaluation	Evaluation Aspect	Specific Evaluation Contents	Effective			
			Agree	Partially Agree	Disagree	Explanation or Suggestions
		Do you agree that the application of this model has the potential to solve the problems in the industry-education cooperation?	5	0	0	
		Do you agree that the application of this model can effectively enhance the competitiveness of higher vocational students?	5	0	0	

According to Table 4.24, 5 experts evaluated the industry-education cooperation ecosystem model constructed in this study from 8 aspects and 19 categories, and the results were unanimously agreed upon by all experts, with a high degree of consensus and credibility. This indicates that the constructed model is effective and feasible.

Chapter 5

Conclusion, Discussion and Recommendations

Conclusion

The research topic "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan " has been designed with 4 research objectives.

1. To identify current problems, opportunities, and success factors in the industry-education cooperation.

2. To evaluate appropriate elements for industry-education cooperation management model to enhance student competence in Sichuan.

3. To design an effective industry-education cooperation management model to enhance student competence in Sichuan.

4. To evaluate the industry-education cooperation management model to enhance student competence in Sichuan.

Based on the findings in Chapter 4, the conclusion are as follows.

Research Objective 1: To identify current problems, opportunities, and success factors in the industry-education cooperation.

The current problems in the industry-education cooperation

There are 8 main problems in the industry-education cooperation, lack of coordination in industry-education cooperation, lack of supportive cooperative environment, imperfect policies and systems, insufficient resource sharing, inadequate organizational support, communication and coordination hindered, benefits not effectively matched, and low-level and superficial cooperation. among them, the 3 most prominent problems are the lack of supportive cooperative environment insufficient resource sharing, and communication and coordination hindered.

Opportunities in industry-education cooperation

There are 6 main opportunities for the industry-education cooperation, strong policy support, modern industrial development, increasing demand for highly skilled personnel, development of modern vocational education systems, educational

positioning in vocational education, and integrated development of industry and education.

The key success factors in industry-education cooperation

There are 10 key success factors for the industry-education cooperation, including university resource investment, Industry Resource Investment, government support Intensity, Social Industrial Structure, technological innovation and transformation, Policies and Institutions, resource sharing mechanisms, organizational support mechanisms, Communication and cooperation mechanism, and Interest balance mechanism.

Research Objective 2: To evaluate appropriate elements for industry-education cooperation management model to enhance student competence in Sichuan.

Current problems in the practice of industry-education cooperation

Both universities and industries agree that the cooperation mechanism (model) is the most prominent problem. In addition, the university believes that the outstanding problems in the practice of industry-education cooperation include the interest adjustment and coordination mechanism. Industries believe that the outstanding problems in the practice of industry-education cooperation include industry (market) needs, industry-academia-research cooperation, student (practical) skills and student employment.

Opportunities in the practice of industry-education cooperation

Both universities and industries believe that technical support (technological innovation), highly skilled personnel cultivation, industry (market) needs, student (practical) skills, etc. are the current opportunities for the industry-education cooperation. In addition, industries also attach great importance to the opportunities brought by industry-academia-research cooperation and student employment.

Key success factors in the practice of industry-education cooperation

Both universities and industries agree that the cooperation mechanism (model) is the most critical success factor. In addition, the university believes that the success factors in practice of industry-education cooperation mainly include coordination mechanism and cooperation project. Industries believe that the success

factors in the practice of industry-education cooperation mainly include industry (market) needs, industry-academia-research cooperation and university needs.

Lessons learned from the practice of industry-education cooperation

The lessons learned from both universities and industries through the practice of industry-education cooperation are cooperation mechanism (model). In addition, the lessons learned put forward by universities mainly include cooperation model, cooperation project and coordination mechanism; the lessons learned put forward by industries mainly include cooperation mechanism and industry needs.

Design an industry-education cooperation ecosystem model

The industry-education cooperation ecosystem model is a relatively fixed, inclusive and open system formed after sorting out the interactive and compatible complex relationships among related entities and elements. The model emphasizes that government, universities and industries have high impact on technological innovation development which result to student working competency. Student working competency is the regulating variable of the positive relationship among government, industries, universities, and technological innovation development. A positive feedback relationship is formed among technological innovation development, universities, industries and student working competency. There is a positive relationship among government, student working competency, technological innovation development.

Research Objective 3: To design an effective industry-education cooperation management model to enhance student competence in Sichuan.

Industry-education cooperation ecosystem is a system that integrates the complex relationship among related entities and various elements. Student working competency is the core of the model, and the regulating variable of the positive relationship among the government, industries, universities, technological innovation development. There is a positive relationship among student working competency, technological innovation development, government, and universities. There is a positive feedback relationship among student working competency, technological innovation development, universities, and industries. Universities and student working competency, industries and student working competency form direct two-way

relationship. The interaction mechanism among various entities is emphasized, and the interactive relationship and mechanism among student working competency cultivation, technological innovation development, universities and industries are perfected and constructed, so as to enhance the practicality of the model.

Research Objective 4: To evaluate the industry-education cooperation management model to enhance student competence in Sichuan.

Experts have reached a consensus on industry-education cooperation ecosystem model, so the model is effective and feasible.

Discussion

This study used questionnaire survey, structured in-depth interview and expert evaluation to analyze the current problems, opportunities and key success factors of the industry-education cooperation. The ecosystem model of the industry-education cooperation is constructed and evaluated, the complex relationship between the relevant subjects and elements is clarified, and the key success factors and lessons are used to solve the current problems of the industry-education cooperation.

The current problem of the industry-education cooperation

Lack of Coordination in industry-education cooperation

There is insufficient coordination among the various entities involved in the industry-education cooperation. This conclusion supports the views of Tang (2019), Fu (2015), Wang (2019), Xie (2022), et al. Governments, universities and industries are the most important actors in the industry-education cooperation, but they often have different needs and priorities. Universities focus on “teaching” and ignore “production”, resulting in insufficient cooperation and interaction with industry (Tang, 2019). Industries pursue profit maximization and need highly skilled personnel (Fu, 2015). The government mainly pursues the goal of maximizing public interests (Wang, 2019).

Lack of Supportive Cooperative Environment

The environmental support for the industry-education cooperation is insufficient. This conclusion supports the views of Du et al. (2018), Dai (2023), Yang (2020), Ouyang (2022), et al. Industrial development and technological innovation affect the industry's demand for highly skilled personnel, universities should closely follow environmental changes to carry out highly skilled personnel cultivation. However, the professional settings of universities do not match local industries (Dai, 2023), and the content and carrier of industry-education cooperation do not match (Du et al., 2018), and insufficient technological achievements and transfer between universities and industries (Yang, 2020). As a result, the problem of " Industry-Academia-Research Cooperation " in the practice of industry-education cooperation has become prominent.

Imperfect Policies and Systems

Policies and systems for the cooperation of industry-education cooperation are not perfect. This conclusion supports the views of Pei et al. (2019), Sun & Yao (2022), and Yu (2023), et al. The government has successively issued policy documents on the industry-education cooperation, but some policies are incomplete and difficult to operate in practice (Pei et al., 2019). In addition, due to the lack of interest mechanism, supervision and regulation mechanism, the system of industry-education cooperation is not perfect, resulting in low enthusiasm of industries and university teachers, etc. are not highly motivated, and the implementation of the industry-education cooperation policy is not in place (Sun & Yao, 2022).

Insufficient resource sharing

Resource sharing for the industry-education cooperation is insufficient. This conclusion supports the views of Yu (2023), Thun (2016), et al. The degree of cooperation between the universities and the industries is not high in personnel setting, training plan formulation, technology research and development and application, lack of mutual resources co-construction and sharing, industry-education cooperation is obviously superficial (Yu, 2023).

Inadequate Organizational Support

The organizational guarantee mechanism for the industry-education cooperation is not complete. This conclusion supports the views of Ouyang (2022), Rufai, et al. (2015), Luo (2018), et al. The effective promotion of the industry-education cooperation requires human, financial and material guarantees. Due to insufficient overall consideration and the lack of necessary funds and personnel investment, it is difficult for the two sides to cooperate deeply for a long time. (Ouyang, 2022) & (Rufai et al., 2015).

Communication and Coordination Hindered

Communication and coordination in the industry-education cooperation are hindered. This problem has attracted great attention from both universities and industries, supporting the views of Wierik et al., (2017), Shen (2021), et al. Imperfect communication and coordination mechanism, unblocked communication channels, and insufficient ability to communicate and resolve conflicts (Wierik et al., 2017) affect the setting of highly skilled personnel cultivation specifications and the monitoring of process by both universities and industries, and affects industry-education cooperation , as well as the quality of highly skilled personnel cultivation (Shen, 2021).

Benefits not effectively matched

The benefits of the industry-education cooperation have not been effectively matched. This conclusion supports the views of Arthur-Mensah (2020), Yang (2020), et al. The benefit distribution and compensation of relevant stakeholders in the industry-education cooperation are crucial for cooperation (Arthur-Mensah, 2020). If the interests of both partners, such as the " Industry Needs" proposed in this study, are not realized, long-term cooperation cannot be maintained.

Low-Level and Superficial Cooperation

The level of industry-education cooperation is low and not deep. This conclusion supports the views of Zhao (2020), Wu (2018), Shi (2019), et al. Universities improve the employment rate of students through cooperation, and industries seek labor force for production and development through cooperation (Zhao, 2020). The form of cooperation is mainly in practical training and practice (Wu, 2018). This study

finds that the problem of " Industry-Academia-Research Cooperation " is a strong proof of the low level of cooperation, which has not been mentioned in the existing studies.

Opportunities in industry-education cooperation

The research conclusions support the views of He et al. (2023), Hahn et al. (2019), Lu (2023), Perry (2023), et al. The emergence of new industries and new technologies has promoted the transformation and upgrading of traditional industries, and there is an urgent need to accelerate the training of technical and highly skilled personnel (He et al., 2023). Our country and even the world attach great importance to and support the industry-education cooperation, and have introduced policies to promote the industry-education cooperation, promote highly skilled personnel cultivation, and promote the development of modern industries (Hahn et al., 2019). For that. The type education orientation of vocational education promotes the construction of modern vocational education system, accelerates the integrated development of industry and education, realizes technological innovation and industrial transformation and upgrading, and improves core competitiveness (Lu, 2023; Perry, 2023).

The key success factors in industry-education cooperation

University Resource Investment

Universities are the key entities in the industry-education cooperation. The intensity of resources invested in the industry-education cooperation (including cost investment and level of effort) has a significant impact. The research conclusion supports the views of Tao et al. (2017), Tseng et al. (2020).

Industry Resource Investment

Industries are important entities in the industry-education cooperation, and their investment, equipment, scientific research personnel, and the construction of training bases are important indicators that reflect the degree of industry-education cooperation. The research conclusions support the views of Wang (2019), Shen et al. (2023), and Ćudić et al. (2022).

Government support

The government is the main supporter of the industry-education cooperation. Although it does not directly participate in the industry-education cooperation, it is the most influential force in regulating and organizing the industry-education cooperation. The research conclusions support the views of Kozlinska (2012), Muscio & Vallanti, (2014), Myoken (2013), and Schofield (2013).

Social Industrial Structure

The social industrial structure provides an important external condition and demand environment for the industry-education cooperation, which is mutually restricted with regional specialty setting and highly skilled personnel cultivation. The research conclusion supports the views of Yu et al. (2020), Pertuz et al. (2021).

Technological Innovation and Transformation

Technological innovation transformation is the external environment of technical support for the industry-education cooperation, which affect the specifications of highly skilled personnel cultivation, and realize the seamless connection between education and industry. The research conclusions support the views of Liu (2018), Rybnicek et al. (2019), and Baleeiro et al. (2023).

Policies and Institutions

Macro-policy is an important external environment affecting the industry-education cooperation, and the lack of local support, regulations and laws will have a negative impact on or limit the cooperation. The research conclusions support the views of Liu (2019), Şerbănică (2011), and Attia (2015).

Resource sharing mechanism

The resource sharing mechanism is conducive to the effective flow of resources and functional complementarity, so that human resources, equipment resources, scientific research results and other resources of governments, universities and industries can be shared and shared. The research conclusions support the views of Xie (2019), Sun et al. (2021), Sjöö et al. (2019), and Gioanes (2019).

Organizational support mechanism

Government networks, public funding or tax incentives, and human resources can promote the industry-education cooperation. The research conclusions support the views of Rampersad (2015), Bertolett et al. (2021).

Communication and cooperation mechanism

The experience and feedback from both universities and industries benefit the development of universities and companies. The frequency of communication is crucial and can significantly reduce the implementation and supervision costs of industry-education cooperation. The research conclusions support the views of Albats et al. (2020), Xi (2018), and Bastos et al. (2021).

Interest balance mechanism

The benefit distribution mechanism is an important factor to promote the deepening of the cooperation of industry-education cooperation, and it is very important to seek a win-win situation in which the interests of both parties are balanced. The research results support the views of Hong et al. (2010), Peng (2019), Figueiredo et al. (2020), and Awasthy et al. (2020).

Build an industry-education cooperation ecosystem model

The industry-education cooperation ecosystem model designed by the research is a relatively fixed, inclusive and open system formed in the process of the cooperation of relevant entities and elements, and an organic whole formed by the coupling of the cooperation entities of industry and university with the external environment through a non-linear mechanism (Huo, 2019). Student working competency is the core of the industry-education cooperation. Government built a platform to actively strengthen the cooperation, higher vocational colleges adjust their structure and take the initiative to meet development needs, the conclusion is consistent with the views of Chen (2022), Liu et al. (2020), and Li et al. (2019). Technological innovation development put forward highly skilled personnel needs, and the model emphasizes interaction and operation mechanisms such as coordination and sharing mechanism, supervision and regulation, and organizational guarantee mechanism. The conclusion is consistent with the views of Cai et al. (2019), Xie (2019), and Zhang (2019), et al. This study proposes that government, universities,

and industries form a positive relationship with student working competency around technological innovation development. This study is a complementary exploration of the existing industry-education cooperation ecosystem.

Recommendations

This study confirms that government, universities and industries form a positive relationship with student working competency around technological innovation development. It emphasizes taking the construction of sound mechanisms as the starting point to promote the interaction and operation among various entities and elements. This intersecting and complex relationship has been expressed visually intuitively and clearly through the construction of models. At this point, based on the existing conclusions, the following recommendations are put forward.

Optimize the structure of technological innovation development.

Technological innovation development restricts the specifications and quantity of highly skilled personnel cultivation. Highly skilled personnels connect the government, education system and industrial system. The relationship among them is not a simple intersection or connection, but a network interweaving. Nowadays, countries in the world have gradually entered the era of "Industry 4.0", The opening of the artificial intelligence era heralds the development of a higher-tech, faster-paced innovative economy. Which country and nation can master newer, more, and higher science and technology will have an advantage in the world economy. Which country and nation can master newer, more, and higher science and technology will have an advantage in the world economy. Therefore, optimizing technological innovation and industrial structure can more effectively enhance student working competency.

Strengthen the goal-oriented industry-education cooperation in cultivating highly skilled personnel. The core of industry-education cooperation is student working competency. Student working competency is not only the goal, but also the standard for evaluating the quality of industry-education cooperation. Therefore, the government, the education system and the industry system should always coordinate the cultivation of highly skilled personnel around student working

competency. Reasonably allocate resources to ensure effective investment of manpower, material resources and funds, and improve students' (practical) abilities and market competitiveness. Establish a flexible and efficient mechanism, improve the suitability of majors and industries, strengthen communication and sharing, promote universities and industries to form close cooperation entities, and cultivate highly skilled personnel around working competency.

Enhancing the collaborative cooperation between universities and industries in the system. The industry-education cooperation ecosystem is a symbiotic system of interests, and every entity is a direct or indirect beneficiary of the system. Student working competency is a common concern for industries and universities. Industries are eager to obtain human resources that are beneficial to the development of their own organizations, and universities obtain space and capital for their own development by delivering qualified highly skilled personnel to industries. To this end, the two entities can formulate a clear cooperation framework, implement mentorship plans, jointly develop courses, jointly build practice bases, scientific research and innovation platforms, etc., to better share resources and industry-academia-research cooperation, so that both entities can achieve mutual benefit and win-win, and promote the deep cooperation of highly skilled personnel cultivation and industrial demands.

Establishing and improving the operational mechanism for industry-education cooperation.

First, improve cooperation mechanisms. The premise of smooth cooperation is to have a corresponding restraint mechanism. The university-industry partners should focus on cooperation, formulate and improve the working system and measures as much as possible, improve the agreement text to clarify the rights and responsibilities of the partners, and consciously abide by the cooperation process.

Second, complete the organizational guarantee mechanism. The support and guarantee of the government is the macro embodiment of the university-industry interest guarantee mechanism, while the clear responsibility and rights of both the university and the industry are the specific implementation at the microscopic level. Macroscopic guarantees and microscopic measures are taken in both directions, such

as: establishing a system in line with the university-industry cooperation, setting up institutions or organizations responsible for operation, and carrying out the monitoring and evaluation of cooperation projects, etc.

Third, improve communication and coordination mechanisms. The industry-education cooperation involves the participation of multiple entities. At the practical level, it is necessary to attach great importance to communication and coordination among various entities, establish an equal dialogue mechanism and a communication and consultation mechanism, and allow all entities to fully express their own wishes, demands and opinions. In addition, based on the concept of multiple co-governance, the internal communication and consultation platform of the system is built, through which functions such as information sharing, real-time communication, feedback and information retention are realized.

Fourth, establish a balance mechanism for benefit distribution. Interests are the key to the continued and in-depth advancement of the industry-education cooperation. First of all, accurately grasp the interest demands of different entities, establish efficient project operation, performance evaluation and practical feedback mechanisms to lay a solid foundation for reasonable distribution of interests. Secondly, improve the internal benefit distribution system. Under government regulation, focus on the distribution among stakeholders, or resolve disputes and conflicts in distribution, and use an effective benefit distribution mechanism to drive the in-depth development of industry-education cooperation.

Exerting the leading role of government departments in the system.

Universities and industries are two kinds of social organizations with different natures. It is unrealistic for them to spontaneously cooperate for win-win results. The state must as the leader and coordinating and guiding the government and industry organizations can industry -industry cooperation achieve scientific and sustainable development. The government plays the role of "special" entity, such as leader, guarantor and regulator, through indirect and indirect participation, does a good job in the overall research and strategic planning of the industry-education cooperation, overall management, and the creation of a collaborative working mechanism, etc., to mobilize the investment of industries, universities and social resources to ensure the

operation of the industry-education cooperation ecosystem.

This system model is a comprehensive framework designed to promote in-depth cooperation between industry and education systems to better adapt industry (market) needs and cultivate high-skilled personnel. It is recommended that relevant government departments set up special management institutions for industry-education cooperation, build information platforms, establish liaison mechanisms, mechanism monitoring and evaluation mechanisms, etc., so that the model can be effectively applied to the practice, and the successful experience of the model can be replicated and promoted. to other fields and institutions.

Prospect

The industry-education cooperation is a complex project involving multiple systems and departments such as education, industry, government, etc. In practice, there are many participants, wide coverage, and difficult promotion. Based on systems thinking, this study designed and constructed an industry-education cooperation ecosystem model from an ecological perspective. In the future, research can be further expanded, extended, and deepened around the following aspects.

1. Strengthen the multi-dimensional paradigm research on the cooperation mechanism of industry and education. This study explores the cooperation mechanism of industry-education cooperation. However, given that the industry-education cooperation ecosystem has the characteristics of multi-level, multi-factor, multi-entity, etc., and has a complex system relationship, it is suggested to explore further from a broader disciplinary perspective and research paradigm. (1) Carry out in-depth empirical research on the ecological mechanism of industry-education cooperation at the micro level; (2) Unite diverse subjects with multi-dimensional work backgrounds and academic backgrounds to jointly conduct research on operating mechanisms.

2. Carry out verification research on the practical application effect of the model. Based on systems thinking, this study constructed an industry-education cooperation ecosystem model, but lacked verification of the practical application effect of the model. In the future, the effect of applying this model can be further

evaluated, and the effectiveness and extent of the model can be more scientifically verified.

3. Explore the evaluation research on the degree of industry-education cooperation. This study strives to understand the current situation of industry-education cooperation through literature review, expert evaluation, and in-depth interviews, and reaches the subjective conclusion that "the level of cooperation is low and not in-depth." This conclusion can only be used as a reference for model construction, and its cooperation degree needs to be evaluated through future research to build an objective evaluation index system.

4. Explore comparative research on the industry-education cooperation. Through expert evaluation and combined with the experience and lessons of 6 production-education cooperation projects in Luzhou Vocational College, this study successfully constructed a model for improving students' competence in Sichuan. The following can be further thought and discussed: (1) Are there differences in the industry-education cooperation in different regions, different industries, different levels, and different types? (2) What are the differences among them? (3) What paths and methods are used to explore these differences?

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APPENDICES

APPENDIX A

List of Experts to Validate and Evaluate Research Instrument

List of experts to validate research instrument

List of experts to validate survey questionnaires and model

No.	Name	Position
1	Dr. Lin Jianbing	Professor, Meishan Vocational and Technical College
2	Dr. Hu Yongfeng	Professor, Hebei Mechanical and Electrical Vocational and Technical College/ Head of Department of Accounting and Management Engineering
3	Dr. He Qing	Assistant Professor, Luzhou Vocational and Technical College/Vice Dean of Electronics and Electrical Engineering
4	Chen Yunjun	Professor, Luzhou Vocational and Technical College/ Director of Academic Affairs
5	Dr. Zhuo Xiande	Professor, Chengdu Vocational and Technical College of Industry and Trade
6	Dr. Zhang Liangyong	Assistant Professor, Sichuan Vocational and Technical College of Chemical Industry/ Vice Dean of Mechanical Engineering
7	Dr. Li Gang	Assistant Professor, Luzhou Vocational and Technical College/Vice Dean of Intelligent Manufacturing Institute
8	Dr. Gong Yong	Assistant Professor, Luzhou Vocational and Technical College/Director of the Luzhou Branch of the Southwest National Center for Technology Transfer
9	Hu Dangping	Assistant Professor, Luzhou Vocational and Technical College/Vice Dean of Intelligent Construction College
10	Wang Youming	Training manager, Otis Elevator LLC
11	Liu Qizhong	Chief Project Engineer, Sichuan South Power Generation Co., Ltd.
12	Chen Yunjian	Senior Engineer, Aerospace Sichuan South Pyrotechnics Technology Co., Ltd

No.	Name	Position
13	Zhou Li	Executive Director and Secretary to the Board of Directors, China Overseas Asphalt Sichuan Co., Ltd.
14	Du Wenqi	Senior Engineer, Sichuan Hongyun Engineering Construction Consulting Co., Ltd.
15	Zhou Jian	Senior Engineer, Chengdu Silicon Technology Co., Ltd.
16	Xu Ceyun	General manager, Luzhou Runze Tianxia Liquor Co., Ltd.
17	Wang Zongwei	Minister of Human Resources Department, Luzhou Nanyuan Hotel (5-star hotel)
18	Meng Juan	Minister of Human Resources Department, Sichuan Liangmuyuan Coffee Co., Ltd.
19	Zhang Ying	Assistant Professor, Temporary cadre at the Sichuan Provincial Department of Education
20	Xu Feng	Professor, Temporary cadre at the Sichuan Provincial Department of Education
21	Luo Mingquan	Assistant Professor, Temporary cadre at the Sichuan Provincial Department of Education

List of experts to interview the project coordinators

No.	Name	Position
1	Li Zaiwen	Senior Human Resources Manager, Luzhou Laojiao Co., Ltd.
2	Zhou Xiaoyan	General Manager, Beijing Shoulv Jianguo Hotel Management Co., Ltd.
3	Wang Youming	China Western Region Training Manager, Otis Elevator Management (Shanghai) Co., Ltd.
4	Zhou Yongfeng	Human Resources Administration Center Manager, Sichuan Bashu Haoli Food Co., Ltd.
5	Ni Ran	Human Resources Administration Manager, Wal Mart (Sichuan) Department Store Co., Ltd.
6	Liu Liling	General Manager, Sichuan Tang Dynasty Laojiao (Group) Co., Ltd.
7	Dr. He Yun	Lecturer, Luzhou Vocational and Technical College, Department Director
8	Xiong Liu	Assistant Professor, Luzhou Vocational and Technical College, Vice Dean of China Winery Academy
9	Wang Fei	Assistant Professor, Luzhou Vocational and Technical College, Vice Dean of Culture and Tourism
10	Dr. Liu Jingcheng	Professor, Luzhou Vocational and Technical College, President of China Winery Academy
11	Dr. He Qing	Assistant Professor, Luzhou Vocational and Technical College, Vice Dean of Electronics and Electrical Engineering

List of experts to evaluate research instrument

List of experts to evaluate the survey questionnaires

No.	Name	Position	Specialty
1	Dr. Liu Jingcheng	Professor, Luzhou Vocational and Technical College	Technological Innovation and Management
2	Dr. Gong Yong	Assistant Professor, Luzhou Vocational and Technical College	Technological Innovation and Management
3	Dr. Sun Jian	Assistant Professor, Luzhou Vocational and Technical College	Data Analysis
4	Dr. Cui jin	Assistant Professor, Luzhou Vocational and Technical College	Human Resource Management
5	Dr. Zhang Jin	Professor, Sichuan Vocational and Technical College of Chemical Industry	Industry Management

List of experts to evaluate the industry-education cooperation model

No.	Name	Position	Specialty
1	Dr. Du Xueyuan	Professor, Sichuan Normal University	Model Evaluation
2	Dr. Yang Dong	Professor, Southwest University	Human Resource Management
3	Dr. Yang Chao	Professor, Luzhou Vocational and Technical College	Statistical Evaluation
4	Dr. Wei Hongmei	Assistant Professor, China West Normal University	Model Evaluation
5	Dr. Xiong Shengyin	Assistant Professor, Southwest Medical University	Model Evaluation

APPENDIX B
Official Letters



Ref.No. MHESI 0643.14/1917

Bansomdejchaopraya Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear Professor, PhD, Liu Jingcheng, Luzhou Vocational and Technical College, Industry and Education Cooperation Management expert

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

The thesis adversity committee has considered that you are an expert in this topic. Your recommendations would be useful for further improvement of this research instrument.

With your expertise, we would like to ask your permission to validate the attached research instrument. Would like to avail ourselves of this opportunity to express our sincere thanks and appreciation for your help.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School

Bansomdejchaopraya Rajabhat University
Tel.+662-473-7000
www.bsru.ac.th
E-mail: grad@bsru.ac.th



Ref.No. MHESI 0643.14/1918

Bansomdejchaopraya Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear Associate Professor, PhD, Gong Yong, Luzhou Vocational and Technical College, Technological Innovation and Management expert

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

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Ref.No. MHESI 0643.14/ 1919

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1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear Associate Professor, PhD, Sun Jian, Luzhou Vocational and Technical College, Data Analysis Expert

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

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Ref.No. MHESI 0643.14/ 1920

Bansomdejchaopraya Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear Associate Professor, PhD, Cui Jin, Luzhou Vocational and Technical College, Human Resource Management Expert

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

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Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear Professor, Zhang Jin, Sichuan Chemical Vocational and Technical College, Enterprise Management expert

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

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Ref.No. MHESI 0643.14/1922

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Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear Senior Human Resources Manager, Master, Li Zaiwen, Luzhou Laojiao Co., Ltd, Human Resources Manager

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

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Ref.No. MHESI 0643.14/1923

Bansomdejchaopraya Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

↓ December 2023

RE: Invitation to validate research instrument

Dear Senior Human Resources Manager, Master, Zhou Xiaoyan, Beijing Shoulv Jianguo Hotel Management Co., Ltd, General Manager

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle “Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan”

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Ref.No. MHESI 0643.14/ 1924

Bansomdejchaopraya Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear Senior engineer, Master, Wang Youming, Otis Elevator Management (Shanghai) Co., Ltd., Otis China Western Region Training Manager

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle “Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan”

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Bansomdejchaopraya Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear Senior Human Resources Manager, Master, Zhou Yongfeng, Sichuan Bashu Haoli Food Co., Ltd., Human Resources Administration Center Manager

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

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1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear Senior Human Resources Manager, Master, Ni Ran, Wal Mart (Sichuan) Department Store Co., Ltd., Human Resources Administration Manager

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

The thesis adversity committee has considered that you are an expert in this topic. Your recommendations would be useful for further improvement of this research instrument.

With your expertise, we would like to ask your permission to validate the attached research instrument. Would like to avail ourselves of this opportunity to express our sincere thanks and appreciation for your help.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School

Bansomdejchaopraya Rajabhat University
Tel.+662-473-7000
www.bsru.ac.th
E-mail: grad@bsru.ac.th



Ref.No. MHESI 0643.14/1927

Bansomdejchaopraya Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear First level wine taster, master, Liu Liling, Sichuan Tang Dynasty Laojiao (Group) Co., Ltd.,
General Manager

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle “Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan”

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Ref.No. MHESI 0643.14/ 1930



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Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear Associate Professor, PhD, Xiong Shengyin, Southwest Medical University, Evaluation expert

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

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Ref.No. MHESI 0643.14/ 1981

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1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

1 December 2023

RE: Invitation to validate research instrument

Dear Professor, PhD, Du Xueyuan, Sichuan Normal University, Evaluation expert

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

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Thonburi Bangkok 10600

↓ December 2023

RE: Invitation to validate research instrument

Dear Professor, PhD, Yang Dong, Southwest University, Human Resource Management expert

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

The thesis adversity committee has considered that you are an expert in this topic. Your recommendations would be useful for further improvement of this research instrument.

With your expertise, we would like to ask your permission to validate the attached research instrument. Would like to avail ourselves of this opportunity to express our sincere thanks and appreciation for your help.

Sincerely,

A handwritten signature in black ink, appearing to be 'K. Sawangcharoen'.

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School

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Ref.No. MHESI 0643.14/ 1933

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↓ December 2023

RE: Invitation to validate research instrument

Dear Professor, PhD, Yang Chao, Luzhou Vocational and Technical College, Statistical Evaluation expert expert

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

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Thonburi Bangkok 10600

↓ December 2023

RE: Invitation to validate research instrument

Dear Associate Professor, PhD, Wei Hongmei, China West Normal University, Evaluation expert

Mrs.Fu Xianquan is a graduate student in Doctor of Philosophy Program in Technology and Innovation Management of Bansomdejchaopraya Rajabhat University. She is undertaking research entitle "Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan"

The thesis adversity committee has considered that you are an expert in this topic. Your recommendations would be useful for further improvement of this research instrument.

With your expertise, we would like to ask your permission to validate the attached research instrument. Would like to avail ourselves of this opportunity to express our sincere thanks and appreciation for your help.

Sincerely,

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Dean of Graduate School

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E-mail: grad@bsru.ac.th

APPENDIX C
Research Instruments

Expert Survey Form and Evaluate Form

Objective1: To identify current problems, opportunities, and success factors in the industry-education cooperation.

Expert survey form

Dear Esteemed Expert,

Greetings!

We are conducting a study on industry-education cooperation and would greatly appreciate your judgment based on your attitudes and perspectives on relevant problems. Your insights will serve as valuable references for understanding the current problems, opportunities, and key success factors in industry-education cooperation.

Please note the following instructions:

1.Options include "Agree," "Partly Agree," or "Disagree," corresponding to scores of 1, 0, and -1, respectively. Kindly mark the appropriate option based on your understanding. If you choose "Partly Agree" or "Disagree," please provide explanations or comments to help us make improvements.

2.The results of this survey will be utilized for scientific research, and your participation will not have any negative impact on you personally or on your organization.

3.Your responses are crucial to us, and to ensure the authenticity and effectiveness of the data, we kindly request that you complete each question patiently and thoughtfully.

Thank you for your assistance and support!

Part I: Personal Information

1. Your gender
 - A. Male
 - B. Female
2. Your Affiliation
 - A. University
 - B. Higher Vocational College
 - C. Industry
 - D. Education Administrative Department
3. Your Occupation
 - A. University/College Teacher
 - B. University/College Administrator
 - C. Industry Administrator
 - D. Education Administrative Personnel
4. Duration of Relevant Work Experience
 - A. 0-5 years
 - B. 6-10 years
 - C. 11-15 years
 - D. Over 16 years
5. Your Academic Degree
 - A. None
 - B. Bachelor's Degree
 - C. Master's Degree
 - D. Doctorate Degree
6. Your Professional Title
 - A. Professor
 - B. Associate Professor
 - C. Lecturer
 - D. Other

Part II: The main problems of industry-education cooperation

"agree" = 1 point,

" Partly Agree " = 0 points,

" disagree " = -1 points.

No.	Lack of Coordination in industry-education cooperation	Agree	Partly Agree	Disagree	Improvement
1	Goals among Government, Educational Institutions, and Industries are not completely consistent in industry-education cooperation				
2	The cooperation philosophy is not completely the same between University and the Industry				
3	Divergent Value Orientations between the University and the Industry				
No.	Lack of Supportive Cooperative Environment				
4	Some universities major offerings are not well matched with local industries.				
5	The content and Infrastructure are not completely matched for industry-education cooperation				
6	Insufficient Technology Transfer and Transformation between University and Industry				
No.	Imperfect Policies and Systems				
7	Incomplete Legal and Regulatory Framework for industry-education cooperation				

No.	Lack of Coordination in industry-education cooperation	Agree	Partly Agree	Disagree	Improvement
8	Lack of Effective Oversight and Evaluation Mechanisms for industry-education cooperation				
9	The constraints of the current educational administrative management system				
No.	Insufficient Resource Sharing				
10	Teaching resources and content not built and shared				
11	Facilities(spare), venues, etc. have not been fully co-constructed and shared.				
12	Both universities and industries have not fully sent or trained teachers to each other				
No.	Inadequate Organizational Support				
13	Lack of necessary financial support				
14	Lack of necessary personnel support				
15	Lack of effective supervision mechanism				
16	Teaching resources, lack of necessary incentive measures				
No.	Communication and Coordination Hindered				
17	Insufficient depth of communication and coordination				
18	Insufficient ability to communicate and resolve conflicts				
No	Benefits not effectively matched				

No.	Lack of Coordination in industry-education cooperation	Agree	Partly Agree	Disagree	Improve ment
19	Uneven distribution of benefits				
20	Unbalanced cost sharing and compensation				
No.	Low-Level and Superficial Cooperation				
21	Poor stability and durability of industry-education cooperation				
22	Insufficient connection between education chain, highly skilled personnel chain, industry chain, and innovation chain				

Part III: Opportunities in industry-education cooperation

No.	Strong policy support	Agree	Partly Agree	Disagree	Improve ment
23	Do you agree that a series of policies and documents, as well as specific measures taken by local governments, that have been intensively introduced and promoted at a high level by the state, are conducive to promoting high-quality development of industry-education cooperation?				
No.	Modern Industrial Development				
24	Do you agree that as China accelerates the construction of a modern industrial system, traditional industries are facing transformation and upgrading, providing favorable				

No.	Strong policy support	Agree	Partly Agree	Disagree	Improve ment
	opportunities for promoting industry-education cooperation?				
No.	Increasing Demand for highly skilled personnel				
25	Do you agree that industry-education cooperation is a key measure to implement the "Skills China Action" implementation plan and achieve the goal of adding over 40 million highly skilled personnel during the 14th Five Year Plan period?				
No.	Development of Modern Vocational Education Systems				
26	Do you agree that industry-education cooperation is an inevitable path to comprehensively integrate the structural elements of the industrial demand side with the modern vocational education system of highly skilled personnel cultivation supply side?				
No.	Educational Positioning in Vocational Education				
27	Do you agree that industry-education cooperation is the basic mode of vocational education, a prominent type of characteristic, and an inevitable choice for high-quality development?				

No.	Strong policy support	Agree	Partly Agree	Disagree	Improvement
No.	Integrated Development of Industry and Education				
28	Do you agree to build an integrated industry education community based on the industry-education cooperation, which can better promote the deepening and implementation of industry-education cooperation?				

Part IV: The key success factors in industry-education cooperation

No.	University Resource Investment	Agree	Partly Agree	Disagree	Improvement
29	The university has a sense of industry-education cooperation				
30	The university possesses the capability for industry-education cooperation in its educational operations				
31	The university has the basic conditions for industry-education cooperation				
32	The university has invested resources in industry-education cooperation				
No.	Industry Resource Investment				
33	Industries have a concept of industry-education cooperation				

No.	University Resource Investment	Agree	Partly Agree	Disagree	Improvement
34	The nature and scale of the enterprise itself				
35	Industries invest resources in industry-education cooperation				
No.	Government Support Intensity				
36	The government formulates policies and regulations for industry-education cooperation				
37	Government supervision of the implementation process of industry-education cooperation				
38	Quality supervision and evaluation of industry-education cooperation by the government				
No.	Social Industrial Structure				
39	Matching Industrial Structure with University Professional Structure				
40	Provincial and municipal industry-education cooperation platform carriers				
41	Social recognition of vocational education for cultivating highly skilled personnel				
42	Social media promotion and reporting on industry-education cooperation				

No.	University Resource Investment	Agree	Partly Agree	Disagree	Improve ment
No.	Technological Innovation and Transformation				
43	The demand of technological change for the cultivation of highly skilled personnel				
44	Application and transformation of new technological achievements				
No.	Policies and Institutions				
45	Implementation of the national, provincial, and municipal industry-education cooperation system				
46	Proper measures taken to promote industry-education cooperation projects				
No.	Resource sharing mechanism				
47	Resource flow and functional complementarity between universities and industries				
48	Resource sharing between universities and industries				
No.	Organizational support mechanism				
49	industry-education cooperation with financial guarantee				
50	industry-education cooperation with personnel guarantee				

No.	University Resource Investment	Agree	Partly Agree	Disagree	Improvement
51	industry-education cooperation has a reward and punishment mechanism				
No.	Communication and cooperation mechanism				
52	Cooperation between universities and industries has a coordinated governance mechanism				
53	Smooth communication channels between universities and industries				
54	Appropriate frequency of information communication between universities and industries				
No.	Interest balance mechanism				
55	Reasonable distribution of benefits between universities and industries in industry-education cooperation				
56	Universities and industries have cost sharing and compensation in industry-education cooperation				

Expert evaluation form

Dear Esteemed Expert,

Greetings!

We are doing a study on “Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan”. In the early stage, we conducted a questionnaire survey on the problems, opportunities and key success factors of industry-education cooperation. Now we invite you to evaluate the questionnaire and the survey results of 21 experts. (For details of the questionnaire and evaluation results, please see the attachment provided)

1. Options include "Agree," "Partly Agree," or "Disagree," corresponding to scores of 1, 0, and -1, respectively. Please check the appropriate options based on your opinion. If you choose "Partly Agree" or "Disagree," please provide explanations or comments to help us make improvements.

2. The results of this survey will be utilized for scientific research, and your participation will not have any negative impact on you personally or on your organization.

Thank you for your assistance and support!

Part I: Personal Information

1. Your gender
 - A. Male
 - B. Female
2. Duration of Relevant Work Experience
 - A.0-5 years
 - B.6-10 years
 - C.11-15 years
 - D. Over 16 years
3. Your Academic Degree
 - A. None
 - B. Bachelor's Degree
 - C. Master's Degree
 - D. Doctorate Degree
4. Your Professional Title
 - A. Professor
 - B. Associate Professor
 - C. Lecturer
 - D. Other

Part II: Expert evaluation form

No.	Question validity	Agree	Partly Agree	Disagree	Improvement
1	The questions are closely aligned with the research objectives, and the quantity is reasonable.				
No.	Clarity of Expression				
24	The expressions are appropriate, clear, and unambiguous.				

No.	Question validity	Agree	Partly Agree	Disagree	Improvement
No.	Completeness of Content				
25	The content is relatively comprehensive, covering issues related to industry-education cooperation.				
No.	procedural regularity				
26	The processes of data collection, analysis, and questionnaire revision are standardized.				
No.	effectiveness of conclusions				
27	The conclusions drawn regarding the current problems in industry-education cooperation are effective.				

Structured in-depth Interview Form

Objective2: To evaluate appropriate elements for industry-education cooperation management model to enhance student competence in Sichuan.

Structured in-depth interview outline for the coordinators of 6 projects (Industry)

Dear Esteemed Expert,

Greetings!

We are doing a study on “Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan”. Please according to your practical experience in industry-education cooperation projects to freely elaborate on the current problems, opportunities and key success factors in industry-education cooperation to provide reference for our research.

The relevant instructions are as follows:

1. The results of this survey will be used for scientific research, and our survey will not have any negative impact on you personally or your organization.
2. Your answer is very important to us. In order to be true and effective, please provide experience reference patiently and carefully.

Thank you for your help and support!

Basic Information:

Cooperation project name:

Organization name:

Nature of your organization:

Size of your organization:

Your name:

Gender:

Position:

Education level:

Duration of Relevant Work Experience:

Interview outline:**Part I: The main problems of industry-education cooperation**

1. What are the common problems you encounter in industry-education cooperation projects?
2. Can you share an example or story of how these problems impacted the project?
3. Do you have any additional explanations regarding industry-education cooperation projects?

Part II: Opportunities in industry-education cooperation

4. What opportunities do you think there are for industry-education cooperation?
5. Can you share any examples or stories of how you leveraged these opportunities to promote project success?
6. Do you have any additional explanations about the opportunities for industry-education cooperation?

Part III: The key success factors in industry-education cooperation

7. Based on your experience, what do you think are the key success factors for the industry-education cooperation projects?
8. In industry-education cooperation, what successful strategies or practices do you have to ensure that cooperation remains positive, effective and sustainable?
9. Do you have any additional explanations about the success factors of industry-education cooperation?

Part IV: Lessons Learned from industry-education cooperation

10. Can you share your lessons learned from industry-education cooperation projects?
11. Can you give specific examples of how to apply previous experiences or lessons to improve industry-education cooperation projects?
12. What suggestions do you have to promote the effective development of future cooperation projects?

**Structured in-depth interview outline
for the coordinators of 6 projects (university)**

Dear Expert:

Hello!

We are doing a study on “Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan”. Please according to your practical experience in industry-education cooperation projects to freely elaborate on the current problems, opportunities and key success factors in industry-education cooperation to provide reference for our research.

The relevant instructions are as follows:

1. The results of this survey will be used for scientific research, and our survey will not have any negative impact on you personally or your organization.
2. Your answer is very important to us. In order to be true and effective, please provide experience reference patiently and carefully.

Thank you for your help and support!

Basic Information:

Cooperation project name:

Your name:

Gender:

Position:

Professional Title:

Education level:

Duration of Relevant Work Experience:

Interview outline:

Part I: The main problems of industry-education cooperation

1. What are the common problems you encounter in industry-education cooperation projects?
2. Can you share an example or story of how these problems impacted the project?

3. Do you have any additional explanations regarding industry-education cooperation projects?

Part II: Opportunities in industry-education cooperation

4. What opportunities do you think there are for industry-education cooperation?

5. Can you share any examples or stories of how you leveraged these opportunities to promote project success?

6. Do you have any additional explanations about the opportunities for industry-education cooperation?

Part III: The key success factors in industry-education cooperation

7. Based on your experience, what do you think are the key success factors for the industry-education cooperation projects?

8. In industry-education cooperation, what successful strategies or practices do you have to ensure that cooperation remains positive, effective and sustainable?

9. Do you have any additional explanations about the success factors of industry-education cooperation?

Part IV: Lessons Learned from industry-education cooperation

10. Can you share your lessons learned from industry-education cooperation projects?

11. Can you give specific examples of how to apply previous experiences or lessons to improve industry-education cooperation projects?

12. What suggestions do you have to promote the effective development of future cooperation projects?

industry-education cooperation Model

Expert Survey Form

Objective3: To design an effective industry-education cooperation management model to enhance student competence in Sichuan.

Dear esteemed expert,

Greetings!

We are doing a study on “Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan” In the preliminary stages, we conducted literature reviews, expert interviews, and expert assessments to understand the current problems, opportunities, and key success factors in industry-education cooperation. Based on this, we have constructed a symbiotic industry-education cooperation ecosystem model, and we would like to invite you to evaluate it.

Here are some instructions:

1.The options are "Agree," "Partly Agree," or "Disagree," corresponding to 1 point, 0 points, and -1 point, respectively. Please mark the appropriate option with a checkmark ("✓") based on your understanding. If you choose "Partly Agree" or "Disagree," please provide explanations or comments for our improvement.

2.The results of this survey will be used for scientific research, and our investigation will not have any negative impact on you personally or your organization.

We appreciate your assistance and support!

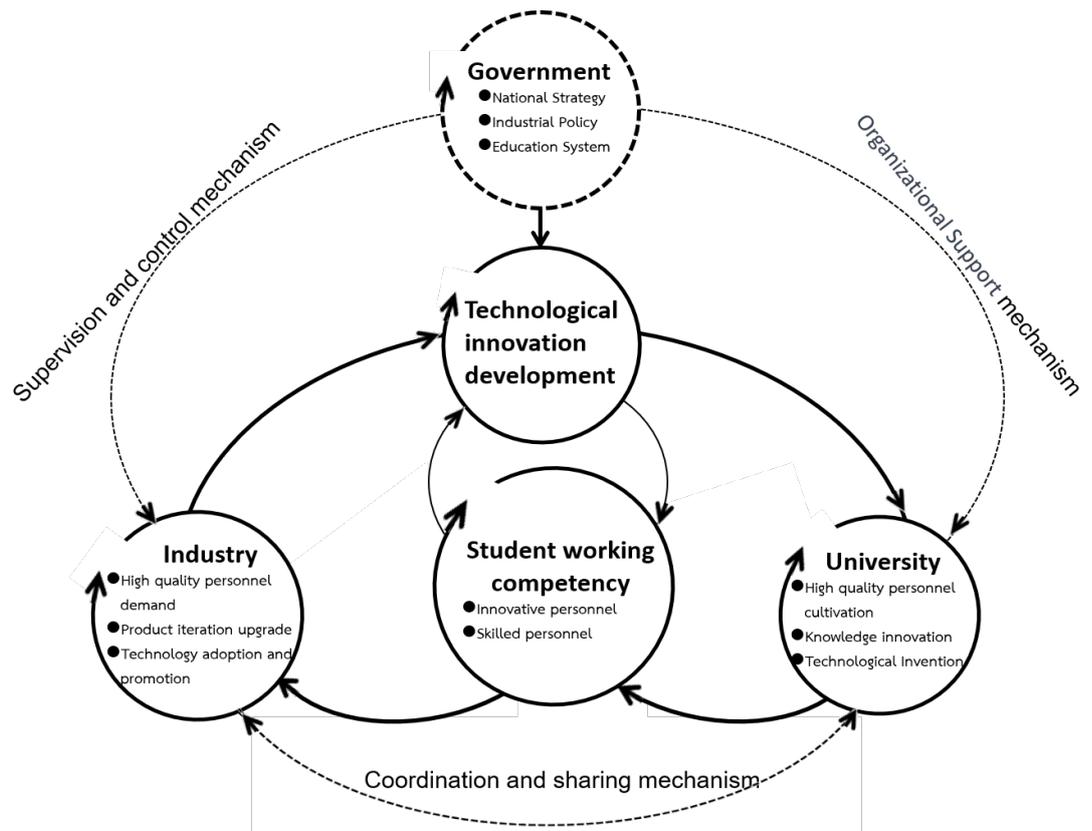


Figure industry-education cooperation Ecosystem Model

Model Explanation:

1. The industry-education cooperation ecosystem model is a relatively fixed and inclusive system formed by the fusion of relevant subjects and elements. The construction of this model aims to provide practical support and platform supply for the cultivation of high-skilled personnel.

2. The government, universities and industries have high impact on technological innovation development which result to student working competency. The government not directly participate in student working competency but acts on universities and industries through supervision regulation mechanisms and organizational guarantee mechanisms, promoting the establishment of coordination and sharing mechanisms among universities and industries to jointly carry out student working competency.

3. Student working competency is the regulatory variable in the positive relationship among the government, industries, and technological innovation development. Technological innovation development are key factors driving social progress and economic development, while industries are important components of the economy, and highly skilled personnel drive technological innovation development. Therefore, the cultivation and rational allocation of high-skilled personnel can form a virtuous circle among the government, industries, technological innovation development, promoting the overall development of society.

4. There is a positive feedback relationship among technological innovation development, universities, industries, and student working competency. Technological innovation development constitutes the industry-education cooperation ecological environment, which restricts the specifications of highly skilled personnel cultivation. Universities need to conduct industry-academy-research cooperation based on the needs of industries, collaboratively cultivating innovative and skilled personnel required by industries.

5. There is a positive relationship among the government, universities, student working competency, and technological innovation development. The government supports universities in developing highly skilled personnel through policies and resources, and the excellent highly skilled personnel cultivated by universities play a role in technological innovation development, thereby forming a virtuous circle that jointly promotes social progress and development.

Project	Score	Opinion	Choice	Needs improvement
Industry-Education	+1	Agree		
Cooperation	0	Partly Agree		
Ecosystem Model	-1	Disagree		

CIPP Expert Evaluation Form

Objective4: To evaluate the industry-education cooperation management model to enhance student competence in Sichuan.

Dear esteemed expert,

Greetings!

We are doing a study on “Development of Industry-Education Cooperation Management Model to Enhance Student Competence in Sichuan” In the early stage, through literature research, expert interviews and evaluations, we mastered the current problems, opportunities and key success factors of industry-education cooperation, and based on this, we built an industry-education cooperation management Model, now we invite you to evaluate

The relevant instructions are as follows:

1.Options include "Agree," "Partly Agree," or "Disagree," corresponding to scores of 1, 0, and -1, respectively. Please mark the appropriate option with a checkmark ("✓") based on your opinion. If you choose "Partly Agree" or "Disagree," please provide explanations or comments to help us make improvements.

2.The results of this survey will be utilized for scientific research, and your participation will not have any negative impact on you personally or on your organization.

Thank you for your assistance and support!

Before you evaluate, please allow me to introduce the process of this research:

Step 1: Survey the problems, opportunities, and success factors of industry-education cooperation.

21 experts were invited to survey the current problems, opportunities, success factors of industry-education cooperation collected through the literature method. Then evaluated by 5 experts. (Please see the attachment for details of the survey and evaluate results.)

Step 2: Evaluate the problems, opportunities, success factors, and lessons learned of industry-education cooperation. Then designed a model.

1. Open-ended in-depth interviews were conducted with the project coordinators of both universities and industries in 6 industry-education cooperation projects. (Please see the attachment for details of the statistical analysis and conclusions of the interview results.)

2. Based on systems thinking and combined with the above research conclusions, designed an industry-education cooperation ecosystem model. See Figure 1.

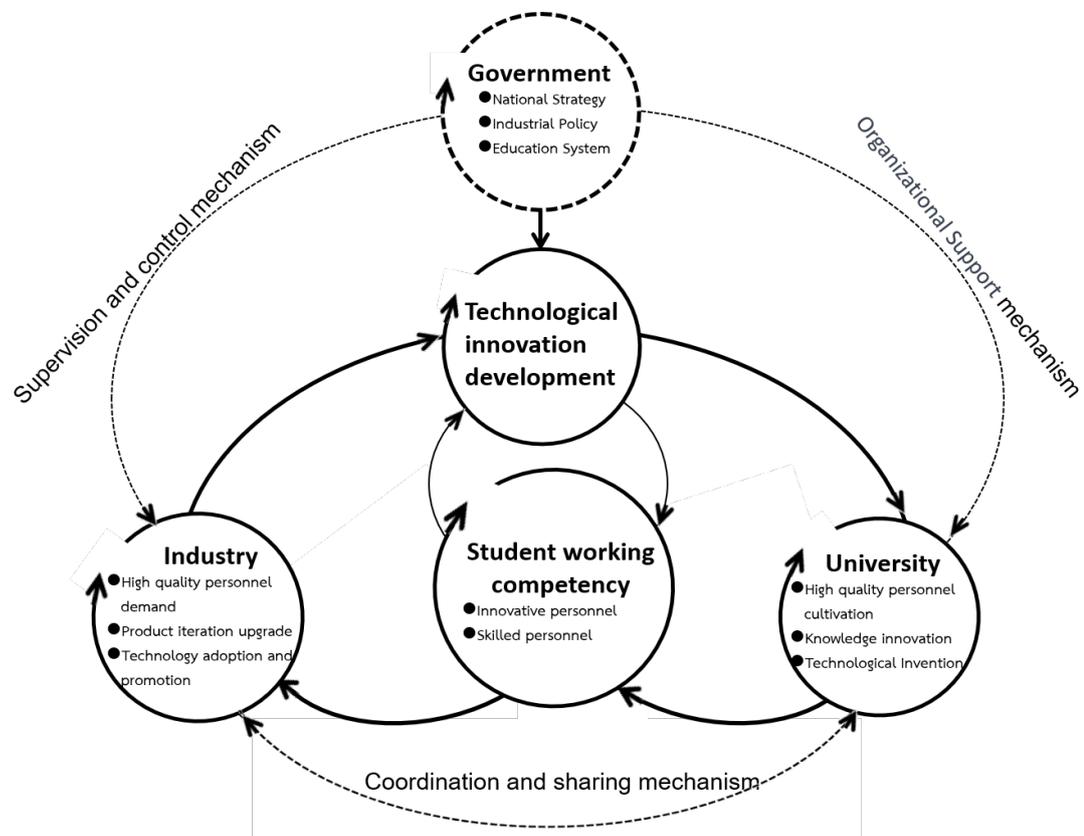


Figure1 industry-education cooperation Ecosystem Model Diagram

Step 3: Expert evaluation and improvement of the model

21 experts were invited to survey the model. 3 experts provided modification opinions, and all the other experts agreed. Revise the model based on expert opinion. See Figure 2.

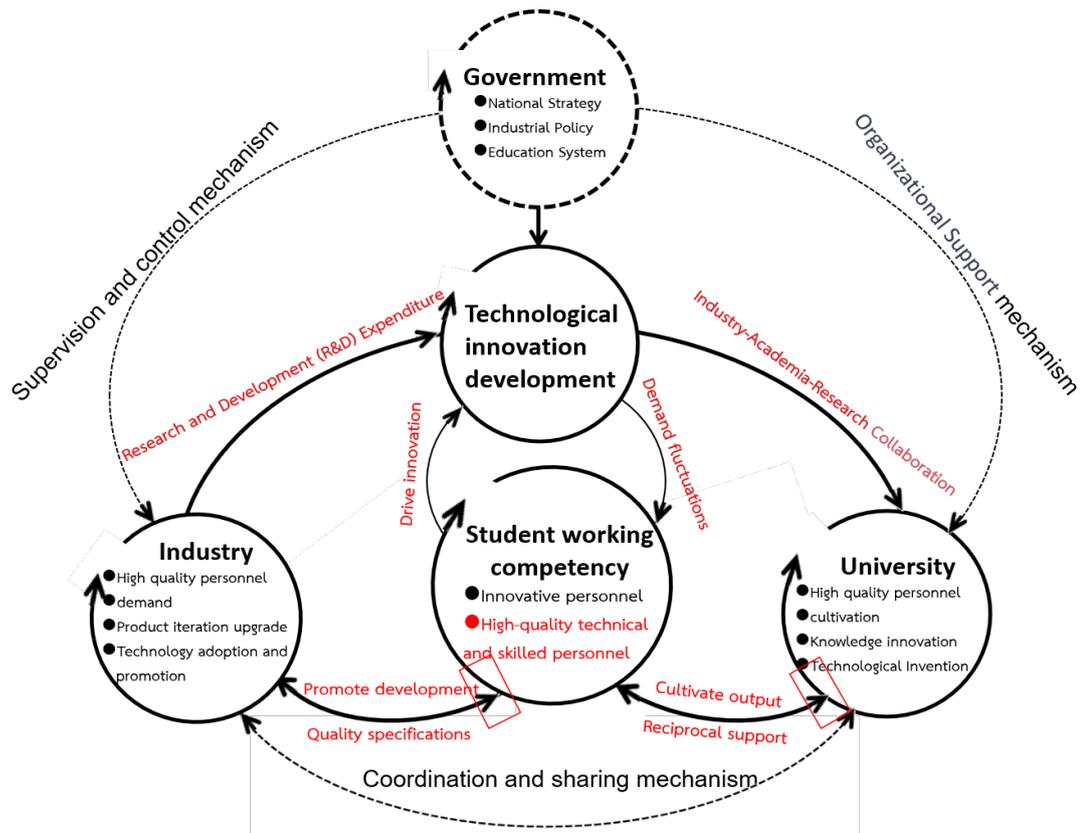


Figure 2 Revised industry-education cooperation Ecosystem Model Diagram

The revised model was sent to 21 experts again, and the results showed that all experts agreed with the revised model.

Now we invite you to evaluate the model, Options include "Agree," "Partly Agree," or "Disagree," corresponding to scores of 1, 0, and -1, respectively. Please check the appropriate options based on your opinion. If you choose "Partly Agree" or "Disagree," please provide explanations or comments to help us make improvements.

Expert Evaluation Form

CIPP evaluate	Evaluation indicators	Specific evaluate content	Effective			
			Agree	Partly Agree	Disagree	Explanation
Context Evaluation	Background and Purpose	Do you agree that this model has a clear background and purpose, and can effectively support the cultivation of higher vocational highly skilled personnel?				
		Do you agree with the role of technological innovation development in this model?				
	Industry-Education Cooperation Entities	Do you agree that the design of this model fully considers the roles of industry, universities and government in the industry-education cooperation?				
		Do you agree that the model takes into account the needs and expectations of all entities involved in the industry-education cooperation?				
		Do you agree that the model effectively reflects the role and participation level of all entities involved in the industry-education cooperation?				

CIPP evaluate	Evaluation indicators	Specific evaluate content	Effective			
			Agree	Partly Agree	Disagree	Explanation
Input Evaluation	Problem Analysis	Do you agree that problems in industry-education cooperation have been fully considered?				
		Do you agree that the formulation of the question adequately considers the diverse perspectives of industry, universities, and the government?				
	Success Factor Analysis	Do you agree that the summarized success factors fully take into account the diversity and complexity of industry-education cooperation?				
		Do you agree that the cooperation model (mechanism) plays a key role in the success of the industry-education cooperation ecosystem?				
Process Evaluation	Cooperation Mechanism	Do you agree that the model sufficiently attention the cooperation mechanism among the government, universities, and industries?				
		Regarding the emphasis on the cooperation model (mechanism), do you think this model fully considers the				

CIPP evaluate	Evaluation indicators	Specific evaluate content	Effective			
			Agree	Partly Agree	Disagree	Explanation
		actual needs and expectations of universities and industries?				
		Do you agree with the design of the supervision and control mechanism, organizational guarantee mechanism and coordination and sharing mechanism in the model?				
	Model Execution Feasibility	Do you agree that this model is practical and executable?				
		Do you agree with the design of the relationships among the elements in the model?				
Product Evaluation	Model Feedback and Improvements	Do you agree that the feedback mechanism designed in this model is flexible and practical enough?				
		Do you agree that adjustments and improved design of the model would improve the applicability of the model?				
	Model Effect	Do you agree that the interview results with the coordinators of industry-education cooperation projects, most of the conclusions consistent with the conclusions drawn from the expert evaluation of goal 1, thereby increasing confidence in the success of the model?				

CIPP evaluate	Evaluation indicators	Specific evaluate content	Effective			
			Agree	Partly Agree	Disagree	Explanation
		Do you agree that using this model can potentially solve problems in the industry-education cooperation?				
		Do you agree that applying this model can effectively enhance student competence in Sichuan?				

APPENDIX D

The Results of the Quality Analysis of Research Instruments

Evaluation Results of IOC for the Expert Survey Form

Part I The current problems of industry-education cooperation

The current problems of industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
No.	Lack of Coordination in industry-education cooperation																								
1	Goals among Government, Educational Institutions, and Industries are not completely consistent in industry-education cooperation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
2	The cooperation philosophy is not completely the same between University and the Industry	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	20	0.95	

The current problems of industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
3	Divergent Value Orientations between the University and the Industry	1	1	1	1	-1	-1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	15	0.71	
No.	Lack of Supportive Cooperative Environment																								
4	Some universities major offerings are not well matched with local industries.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
5	The content and Infrastructure are not completely matched for industry-education cooperation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	20	0.95		
6	Insufficient Technology Transfer and Transformation	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	20	0.95		

The current problems of industry-education cooperation		EXPERTS																				Total	Mean	Result			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21		
	between University and Industry																										
No.	Imperfect Policies and Systems																										
7	Incomplete Legal and Regulatory Framework for industry-education cooperation	1	-1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	17	0.81			
8	Lack of Effective Oversight and Evaluation Mechanisms for industry-education cooperation	1	-1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	-1	1	1	1	1	15	0.71			
9	The constraints of the current educational administrative management system	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00			
No.	Insufficient Resource Sharing																										

The current problems of industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
10	Teaching resources and content not built and shared	1	-1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	16	0.76	
11	Facilities(spare), venues, etc. have not been fully co-constructed and shared.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	
12	Both universities and industries have not fully sent or trained teachers to each other	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	
No.	Inadequate Organizational Support																								
13	Lack of necessary financial support	1	-1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	18	0.86	
14	Lack of necessary personnel support	1	-1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	17	0.81	
15	Lack of effective supervision mechanism	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	19	0.91	

The current problems of industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
16	Teaching resources, lack of necessary incentive measures	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	20	0.95	
No.	Communication and Coordination Hindered																								
17	Insufficient depth of communication and coordination	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	19	0.91	
18	Insufficient ability to communicate and resolve conflicts	1	1	1	1	1	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19	0.91	
No	Benefits not effectively matched																								
19	Uneven distribution of benefits	1	1	1	1	0	1	1	1	1	1	-1	1	1	1	1	1	1	1	1	1	1	18	0.86	
20	Unbalanced cost sharing and compensation	1	1	1	1	1	-1	1	1	1	1	1	1	1	1	1	1	-1	1	1	1	1	17	0.81	

The current problems of industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
No.	Low-Level and Superficial Cooperation																								
21	Poor stability and durability of industry-education cooperation	1	1	1	1	0	-1	1	1	1	1	1	1	1	1	1	1	1	1	0	-1	1	15	0.71	
22	Insufficient connection between education chain, highly skilled personnel chain, industry chain, and innovation chain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		1	1	20	0.95	

Opportunities in industry-education cooperation		EXPERTS																				Total	Mean	Result			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21		
	development of industry-education cooperation?																										
No.	Modern Industrial Development																										
24	Do you agree that as China accelerates the construction of a modern industrial system, traditional industries are facing transformation and upgrading, providing favorable opportunities for promoting industry-education cooperation?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
No.	Increasing Demand for Highly Skilled Personnel																										
25	Do you agree that industry-education	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid

Opportunities in industry-education cooperation		EXPERTS																				Total	Mean	Result		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21	
	cooperation is a key measure to implement the "Skills China Action" implementation plan and achieve the goal of adding over 40 million highly skilled personnel during the 14th Five Year Plan period?																									
No.	Development of Modern Vocational Education Systems																									
26	Do you agree that industry-education cooperation is an inevitable path to comprehensively integrate the structural elements of the industrial demand side with the modern	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid

Opportunities in industry-education cooperation		EXPERTS																				Total	Mean	Result							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21						
	vocational education system of highly skilled personnel cultivation supply side?																														
No.	Educational Positioning in Vocational Education																														
27	Do you agree that industry-education cooperation is the basic mode of vocational education, a prominent type of characteristic, and an inevitable choice for high-quality development?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid	
No.	Integrated Development of Industry and Education																														
28	Do you agree to build an integrated industry education community	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid

Opportunities in industry-education cooperation		EXPERTS																				Total	Mean	Result		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21	
	based on the industry-education cooperation, which can better promote the deepening and implementation of industry-education cooperation?																									

Part III The key success factors in industry-education cooperation

The key success factors in industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
No.	University Resource Investment																								
29	The university has a sense of industry-education cooperation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
30	The university possesses the capability for industry-education cooperation in its educational operations	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
31	The university has the basic conditions for industry-education cooperation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
32	The university has invested resources in	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid

The key success factors in industry-education cooperation		EXPERTS																				Total	Mean	Result			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21		
	industry-education cooperation																										
No.	Industry Resource Investment																										
33	Industries have a concept of industry- education cooperation	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	18	0.86		
34	The nature and scale of the enterprise itself	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid		
35	Industries invest resources in industry-education cooperation	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	20	0.95			
No.	Government Support Intensity																										

The key success factors in industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
36	The government formulates policies and regulations for industry-education cooperation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
37	Government supervision of the implementation process of industry-education cooperation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
38	Quality supervision and evaluation of industry-education cooperation by the government	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid

The key success factors in industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
No.	Social Industrial Structure																								
39	Matching Industrial Structure with University Professional Structure	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
40	Provincial and municipal industry-education cooperation platform carriers	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
41	Social recognition of vocational education for cultivating highly skilled personnel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid

The key success factors in industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
42	Social media promotion and reporting on industry-education cooperation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
No.	Technological Innovation and Transformation																								
43	The demand of technological change for the cultivation of highly skilled personnel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
44	Application and transformation of new technological achievements	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
No.	Policies and Institutions																								

The key success factors in industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
45	Implementation of the national, provincial, and municipal industry-education cooperation system	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
46	Proper measures taken to promote industry-education cooperation projects	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
No	Resource Sharing Mechanism																								
47	Resource flow and functional complementarity between universities and industries	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	21	1.00	Valid	

The key success factors in industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
48	Resource sharing between universities and industries	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
No.	Organizational Support Mechanism																								
49	industry-education cooperation with financial guarantee	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
50	industry-education cooperation with personnel guarantee	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
51	industry-education cooperation has a reward and punishment mechanism	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid

The key success factors in industry-education cooperation		EXPERTS																				Total	Mean	Result	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21
No.	Communication and Cooperation Mechanism																								
52	Cooperation between universities and industries has a coordinated governance mechanism	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
53	Smooth communication channels between universities and industries	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid
54	Appropriate frequency of information communication	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid

The key success factors in industry-education cooperation		EXPERTS																				Total	Mean	Result			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21		
	between universities and industries																										
No.	Interest Balance Mechanism																										
55	Reasonable distribution of benefits between universities and industries in industry-education cooperation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid	
56	Universities and industries have cost sharing and compensation in industry-education cooperation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	1.00	Valid		

Evaluation Results of IOC for the Expert Evaluate Form

Expert evaluation form		EXPERTS					Total	Mean	Result
		1	2	3	4	5			
No.	Question validity								
1	The questions are closely aligned with the research objectives, and the quantity is reasonable.	1	1	1	1	1	5	1	Valid
No.	Clarity of Expression								
24	The expressions are appropriate, clear, and unambiguous.	1	1	1	1	1	5	1	Valid
No.	Completeness of Content								
25	The content is relatively comprehensive, covering issues related to industry-education cooperation.	1	1	1	1	1	5	1	Valid
No.	Procedural Regularity								
26	The processes of data collection, analysis, and questionnaire revision are standardized.	1	1	1	1	1	5	1	Valid
No.	Effectiveness Of Conclusions								

Expert evaluation form		EXPERTS					Total	Mean	Result
		1	2	3	4	5			
27	The conclusions drawn regarding the current problems in industry-education cooperation are effective.	1	1	1	1	1	5	1	Valid

Evaluation Results of IOC for the CIPP Expert Evaluate Form

CIPP evaluate	Evaluation indicators	Specific evaluate content	EXPERTS					Total	Mean	Result
			1	2	3	4	5			
Context Evaluation	Background and Purpose	Do you agree that the background and purpose of this model are clear and can effectively enhance the student working competency?	1	1	1	1	1	5	1	Valid
		Do you agree with the role of technological innovation development in this model?	1	1	1	1	1	5	1	Valid
	Industry-Education Cooperation Entities	Do you agree that the design of this model takes full account of the roles of industries, universities, and the government in the industry-education cooperation?	1	1	1	1	1	5	1	Valid
		Do you agree that this model takes into account the needs and expectations of all entities involved in the industry-education cooperation?	1	1	1	1	1	5	1	Valid

CIPP evaluate	Evaluation indicators	Specific evaluate content	EXPERTS					Total	Mean	Result
			1	2	3	4	5			
		Do you agree that this model effectively reflects the roles and levels of participation of all entities involved in the industry-education cooperation?	1	1	1	1	1	5	1	Valid
Input Evaluation	Problem Analysis	Do you agree that the problems in the industry-education cooperation have been fully considered?	1	1	1	1	1	5	1	Valid
		Do you agree that the formulation of the question has taken into account the diverse perspectives of industry, university, and government?	1	1	1	1	1	5	1	Valid
	Success Factor Analysis	Do you agree that the summarized success factors fully consider the diversity and complexity of the industry-education cooperation?	1	1	1	1	1	5	1	Valid
		Do you agree that the cooperation mode (mechanism) of industry-education	1	1	1	1	1	5	1	Valid

CIPP evaluate	Evaluation indicators	Specific evaluate content	EXPERTS					Total	Mean	Result
			1	2	3	4	5			
		cooperation plays a key role in the success of the ecosystem of industry-education cooperation?								
Process Evaluation	Cooperation Mechanism	Do you agree that the cooperation mechanism between the government, universities, and industries in this model has received sufficient attention?	1	1	1	1	1	5	1	Valid
		Regarding the emphasis on the cooperation model (mechanism), do you think this model fully considers the actual needs and expectations of universities and industries?	1	1	1	1	1	5	1	Valid
		Do you agree with the design of the supervision regulation mechanism, organizational guarantee mechanism, and coordination and sharing mechanism in the model?	1	1	1	1	1	5	1	Valid

CIPP evaluate	Evaluation indicators	Specific evaluate content	EXPERTS					Total	Mean	Result
			1	2	3	4	5			
	Model Execution Feasibility	Do you agree that this model has strong practicality and executability?	1	1	1	1	1	5	1	Valid
		Do you agree with the design of the relationships between the various elements in the model?	1	1	1	1	1	5	1	Valid
Product Evaluation	Model Feedback and Improvements	Do you agree that the feedback mechanism designed in this model is flexible and practical enough?	1	1	1	1	1	5	1	Valid
		Do you agree that the adjustment and improvement design of this model can improve its applicability?	1	1	1	1	1	5	1	Valid
	Model Effect	Do you agree that the results of the interviews with industry-education cooperation coordinators largely align with the conclusions of the expert evaluation for objective 1, increasing confidence in the success of the model?	1	1	1	1	1	5	1	Valid

CIPP evaluate	Evaluation indicators	Specific evaluate content	EXPERTS					Total	Mean	Result
			1	2	3	4	5			
		Do you agree that the application of this model has the potential to solve the problems in the industry-education cooperation?	1	1	1	1	1	5	1	Valid
		Do you agree that the application of this model can effectively enhance the competitiveness of higher vocational students?	1	1	1	1	1	5	1	Valid

APPENDIX E
Certificate of English



BANSOMDEJCHAOPRAYA
RAJABHAT UNIVERSITY

This is to certify that

Mrs. Fu Xianquan

Achieved BSRU English Proficiency Test (BSRU-TEP) level

C2

Given on 25th January 2021

A handwritten signature in blue ink, appearing to read 'Kul Sirin'.

(Assistant Professor Dr Kulsirin Aphiratvoradej)

Director

APPENDIX F

The Document for Accept Research

NO. SVIT 008/2024



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10 January, 2024

ACCEPTANCE LETTER

Dear Authors,

Fu Xianquan, Kittirat Thansuwansni, Sombat Teekasap
and Nukul Sarawong

Congratulations!

Your manuscript entitled: **“PROBLEMS AND SUCCESS FACTORS FOR INDUSTRY EDUCATION COOPERATION”** has been accepted and considered for publication in **The Journal of Suvarnabhumi Institute of Technology (Humanities and Social Sciences)**, Volume 10 Issue 1, January – June 2024, after the double-blind reviews process.

Thank you for submitting your work to our journal. We hope to receive it in the future.

Yours sincerely,

(Chalinee Plukphonngam, Ph.D.)
Editor-in-Chief and Editor

The Journal of Suvarnabhumi Institute of Technology

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